THE ECONOMIC IMPACT
OF
CHILDHOOD DEVELOPMENTAL LANGUAGE DISORDER

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Certificate of Authorship/Originality

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Ethics Approval

All studies used the Longitudinal Study of Australian Children (LSAC). This research was approved through the Centre for Health Economics Research and Evaluation's (CHERE) program ethics approval UTS HREC REF NO. 2015000135.

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List of Abbreviations

ABS	Australian Bureau of Statistics
ACARA	Australian Curriculum, Assessment and Reporting Authority
ADHD	Attention deficit hyperactivity disorder
AIC	Akaike information criterion
AIFS	Australian Institute of Family Studies
AIHW	Australian Institute of Health and Welfare
AMA	Australian Medical Association
ASD	Autism spectrum disorder
ATC	Anatomical Therapeutic Chemical
BIC	Bayesian information criterion
B cohort	Birth cohort – Longitudinal Study of Australian Children
CDI	Communicative Development Inventory
CHERE	Centre for Health Economics Research and Evaluation
CI	Confidence interval
COI	Cost-of-illness
CSBS	Communication and Symbolic Behavior Scales
CSRI	Client Service Receipt Inventory
DLD	Developmental language disorder
Eq.	Equation
EMSN	Extended Medicare Safety Net
FE	Fixed effects
FTE	Full-time equivalent
GDP	Gross domestic product
GLM	Generalised linear model
GP	General practitioner
ICF	International Classification of Functioning, Disability and Health
ICF-CY	International Classification of Functioning, Disability and Health for Children and Youth
ICSEA	Index of Community Socio-Educational Advantage
IV	Instrumental variable

K cohort	Kindergarten cohort – Longitudinal Study of Australian Children
LFP	Labour force participation
LR	Log-likelihood ratio
LSAC	Longitudinal Study of Australian Children
MBS	Medicare Benefits Scheme
MLE	Maximum likelihood estimation
NAPLAN	National Assessment Program of Literacy and Numeracy
NB	Negative binomial
NESB	Non-English speaking background
NDIS	National Disability Insurance Scheme
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary least squares
OOP	Out-of-pocket
PBS	Pharmaceutical Benefits Scheme
PEDS	Paediatric quality of life scores
PIAC	Programme for the International Assessment of Adult Competencies
PPVT-III	Peabody Picture Vocabulary Test – Third Edition
PSDQ	Parental Strengths and Difficulties Questionnaire
RE	Random effects
REML	Restricted Maximum likelihood
SD	Standard deviation
SDQ	Strengths and Difficulties Questionnaire
SE	Standard error
SEP	Socioeconomic position
SES	Socioeconomic status
SLCN	Speech language and communication needs
UK	United Kingdom
USA	United States of America

Abstract

This thesis examines the economic impact of childhood developmental language disorder (DLD) on individuals, families and society, using a national Australian panel data set of 10,000 children—the Longitudinal Study of Australian Children (LSAC).

The thesis comprises four studies. The first study investigates healthcare consumption decisions of families with a child with DLD. This study demonstrates a consistent positive relationship between a child's language difficulties and their increased medical services utilisation and expenditure. These children seek more general practitioner services, and this is observed in conjunction with higher referral rates to paediatricians, speech pathologists and other specialists. Healthcare utilisation makes up a relatively small portion of the overall costs of language difficulties. However, language difficulties are likely to place an increasingly larger burden on the health and welfare system as these children move through school and after they leave school.

The second study examines the effects of DLD on future human capital and economic success. The results provide strong evidence of the impact of language difficulties on future earning potential, as a result of low levels of literacy and numeracy. This effect is greater than the effect socioeconomic disadvantage alone. Although many of these children are behind when they start school, there is some evidence that a school of high academic achievement mitigates the effects of this impairment on academic achievement. The results also demonstrate that early identification and intervention exerts a positive effect on cognitive and non-cognitive skills.

In the third study, the labour force decisions of families with a child with DLD are explored by measuring the indirect costs associated with reduced maternal labour force participation. This study highlights that the impact of language difficulties on labour force participation is considerable and represents the largest proportion of overall costs. The results show that carers of children with language difficulties substitute paid for unpaid work by working fewer hours. When their child's condition is severe or persistent, mothers are less likely to be employed, and when the child is older, mothers receive a wage rate premium to remain in the workforce. For these carers, the

substitution, respite and income effect are equally important.

The final study uses estimates from the three preceding studies to calculate the societal costs of DLD in Australia. The total cost to society of language difficulties is estimated to be between $1.362 billion per year and $3.308 billion per year (based on a prevalence range 7 to 17 per cent). The annual cost per child with language difficulties is estimated to be $4,353. Productivity losses account for the largest proportion of this cost, with 42% attributable to productivity losses of the child's mother, 30% attributable to productivity losses of the child and 28% attributable to costs borne by the health and welfare system.

While the individual costs associated with DLD are not as high as other childhood conditions such as autism spectrum disorder (ASD) and attention deficit hyperactivity disorder, its high prevalence and broad impact has made DLD an important public health concern. The total cost to society of language difficulties could be similar to the cost of asthma ($3.6 billion per year)[1] and ASD ($5.5 billion per year).

The costs associated with DLD have important implications for intervention of language disorders. This study provides decision makers with a picture of the global burden of DLD and more importantly, of the major cost components and the areas where cost containment policies would have the greatest impact and should therefore be prioritised. These estimates can be used to inform cost-effectiveness models of effective interventions for children with DLD.

Chapter 1: Background

1.1 Introduction

The ability to communicate is fundamental to a person's development and quality of life. It can affect an individual's ability to learn effectively, establish relationships and seek gainful employment. If undiagnosed or untreated, speech, language or communication disorders can drastically affect individual academic performance and have long-term social and economic consequences. Despite this, communication impairments have been largely overlooked by health, education and disability policymakers in Australia[2].

Undiagnosed and untreated communication impairments in children impose a significant burden on the individual, their family and society. In the short term, the demands of caring for an infant who struggles to communicate may constrain the parental labour force participation (LFP)[3]. Additionally, there may be increased financial demands due to increased health utilisation[4]. As these children progress to school age, they are at increased risk of starting school not 'developmentally ready', and research shows that children who lag behind their peers when they commence school often require additional remedial services[5] and achieve lower grades[6]. In the long term, they complete fewer years of formal education and are more likely to be in less skilled employment[7]. Limited employment options can lead to periods of unemployment, a dependence on welfare, reduced health and a higher likelihood of interaction with the justice system[8-12]. The evidence suggests that the residual effects of early communication impairment may be lifelong, affecting educational achievement, occupation, and ultimately socioeconomic status (SES)[13,14].

There is some debate in the literature regarding the correct terminology for describing childhood speech, language and communication impairments, and during the review of the literature, a number of different labels and subgroups have been identified, which are important to first describe. 'Speech language and communication needs' (SLCN) is an overarching term that encompasses a number of distinct groups. It is largely used in educational services in the United Kingdom (UK), less so in Australia and the United States of America (USA). Figure 1 outlines the prevalence of SLCN, based on a UK discussion paper by Hartshorne[15], which indicates that at least 50 per cent of our most disadvantaged populations commence school with some form of communication problem. In Australia, this group includes Aboriginal and Torres Strait Islander children, children from low socioeconomic backgrounds and children from non-English speaking backgrounds. Of these, a large proportion present with low language. This is related to opportunity, and for 90% of children, it is often remediated over time with consistent language and literacy exposure. The remaining 10 per cent present with a persistent problem, which cannot be remediated without some sort of intervention.

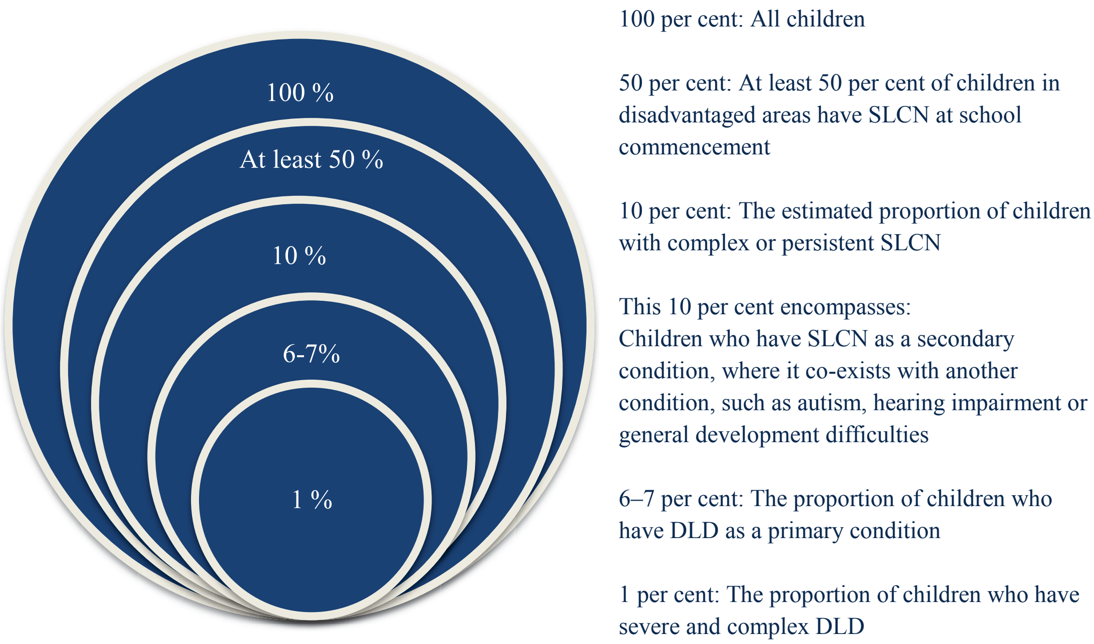

Figure 1: Prevalence of SLCN

Adapted from: Hartshorne[15]

Within this 10 per cent, there is a group of children who have coexisting conditions; the impairment for these children can be described as secondary language impairment. A more recent definition for this impairment is 'DLD associated with X[i][16,17] . However, it is also possible to identify children who have specific or primary language impairments;

[i] X represents the comorbidity

that is, they do not experience difficulties in areas other than language. This is the remaining 6–7 per cent. These children have developmental language disorder (DLD). This thesis focuses on children who have been diagnosed with specific language impairment, or DLD. The term 'DLD' will be used throughout this thesis.

A distinct feature of DLD is that it has no known aetiology; that is, these children have otherwise normal development. As a result, DLD is a condition that is largely 'hidden', with many children remaining undiagnosed and subsequently untreated [16,17]. In addition, there is a lack of national data on the incidence and prevalence of DLD in Australia, with some evidence that the prevalence could be as high as 17 per cent[18-22], with much higher rates in children from disadvantaged backgrounds[23]. Based on these estimates, DLD is more prevalent than autism spectrum disorder (ASD) (0.5 to 2 per cent)[24,25] and could be considered as prevalent as asthma (10 per cent)[26] and childhood obesity (~ 25 per cent)[27].

To add to this puzzle, there is significant variation in the developmental trajectories of these children[28], and consequently, there is a paucity of robust evidence on the short- and long-term effects of DLD. Understanding the specific effects of children's language impairment is therefore important to inform and guide government policy in this area.

In response to the lack of Australian evidence on speech, language and communication impairments, a national Senate inquiry was established in 2011 to look at the gaps in policy related to speech, language and communication impairments. For some time, the Speech Pathology Association of Australia had advocated a review to address concerns that despite their high prevalence and broad impact, communication impairments were largely 'invisible' in public policy[2]. The national Senate inquiry identified an urgent need for the measurement of short-, medium- and long-term social and economic impacts of speech and language-related disorders.

The aim of this doctorate was to address this need by examining the various impacts of DLD, specifically the healthcare consumption decisions of families, the effect of cognitive and non-cognitive deficits on labour-market and social outcomes, and the labour-force decisions of families. In addition, the thesis used a cost-of-illness (COI) approach to estimate the first-ever societal estimates of the economic impact of children with DLD.

This chapter presents an overview of the existing evidence regarding DLD: Section 1.2 discusses the theoretical framework, which includes human capital theory and the health production function; Section 1.3 reviews the evidence of the impact of DLD on direct and indirect costs, which includes key recommendations from the recent national Senate inquiry held in 2013; Section 1.4 and 1.5 provide a synopsis of DLD in the context of disability and education policy, internationally and in Australia; and Section 1.6 sets out the main aims and outline of this thesis.

1.2 Theoretical framework

The human capital theory and the health production function provide the theoretical framework of this thesis. The conceptual framework of human capital was first introduced by Becker[29] in 1985 and assumes that 'human capabilities', or stock, are inputs into the production of human capital, which is the accumulation of skills and knowledge needed to be productive in society. Heckman defines human capital as 'stock', which could be health, or cognitive and non-cognitive skills[30-41]. Cognitive skills are those skills that are usually measured by achievement tests, for example, intelligence, literacy and numeracy. Non-cognitive skills are defined as personality traits, such as motivation, as well as social and emotional skills. Both cognitive and non-cognitive skills contribute to health stock and vice versa.

According to Heckman children are assumed to possess a vector of cognitive, non-cognitive and health capabilities, which are created through genetic endowment at birth and then at each age as a function of current and past parental investments—known as 'technology'—and the child's environment. [30-41]. Within this framework, ability gaps between individuals and across socioeconomic groups open up early, in both cognitive and non-cognitive skills, which contribute to health. There are critical time periods during development, as the skills outputs from each stage are augmented in later stages, known as 'self-productivity', and the skills output at one stage increases the productivity of investment in subsequent time periods, defined as 'dynamic complementarity'. In other words, capabilities or skills at each age are used with different weights to determine labour and social outcomes.

The key assumption in Heckman's work is that if early and late investments are perfect substitutes, it does not matter when investment occurs. However, if complementarity is low, as in the case of disadvantage or impairment, early investment is preferred. This is because dynamic complementarity and self-productivity produce multiplier effects, which are the mechanisms through which capabilities bring about additional capabilities[42]. The marginal productivity of later investment depends on the level of skills acquired during prior time periods. If the skills levels can be lifted early, the multiplier effect has a greater impact. Correspondingly, these parental investment constraints in childhood have lifelong effects on adulthood abilities. Investing during later time periods might not compensate for under-investment in the earlier years, because the value of the investment depreciates over time.

Grossman[43] defines health as one form of human capital. Known as the 'health production function', it describes the flow of inputs and outputs, where the output is health and the inputs include a number of factors, such as health care, investment through parental education and income, and the initial genetic endowment. According to Grossman, health differs from other forms of human capital, as an individual can demand it as a consumption commodity or it can be an investment commodity. The concept of the health production function explains why individuals invest in health-promoting activities, such as early intervention.

On the consumption side, a child's wellbeing contributes to the utility of the family. Parents make decisions about what to purchase and how much time to spend caring for their children in order to increase the overall utility of the family. On the investment side, parents make decisions about whether and how much to work (both paid and unpaid), based on the needs of the family.

Figure 2 presents a model which outlines how mothers allocate time between household production, labour-market participation and leisure time. The investment in the child's health requires resource inputs, such as health care and the parent's time. Resources are scarce. Therefore, to maximise utility, parents must determine the optimum investment in their child's health within these constraints[43]. In this case the choice that mothers make about whether to work and what hours to work will depend on the trade-off between caring (household production) and the income that mothers can earn (the higher the wage rate, the greater the amount available for investment and the more efficient this investment may be), conditional on other variables, including the quality, cost and availability of child care. The focus is specifically on mothers as they are the primary carer in the majority of cases in the data of interest. Equally, this model could apply to fathers. Child care is a substitute for household production. The model assumes that having a child with DLD (and therefore lower health) may lead to increased labour supply to meet the demands of consuming additional health care. Parents may also wish to invest more in their child's health production (through early intervention) and human capital accumulation by increasing LFP. Equally, parents may choose to reduce LFP if the marginal rate of substitution is low; that is, if the increased wages are insufficient to compensate for the lost time with the child with poor health[3].

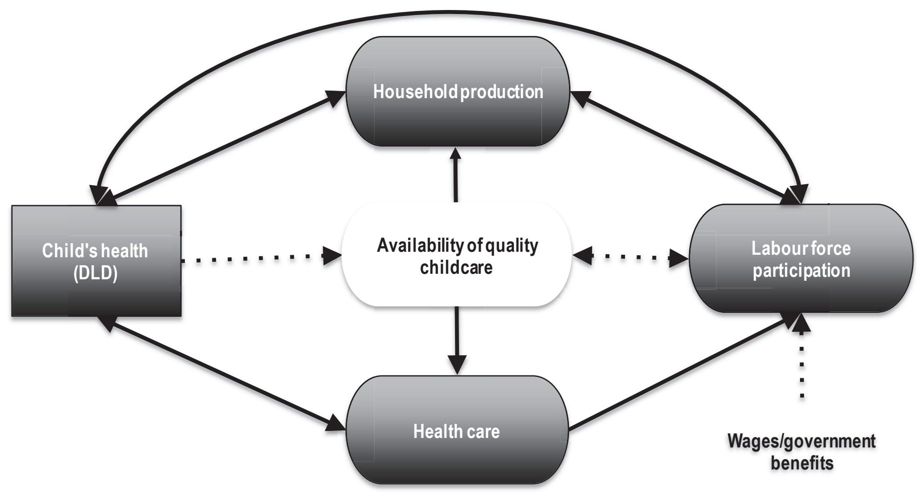

Figure 2: Household production and labour force participation of mothers with children with DLD

Adapted from Stabile et al.[3]

The human capital theory and health production function provide a framework for the empirical literature on the long-term consequences of DLD. Figure 3 presents a model of human capital, adapted from Stabile et al[3]. In this model, the vector of abilities or capabilities that children are born with can be eroded by DLD. The child's stock in subsequent time periods is a function of the prior period's stock plus parental investments through time and resources, minus any shocks due to impairment.

Productive efficiency exists where the more educated families (and those with higher wages), will use inputs more efficiently (i.e., use fewer inputs) to produce the same quantity of parental investment in the child's health, which subsequently decreases the marginal cost of the investment and increases the child' health. In addition, families with higher wages will also be able to consume more health and social care, which will have a direct effect on the child's health status and therefore accumulated stock of human capital[43].

Similarly, early identification increases the child's capabilities in that time period, which has a multiplier effect on the accumulated human capital in subsequent time periods, and therefore improves efficiency further. Bridging the gap is difficult with late identification due to this multiplier effect as well as the depreciating value of the investment over time. Accumulated human capital in turn affects future LFP.

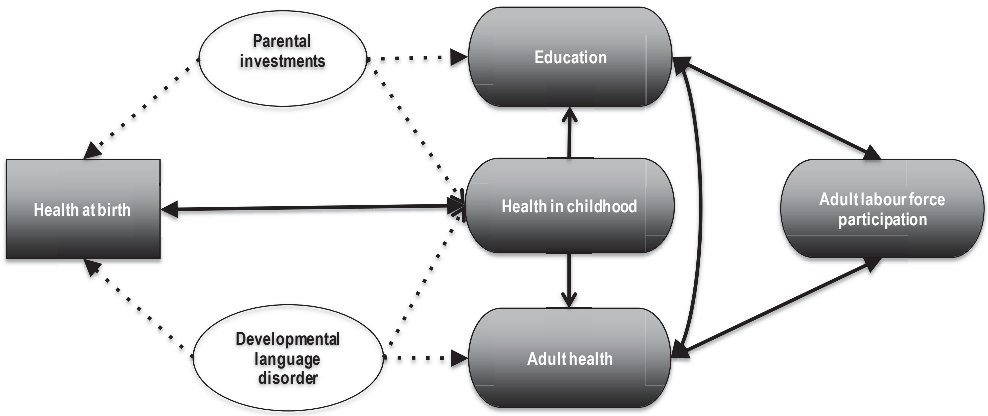

Figure 3: Accumulation of human capital for children with DLD

Adapted from Stabile et al.[3]

1.3 Existing literature

A number of empirical studies have estimated the impact of DLD on accumulated human capital. The two main research areas in the literature that are relevant to DLD in children are disability research and communication impairment research.

Grossman[44] focuses on the demand for health care as a direct input into the health production function, and this is covered extensively in both research areas in the literature. In the disability literature, the direct costs include spending on health care; therapeutic, behavioural, and education-based services; special needs equipment; and informal care[3,45,46]. In addition, there are indirect inputs related to the LFP of the parents and subsequent investment in the child's health, and accumulation of human capital. Within this framework, research has focused primarily on the loss of productivity related to parents' choices in relation to LFP[4,47-55]. Very few studies to date have examined the effect that caring has on Australian women's LFP and earnings, taking into account of the type and severity of the child's disability. DLD has not been considered in the disability literature.

1.3.1 Communication impairment research

The empirical studies in the area of communication impairment follow Heckman's approach in focusing on the effects of cognitive and non-cognitive deficits for human capital accumulation and economic wellbeing for children with DLD.

Much of the literature relating to the burden of language disorders pertains to the broader set of problems covered by SLCN rather than focusing specifically on language impairment. The cost of SLCN is considered in the literature in terms of the individual, families and society. In terms of individual costs, a considerable literature base supports a correlation between SLCN, academic achievement and economic success, a correlation largely driven by the link between early spoken language and subsequent literacy skills. The link between language skills and literacy development is considered fundamental to educational achievement, emotional and behavioural health, occupational success and, ultimately, SES[5,13,14].

In the UK, longitudinal studies have found that children with SLCN and without remediation have lower levels of examination completion and lower rates of education, and are subsequently at higher risk of lower wages and reliance on welfare[7] and of higher levels of redundancy, underemployment and workplace conflict[56]. However, there is no evidence regarding the long-term effects of language impairment in the Australian context.

A series of reviews support the potential of early intervention to impact positively on academic success at school in at-risk groups[9-11]. The research concludes that with properly structured and funded early intervention, cognitive gains would be sustainable into early adulthood[57]. However, these reviews were unable to directly measure the impact of the early intervention beyond the short term.

A number of retrospective studies have attempted to link social and economic outcomes to communication impairment in childhood. Bynner et al.[58] calculated that adults with less than adequate literacy skills, compared to adults with adequate literacy skills, had 11 per cent lower wages, and a number of studies of juvenile offenders found a substantial proportion had special educational needs[59] and significantly lower literacy levels[12,60]. There are limitations to the generalisability of these studies as it is unclear whether the outcomes are related to impairment or to social disadvantage.

From a societal perspective, only two studies have quantified the long-term costs of SLCN. In the UK, Clegg and Henderson[13] measured the costs of health, education and LFP for 20 children with language difficulties compared with their typically developing siblings. Using a Client Service Receipt Inventory (CSRI) covering education, accommodation, health and employment, they found a considerable differential for children with language difficulties, most notably in the provision of education. However, this study had limitations in that the sample size was small and the methods lacked statistical rigour. One other regularly cited US study, conducted by Ruben[61] attempted to quantify the long-term costs of SLCN using a measure of underemployment and lost income. The authors estimated the cost of underemployment to be between US$154.3 billion and US$186 billion per year[61]. However, the authors did not consider the complexity of the condition or the confounding factors associated with underemployment, and the assumptions and methods used were not sufficiently justified. As a result, there is considerable uncertainty around their estimates.

Only one Australian study has attempted to measure the direct costs of language impairment. Sciberras et al.[62] found that children with language difficulties at 4 to 5 years of age have Medicare costs 36 per cent higher than children of the same age who do not have language impairment. This study did not estimate out-of-pocket costs, which may be substantial for Australians.

Overall, there are significant gaps in the literature on the measurement of both direct and indirect costs, most notably with regard to lost productivity. Prospective, longitudinal data is lacking, as is the use of robust econometric methods, and the research does not consider the interplay between cognitive and non-cognitive skills or the impact of increased investment in measuring long-term outcomes, particularly with regard to other social disadvantage.

1.4 Disability policy: background

Disability policy remains one of the biggest social and labour-market challenges for policymakers. Over the past few decades, there has been growing recognition of the importance of investing in children with chronic and disabling conditions. It is widely documented that the prevalence of children with disability is increasing and that the nature of health conditions responsible for these impairments are changing[63]. Although there is no simple explanation, a review from the US attributed this increase in reported prevalence to a variety of factors, such as changes in data-collection procedures, increased exposure to risks, declines in resistance, changes in diagnosis, changes in the availability of health and services targeted to children with disability and changes in expectations regarding ‘normal’ development versus ‘impairment’[63].

Despite improvements in recognition, diagnosis, early intervention and treatment programs, significant social inequality persists. People with disability are at risk of lower educational attainment (Year 10), higher unemployment and much lower disposable income levels with significantly higher risk of relative income poverty (1.6 times more likely to be at the poverty line)[64]. Incapacity-related public spending is high, on average, across the member countries of the Organisation for Economic Cooperation and Development (OECD), roughly 2.5 times the spending on unemployment benefits, and disability benefits is the main working-age benefit[65]. In response to these issues, the United Nations Convention on the Rights of Persons with Disabilities was ratified in 2008, forming the basis for broad-based international disability reforms.

1.4.1 Measurement of disability

Historically, there has been little uniformity across time or studies regarding the definition of 'disability'. In 2001, the World Health Organization developed the International Classification of Functioning, Disability and Health (ICF), which is an integration of two previously competing models: the biomedical model and the social model. The key features of the biomedical model are 1) a focus on patients rather than on persons in their environments, 2) the attribution of impairments to deficiencies and disease and 3) dysfunction treated with medical intervention. In contrast, the key feature of the social model is a focus on social and environmental barriers rather than on individuals. The synthesis of these two approaches recognises that disability is a dynamic continuum, influenced by biology, social factors, the environment, health services and personal preferences[66] and this is outlined in Figure 4.

The ICF describes how health conditions interact with personal and environmental factors to affect functioning at the levels of the body, the person and the person in social situations. Subsequently, in 2007, the World Health Organization released the International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY), which defines disability in terms of delays, deviations and variations of development.

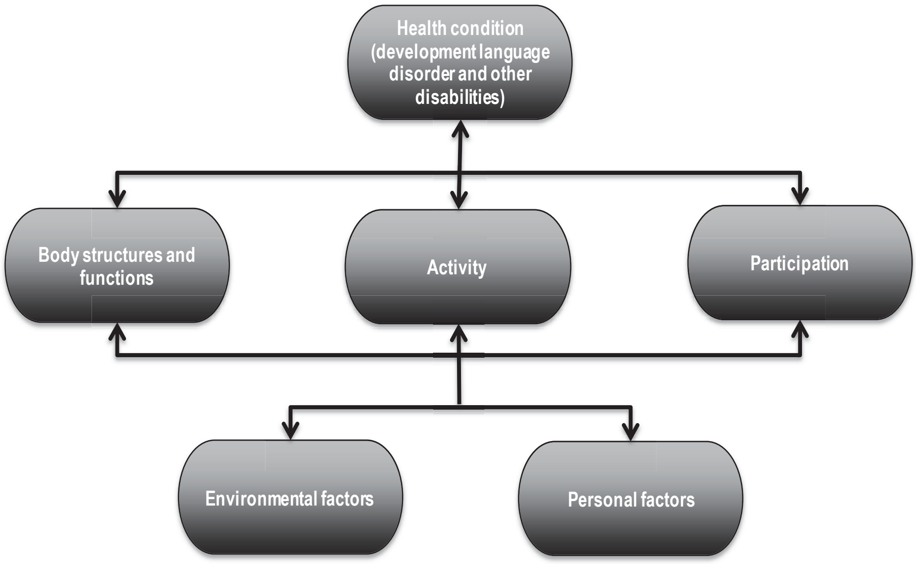

Figure 4: World Health Organization's Model of the International Classification of Functioning, Disability and Health for Children and Youth
Source: Adapted from World Health Organization[66]

Based on these frameworks, the United Nations Convention on the Rights of Persons with Disabilities subsequently developed a new definition of disability in 2010. This new definition included explicit inclusion of sensory impairments, of which DLD is a subgroup: 'Persons with disabilities include those who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others'[67(p5).] The convention now has 149 signatory countries, including Australia.

1.5 The Australian policy context

Internationally, Australia is lagging in a number of disability-related performance measures [64,65]. Its system is fragmented, with resources mostly focused on benefits as a last resort for people who are unable to participate in the labour market. Australia currently spends approximately 2 per cent of gross domestic product (GDP) on disability, which is less than half that of the countries with the highest expenditure for example in Denmark, Norway and Sweden. The employment rate for people with disability in Australia is approximately 40 per cent, compared with 80 per cent for people without disability. In the top eight OECD countries, the employment rate for people with disability is 70 per cent. In Australia, 45 per cent of people with disability live on or near the poverty line, more than double the OECD average of 22 per cent. This represents a relative poverty risk of 2.6; the OECD average is 1.6 [64,65].

1.5.1 Policy settings to address developmental language disorder

Current government policies and programs for children with language difficulties can be divided into two general areas: 1) health and welfare and 2) education. Until recently, Australian policy and legislation has largely overlooked communication impairments.

The issue to date has been that the policy framework is fragmented across national and state jurisdictions, resulting in differences in eligibility criteria and, therefore, difference in access to services[2,70]. At a national level, the *Disability Services Act 1986* and the *Disability Discrimination Act 1992* defined communication impairment as a 'disorder or malfunction that results in a person learning differently'. Each Australian state was then mandated to create its own disability framework, including defining services, policies and guidelines for health, education and disability. This resulted in substantial state-by-state differences in the eligibility criteria for services and ultimately resulted in some children falling through the cracks in service delivery, despite having been diagnosed with communication impairment. In a review of current health, education and disability legislation, McLeod et al.[2,70] found that 'clear policy gaps in the area of communication impairment are causing many children to miss out on appropriate and timely interventions'. This thesis considers state and regional differences in education policy in Chapter 4.

1.5.1.1 Health and welfare

Prior to the National Disability Insurance Scheme (NDIS), the main source of income support for children with disability was through carers' benefits, for which eligibility is skewed towards severe disabilities (i.e., carers who were unable to work because of their full-time carer responsibilities). There are two levels of benefits (Carer Payment and Carer Allowance). Carers are entitled to Carer Payment if they cannot support themselves through paid employment due to their caring responsibility, subject to means and assets testing. Carer Allowance is a supplementary payment, paid to all carers who provide daily care in a private home to a person with disability[65]. However, there is a limited range of disabilities covered and there are strict criteria about the level of care being provided. A recent survey of carers reported that only 20 per cent felt the current system met their disability needs[68].

In addition to disability and carers' benefits, the Australian Government contributes a rebate (Medicare benefit) towards services provided by medical specialists and by allied health clinicians, such as speech pathologists and psychologists, when referred by a general practitioner (GP). The standard early intervention treatment for DLD is speech pathology therapy. This most commonly occurs during the preschool and early school years, and treatment depends on the severity and type of diagnosis. The costs associated with carers' benefits are measured in Chapter 3, Chapter 5 and Chapter 6. Healthcare consumption is examined in Chapter 3.

1.5.1.2 Education

In 2005, the Australian Government introduced the Disability Standards for Education as a part of the mandated Disability Discrimination Act. The Disability Standards provided a framework 'to ensure that students with disability are able to access and participate in education on the same basis as other students and considers that all people with disability have the right to participate as fully as possible in community life and is committed to increasing fair access to education and training for all groups'[69,(piii)].

1.5.1.2.1 Educational reforms

In 2008, the Australian Government introduced wide-scale educational reforms to improve educational outcomes for disadvantaged groups and to strengthen accountability and transparency in the education system. These groups include Indigenous Australians, students from low socioeconomic backgrounds, new migrants, homeless young people and people with disability[70]. New targeted policies have included the introduction of the Smarter Schools National Partnership for Low Socio-economic Status School Communities, which focuses on the learning and wellbeing of disadvantaged students to support their transitions to further education, work and community participation[71]; the Aboriginal and Torres Strait Islander Education Action Plan aimed at closing the gap between Aboriginal and Torres Strait Islander peoples and their peers[72]; and the National Early Childhood Development Strategy aimed at giving every child 'the best start in life'[73,p4].

In addition, broad national reforms were introduced; key features included a national curriculum, national testing and public reporting. At the time, it was considered an 'education revolution', providing an opportunity to improve educational, social and health prospects for children with communication and additional impairments[74]. However, the introduction of market-oriented principles has received considerable criticism from educators, with suggestions that national testing and the publication of results at a school level, while being designed to help students, is being deployed in ways that may have a negative impact on the most vulnerable students[75,76]. An OECD report in 2008 cautioned that school-choice policies need careful implementation to ensure they do not exacerbate equity issues by increasing the segregation of some students in schools of low academic quality[77].

1.5.1.3 Disability policy reform

Following Australia's ratification of the United Nations Convention on the Rights of Persons with Disabilities in 2008, the National Disability Strategy was introduced in 2010 to ensure people with disability would have the opportunity to fully participate in the economic, social and cultural life of the nation. As part of the strategy, the Disability Standards for Education of 2005 were reviewed. The review found that the Disability Standards had assisted people in accessing education to a 'varying degree'[78, p58), but there were considerable improvements needed to ensure equality for students with disability in Australian schools. Some of the issues raised included the need for adequate resourcing to provide additional support for increasing numbers of students attending mainstream schools; difficulties in accessing necessary support; different interpretations of eligibility criteria; inconsistent access to services; and concerns that the national curriculum, national assessment and national reporting did not adequately meet the needs of children with disability, resulting in unnecessary exclusion[78].

In 2015, the Nationally Consistent Collection of Data on School Students with Disability Guidelines was introduced to ensure that the specific learning needs of students are addressed across the full range of abilities. The guidelines improved the categorisation of disabilities, according to four groups: physical, cognitive, social-emotional and sensory. In addition, they defined four levels of adjustment: support within differentiated teaching, supplementary, substantial and extensive. The guidelines and the NDIS are beyond the scope of this thesis. The impact of education policies implemented from 2004 to 2015 is considered in Chapter 4.

1.5.1.4 National Senate inquiry

In addition to the national disability reforms, a national Senate inquiry was established around the same time to respond to the challenge of communication disorders. The national peak body Speech Pathology Australia had been advocating a parliamentary inquiry for some time. The overall aim was of the inquiry was to suggest areas of reform with regard to national policies and government funding of services. The inquiry was established in response to a lack of Australian data relating to national prevalence and incidence estimates of speech, language and communication impairments; workforce issues, including large waitlists for intervention services, particularly in remote areas; and costs. Of the inquiry's key recommendations, a number are relevant to this thesis, specifically:

- to consider the costs to the individual and to society of failing to intervene in a timely and effective way to address speech and language disorders in Australia; and
- to address the key recommendations in the development of relevant policies and programs.

1.6 Aims and outline of this thesis

From the review of the existing evidence regarding DLD, it was possible to identify a number of gaps in the applied literature and research on the economic impact of language difficulties. The analysis in this thesis uses data from the Longitudinal Study of Australian Children (LSAC)—a population-based sample of two cohorts of children with linked administrative Medicare data; the Australian Curriculum, Assessment and Reporting Authority (ACARA), also known as My School; and the National Assessment Program of Literacy and Numeracy (NAPLAN) data.

Subsequent chapters of this thesis will address the following key themes:

Theme 1: Consumption decisions of families with a child with language difficulties

1.1 What are the direct health utilisation costs of language difficulties?

In Chapter 3, several models will be used to explore heterogeneity in health utilisation and healthcare expenditure for children with language difficulties. The cross-sectional and longitudinal relationship between medical and pharmaceutical usage and children's language difficulties will be discussed. This chapter will add to the empirical literature by estimating total health care as well as the first-ever estimates of out-of-pocket costs for families of children with language difficulties from birth to 15 years. These estimates will inform a COI model in Chapter 6.

Theme 2: Childhood communication impairment, future human capital and economic success

2.1 What are the cognitive and non-cognitive deficits with children with language difficulties?

2.2 What are the effects of cognitive and non-cognitive abilities and health on labour-market outcomes and social outcomes in children with language difficulties?

2.3 What is the impact of increased investment in the academic achievement of schools and early identification on these outcomes?

Children with language difficulties are at increased risk of starting school not 'developmentally ready', and research indicates that the residual effects of an early language difficulty may be lifelong[13,14]. Although several studies describe associations between language and health and between language and educational outcomes at the individual and interpersonal level, none have addressed associations at the organisational or school level.

The primary focus of Chapter 4 is to examine whether the academic achievement of a school affects a student's academic achievement, emotional and behavioural health, NAPLAN attendance, and expectations for school completion at 15 years, based on individual language difficulties status. Chapter 4 will further add to the literature by measuring the impact of early and late identification of language difficulties as well as language difficulties persistence. The estimates of academic achievement at 15 years will be extrapolated to adult LFP and health status. The adult estimates will inform a COI model presented in Chapter 6.

Theme 3: What are the labour force decisions of families with a child with language difficulties?

3.1 What are the indirect costs associated with reduced maternal LFP for children with language difficulties?

A large body of international literature has found LFP differentials between carers[ii] and non-carers of children with *disability*; however, the impact of a child's disability on carers' LFP and wages within the Australian context is less clear. The impact of DLD on LFP has not been considered.

Chapter 5 will examine whether mothers who are carers of children with language difficulties and additional impairments, on average, earn lower hourly wages and have different LFP from mothers who are not carers of children with language difficulties. While LFP could equally affect both parents, mothers are considered to be the primary carer of the child in more than 95 per cent of cases in the LSAC. This chapter makes a number of contributions to the literature. First, the analysis will compare Heckman selection models and fixed effects models to better account for selection and time-invariant heterogeneity into having a child with language difficulties. Second, this study will exploit mother's pre-birth labour force behaviour as the source of exogenous variation in pre-caring LFP[iii]. Whether the carer's LFP and wage differential differs among other types of disability, caring intensity and by household structure (single parents, number of children) will also be investigated. These will inform cost of illness in Chapter 5.

[ii] Carers in this context are mothers of children with language difficulties and additional impairments. Non-carers are mothers of children without impairments.
[iii] Available for the LSAC B cohort.

Theme 4: How do these direct and indirect costs flow into the human capital framework?

4.1 What are the societal costs of language difficulties in Australia?

4.2 What are the policy implications of these results?

Based on the results discussed in Chapters 3 to 5, it is possible to calculate the societal costs of language difficulties using a COI approach[79-82]. COI studies aim to identify and measure all the costs of a condition or disease[79]. They describe and estimate the economic burden of a specific condition on a society and, therefore, the savings that could be achieved if the condition were remediated or the disease eradicated. The use of COI studies as decision-making tools has been debated[83-85], but they serve a number of purposes for policy[80]. First, it is hypothesised that using a COI approach to estimate the economic burden of language difficulties will underscore this condition as a high priority for future policymakers. Second, the estimate will enable policymakers to target specific policies where the greatest gains can be made. Third, the estimates will provide robust baseline measures from which to determine the efficacy of health policies and programs that are designed to reduce the effects of language difficulties, and last, the estimates will provide the first-ever societal costs for children with language difficulties in Australia to facilitate international comparisons of the condition. The methods used in this research and discussed in this thesis follow international guidelines described by Drummond et al.[81] and are discussed in detail in Chapter 6.

Chapter 2: Data and Key Variables

In the three empirical chapters, one main dataset is used throughout: the LSAC. The advantage of using longitudinal data is that it enables robust panel data analysis, which facilitates the exploration of the developmental trajectories of children with DLD. At the same time, the use of longitudinal datasets presents several challenges in measuring the impact of specific conditions, notably so for a condition such as DLD where there is much debate in the literature around definitions.

This chapter discusses the LSAC, focusing on the definitions of DLD and measures of persistence and early identification, which are used to inform Chapters 3, 4 and 5. This chapter is structured as follows: Section 2.1 discusses the components of the LSAC, including individual linkage to Medicare, My School and the NAPLAN datasets; Section 2.1.1 discusses the measures used to assess language and the definition of DLD; Section 2.1.2 discusses the measures used to approximate early identification and persistence of DLD; Section 2.1.4 discusses other data limitations and Section 2.1.5 outlines the modelling approach used in each chapter.

2.1 The Longitudinal Study of Australian Children

The LSAC is a national Australian panel data set of 10,000 children recruited using a cross-sequential research design stratified by 1) state, 2) metropolitan and regional and 3) rural and remote. This study follows two cohorts of children, a birth cohort (B cohort) and a kindergarten cohort (K cohort), each comprising 5,000 children. The LSAC B cohort tracks a sample of 0- to 1-year-old children over a period of 10 years to capture transitions in early childhood and primary school. The LSAC K cohort tracks a sample of 4- to 5-year-old children over a period of 10 years to capture young children's transition into primary school and high school. The sample is broadly representative of all Australian children (citizens and permanent residents) in each of the two selected age cohorts. Children in very remote parts[iv] of Australia were excluded from the sampling because of the high data-collection costs. Questionnaires were distributed to the parents who lived with the child, the child (including direct assessment of development and

[iv] Accessibility Remoteness Index Australia (ARIA)[83].

learning, and child interview), and the child's teacher (for the K cohort). Full details of the study design have been previously published [86].

The LSAC is individually linked to federally funded Medicare records (Medicare and Pharmaceutical Benefits Scheme), NAPLAN and ACARA datasets (My School), which provides a rich set of individual-level health utilisation, and individual academic and school-level measures. Relevant details of these linked datasets are provided in the chapters utilising these data.

2.1.1 Measures used to assess language

The LSAC includes several measures that assess communication and language, which are outlined in Table 1. The main measures used for the LSAC were the Communication and Symbolic Behaviour Scales (CSBS) (0–1 years)[62,87], the MacArthur-Bates Communicative Development Inventory (CDI) (2–3 years)[62,88], the short version of the Peabody Picture Vocabulary Test-Third Edition (PPVT-III) (4–9 years)[89] and the Academic Rating Scale: Language and Literacy, 10–15 years)[90]. In each of the four main measures, 'impairment/disorder or difficulty' was defined by standardised scores of > 1.25 standard deviation (SD) away from the mean at each age. These measures are consistent with the language and communication literature[62,91] and have the advantage of being directly assessed in three waves. Although the PPVT-III is a widely accepted screening tool used in longitudinal studies for children aged between four and nine years due to its cost-effectiveness and good reliability[89], one limitation is that it is insufficient to allow classification of children as meeting criteria for a clinically diagnosed language disorder[92,93]. With each of the four main measures, it is not possible to distinguish between communication impairment and low language acquisition related to inadequate educational opportunity and/or neglect or communication impairment and low language acquisition as a secondary condition–that is, where it coexists with another condition[23v].

In addition, Table 1 presents the supplementary measure that was available: a broad-based medical/disability measure taken between ages 0 to 15 years, which identified the presence of medical conditions persistent for more than 6 months. This measure is

[v] Such as ASD, hearing impairment, general developmental difficulties, behavioural or emotional difficulties, neurological impairment, bilingualism, cleft lip or palate, and episodic otitis media.

consistent with definitions of disability/impairment used in previous studies[47,49] and has the additional advantage that it was measured at each age group in the LSAC from birth to 15 years of age. However, in the context of the language and communication literature, this measure has its limitations. Using the speech/learning variable, the prevalence is lower than the direct language assessment variables. It is a parent-reported measure, and there is evidence that some households are less likely than others to report health conditions[94]. It is possible that relying on this variable alone would provide an underestimation of the effect of speech and language difficulties.

Table 1: Measures used to assess language difficulties

Cohort	Age	Measure	Description
B	0–1	Communication and Symbolic Behaviour Scales (CSBS)	A 24-item parent-completed questionnaire of early communication, including social, speech and symbolic subscales as well as a total raw score. The social subscale assesses nonverbal communication (e.g., gaze, gesture, attention), the speech subscale assesses consonants and vowel sounds, and the symbolic subscale assesses early comprehension skills (e.g., responding to name, following directions). CSBS scores predict language outcomes at 2– 3 years.[62,87]
B	2–3	MacArthur-Bates Communicative Development Inventory (CDI) Words and Sentences[a]	A subscale of MacArthur-Bates CDI assesses early vocabulary. The words and sentences subscale assesses receptive and expressive vocabulary, with parents reporting their child's use of 94 common words (yes/no). The MacArthur-Bates CDI is effective in distinguishing between children with language difficulties and those without. [62,88]
B, K	4–9	Peabody Picture Vocabulary Test-Third edition (PPVT-III)[b] – short version	An Australian-adapted short version of the PPVT-III (Dunn et al.[95] assesses a child's receptive vocabulary. The PPVT-III is a direct assessment; children are asked to select pictures that correspond to words read out by the examiner. Forty items are administered, consisting of 20 core items and 10 base and ceilings items. Raw scores are converted to scaled scores. This adapted version has good reliability (0.76).[89]
K	10–15	Academic Rating Scale: Language and Literacy[ab]	A 9-item teacher-completed questionnaire of reading and comprehension (e.g., conveys ideas clearly, understands and interprets text, reads and comprehends).Teachers report the proficiency of the child on a 5-point scale (Not yet; Beginning ; In progress; Intermediate; Proficient).[90]
<u>Supplementary measures</u>			
B, K	0–15	Long-term medical problems	A parent-completed questionnaire about whether the child has any long-term medical conditions or disabilities. Three categories of childhood disability are constructed. These are based on three parental questions: 'Does your child have a medical condition or disability that lasted or was likely to last for 6 months or more at the time of interview?', 'What type of medical condition does your child have?' & 'Does your child have Attention Deficit Hyperactivity Disorder ADHD?' These definitions are consistent with definitions used in previous studies. [47,49,96,97] *Physical mental/emotional/cognitive conditions* Blackouts, fits or loss of consciousness; limited use of arms or fingers; difficulty gripping things; limited use of legs or feet; any disfigurement or deformity; chronic or recurring pain; any condition that restricts physical activity or physical work; shortness of breath or difficulty breathing; any mental illness for which help or supervision is required; nerves or emotional conditions that require treatment *Speech/learning* Speech problems; difficulty learning or understanding things *Other* Long-term effects because of a head injury, stroke or other brain damage; any other long-term condition such as arthritis, asthma, heart disease, Alzheimer's disease, dementia etc.; any other long-term condition that requires treatment or medication (including ADHD); sight problems and hearing problems.

[a]Children were defined as having language difficulties at each age if their standardised language scores were > 1.25 SD away from the mean. [b]Language scores were standardised using the transformation of raw scores to Z-scores at each age group. Physical mental/emotional/cognitive conditions were combined into one variable because the prevalence of mental health issues is very small. Children identified as having asthma were categorised as having a physical condition only, as it is possible that a child could be double counted by being counted in both the physical group and the other group.

2.1.2 Defining developmental language disorder

For the purposes of the analysis, a number of steps were taken to consider this first challenge of defining DLD. First, measures of language and disability are combined into the definition to create mutually exclusive language variables[vi]. This is labelled *Language difficulties – Definition 1* and is outlined in Table 2.

Second, a number of other covariates have been considered in all the analyses. Measures of other impairment are considered to distinguish between DLD/language impairment that coexists with other conditions and DLD'/specific' language impairment where there are no difficulties in areas other than language. Socioeconomic status and non-English speaking backgrounds are considered to account for low language acquisition due to inadequate educational opportunity or due to English being a second language. Children with low cognitive ability (lowest 10% of sample WAI) are excluded from the analyses.

Third, the more conservative label *language difficulties* are used as an approximation of DLD when referring to the analysis of the LSAC, throughout the thesis. The term *DLD* is used when referring to the clinical term for development language disorder and it is assumed that these terms (DLD/language difficulties) are interchangeable in the concluding chapters. Last, robust econometric techniques with extensive sensitivity analyses are utilised to account for possible endogeneity biases.

[vi] As a part of robustness checks in Chapter 3, this measure is validated against a non-mutually exclusive language variable.

Table 2: Language difficulties – Definition 1

Definition	Description
Language difficulties only	Language difficulties on each of the corresponding main measures at each age were defined as scores greater than 1.25 SD away from the standardised mean. This resulted in a language dummy variable (yes/no) for a child by age group
Language difficulties and one or more long-term medical problems	Language difficulties plus one or more of (physical mental/emotional/cognitive conditions and/or other conditions)
One long-term medical problem (other than language)	One of (physical mental/emotional/cognitive conditions and/or other conditions)
Two or more long-term medical problems (other than language)	Two or more of (physical mental/emotional/cognitive conditions and/or other conditions)
Carer Allowance	Any child with an impairment that is severe enough for their carer to receive Carer Allowance
Carer Payment	Any child with an impairment that is severe enough for their carerto receive Carer Payment

2.1.3 Early identification and persistence

As well as the challenge of defining DLD, there is the challenge of no diagnosed measure of language difficulties persistence or severity in these data and no measure of early intervention. The analysis will exploit the longitudinal nature of the data to define language difficulties in terms of persistence and timing of identification. Persistence will be defined in terms of whether children have a language difficulty present at one time point only, at two time points, or at more than two time points, which is consistent with definitions of persistence in the literature[62,91]. Additionally, the longitudinal nature of these data allows the analysis to go further than the literature in providing an approximation of early diagnosis by categorising language difficulties according to the timing of identification. This measure captures the differential effects of children who have the same level of persistence of language difficulties but who are identified at different ages. This is labelled *Language difficulties persistence and timing – Definition 2* and is outlined in Table 3. Three age ranges were identified: birth to 3 years, 4 to 7 years, and 8 years and older. These age ranges were chosen for two reasons: 1) to capture the age ranges at which children are commonly identified with language difficulties[6,98-101] and 2) to capture at least two waves of data for each age range, in each of the two LSAC cohorts.

Table 3: Language difficulties persistence and timing – Definition 2

Timing	Definition	Ages data available	
		B cohort	K cohort
Typical language	No language difficulties at any age	0–11 years	4–15 years
LD1_0–3 years	Language difficulties identified at one time only, between 0–3 years of age	0–3 years	N/A
LD1_4–7 years	Language difficulties identified at one time only, between 4–7 years of age	4–7 years	4–7 years
LD1_≥8 years	Language difficulties identified at one time only, at 8 years or older	8–11 years	8–15 years
LD2_0–3 years	Language difficulties identified twice, the first time at 0–3 years of age	0–3 years	N/A
LD2_4–7 years	Language difficulties identified twice, the first time between 4–7 years of age	0–7 years	4–7 years
LD2_≥8 years	Language difficulties identified twice, the first time at 8 years or older	8–11 years	8–15 years
LD3_0–3 years	Language difficulties identified three or more times, the first time between 0–3 years of age	0–3 years	N/A
LD3_4–7 years	Language difficulties identified three or more times, the first time between < 8 years of age	0–7 years	4–7 years
LD3_≥8 years	Language difficulties identified three or more times, the first time at 8 years or older	N/A	8–15 years

Note. For the age range of 0 to 3 years, identification in the B cohort relates to two waves of data: at 0 to 1 years and at 2 to 3 years. The age range 4 to 7 years relates to when the children were 4 to 5 years and 6 to 7 years, and identification at 8 years or older relates to when children were 8 to 9 years and 10 to 11 years. In the K cohort, the first age range was 4 to 7 years, relating to when the children were 4 to 5 years and 6 to 7 years. Identification at 8 years or older for the K cohort relates to four waves of data: at 8 to 9 years, 10 to 11 years, 12 to 13 years and 14 to 15 years. As a result of this approach, the sample of B cohort children with LD3_≥8 years (identification at 8 years or older with condition in more than two waves) and K cohort children with LD (1, 2, 3) _0–3 years (identification between birth and 3 years) is not available in these data and therefore not considered. N/A = not available in the data.

A third broad-based measure indicating whether the child's condition is severe enough for parents to receive a carers' benefit (Carer Allowance and Carer Payment) is considered in the analysis. By definition, conditions that meet the eligibility criteria for Carer Payment are sufficiently severe that carers are unable to fully participate in the workforce because of their caring responsibilities. Therefore, this measure provides not only another approximation of severity but also a way of validating the approach utilised to define language difficulty, persistence and timing. To illustrate this latter point, Table 4 shows the proportion of language impairment children whose carer receives a carers' benefit. Based on the first definition of language difficulties, the proportion of B cohort children with language difficulties whose carer receives Carer Allowance is 6.62 per cent, with a further 3.33 per cent receiving Carer Payment. When persistence and timing are considered, the rates for Carer Allowance and Carer Payment increase to 12 per cent and 5.87 per cent respectively, for children with LD3_0–3 years[vii]. Notably, the proportion of children with LD3_4–7 years whose carer receives a carers' benefit is very low. The prevalence of this group is less than half that of the same group of children in the K cohort. Recall from Table 1 that the language difficulties measures in Wave 1 and Wave 2, when children are 0 to 3 years of age, are parent-reported measures (CSBS) and (Macarthur-Bates CDI). It is feasible that children in the B cohort may have been identified as having language difficulties earlier than the wider population, due solely to their participation in the LSAC survey. This would result in the categorisation of the language difficulty groups being skewed towards 'early identification' (0–3 years). This limitation in the interpretation of results will be considered in Chapter 5.

Compared with the B cohort, the rate of carers' benefits for the K cohort is slightly higher, with the proportion of children with language difficulties whose carer receives Carer Allowance being 7.68 per cent, with a further 5.28 per cent receiving Carer Payment. When persistence and timing are considered, the rates for Carer Allowance and Carer Payment increase to 11.1 per cent and 10.1 per cent respectively, for children with LD3_≥8 years. Overall, the descriptive statistics strengthen the validity of the language variables as a measure of language impairment.

[vii] Due to limitations of the data, LD3_≥8 children in the B cohort cannot be estimated. This is likely to underestimate the true prevalence of carers' benefits for younger children with language difficulties.

Table 4: Proportion of children with language difficulties who are eligible for carers' benefit (B and K cohorts)

	B cohort				K cohort			
	Carer Allowance		Carer Payment		Carer Allowance		Carer Payment	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Language definitions								
Typical language	0.033	−26.25	0.016	−18.37	0.035	−27.29	0.023	−21.95
Language difficulties only	0.066	−18.85	0.033	−13.26	0.077	−17.80	0.053	−14.90
Language by persistence and timing of identification								
LD1_0–3 years	0.032	−7.43	0.018	−5.71	N/A		N/A	
LD1_4–7 years	0.028	−6.68	0.019	−6.33	0.046	−9.28	0.028	−6.95
LD1_≥8 years	0.035	−7.32	0.022	−6.63	0.055	−13.83	0.035	−10.71
LD2_0–3 years	0.056	−1.64	0.032	−9.29	N/A		N/A	
LD2_4–7 years	0.055	−7.50	0.030	−5.82	0.048	−5.56	0.040	−5.65
LD2_≥8 years	0.052	−3.44	0.039	−3.61	0.051	−8.04	0.063	−12.09
LD3_0–3 years	0.120	−3.80	0.059	−16.22	N/A		N/A	
LD3_4–7 years	0.006	0.41	0.000	0	0.111	−11.71	0.101	−13.02
LD3_≥8 years	N/A		N/A		0.106	−17.33	0.071	0.23

Note. Correlations based on ordinary least squares (OLS). N/A = not available in the data.

2.1.4 Other data limitations

2.1.4.1 Attrition

Given that the LSAC is a longitudinal survey, there is a possibility that different groups of respondents drop out of the survey at different rates, which may lead to attrition bias. For each wave of the survey, a weight is calculated from the key variables to account for the effect of differential attrition. These attrition weights adjust the sample to ensure that the distribution matches that observed in the first wave.

The LSAC uses a two-stage weighting process. The first stage uses a propensity score adjustment to correct for attrition between waves. The purpose of this step is to adjust for differential non-response across demographic groups. The key variables used in the propensity score adjustment in the B cohort are as follows: Parent 1 age; mother's highest educational attainment; return of Parent 2 questionnaire; teacher-reported school achievement; and Parent 1 housing tenure. The additional key variables used in the K cohort include reading ability, whether Parent 1 is renting and the number of days someone in the household helps with homework[102].

The second stage is a stratum adjustment to realign weights with known totals from the original sample. The Wave 6 longitudinal weights used in this analysis apply to those who have responded to all waves (1 to 6). Longitudinal weights are provided with the LSAC dataset. Details on the creation of attrition weights for the LSAC are provided in one of the LSAC technical papers[102]. For the purposes of this thesis, the approach to attrition weights will be considered separately in each chapter.

The final challenge is the need to use language definitions that are consistent with the existing literature in the area as well as the modelling approach used. For example, when fixed effects models are used, it is not possible to define language difficulties in terms of Definition 2 (persistence and timing) as this variable is time invariant and will subsequently be omitted from the analysis.

2.1.5 Modelling approach in each chapter

Table 5 summarises the measures and approaches used in each chapter to tackle these data limitations.

Table 5: Language difficulties – measures and approaches by chapter

Chapter	Language difficulty definition	Approach to comorbidities	Approach to low language acquisition biases	Carers' benefits included	Attrition (pweights)
3 Health care	Definition 1	Mutually exclusive non-language covariates	NESB, household income, fixed effects models	Yes	Yes
4 Education	Definition 2[a]	Mutually exclusive non-language covariates	NESB, household income, propensity score methods	No[b]	No[d]
5 Maternal LFP	Definition 2	Other types of impairment covariates	NESB, household income, pre-birth income[c], dynamic random effects models	Yes	Yes[d]

Note. NESB = non-English speaking background.
[a]Definition 1 is used when the model would not converge with Definition 2. [b]Carers' benefits were not considered relevant to education outcomes. [c]Available for B cohort. [d]Some model specifications do not allow pweights.

Table 6 shows the prevalence of language difficulties among various demographic groups in the Australian population. Between 10.1 per cent and 10.7 per cent of children were defined as having language difficulties in 2004 (represented by Wave 1 only). Prevalence estimates were higher in the B cohort than in the K cohort and varied according to the sociodemographic characteristics of the children and their families. In both the B cohort and the K cohort, language difficulties were more prevalent among males (11.3 per cent B cohort, 12.3 per cent K cohort) than females (10.1 per cent B cohort, 8.1 per cent K cohort) and among children in the lowest family income quintile (10.2 per cent B cohort, 5.6 per cent K cohort) than in the highest family income quintile (10.1 per cent B cohort, 5.6 per cent K cohort). Prevalence was higher in Indigenous children (10.8 per cent B cohort, 17.4 per cent K cohort) than non-Indigenous children, and those with average health status (13.2 per cent B cohort, 12.2 per cent K cohort), compared with excellent health[viii]. Overall, these descriptive results showed that the prevalence of language definitions is consistent with estimates in the literature.

[viii] These estimates are based on Wave 1 only and will differ slightly from the overall estimates used in the analysis, as indicated in Table 7.

Table 6: Prevalence of language difficulties – Australia 2004

Definition		B Cohort			K Cohort	
		Number (%) with language difficulties			Number (%) with language difficulties	
Language difficulties[a]	4,769	509	(10.7)	4,606	466	(10.1)
Gender						
Male	2,453	276	(11.3)	2,250	276	(12.3)
Female	2,316	233	(10.1)	2,356	190	(8.1)
Mother's language spoken at home						
NESB	664	65	(9.8)	715	147	(20.6)
English speaking	4,105	444	(10.8)	3,891	319	(8.2)
Child is Indigenous						
Indigenous	213	23	(10.8)	172	30	(17.4)
Non-Indigenous	4,556	486	(10.7)	4,434	436	(9.8)
Household Income						
Lowest	1,240	127	(10.2)	1,130	174	(15.4)
Quintile 2	1,180	157	(13.3)	1,102	121	(11.0)
Middle	820	81	(9.9)	869	73	(8.4)
Quintile 4	654	62	(9.5)	663	43	(6.5)
Highest	545	55	(10.1)	480	27	(5.6)
Health Insurance						
Private health insurance	2,202	246	(11.2)	2,135	136	(6.4)
Uninsured	2,564	262	(10.2)	2,463	330	(13.4)
Child's global health status						
Excellent health	2,564	274	(10.7)	2,644	236	(8.9)
Good health	1,235	156	(12.6)	1,390	160	(11.5)
Average or health	599	79	(13.2)	572	70	(12.2)
Long-term medical conditions						
Medical conditions	260	2	(0.8)	949	190	(20.0)
No medical conditions	4,509	507	(11.2)	3,657	276	(7.5)
Sample size		4,769			4,606	

Note. See Appendix E: Data for the definition of variables and description of the sample. NESB = non-English speaking background; B = birth; K = kindergarten. Adapted from the 2004, 2006, 2008, 2010, 2012 and 2014, Longitudinal Study of Australian Children (B and K cohorts).
Prevalence estimates based on Wave 1 only. Sample size may differ slightly to the overall sample used for the analysis. Sample is subject to missing observations. [a] Language definition is mutually exclusive. Sample may differ slightly from prevalence sample in published paper.

Chapter 3: Health Utilisation and Health Expenditure

3.1 Introduction

Increased healthcare utilisation among children with general special needs is well documented[45,46], but there is a lack of research examining healthcare costs associated with language-specific problems. The demand for primary care services is likely to be higher in children with language difficulties given that they are commonly referred to a wide range of services for diagnosis and treatment. These services include speech pathology, psychology, paediatric and early intervention services[91,103]. Additionally, there may be downstream costs to the health system, due to secondary health conditions that develop as a result of the difficulties, such as emotional problems or behavioural difficulties[104].

This chapter explores the direct costs of health utilisation associated with a child's language difficulties. The chapter is structured as follows: Section 3.2 reviews the empirical literature and discusses the theoretical reasons for increased health utilisation and expenditure for children with language difficulties. Section 3.3 describes the LSAC data and sample and presents the modelling approach adopted in this chapter. Section 3.4 discusses the health utilisation model, and Section 3.5 discusses the health expenditure model. Section 3.6 presents the sensitivity analyses. The chapter concludes with the discussion and policy implications in Sections 3.7 and 3.8.

3.2 Existing evidence

Human capital theory suggests several reasons why health utilisation may be higher for a child with language difficulties. Children are assumed to possess a vector of health capabilities, created though genetic endowment at birth and then at each age as a function of current and past parental investments as well as of the child's environment[31,42]. Impairments or health shocks can occur that affect the child's health status and drive some parents to invest more into their child, through intervention. However, when parental investments are lower, notably when the language-disordered child is from a low socioeconomic household, the child accumulates lower levels of human capital, which may lead to lower levels of health and a demand for additional health care.

A small number of studies indicate higher healthcare expenditure among families with children with language difficulties[62,91]. For example, Skeat et al. [91] reported both government and out-of-pocket costs for families using the Early Language in Victoria Study. This study considered costs at one time point and did not consider other predictors of healthcare utilisation. To date, the longitudinal relationship between healthcare utilisation and language difficulties has been largely unexplored.

Using the LSAC, Sciberras et al. [62] measured the direct healthcare costs associated with language difficulties of children aged between 4 and 8 years and found that children with language difficulties have biennial healthcare expenditures that are, on average, \$206 (95% CI: \$90, \$321) higher at age 4 to 5 years than children of the same age without language problems. However, children with language difficulties are more likely to be found in families where English is not the main language spoken[105]. It is possible that simple cross-sectional correlation without consideration of this confounder may provide biased estimates of the impact of a child's low language on healthcare costs. Additionally, there is limited evidence on total healthcare costs for children with language difficulties. Sciberras et al.[62] study considered healthcare costs defined by the Medicare benefit but did not consider the portion of total healthcare costs paid for by the family or out-of-pocket costs. The Australian Institute of Health and Welfare (AIHW) estimated that from 2010 to 2011, 57.1 per cent of health expenditure was borne by the family (out-of-pocket healthcare expenses), which equates to 3.2 per cent of household expenditure, with considerably higher costs for people with chronic or long-term conditions[106]. It is likely that the total healthcare costs for a child with language difficulties are considerably higher than current literature estimates.

The purpose of this chapter is to explore the relationship between language difficulties and healthcare utilisation and expenditure, something that has largely been ignored in the literature to date. This study contributes to the literature in a number of ways. First, by using prospective longitudinal data, this study expands on the existing literature by including six additional years of data (up to 15 years). Second, patient out-of-pocket expenses are estimated to provide a more accurate estimate of the overall healthcare cost. Third, panel data methods are used to consider the correlation of health care over time as well as the interplay of other relevant explanatory variables, such as non-English speaking households, long-term medical conditions and health insurance, which may confound the relationship between language difficulties and healthcare costs.

3.3 Methods

3.3.1 Data and sample

3.3.1.1 Measures used to assess language

Language difficulties – Definition 1 is used in this chapter. Full details of the LSAC are available in Chapter 2. For interpretation, the language difficulty coefficient will represent the costs for children who have language difficulties but whose carers are not eligible for carers' benefits. Whether there is any interaction effect—that is, whether there are differences between the costs for children with language difficulties whose carer receives carers' benefits and the costs for children with additional impairments whose carer receives carers' benefits—is also explored.

3.4 Descriptive statistics

Table 7 shows the summary statistics for the variables considered in both analyses. The summary statistics for the outcome variables are shown in Panel A, Table 7. In a two-year period, children in the B cohort had, on average, 17.6 visits to medical providers and filled 2.0 pharmaceutical prescriptions, amounting to $2,178 of healthcare expenditure, of which $428 was an out-of-pocket expense. In the K cohort, children had, on average, 13.6 visits to medical providers and filled 2.0 prescriptions over a two-year period; the cost of medical services was $1,956 of which $403 was an out-of-pocket expense.

In estimating the equations, the regression analysis controlled for the basic demographic characteristics of the child in order to determine which types of characteristics contribute to health service utilisation and expenditure, such as child's age and Indigenous status (Panel B, Table 7). Human capital, family resources and attitude to health risk were measured by mother's education (Panel C, Table 7), household income and health insurance (Panel D, Table 7). Total household gross income, which was defined as the sum of maternal income, resident partner's income and the income of any other employed person present in the household, equivalised by the number of people in the household, was between $51,506 and $52,265 (in 2014 prices), on average, for the K cohort and B cohort respectively.

The LSAC generally considers the mother to be the primary carer of the child. The analysis explored whether any particular attributes of the mother or household influences whether a child seeks medical care, for example, recent health shocks (mother's relative has suffered a serious illness, injury or assault in the last year) and the mother's long-term medical conditions (Panel C, Table 7). Also controlled for were the household characteristics, such as marital status (resident partner in the home), the number of siblings in the household and mother's language spoken at home[ix]. Approximately 15 to 16 per cent of mothers speak a language other than English at home, and 9 per cent of mothers have a long-term medical condition.

The explanatory variable of interest is the generated dummy variable indicating whether a child has language difficulties[x] (Panel B, Table 7) and has a prevalence of between 9.5 per cent and 11.5 per cent when defined in terms of the main language measures[xi]. Receipt of carers' benefits is also considered a measure of severity/persistence. Between 2 and 5 per cent of the sample received a carers' benefit: an income supplement that is paid to carers who provide additional daily care and attention for someone with a long-term disability or medical condition.[xii] (For detailed definitions, see Appendix E: Data).

[ix] A child's gender was not included in the analysis as there was little evidence that gender was associated with changes in health care or out-of-pocket expenses.

[x] Language difficulties on each of the corresponding measures at each age were defined as scores less than 1.25 SD below the standardised mean. Language measures with missing observations were categorised as 'unknown'. See Table 29 for details.

[xi] Based on prevalence estimates across all waves (1–6). This will differ slightly from the prevalence estimates in Appendix 0, which are based on Wave 3 only.

[xii] To be eligible for Carer Allowance, carers must provide additional daily care and attention to a person with a long-term (of at least 12 months duration) disability or medical condition, and meet the residence requirements. Carer Allowance is neither income tested nor asset tested and can be paid in addition to wages or other income support payments such as Carer Payment or Age Pension. See Appendix E: Data for details.

Table 7: Summary statistics

		B cohort		K cohort	
Variable	Measurement	Mean	SE	Mean	SE
	Panel A. Outcome variables				
Medical services visits	Number of Medical services (MBS) visits	17.6	0.1	13.6	0.1
Pharmaceutical prescriptions	Number of Pharmaceutical (PBS) prescriptions filled	2.0	0.1	2.0	0.0
Healthcare expenditure	Healthcare expenditure = Medical Services (MBS) + Pharmaceuticals (PBS) + Hospital Costs	2178	22	1956	23
Out-of-pocket expenses (OOP)	OOP = Health care expenditure − Co-payments 1	428	6	403	6
	Panel B. Child's characteristics				
Language difficulties	Dummy variable 1 = Yes, 0 = No	11.6	0.3	8.9	0.3
Missing language difficulties	Dummy variable 1 = Yes, 0 = No	0.0	0.0	NA	NA
Language difficulties plus medical conditions	Language plus one other long-term medical condition	2.1	0.1	3.0	0.2
Long-term medical condition	One condition other than language	5.1	0.2	8.8	0.2
	Two or more conditions other than language	2.1	0.1	3.0	0.1
Mother receives Carer Allowance	Dummy variable 1 = Yes, 0 = No	3.9	0.2	4.4	0.2
Mother receives Carer Payment	Dummy variable 1 = Yes, 0 = No	2.1	0.1	3.1	0.2
Child is Indigenous	Dummy variable 1 = Yes, 0 = No Includes Aboriginal and Torres Strait Islander	3.6	0.2	3.1	0.2
Child's global health status	Excellent health	49.3	0.4	48.9	0.4
	Very good health	36.4	0.4	35.8	0.4
	Average health	14.3	0.3	15.3	0.3
	Panel C. Mother's characteristics				
Mother speaks another language at home	Dummy variable 1 = Yes, 0 = No	16.0	0.3	16.0	0.3
Mother has completed Year 12	Dummy variable 1 = Yes, 0 = No	60.1	0.4	50.3	0.4
Mother has a long-term medical condition	Dummy variable 1 = Yes, 0 = No	9.8	0.2	10.8	0.3
Mother's relative has suffered a serious illness, injury or assault in the last year	Dummy variable 1 = Yes, 0 = No	14.7	0.3	15.9	0.3
Mother has a resident partner	Dummy variable 1 = Yes, 0 = No	86.8	0.3	82.6	0.3

		B cohort		K cohort	
Variable	Measurement	Mean	SE	Mean	SE
Panel D. Household characteristics					
Household income	Annual gross household income equivalised	50028	281	50254	278
Missing household income	Dummy variable 1 = Yes, 0 = No	5.0	0.18	5.5	0.2
Health insurance	Dummy variable 1 = Yes, 0 = No	122.8	0.59	48.7	0.6
Number of siblings the child has	Range 0–11	0.2	0.00	1.36	0.01
Number of observations (child * year)		28651		27618	
Number of observations with no missing values for household income		23395		23697	
Number of observations with no missing values for language difficulties		28641		27618	
Number of observations with attrition weights[a]		19510		18338	
Unique number of observations (child) [a]		4769		4606	

Note. Based on weighted sample. Refer to Appendix E for the definition of the variables and the description of the sample. B = Birth cohort; K = Kindergarten cohort; MBS = Medicare Benefits Scheme; OOP = out-of-pocket; PBS = Pharmaceutical Benefits Scheme. Adapted from the 2004, 2006, 2008, 2010, 2012 and 2014 Longitudinal Study of Australian Children (B and K cohorts). *= multiplied by
[a]Model sample with attrition weights omits children without observations in Wave 6.

3.5 Health utilisation model

3.5.1 Econometric framework

The analysis first examined whether the healthcare expenditure of children who have language difficulties differs from the healthcare expenditure of those with typical language, using pooled analysis from 10 years. However, non-normality of data violates a key assumption of common linear models such as ordinary least squares (OLS). The normality of the residuals of the log transformed OLS is tested using the Shapiro-Wilk test for normality and finds that the null hypothesis is rejected (Probability > Z = 0.00). The Breusch-Pagan test is then used to help detect heteroscedasticity. Complex heteroscedasticity (likely to be due to interaction effects) rules out OLS on log (total health care) in favour of generalised linear models (GLMs).

The Poisson model provides a standard GLM framework for this type of analysis[107-109]. However, count data are often over-dispersed relative to the Poisson distribution due to the restrictive assumption that the conditional variance equals the conditional mean. One frequent manifestation of over-dispersion is that the incidence of zero counts is greater than expected for the Poisson distribution. The negative binomial model is an attractive alternative to the Poisson model as it allows for over-dispersion by relaxing the restriction of equidispersion. However, the negative binomial model also has its limitations in that the estimates can be biased if the X_{it} is correlated with the error term e_{it}.

As a final model, a fixed effects model is specified. Fixed effects models provide a method of dealing with omitted variable bias by applying mother-level fixed effects (within person effects[110]). The fixed effects specification is as follows:

$$Y_{it} = B_0 + B_1 H_{it} + B_2 X_{it^n} + u_i + e_{ij} \qquad (3.4.1.1)$$

$$n = 1,2,3$$

H_{it} is the language difficulty or other impairment status of the child. X_{it^n} is the explanatory variables of the household $(n = 1)$, mother $(n = 2)$ and child $(n = 3)$, starting with household characteristics. X_{it^1} is determined by one variable indicating impairment severity if the household receives a carer's benefit; three categorical dummy variables indicating the number of the child's siblings (0, 1, 2 or more); and gross income of the household, equivalised for the number of people in the household (categorised into quintiles plus a 'missing') (Panel D, Table 7).

X_{it^2} includes the mother's characteristics, determined by one dummy variable if the mother is from a non-English speaking background, one dummy variable for the mother's educational attainment (mothers who completed Year 12), one dummy variable indicating the mother's health status (long-term medical conditions), one dummy variable indicating health shocks (relatives who suffered serious injury) and one dummy variable indicating whether the mother has a resident partner (Panel C, Table 7).

X_{it^3} includes other child characteristics: the health status of the child (excellent, very good and average) and those who are Aboriginal or Torres Strait Islander (Panel B Table 7). Finally, time is captured as six dummy variables (Wave 1 to Wave 6).

u_i are the fixed effects for each mother, child and household, and e_{ij} are the unobserved time-varying explanatory variables, such as changes in Medicare or pharmaceuticals policy, and changes in economic conditions altering spending habits. While there is the possibility of bias from the time-variant heterogeneity, the overall bias is reduced because time-invariant heterogeneity is accounted for in the fixed effects specification, allowing exploration of the causal relationship between the onset of language difficulties and the consumption decisions of families.

In addition to dealing with omitted variable bias, reverse causality also needs to be considered. One approach to dealing with reverse causality is through cross-lagged models, whereby lagged dependent and independent variables are used as instrumental variables[111]. However, lagged dependent variables in fixed effects models with greater than two time points cause biased estimates because a lagged dependent variable with greater than two time points induces correlation between the lagged dependent variable and the error term, violating an assumption of fixed effects models[xiii]. Using lagged explanatory variables allows for time ordering, which can improve the ability to infer causation. The trade-off is that a wave of data is lost. For the K cohort sample, this is important because utilisation is largely driven by the first wave of data when the children are 4 to 5 years. For the purposes of the analysis, lagged explanatory variables were not considered in the final model of the results tables in this chapter (Column 8) but are considered in the results table as a robustness check (Column 9). Additionally, the issue of reverse causality is tested by including lagged independent variables in exploratory equations (discussed further in Section 3.7).

The outcome variables of interest for these analyses are the number of medical services visits and the number of pharmaceutical prescriptions.

[xiii] Using lagged values of x and y (or their first differences) as instrumental variables—variables that, by assumption, are not correlated with the error terms in the equations—is a common approach to control for endogeneity[111]However, lagged dependent variables in fixed effects models with greater than two time periods can cause significant bias. In a standard fixed effects model using a lagged y induces correlation between the lagged y and the error term, violating an assumption of fixed effects models

3.5.2 Results

3.5.2.1 Descriptive results

Table 8 shows a cross-tabulation of health utilisation, defined by counts of medical services visits and pharmaceutical prescriptions and a child's language status. The table shows that across all language measures, biennial health utilisation was, on average, higher in the B cohort than in the K cohort. In the B cohort, a child with language difficulties had, on average, 20.5 medical services visits and 3.1 pharmaceutical prescriptions over a two-year period compared with between 17.3 medical services visits and 1.8 pharmaceutical prescriptions for a child with typical language. When severity was considered, a child who was severe enough for their carer to be eligible to receive Carer Payment had 22.8 medical services visits and 5.5 pharmaceutical prescriptions over a two-year period in which their carer was eligible for Carer Allowance, and 23.5 medical services visits and 7.4 pharmaceutical prescriptions over a two-year period in which their carer was eligible for Carer Payment. In comparison, in the K cohort, children with language difficulties had 15.4 medical services visits and 3.1 pharmaceutical prescriptions over a two-year period compared with 13.5 services visits and 1.9 pharmaceutical prescriptions for a child with typical language. When severity was considered, children in the K cohort who was severe enough for their carer to receive Carer Payment had 20.5 medical services visits and 7.5 pharmaceutical prescriptions over a two-year period in which their carer was eligible for Carer Allowance and 20.4 medical services visits and 6.2 pharmaceutical prescriptions over a two-year period in which their carer was eligible for Carer Payment.

Table 8: Cross-tabulation of health utilisation (MBS, PBS), child's language and other measures by cohort (counts)

Definition	B cohort				K Cohort			
Outcome (1 if present)	MBS		PBS		MBS		PBS	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Typical language	17.3	0.1	1.8	0.1	13.5	0.1	1.9	0.0
Language difficulty	20.5	0.5	3.1	0.2	15.4	0.5	3.1	0.2
Language difficulty plus one other long-term medical condition	32.3	1.6	8.3	0.7	23.7	1.0	9.3	0.7
One condition other than language difficulties	27.4	0.9	6.4	0.6	19.7	0.6	5.6	0.3
Two or more conditions other than language difficulties	29.7	1.6	8.4	0.7	24.4	1.0	9.6	0.7
Carer Allowance	22.8	0.8	5.5	0.4	20.5	0.9	7.7	0.5
Carer Payment	23.5	1.5	7.4	0.7	20.4	1.0	6.2	0.5

Note. Based on weighted sample. Language and additional impairments are mutually exclusive. Carer Allowance and Carer Payment include any child who has a condition that is severe enough for their carer to be eligible for that particular benefit. MBS = Medicare Benefits Scheme; PBS = Pharmaceutical Benefits Scheme.

3.5.2.2 The effects of language difficulties on health utilisation: B cohort

Table 9, Table 10 and Table 11 show the coefficients for the independent variables of interest, language difficulties, additional impairments, and carers' benefits. The full estimation (Columns 5–8, Table 9) includes all covariates outlined in Panels B–D in Table 7. Columns 1 and 2 in Table 9 indicate the estimates for the association between total healthcare utilisation (in counts) and the child's language difficulties, based on cross-sectional GLM: Poisson and negative binomial (without any covariates)[xiv]. The model considered specification in the Poisson regression model by using the traditional log gamma distribution and a robust covariance matrix[112]. The results (Column 1, Table 9) show that a child with language difficulties had 17 per cent higher healthcare utilisation than a child with typical language. However, the test statistics (log-likelihood, Akaike information criterion (AIC), Bayesian information criterion (BIC) indicate that the pooled Poisson was not a good fit for the data. The pooled negative binomial model (Column 2, Table 9) provided a better fit than the Poisson. However, the negative binomial model still had a deviance above the 5 per cent critical value, indicating that the data exceeded the distributional assumption of the model. The

[xiv] Time and missing variables are considered in the base model.

introduction of panel data methods, fixed and random effects estimates, indicated a further improvement in the model fit (log-likelihood, AIC, BIC) (Columns 3 and 4, Table 9), and the results showed considerable changes to the estimates when compared with the pooled results. These results suggested that the estimates in a pooled analysis may be overestimated (Columns 3 and 4, Table 9). When the Hausman test was applied, the random effects model was rejected in favour of fixed effects[xv].

The other issue is that health utilisation (see Eq. 3.4.1.1) is not exogenously determined. The endogeneity derives from two issues. The first is one of omitted variable bias, in that healthcare utilisation and costs may be correlated with the error terms that capture the mother's and family's motivation or preferences. The prevalence table (Table 6) suggests that the baseline characteristics may systematically differ between children with language difficulties and children without language difficulties. For example, children from non-English speaking backgrounds, when compared with English speakers, have been found to perform poorly on receptive language assessments at early ages but to have higher rates of language acquisition growth. However, their parents are less likely to seek help for their child's difficulties[103,113-117]. Similarly, carers of children with low SES may be less likely to seek medical care from a GP and more likely to have a language difficulty driven by low educational opportunity[118]. This would bias the estimates downwards. The second source of endogeneity is an issue of reverse causality. In practice, although health status drives health utilisation, it is equally likely that more frequent trips to the GP may contribute to a lower level of self-reported health. This issue would bias health care upwards. Regression adjustment methods are typically used to account for systematic baseline differences between groups of interests and will be considered in this chapter (discussed in Chapter 2:). In addition, the panel nature of these data needs to be considered as well as the likely over-dispersion in the outcomes of interest.

As discussed in Section 3.5.1, the results of the fixed effects model estimation (Columns 4 and 8, Table 9) are more likely to shed light on the causal effect of children's language difficulties on healthcare utilisation, as this type of estimation can

[xv] $Chi^2(35) = (b - B)'[(V\_b - V\_B)^\wedge(-1)](b - B) = 379.97. Prob > chi^2 = 0.0000$

control for unobserved factors, such as the confounding effects of the child being from a non-English speaking background, as long as these do not change over time. When covariates were considered, the fixed effects model indicated that as a child developed language difficulties between the LSAC waves, the healthcare utilisation increased by 6.7 percentage points (Column 8, Table 9). When lagged health was considered, this reduced to a 4.4 percentage point difference.

The coefficient for Carer Allowance was large, positive and highly significant, which is unsurprising given that it is a fixed payment to help carers who are looking after a child with high care needs. Interestingly, the coefficient for Carer Payment was also large and positive, but there is evidence that these children do not consume as much health care as do children whose carers receive Carer Allowance. Carer Payment is an assets- and means-tested income support payment for carers, who, because of the demands of their caring role, are unable to fully participate in the labour force. Perhaps these results are showing the effects of socioeconomic disadvantage on families' reduced consumption of Medicare-related health care.

Children with additional disabilities or impairments also consumed significantly higher amounts of health care, most notably children with two or more impairments other than language difficulties.

Table 9: Total health utilisation and the children's language difficulties (2004, 2006, 2008, 2010, 2012, 2014) – B cohort (%)

	No Covariates				With Covariates				
Definition	Poisson (1)	NB (2)	NBRE (3)	NBFE (4)	Poisson (5)	NB (6)	NBRE (7)	NBFE (8)	NBFE (9) lag
1 if language difficulty	0.170**	0.154**	0.031*	0.0069	0.154**	0.143**	0.082**	0.067**	0.044*
	(0.027)	(0.020)	(0.016)	(0.017)	(0.023)	(0.018)	(0.014)	(0.015)	(0.018)
1 if language difficulty and one or more long-term medical conditions					0.093+	0.100*	0.091**	0.079*	0.017
					(0.049)	(0.047)	(0.033)	(0.035)	(0.039)
One long-term medical condition (other than language)					0.464**	0.486**	0.260**	0.192**	0.168**
					(0.032)	(0.027)	(0.020)	(0.021)	(0.024)
Two or more long-term medical conditions (other than language)					0.560**	0.561**	0.306**	0.232**	0.206**
					(0.047)	(0.044)	(0.031)	(0.033)	(0.036)
Carer Allowance					0.344**	0.358**	0.226**	0.170**	0.156**
					(0.042)	(0.030)	(0.025)	(0.028)	(0.032)
Carer Payment					0.313**	0.366**	0.183**	0.136**	0.113**
					(0.063)	(0.042)	(0.036)	(0.040)	(0.044)
Number of observations	28651	28651	28651	28650	24631	24631	24631	24352	19590
Log-likelihood	−272390	−109978	−105638	−79228	−201010	−95177	−92213	−66774	−50032
AIC	544795	219973	211296	158473	402081	190415	184491	133609	100127
BIC	544862	220040	211379	158539	402324	190658	184751	133852	100371

Note. Standard errors in parentheses. Sample size (9) is smaller due to lagged variable resulting in a loss of one wave of data. NB = negative binomial; NBRE = negative binomial random effects; NBFE = negative binomial fixed effects.
+significant at 10%. *significant at 5%. **significant at 1%.

Table 10 shows the results for the Medicare Benefits Scheme (MBS) and Pharmaceutical Benefits Scheme (PBS) health utilisation estimates separately, for the B cohort. The results indicate that the onset of language difficulties in this cohort increased MBS utilisation by 5 percentage points.

Table 10: MBS and PBS health utilisation and the children's language difficulties (2004, 2006, 2008, 2010, 2012, 2014) – B cohort (%)

Definition	MBS utilisation	PBS utilisation
	NBFE	
1 if language difficulty	0.049**	0.079+
	(0.018)	(0.041)
1 if language difficulty and one or more long-term medical condition	0.052	−0.103
	(0.039)	(0.074)
One long-term medical conditions (other than language)	0.138**	0.363**
	(0.024)	(0.050)
Two or more long-term medical conditions (other than language)	0.186**	0.390**
	(0.036)	(0.067)
Carer Allowance	0.132**	0.453**
	(0.032)	(0.059)
Carer Payment	0.072+	0.426**
	(0.043)	(0.072)
Number of observations	19590	10319
Log-likelihood	−48821	−12482
AIC	97705	25026
BIC	97949	25250

Note. Sample sizes omit observations where there is 0 in dependent variable for all waves. Standard errors in parentheses. NBFE is a conditional fixed effects model. NBFE = negative binomial fixed effects. PBS=Pharmaceutical MBS= Medical services
+significant at 10%. *significant at 5%. **significant at 1%.

When the type of medical service was considered (Table 11), the results indicated that GP visits (Column 1, Table 11), paediatric visits (Column 3, Table 11) and speech pathology were associated with 5 percentage points, 19 percentage points and 74 percentage points higher utilisation, respectively, compared with children with typical language. For children whose carer received a carers' benefit, the results showed that total health care appeared to be driven by pharmaceutical usage, paediatrician visits and mental health providers.

Table 11: MBS health utilisation by service and the children's language difficulties (2004, 2006, 2008, 2010, 2012, 2014) - B cohort (%)

	GP (1)	Other specialists (2)	Paediatrician (3)	Mental health (4)	Speech pathology (5)	Other (6)	Hospital (7)
Definition				NBFE			
1 if language difficulty	0.049**	−0.007	0.191**	0.171	0.746**	−0.008	0.102
	(0.018)	(0.075)	(0.071)	(0.170)	(0.209)	(0.031)	(0.110)
1 if language difficulty and one or more long-term medical conditions	0.080*	0.184	−0.067	0.293	0.702*	0.0853	−0.005
	(0.039)	(0.128)	(0.095)	(0.225)	(0.345)	(0.065)	(0.200)
One long-term medical condition (other than language)	0.067**	0.254**	0.831**	0.446**	−0.094	0.065	0.428**
	(0.024)	(0.086)	(0.068)	(0.136)	(0.313)	(0.040)	(0.123)
Two or more long-term medical conditions (other than language)	0.123**	0.235+	0.840**	0.302	−0.026	0.127*	0.420*
	(0.035)	(0.124)	(0.089)	(0.194)	(0.408)	(0.059)	(0.181)
Carer Allowance	0.053	0.198	0.516**	0.382*	0.465	0.089+	−0.119
	(0.033)	(0.122)	(0.087)	(0.167)	(0.291)	(0.052)	(0.189)
Carer Payment	0.077+	−0.112	0.304**	0.188	0.850*	−0.047	−0.028
	(0.043)	(0.164)	(0.114)	(0.202)	(0.359)	(0.069)	(0.250)
Number of observations	19567	8192	7275	2531	686	19128	4981
Log-likelihood	−35269	−5143	−5304	−1522	−438	−26855	−3099
AIC	70600	10347	10671	3106	934	53773	6257
BIC	70844	10558	10885	3287	1065	54017	6446

Note. Sample sizes omit observations where there is 0 in dependent variable for all waves. Standard errors in parentheses. GP = general practitioner; NBFE = negative binomial fixed effects.
+significant at 10%. *significant at 5%. **significant at 1%.

3.5.2.3 The effects of language difficulties on health utilisation: K cohort

Table 12, Table 13 and Table 14 show the estimated coefficients for biennial healthcare utilisation for the K cohort. In terms of model fit, a similar pattern was observed for the K cohort for the pooled and panel fixed and random effect estimation, when compared with the B cohort. Of all of the results, the full estimation of the fixed effects model (Column 8, Table 12) provided the best model fit (as indicated by the AIC and the BIC). Based on the fixed effects model, the onset of language difficulties in this cohort was associated with an increase in healthcare utilisation of 6.7 percentage points, which is consistent with the effects observed for the B cohort[xvi]. However, Table 13 shows that only MBS utilisation was significantly higher at the onset of language difficulties in the K cohort, which differs significantly from the B cohort estimation results, which found significant differences in MBS utilisation. The coefficient for Carer Allowance was large, positive and highly significant in the unlagged health model. When lagged health was considered, this reduced the coefficient considerably. The coefficient for Carer Payment and additional impairments are also large, positive and highly significant, which is consistent with the results from the B cohort.

[xvi] Lagged health is not used in the K cohort model, as it was not significant.

Table 12: Total health utilisation and the children's language difficulties (2004, 2006, 2008, 2010, 2012, 2014) – K cohort (%)

	No covariates				With covariates			
Definition	Poisson (1)	NB (2)	NBRE (3)	NBFE (4)	Poisson (5)	NB (6)	NBRE (7)	NBFE (8)
1 if language difficulty	0.109**	0.095**	−0.003	−0.010	0.102**	0.099**	0.076**	0.067**
	(0.034)	(0.024)	(0.020)	(0.0212)	(0.028)	(0.023)	(0.019)	(0.020)
1 if language difficulty and one or more long-term medical conditions					0.000	0.004	0.038	0.023
					(0.041)	(0.042)	(0.030)	(0.033)
One long-term medical condition (other than language)					0.443**	0.455**	0.273**	0.204**
					(0.030)	(0.024)	(0.018)	(0.019)
Two or more long-term medical conditions (other than language)					0.580**	0.602**	0.329**	0.241**
					(0.045)	(0.041)	(0.029)	(0.031)
Carer Allowance					0.431**	0.408**	0.172**	0.0859+
					(0.077)	(0.060)	(0.047)	(0.051)
Carer Payment					0.366**	0.369**	0.222**	0.148**
					(0.059)	(0.043)	(0.036)	(0.040)
Number of observations					23715	23715	23715	23443
Log-likelihood					−183479	−86551	−84153	−60580
AIC					367022	173167	168374	121225
BIC					367280	173425	168648	121483

Note. Model convergence not achieved with lagged variable. Standard errors in parentheses. NB = negative binomial; NBRE = negative binomial random effects; NBFE = negative binomial fixed effects.
+significant at 10%. *significant at 5%. **significant at 1%.

Table 13: MBS and PBS health utilisation and the children's language difficulties (2004, 2006, 2008, 2010, 2012, 2014) - K cohort (%)

Definition	MBS utilisation	PBS utilisation
	NBFE	
1 if language difficulty	0.076**	0.0298
	(0.020)	(0.040)
1 if language difficulty and one or more long-term medical conditions	0.045	−0.088
	(0.033)	(0.055)
One long-term medical condition (other than language)	0.171**	0.329**
	(0.019)	(0.037)
Two or more long-term medical conditions (other than language)	0.216**	0.414**
	(0.031)	(0.054)
Carer Allowance	0.021	0.487**
	(0.052)	(0.089)
Carer Payment	0.114**	0.446**
	(0.041)	(0.068)
Number of observations	23443	14029
Log-likelihood	−58792	−16468
AIC	117648	33000
BIC	117906	33242

Note. Sample sizes omit observations where there is 0 in dependent variable for all waves. Standard errors in parentheses. NBFE = negative binomial fixed effects. NBFE is a conditional fixed effects model. PBS=Pharmaceutical MBS= Medical services
+significant at 10%. *significant at 5%. **significant at 1%

Table 14 explores this further, with estimates for the type of medical services and pharmaceuticals that children utilised. Most notably, the results indicated that visits to a GP (Column 1, Table 14), other specialists (Column 2, Table 14) and paediatricians (Column 3, Table 14), and speech pathology services (Column 6, Table 14) were 6.3 percentage points, 20 percentage points, 18 percentage points and 85 percentage points higher, respectively, at the onset of language difficulties. For children whose carer received a carers' benefit, the results showed that visits to a paediatrician were 54 per cent and 59 per cent higher at the point of eligibility for Carer Allowance and Carer Payment respectively.

Table 14: MBS health utilisation by service and the children's language difficulties (2004, 2006, 2008, 2010, 2012, 2014) – K cohort (%)

Definition	GP (1)	Other specialists (2)	Paediatrician (3)	Mental health (4)	Speech pathology (6)	Other (7)	Hospital (8)
	NBFE						
1 if language difficulty	0.063**	0.199**	0.176*	0.127	0.848*	0.068*	0.203+
	(0.020)	(0.075)	(0.074)	(0.159)	(0.373)	(0.031)	(0.117)
1 if language difficulty and one or more long-term medical condition	0.053	0.0899	−0.142+	−0.124	0.081	0.038	−0.001
	(0.034)	(0.106)	(0.079)	(0.197)	(0.486)	(0.054)	(0.161)
One long-term medical conditions (other than language)	0.097**	0.426**	0.683**	0.493**	0.781	0.136**	0.330**
	(0.019)	(0.065)	(0.059)	(0.125)	(0.501)	(0.031)	(0.097)
Two or more long-term medical conditions (other than language)	0.131**	0.302**	0.879**	0.711**	0.926+	0.188**	0.289+
	(0.032)	(0.105)	(0.078)	(0.175)	(0.554)	(0.048)	(0.154)
Carer Allowance	0.0129	0.041	0.541**	0.145	0.070	−0.037	−0.109
	(0.054)	(0.186)	(0.130)	(0.259)	(0.618)	(0.077)	(0.272)
Carer Payment	0.106*	−0.023	0.591**	0.170	0.928+	0.079	−0.025
	(0.0419)	(0.149)	(0.108)	(0.233)	(0.563)	(0.061)	(0.225)
Number of observations	23410	10759	7902	3423	307	22874	6371
Log-likelihood	−42068	−6805	−5867	−1918	−165	−33560	−3899
AIC	84201	13675	11799	3898	388	67185	7863
BIC	84459	13908	12022	4089	496	67442	8079

Note. Sample sizes omit observations where there is 0 in dependent variable for all waves. Standard errors in parentheses. NBFE is a conditional fixed effects model. GP = general practitioner; NBFE = negative binomial fixed effects; AIC = Akaike information criteria; BIC = Bayesian information criterion.

+significant at 10%. *significant at 5%. **significant at 1%.

3.5.3 Summary of findings

This analysis has investigated the cross-sectional and longitudinal relationship between healthcare utilisation and children's language difficulties using the 2003–2014 Medicare-linked LSAC. This study found that the fixed effects offered the best fit in terms of dealing with heterogeneity in a panel data specification.

The first set of findings is that in both the B cohort and the K cohort, there is a consistent positive relationship between a child's language difficulties and their utilisation of medical services. Notably, children in both cohorts seek more primary care services at the onset of language difficulties, and this is observed in conjunction with higher referral rates to paediatricians and speech pathologists. For the K cohort children with language difficulties, the increased demand in primary care is observed in parallel with demand for additional specialist services.

Children with language difficulties and who meet the eligibility criteria for carers' benefits have consistently higher medical services and pharmaceutical usage than children with language difficulties whose carers do not receive benefits.

The next section explores whether increased health utilisation is associated with increased health expenditure for children with and without language difficulties.

3.6 Health expenditure model[xvii]

3.6.1 Medical, pharmaceutical and hospital utilisation

Health care in Australia is funded through a combination of state and federal governments (70 per cent), private insurance (13 per cent) and individual out-of-pocket expenses (17 per cent)[119]. The federal government funds a public insurance scheme for all Australians (Medicare), which provides subsidised access to medical services provided in the community (MBS), free public hospital treatment (which is also partly funded by state governments) and subsidised access to pharmaceuticals (PBS). In addition, a second tier includes partially government-subsidised privately funded health insurance, which covers private hospital services and a portion of allied health services. Co-payments (a portion of the total service fee payable by the patient) apply to many services.

3.6.1.1 Calculation of medical service fees

The MBS is designed to fund in-hospital and out-of-hospital medical services provided by private practitioners on a fee-for-service basis. Currently, the MBS contributes a rebate of 85 per cent of the fee set under the Medicare Benefits Schedule for out-of-hospital services, non-GP services and 75 per cent of the fee for services incurred in hospitals. Providers are free to set their own fees, above the Medicare Schedule fee, in which case the excess cost is borne by the patient. For some services, private health insurance will cover the gap between the Medicare schedule fee and the provider's fee. Some GPs send their patients' bills to the Health Insurance Commission, which accepts the Medicare Schedule fee[xviii] as payment in full. This is known as bulk-billing, and patients who attend bulk-billing doctors incur no out-of-pocket costs[120].

Medicare contributes a rebate (or 'benefit') towards services provided by paediatricians, other specialist physicians, speech pathologists, psychologists and other allied health providers if services are accessed via a GP. With the exception of paediatricians and other specialist physicians, the GP nominates the number of services up to a maximum

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[xviii] Since January 2005 GPs who bulk-bill receive 100 per cent of the MBS schedule fee for GP services. All other providers receive 85 per cent of the MBS schedule fee (MBS benefit) for bulk-billing.

of five per calendar year, for assessment and/or collaboration in the development of a treatment and management plan[121]. The provider determines the patient's co-payment, and most patients will incur a co-payment.

Patients can purchase private health insurance, which covers a proportion of the out-of-pocket expenses for private hospital visits and inpatient MBS services (includes private patient in a private or public hospital). Private health insurance also covers a proportion of out-of-pocket expenses for outpatient medical services where the service is not eligible for a Medicare benefit (private allied health services, including speech pathology). Private allied health service data are not available in the LSAC dataset.

Speech pathology and psychology services can also be accessed through community health centres and schools, depending on the state in which the patient resides. Community health centres are part of the state-funded health system, and patients attending these services at community health centres or receiving services through the the state education system do not incur any out-of-pocket costs.

3.6.1.2 Calculation of pharmaceutical fees

In Australia, pharmaceuticals are subsidised by the federal government via the PBS. Currently, over 90 per cent of prescribed medicines are listed on the PBS[122]. Patients pay a co-payment determined by their concessional status (A$6.10 concession and A$37.70 non-concession in 2014)[119].

For this analysis, all MBS and PBS items were retrieved for individuals in the LSAC from 1 January 2003 until 31 December 2014. Costs in the Medicare-linked dataset are reported at an item level and include the Medicare benefit and the PBS subsidy of the total service fee only, for all children who consented to have their data linked (93%)[86]. Pharmaceuticals were classified according to the Anatomical Therapeutic Chemical (ATC) classification system. These categories included alimentary tract, antibiotics, respiratory, dermatological, nervous system, sensory and hormonals (excluding sex hormones), creams, musculoskeletal, anti-parasitic, and other (defined as 'various' by the ATC classification system).

In terms of medical services, there are no standard definitions. Medical services were broadly based on medical and surgical specialist categories[123], which identify provider specialty. The exception to this is the category of mental health, which included both psychology and mental health services provided by GPs. MBS visits (both in hospital and out of hospital) were defined as GP visits, paediatrician, other specialists, allied health (excluding speech pathology), mental health, speech pathology, diagnostics (minor procedures, diagnostic tests, imaging and pathology) and anaesthetics.

Table 15 summarises the funding arrangements of medical, pharmaceutical and hospital services in Australia. This analysis captures visits to GPs, specialist physicians (including paediatricians) and psychology services (Line 1, Table 15); MBS-funded speech pathology, early intervention services and specialist services, which are accessed through GPs (Line 4, Table 15); and hospital visits for patients with health insurance (Line 2, Table 15). State-funded community health (Line 4, Table 15) and educationally based providers (Line 4, Table 15), and private non-referred health services (Line 5, Table 15) are not accounted for in these analyses as they are not included in the dataset. The AIHW estimates that approximately 10 per cent of all primary healthcare costs are from state-funded community health services and a further 4.5 per cent are from private non-referred health services[119].

Table 15: Funding of medical, pharmaceutical and hospital services

	Service	State government	Federal government (Medicare)	Health insurance	Patient (co-payment[a])
	Medical services (MBS)				
1	Out of hospital		✔		✔
2	In hospital		✔	✔[1]	✔
3	Pharmaceuticals (PBS)		✔		✔
4	Community health/educational	✔(X)	✔		
5	Other allied health (non- referred)			✔(X)	✔
	Hospital visits				
6	Public	✔(X)			
7	Private (in public or private hospital)			✔[1]	✔

Note: Data are available for all children for whom parents consented to have data linkage (93%)[86]. MBS = Medicare Benefits Schedule; PBS = Pharmaceuticals Benefits Schedule; X = not in the analyses.
[a] Calculated as part of the analysis.

Healthcare expenditure is defined as the sum of total service fees for medical services, pharmaceuticals, and hospital costs (determined by the sum of the MBS rebate and the PBS subsidy and a calculated co-payment). Out-of-pocket costs (sum of all co-payments) were reported as the portion of total service fees that were paid for by the family on behalf of the child. Overall, out-of-pocket costs represented approximately 25 per cent of total healthcare costs in the analysis. The AIHW estimated that individual out-of-pocket costs in 2011 made up 28 per cent of total federal government health expenditure. Given that the sample of interest is children, for whom there is likely to be a higher rate of bulk-billing, the calculated out-of-pocket costs are consistent with the literature[119].

3.6.1.3 Calculation of total service fees and out-of-pocket costs

Due to data limitations, the total service fee for each medical service was not available in the LSAC-linked dataset. For the purposes of the analysis, out-of-pocket costs were estimated. Table 16 summarises the assumptions made to calculate total service fees and co-payments. Of the total available Medicare records (~829,000), 70 per cent of items were bulk-billed; that is, health service providers accepted the Medicare benefit as full payment for the service'[xix]. For these items, no further assumptions need to be made

[xix] Bulk-billing refers to when the service provider accepts the MBS benefit as full payment for services.

(Line 4, Table 16). For the remainder of the medical service items (30 per cent), assumptions needed to be made about the total service fee (i.e., the additional co-payment).

3.6.1.3.1 Total service fees

The Australian Medical Association (AMA) publishes a suggested schedule of fees for its members for in-hospital and out-of-hospital medical services. The AMA schedule of fees (2014)[124] was matched to the LSAC Medicare records using individual MBS item numbers (Line 1, Table 16). This matching allowed 22 per cent (~192,000) of items to be matched. For the remaining 8 per cent, the LSAC Medicare total service fee needs to be estimated. To calculate the total service fee for the remaining 8 per cent of the MBS item numbers, an Medicare Schedule fee service fee multiplier was generated, using the matched Medicare records for inpatient (Line 2, Table 16) and outpatient MBS item numbers (Line 3, Table 16). All Medicare expenditure was inflated to 2014 dollars, using the health component of the Australian Consumer Price Index[125].

3.6.1.3.2 Co-payments and out-of-pocket costs

To calculate patient co-payments and total out-of-pocket costs (sum of all co-payments), health insurance status needs to be considered. In the LSAC survey, parents were asked whether they have private health insurance in 2004 only. For this analysis, it is assumed that the health insurance status in 2004 remains constant throughout subsequent years (2006, 2008, 2010, 2012 and 2014). The constant rate of insurance is consistent with national estimates[126]. In Australia, health insurers publish their gap-cover fees by MBS item number annually. It was not possible to distinguish between the health insurance provider and the level of health insurance that participants had. Conservatively, it was assumed that those children who had health insurance had the maximum cover available. Using the private health insurer, Medibank Private's published gap-cover fees (2014), co-payments were calculated for all eligible item numbers[127]. For medical services that were eligible for health insurance cover (inpatient hospital stays, all private allied health providers and medical services conducted in hospital) co-payments were calculated as the medical service fee minus the MBS benefit minus the health insurance gap cover (Line 6, Table 16). For medical services that were not eligible for health insurance cover (outpatient medical services), co-payments were calculated as the medical service fee minus the Medicare benefit (Line 5, Table 16).

Table 16: Calculation of total service fees and co-payments

	Total service fee medical services	Calculated multiplier	Observations %
1	Total service fee = AMA schedule [a]	AMA schedule	22.0
2	Total service fee multiplier outpatient = AMA service fee/MBS benefit if AMA > MBS benefit	2.89	8.0
3	Total service fee multiplier inpatient = AMA service fee/Medicare benefit if AMA > MBS benefit	2.9	
4	Total service fee = Medicare benefit/MBS schedule fee [c]	bulk-billed/ concessional patient	7.0
	Co-payment		
5	Co-payment (outpatient) = Total service fee – MBS benefit		
6	Co-payment (inpatient services and eligible outpatient) = Total service fee – MBS benefit – health insurance gap cover2		

Note. AMA = Australian Medical Association; Adapted from a. AMA schedule of fees 2014[124] b. Medibank Private Gap Cover 2014[127]. c. Medicare service fee = Medicare benefit for GP bulk-billed consultations. From January 2005, the Medicare benefit paid to a GP for almost all services (whether bulk-billed or not) increased from 85% to 100% of the Medicare Schedule fee. This meant that GPs received an extra 15% for both bulk-billed and non–bulk-billed patients. Total Service fee = Medicare benefit for services (GP and non-GP) when the patient has healthcare concessional status and has not been bulk-billed. Medicare schedule fee = Medicare benefit * 1.15 for outpatient services. Medicare schedule = Medicare benefit *1.25 for inpatient services[119].

Table 17 provides examples of how the total service fee and the co-payments were calculated. For example, a GP charges a total service fee of $58 (Line 1, Table 17). The Medicare benefit is $37.10 and the resulting co-payment is $20.90. If the GP has chosen to bulk-bill, the total service fee is equal to the Medicare benefit, and the co-payment is 0 (Line 2, Table 17).

With regard to inpatient service (Line 6, Table 17), a physician charges $178 for an inpatient service. The Medicare benefit is $82.50. For a patient without health insurance, the co-payment for this service is $95.50 ($178 – $82.50). If the patient has private health insurance, the gap cover pays up to $145.75 of the service fee, which means the patient's co-payment expense is $32.30 ($178 – $145.70)

Pharmaceutical co-payments are calculated based on the patient's concessional status. For example, antibiotic 1891M has a total fee of $14.70. A concessional patient will pay a flat co-payment of $6.10, and the PBS subsidy will be $8.60 ($14.70 – $6.10). A general patient will pay up to $37.10 in a co-payment for any pharmaceutical. In this example, the general patient pays the full PBS service fee of $14.70 for antibiotic 1891M. A patient's out-of-pocket expense is the sum of the co-payments for the six time periods available in the LSAC, 2003–2004, 2005–2006, 2007–2008, 2009–2010, 2011–2012 and 2013–2014.

Table 17: Examples of calculation of total service fees

Provider		Medicare benefit /PBS subsidy $	Co-payment $	Total service fee $
GP				
1	Outpatient 5–15 minute (MBS23)	37.1	20.9	58.0
2	5–15 minute bulk-billed (MBS23)	37.1	0.0	37.1
Speech pathology				
3	1 hour appointment (MBS10970)	53.0	100.2	153.2
Pharmaceuticals				
4	Antibiotic (GEX) 1891M	0.0	14.7	14.7
5	Antibiotic (COC) 1891M	8.6	6.1	14.7
Hospital				
6	(Ear nose and throat) with health insurance (MBS41500)	82.5	32.3	178.0

Note. MBS = Medical Benefits Schedule

1. based on AMA schedule of fees[124]

2. GPs receive Medicare benefit + bulk-billing incentive for services that are bulk-billed. In January 2005, the Medicare benefit paid to a GP for services (whether bulk-billed or not) increased from 85 per cent to 100 per cent of the Medicare Schedule fee.

3. Assumed a co-payment contribution rate for outpatient = Median (AMA list of medical fees/Medicare benefit)* Medicare benefit if service is out of hospital[121]

4, 5. GEX = general patient; COC = concessional patient. GEX pays first $37.10; COC pays first $6.10. If PBS subsidy = 0 (i.e., co-payment threshold is not reached, it does not appear in the data)[121]

6. Assumed health insurance gap cover $145.75[127]

The outcome variables of interest for these analyses are total healthcare expenditure and out-of-pocket expenditure filed in the last two calendar years. These capture all the services and prescriptions for the time periods 2003–2004, 2005–2006, 2007–2008, 2009–2010, 2011–2012 and 2013–2014.

Table 18 shows a cross-tabulation of health expenditure—in particular the cost of medical services visits and pharmaceutical prescriptions—and a child's language status. The table shows that, on average, biennial health expenditure was higher in the B cohort than in the K cohort across all measures. In the B cohort, a child with language difficulties had expenses of $2,179 over a two-year period, compared with $1,945 for a child with language difficulties in the K cohort. Interestingly, children in the K cohort with language difficulties compared with those in the K cohort with typical language had higher total expenditure ($2,070 cf. $1,945) and lower out-of-pocket costs ($363 cf. $407). One explanation for this is that children with language difficulties are more likely to be bulk-billed, and although their visits are higher, this may not be reflected in higher overall costs. An alternative explanation is that their service mix is different, and they are seeing different providers at different ages, which is consistent with the profile observed in Sections 3.5.2.2 and 3.5.2.3.

Last, Table 18 shows that those children with language difficulties and other long-term medical conditions and those with language difficulties whose carer receives a carers' benefit, have considerably higher healthcare costs than children with language difficulties alone, which is consistent with the higher number of services shown in Table 8. This highlights the importance of considering language definitions carefully in this analysis in order to best capture the language-related utilisation (discussed further in Section 3.7).

Table 18: Cross-tabulation of health expenditure and out-of-pocket (total medical services + pharmaceuticals + hospital) against child's language, by cohort ($)

	B Cohort				K Cohort			
Outcomes (1 if condition is present)	Total expenditure		Out-of-pocket		Total expenditure		Out-of-pocket	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Typical language	$2,179	$23	$437	$6	$1,945	$24	$407	$6
Language difficulties	$2,173	$65	$354	$13	$2,070	$81	$363	$19
Language plus one other long-term medical condition	$4,982	$292	$852	$70	$4,088	$242	$654	$57
One condition other than language	$4,469	$180	$854	$46	$3,251	$112	$632	$30
Two or more conditions other than language	$5,247	$329	$976	$86	$4,402	$233	$733	$47
Carer Allowance	$3,597	$176	$663	$48	$3,722	$209	$600	$44
Carer Payment	$3,903	$281	$609	$63	$3,309	$241	$556	$56

Note. Based on a weighted sample. Language and additional impairments are mutually exclusive. Carer Allowance and Carer Payment include any child who has a condition that is severe enough to be eligible for a carers' benefit. SE = standard error.

3.6.2 Econometric framework

This second analysis examines whether the healthcare expenditure spent on children who have language difficulties is different from healthcare expenditure spent on children with typical language, using pooled OLS and generalised linear and fixed effects models. Goodness of fit statistics were used to compare these models with fixed effects models, providing the best model fit[110]. The fixed effects specification is as follows:

$$Y_{it} = B_0 + B_1 H_{it} + B_2 X_{it^n} + u_i + e_{ij} \qquad (3.6.2.1)$$

$$n = 1,2,3$$

H_{it} is the language difficulty or other impairment status of the child. X_{it^n} is the explanatory variables of the household $(n = 1)$, mother $(n = 2)$ and child $(n = 3)$, which are consistent with the variables identified in Eq. 3.5.1. u_i is the fixed effects for each mother, child and household, and e_{ij} is the unobserved time-varying explanatory variables.

3.6.3 Results

3.6.3.1 The effects of language difficulties on health expenditure – B cohort

Table 19 and Table 20 present the coefficients for the independent variable of interest: language difficulties, other medical conditions and Carer Payment. Columns 1–4 in each of the two tables show the coefficients of interest, without any covariates (other than time). The full estimation (Columns 5–8) includes all covariates outlined in Panel B to Panel D in Table 7. As an example, the full results of the regression analyses for healthcare expenditure are presented in Appendix D.

3.6.3.1.1 Total Healthcare Expenditure

Table 19 shows the estimated coefficients for biennial healthcare expenditure for the B cohort. The first column in Table 19 indicates the estimates for the association between healthcare expenditure and the child's language difficulties based on pooled models: OLS, without any covariates (other than time). The pooled results showed that a child with language difficulties had $179 more expenditure than a child with typical language, when background characteristics were considered. There were some differences observed when the equations were estimated using panel data models: random effects, GLM and fixed effects (Columns 6, 7 and 8, Table 19). The panel data effects were smaller than the pooled effects and were largely consistent . One exception is the lagged FE results (Column 9), which showed that healthcare expenditure differences were not significantly different at a p-value of 0.05. As discussed in Section 3.5.1, the reason for this is that the lagged model excludes Wave 1 of the data, which is a driver of overall consumption in these children. The lower goodness of fit statistics in this model are largely driven by the reduced number of overall observations.These results are presented as a robustness check only.

These fixed effects showed that as a child developed language difficulties between the LSAC waves, the healthcare expenditure increased by $233 when compared with a child with typical language[xx]. For children with language difficulties severe enough for their carer to receive a carers' benefit, they consumed $663 and $918 higher healthcare costs than a child whose carer did not receive a carers' benefit, for Carer Allowance and

[xx] Lagged health variables were omitted from this analysis as there were no significant effects.

Carer Payment respectively.

Table 19: Healthcare expenditure and the children's language difficulties (2004, 2006, 2008, 2010, 2012, 2014) – B cohort ($)

	No covariates				With covariates				
	OLS (1)	RE (2)	GLM (3)	FE (4)	OLS (5)	RE (6)	GLM (7)	FE (8)	FE (9) lag
1 if language difficulty	$16.3	$55.0	$16.5	$77.8	179.0**	320.1**	147.2**	232.8**	$115.8+
	(−$69.0)	(−$51.8)	(−$57.0)	(−$68.5)	(−$66.2)	(−$51.9)	(−$57.0)	(−$65.9)	(−$69.3)
1 if language difficulty and one or more long-term medical conditions					$34.7	468.4+	$74.4	$185.5	$24.6
					(−$345.7)	(−$255.4)	(−$141.7)	(−$284.9)	(−$293.0)
One long-term medical condition (other than language)					$2,188.1**	$1,444.9**	800.2**	$1,285.8**	1104.4**
					(−$200.7)	(−$137.0)	(−$112.8)	(−$179.6)	(−$188.9)
Two or more long-term medical conditions (other than language)					$2,914.9**	$1,996.0**	889.4**	$1,566.0**	$1,333.1**
					(−$336.0)	(−$258.0)	(−$162.5)	(−$307.5)	(−$318.2)
Carer Allowance					$1,111.6**	$1,208.3**	536.9**	$662.8**	$704.9**
					(−$161.9)	(−$185.7)	(−$127.1)	(−$246.4)	(−$267.1)
Carer Payment					$1,295.5**	$1,091.6**	753.5**	$917.5**	$872.2**
					(−$261.4)	(−$225.5)	(−$161.2)	(−$282.7)	(−$283.7)
Number of observations	19510	28651	19495	19510	19510	24631	19495	19510	16254
Chi-squared	0.013			0.024	0.139			0.067	0.051
Log-likelihood	−182350			−176023	−181014			−175578	−145186
Sigma_u		1569		1928		1439		2229	1858
Sigma_e		2106		2197		2105		2148	2051
rho								0.518	0.451
AIC	364716			352058	362089			351204	290423
BIC	364779			352105	362325			351393	290615

Note. Robust standard errors in parentheses. Weighted for attrition. RE model does not allow pweights with maximum likelihood estimation. Sample size will be higher.OLS = ordinary least squares; RE = random effects; GLM = generalised linear model; FE = fixed effects; AIC = Akaike information criterion; BIC = Bayesian information criterion.
+significant at 10%. *significant at 5%. **significant at 1%.

3.6.3.1.2 Out-of-pocket expenditure

Table 20 shows the out-of-pocket expenditure for a child with language difficulties. There were some differences observed for out-of-pocket expenditure across both pooled and panel data models when background characteristics were considered. Based on the fixed effects model (Column 8, Table 20), the results showed that as a child develops language difficulties, the out-of-pocket expenditure increases $48, when compared to a child with typical language. There were no significant differences in out-of-pocket costs observed for children with and without language difficulties plus one or more medical conditions. For children with language difficulties severe enough to meet the eligibility criteria for carers' benefits, they had $175 and $132 higher out-of-pocket healthcare costs than a child without carers' benefits, for recipients of Carer Allowance and Carer Payment respectively.

Table 20: Out-of-pocket expenditure and the children's language difficulties (2004, 2006, 2008, 2010, 2012, 2014) – B cohort ($)

	No covariates				With covariates				
	OLS (1)	RE (2)	GLM (3)	FE (4)	OLS (5)	RE (6)	GLM (7)	FE (8)	FE (9) lag
1 if Language difficulty	−71.9**	−$7.3	−22.61+	$15.8	$3.2	$51.3**	−$1.1	$48.2**	$26.1
	(−$14.4)	(−$12.4)	(−$12.4)	(−$15.5)	(−$14.1)	(−$12.8)	(−$12.8)	(−$15.5)	(−$16.8)
1 if language difficulty and one or more long-term medical conditions					−$90.3	$33.1	−$11.6	$9.0	−$24.3
					(−$84.6)	(−$68.9)	(−$35.9)	(−$78.2)	(−$76.0)
One long-term medical condition (other than language)					$443.3**	$317.6**	$154.0**	$287.7**	$254.0**
					(−$50.7)	(−$36.8)	(−$23.2)	(−$45.3)	(−$45.8)
Two or more long-term medical conditions (other than language)					$605.4**	$450.6**	$190.7**	$344.9**	$292.1**
					(−$88.5)	(−$72.8)	(−$38.2)	(−$81.7)	(−$82.1)
Carer Allowance					$180.6**	$216.6**	$104.5**	$174.6**	$193.7**
					(−$43.7)	(−$49.2)	(−$31.7)	(−$63.4)	(−$71.4)
Carer Payment					$124.1*	$150.1*	$128.4**	$132.1*	$133.5*
					(−$61.2)	(−$60.2)	(−$37.9)	(−$63.0)	(−$65.0)
Number of observations	19510	28651	19495	19510	19510	24631	19495	19510	16254
Chi-squared	0.029			0.050	0.129			0.077	0.074
Log-likelihood	−155850			−150179	−154797			−149893	−124053
Sigma_u		373		484		312		1600	483
Sigma_e		552		584		570		576	559
rho								0.885	0.427
AIC	311716			300370	309654		.	299835	248155
BIC	311779			300417	309890			300024	248348

Note. Robust standard errors in parentheses. Weighted for attrition. RE model does not allow pweights with maximum likelihood estimation. Sample size will be higher. OLS = ordinary least squares; RE = random effects; GLM = generalised linear model; FE = fixed effects; AIC = Akaike information criterion; BIC = Bayesian information criterion.
+significant at 10%. *significant at 5%. **significant at 1%.

When type of healthcare expenditure was considered, the fixed effects model indicated that as a child first developed language difficulties between the LSAC waves, MBS expenditure increased by $190, with $45 of this expense paid for by the family (Columns 1 and 2, Table 21). PBS expenditure increased by $43, with $3 of this expense paid for by the family (Columns 3 and 4, Table 21). Children with language difficulties severe enough for their carer to receive Carer Allowance had medical services costs $627 higher. Children whose carer received Carer Payment had medical services costs $691 higher and pharmaceutical costs $227 higher than non-carers at the onset of the condition.

Table 21: Medical services and pharmaceutical healthcare and out-of-pocket expenditure and the children's language difficulties (2004, 2006, 2008, 2010, 2012, 2014) – B cohort ($)

	MBS expenditure	MBS OOP	PBS expenditure	PBS OOP
	FE			
1 if Language difficulty	$190.0**	$44.7**	$42.75*	$3.4*
	-$59.3	-$15.3	-$19.2	-$1.5
1 if language difficulty and 1 or more long term medical condition	$227.4	$13.1	-$41.8	-$4.1
	-$264.0	-$76.1	-$73.2	-$10.5
1 long term medical condition (other than language)	$1,050.6**	$255.8**	$235.1**	$31.86**
	-$152.7	-$42.4	-$52.0	-$6.0
2 or more long term medical condition (other than language)	$1,367.3**	$317.4**	$198.7**	$27.5**
	-$289.2	-$80.0	-$71.4	-$6.7
Carers Allowance	$627.2**	$166.7**	$35.6	$7,868+
	-$206.0	-$62.1	-$81.3	-$4.6
Carers Payment	$690.9**	$117.3+	$226.6*	$14.9*
	-$249.9	-$61.6	-$106.6	-$6.5
Number of observations	19510	19510	19510	19510
Chi-squared	0.065	0.076	0.024	0.027
Log likelihood	-174445	-149538	-145959	-105051
Sigma_u	9022	3755	1595	107
Sigma_e	2027	566	471	58
Rho	0.952	0.978	0.920	0.773
AIC	348941	299124	291967	210152
BIC	349138	299313	292164	210349

MBS= Medical Benefit Scheme, PBS= Pharmaceutical Benefits Scheme, OOP= Out-of-pocket. Weighted for attrition. AIC= Akaike Information Criterion, BIC= Bayesian Information Criterion

3.6.3.2 The effects of language difficulties on health expenditure – K cohort

3.6.3.2.1 Healthcare Expenditure

Table 22 shows the estimated coefficients for biennial healthcare expenditure for the K cohort. The first column in Table 22 indicated the estimates for the association between healthcare expenditure and the child's language difficulties based on pooled models: OLS, without any covariates (other than time). The pooled and panel results showed that a child with language difficulties had no higher expenditure when compared with a child with typical language.

When covariates were considered in the model (Columns 4–8, Table 22) there was a consistent pattern in effects across from both pooled and panel models. The fixed effects model showed that as a child developed language difficulties between the LSAC waves, the healthcare expenditure increased by $245 when compared to a child with typical language. The expenditure remained consistent with the inclusions of a lagged health variable (Column 9, Table 22). There were no significant differences observed for children with and without language plus one of more medical conditions. For children with language difficulties severe enough to meet the eligibility criteria for carers' benefits, they had $715 and $744 higher healthcare costs than a child without carers' benefits, for Carer Allowance and Carer Payment respectively (Column 8, Table 22).

Table 22: Healthcare expenditure and the children’s language difficulties (2004, 2006, 2008, 2010, 2012, 2014) – K cohort ($)

	No covariates				With covariates				
	OLS (1)	RE (2)	GLM (3)	FE (4)	OLS (5)	RE (6)	GLM (7)	FE (8)	FE (9) lag
1 if Language difficulty	$88.9	−$15.3	$114.8	$89.8	$235.8**	$217.6**	$253.9**	$245.2**	$246.8**
	($84.4)	($53.8)	($76.0)	($82.0)	($79.6)	($57.0)	($72.6)	($78.3)	($89.5)
1 if Language difficulty and one or more long-term medical condition					$249.7	$103.0	−$23.5	$57.0	−$10.3
					($242.5)	($169.8)	($117.0)	($251.4)	($306.2)
One long-term medical condition (other than language)					$1,301.5**	$970.4**	$677.1**	$733.6**	$747.1**
					($114.7)	($91.0)	($62.2)	($108.5)	($125.7)
Two or more long-term medical conditions (other than language)					$1,941.6**	$1,601.6**	$753.6**	$976.4**	$858.9**
					($224.0)	($183.9)	($107.1)	($208.1)	($251.7)
Carer Allowance					$1,191.7**	$1,140.6**	$550.1**	$715.1**	$553.8*
					($203.4)	($193.0)	($111.8)	($233.4)	($244.8)
Carer Payment					$995.2**	$772.7**	$576.6**	$744.1**	$623.3**
					($221.2)	($164.1)	($129.1)	($211.0)	($215.9)
Number of observations	18338	27618	18316	18338	18338	23697	18316	18338	15275
Chi-squared	0.028			0.052	0.129			0.081	0.080
Log-likelihood	−171674			−166179	−170678			−165893	−138508
Sigma_u		1441		2031		1282		1927	2083
Sigma_e		2230		2286		2262		2252	2348
rho		0.295		0.441		0.243		0.423	0.440
AIC	343362			332371	341416			331839	277068
BIC	343417			332418	341650			332042	277267

Note. Robust standard errors in parentheses. Weighted for attrition. RE model does not allow pweights with maximum likelihood estimation. Sample size will be higher. OLS = ordinary least squares; RE = random effects; GLM = generalised linear model; FE = fixed effects; AIC = Akaike information criterion; BIC = Bayesian information criterion.

+significant at 10%. *significant at 5%. **significant at 1%.

3.6.3.2.2 Out-of-pocket expenditure

Table 23 depicts the out-of-pocket expenditure (portion of healthcare expenditure paid by the family) for a child with language difficulties. The effects became larger when panel data methods were considered. Based on the fixed effects model (Column 8, Table 23) the results showed that as a child develops language difficulties, the out-of-pocket healthcare expenditure increased to $62, when compared to a child with typical language. For children with language difficulties severe enough to meet the eligibility criteria for carers' benefits they had $131 and $118 higher out-of-pocket healthcare costs, for Carer Allowance and Payment respectively.

Table 23: Out-of-pocket expenditure and the children's language difficulties (2004, 2006, 2008, 2010, 2012, 2014) – K cohort ($)

	No Covariates				With Covariates				
Definition	OLS (1)	RE (2)	GLM (3)	FE (4)	OLS (5)	RE (6)	GLM (7)	FE (8)	FE (9) lag
1 if language difficulty	−$55.9**	−$37.7**	$0.9	$22.11	$21.5	$26.2+	$39.1*	$61.6**	$66.0**
	($19.5)	($13.1)	($17.1)	($21.7)	($18.8)	($14.1)	($16.5)	($20.3)	($22.9)
1 if language difficulty and one or more long-term medical condition					−$36.67	−$57.8	−$6.1	$25.1	$24.7
					($60.6)	($43.6)	($24.6)	($64.4)	($80.7)
One long-term medical conditions (other than language)					$280.4**	$247.9**	$145.8**	$191.0**	$209.7**
					($29.2)	($25.3)	($15.2)	($29.3)	($35.5)
Two or more long-term medical conditions (other than language)					$308.0**	$342.9**	$139.1**	$180.0**	$176.2**
					($52.1)	($50.1)	($22.9)	($51.4)	($61.5)
Carer Allowance					$89.9*	$106.9*	$59.7**	$131.5*	$104.8
					($44.1)	($41.5)	($23.0)	($58.2)	($65.8)
Carer Payment					$118.6*	$65.4	$91.7**	$118.4*	$106.6*
					($53.0)	($42.4)	($29.4)	($53.8)	($51.5)
Number of observations	18338	27618	18316	18338	18338	23697	18316	18338	15275
Chi-squared	0.050			0.078	0.119			0.099	0.098
Log-likelihood	−147456			−143258	−146777			−143051	−119673
Sigma_u		346		473		237		467	528
Sigma_e		624		655		651		648	684
rho		0.235		0.344		0.117		0.342	0.373
AIC	294926			286529	293614			286152	239399
BIC	294981			286576	293849			286348	239598

Notes: Robust standard errors in parentheses. Weighted for attrition. RE model does not allow pweights with maximum likelihood estimation. Sample size will be higher. OLS = ordinary least squares; RE = random effects; GLM = generalised linear model; FE = fixed effects; AIC = Akaike information criterion; BIC = Bayesian information criterion.
+ significant at 10%; *significant at 5%; **significant at 1%.

When type of healthcare expenditure was considered, the fixed effects model indicated that as a child first developed language difficulties between the LSAC waves, MBS healthcare utilisation increased by $241, with $60 of this expense paid for by the family (Columns 1 and 2, Table 24). There is little evidence of higher PBS utilisation for these children. However, as evidenced in the published paper (Appendix C) presenting mean values over all age groups may disguise wave-by-wave differences, and this is explored in Table 26. Children whose carers receive Carer Allowance have $529 higher MBS expenditure (Column 1, Table 24), at the onset of their condition, of which $119 (Column 2, Table 24) and $13 (Column 4, Table 24) is an out-of-pocket co-payment. Children whose carers receive Carer Payment have $542 higher MBS expenditure (Column 1, Table 24) and $202 (Column 3, Table 24) higher PBS expenditure, at the onset of their conditions, of which $119 (Column 2, Table 24) and $9 (Column 4, Table 24) are out-of-pocket co-payments.

Table 24: Medical services, pharmaceutical health care and out-of-pocket expenditure and children's language difficulties (2004, 2006, 2008, 2010, 2012, 2014) – K cohort ($)

	MBS expenditure	MBS OOP	PBS expenditure	PBS OOP
	FE			
1 if language difficulty	$240.8**	$60.1**	$4.4	$1.6
	($74.2)	($19.9)	($16.2)	($2.0)
1 if language difficulty and one or more long-term medical conditions	$64.7 ($223.8)	$35.8 ($63.0)	−$7.7 ($108.4)	−$10.6 ($6.7)
One long-term medical condition (other than language)	$659.6** ($101.5)	$166.2** ($28.6)	$73.9* ($35.1)	$24.8** ($4.1)
Two or more long-term medical conditions (other than language)	$711.2** ($188.7)	$151.5** ($50.6)	$265.2** ($65.2)	$28.5** ($5.3)
Carer Allowance	$529.1*	$118.8*	$186.1+	$12.7*
	($208.9)	($57.0)	($95.8)	($5.5)
Carer Payment	$542.2**	$109.7*	$202.0*	$8.7*
	($194.7)	($53.3)	($82.0)	($3.6)
Number of observations	18338	18338	18338	18338
Chi-squared	0.077	0.097	0.020	0.019
Log-likelihood	−165091	−142836	−137324	−98176
Sigma_u	1572	453	908	55
Sigma_e	2155	640	474	56
rho	0.347	0.334	0.786	0.494
AIC	330234	285723	274700	196404
BIC	330437	285919	274903	196607

Note. Weighted for attrition. MBS = Medical Benefit Scheme; PBS = Pharmaceutical Benefits Scheme; OOP = out-of-pocket; AIC = Akaike information criterion, BIC = Bayesian information criterion. + significant at 10%; *significant at 5%; **significant at 1%

3.6.4 Summary of findings

The findings show that, in both the B cohort and the K cohort, children with language difficulties had higher health care and out-of-pocket costs than children without language difficulties. In line with the results discussed in Section 3.5.2, this was due to children with language difficulties seeking more GP services in conjunction with increased referrals to paediatricians and speech pathology. For the K cohort children with language difficulties, the increased demand for primary care is in parallel with demand for additional specialist services.

Children with language difficulties whose carers are eligible for a carers' benefit have consistently higher MBS and PBS expenditure than children with impairments whose carers who are not eligible for benefits, which is consistent with the higher rates of services observed in Section 3.5.2.

3.7 Heterogeneity in the association between children's language difficulties and healthcare utilisation and expenditure

There are a number of sources of heterogeneity in these data. To test the robustness of the modelling approach, the assumptions related to language definitions, lagged variables, interactions missing observations, attrition and bulk-billing incentives were tested in a sensitivity analysis.

3.7.1 Language definitions

One of the limitations of this study is how language difficulties were defined at each age. A number of language screening measures are available in the LSAC, and these vary appropriately to match the developmental age of the child. For example, the PPVT-III is a widely accepted screening tool used in longitudinal studies for children aged between four and nine years due to its cost-effectiveness and good reliability[89]. However, all of these screening tools provide insufficient detail to allow the classification of children according to the criteria for a clinical diagnosed language disorder[92,93] [86,128]. A further limitation is that there is both direct and indirect language screening measures available in the LSAC.

A second challenge was how to disentangle the effects of language difficulties from the effects of other developmental impairments that may drive our outcomes of interest[23]. For example, the literature suggests that children with language difficulties are at increased risk of attention deficit hyperactivity disorder (ADHD) symptoms[104]. To explore these issues, two definitions of language difficulties are considered. The first is defined simply as population standardised scores (>1.25 SD away from the mean). The second definition excludes from the language group those children whose parents identify any other long-term medical condition, and categorises other medical conditions into mutually exclusive groups (Table 25).

Table 25: Definitions of language difficulties – sensitivity analysis

Non–mutually exclusive language definition		Prevalence
Language difficulties	Dummy variable 1 = Yes, 0 = No	0.10
Long-term medical condition	Dummy variable 1 = Yes, 0 = No	0.08
(Chapter 2: Definition 1– Mutually exclusive language)		
Language difficulties	Dummy variable 1 = Yes, 0 = No	0.095
Language difficulties plus medical conditions	Language plus one other long-term medical condition	0.02
Long-term medical condition	One condition other than language	0.07
	Two or more conditions other than language	0.02

The non–mutually exclusive definition produced prevalence estimates of approximately 10 per cent and the mutually exclusive definition produced a prevalence of approximately 9.5 per cent in the K cohort, both of which are consistent with prevalence estimates reported in the literature[18,20,22]. The sensitivity analysis showed that both definitions produced consistent estimates of healthcare expenditure for the K cohort, but the non-mutually exclusive definition produced lower out-of-pocket expenses (~$26) than the mutually exclusive definition.

One explanation for these differences is that the non–mutually exclusive definition includes some expenditure that is unrelated to language difficulties. By creating mutually exclusive covariates, the argument that the differential health care observed for these children is related to language-specific healthcare needs was strengthened. The mutually exclusive definition brought about improvement to model fit. Overall, these findings support healthcare cost differences, irrespective of the measure used to define language difficulties. For the purposes of this thesis, the mutually exclusive definition is used throughout.

3.7.2 Interactions with time and lagged health

One of the limitations of the fixed effects model for the explanatory variable of interest is that children who present with a language difficulty in each wave will be omitted from the analysis due to the time-invariant nature of the variable. It is possible that the utilisation and expenditure may be underestimated as the most severe children are omitted. While this issue is partly resolved by the inclusion of children whose condition is persistent enough to meet the criteria for a carers' benefit, an interaction of language difficulties with time is also considered[xxi].

The analysis considered that health status and health utilisation and expenditure are not exogenously determined, but derived from an issue of reverse causality. This issue was tested by including lagged independent variables in fixed effects equations. Using lagged X's allows for time ordering, which can improve the ability to infer causation. However, for each lag, a wave of data is lost. The results (Column 2, Table 26) and the literature[62] show that there is a high demand for additional medical services at 4 to 5 years, consistent with the identification of language difficulties during preschool years or when the child starts school[91,103,129]. The robustness of this approach is tested in a sensitivity analysis. Table 26 shows that the results for the unlagged and lagged models are largely consistent. For the purposes of this thesis, an unlagged model is estimated as the final model.

[xxi] Table 26 shows the health expenditure for the B and K cohorts at each age. There are small differences in the estimates observed from the publication (Appendix C) and these chapter estimates. The reason for these differences is that the publication is based on 5 waves of data and the chapter estimates are based on 6 waves of data. The results suggest that healthcare expenditure is particularly increased among children aged 0 to 1 years, 2 to 7 years and 10 to 11 years. Once type of healthcare expenditure is considered over time, this expenditure can be seen to be largely driven by MBS utilisation. There is some evidence of higher PBS utilisation for these children. However, significant effects are not consistently observed across both cohorts

Table 26: Interactions with time ($)

	B cohort	K cohort		
	FE			
	(no lag)[a] (1)	Publication (5 waves) (2)	Chapter (6 waves) (3)	Chapter (lag) (4)
Wave 1 (child aged 0–1 years [B], 4–5 years [K])	$231	$359*	$383*	
	$175	$153	$152	
Wave 2 (child aged 2–3 years [B], 6–7 years [K])	$256*	$602*	$663**	$728**
	$127	$238	$234	$259
Wave 3 (child aged 4–5 years [B], 8–9 years [K])	$440**	$58	$90	$110
	$104	$132	$127	$137
Wave 4 (child aged 6–7 years [B], 10–11 years [K])	$412**	$504**	$549**	$560**
	$151	$179	$176	$178
Wave 5 (child aged 8–9 years [B], 12–13 years [K])	−$11	$48	$94	$127
	$107	$152	$156	$156
Wave 6 (child aged 10–11 years [B], 14–15 years [K])	$30		−$167	−$144
	$191		$238	$237
Number of observations	19510	23697	18338	15275
Chi-squared	0.067	0.0938	0.0826	0.0817
Log-likelihood	−175583	−214329	−165855	−138471
Sigma_u	7092.2	1821.6	1932.0	2090.9
Sigma_e	2149.4	2286.0	2247.6	2343.0
rho	0.916	0.388	0.425	0.443
AIC	351223	428722	331768	276998
BIC	351452	428980	331995	277212

Note. Robust standard errors in parentheses. AIC = Akaike information criterion; BIC = Bayesian information criterion.

[a]Lagged variables not significant in the B cohort and omitted from the analysis.

+Significant at 10%. *significant at 5%. **significant at 1%.

Table 27: MBS and PBS expenditure by age (B and K cohorts) ($)

	B cohort		K cohort	
	FE			
	MBS	PBS	MBS	PBS
Wave 1 (child aged 0–1 years [B], 4–5 years [K])	$223	$8	$402**	−$19
	$161	$31	$147	$37
Wave 2 (child aged 2–3 years [B], 6–7 years [K])	$202+	$54	$660**	$4
	$112	$54	$223	$46
Wave 3 (child aged 4–5 years [B], 8–9 years [K])	$391**	48*	$85	$6
	$98	$20	$120	$31
Wave 4 (child aged 6–7 years [B], 10–11 years [K])	$343**	70+	$497**	$52
	$98	$35	$163	$41
Wave 5 (child aged 8–9 years [B], 12–13 years [K])	−$28	$17	$112	−$18
	$100	$24	$148	$30
Wave 6 (child aged 10–11 years [B], 14–15 years [K])	−$37	$67	−$172	$5
	$162	$58	$227	$44

Note. FE = fixed effects; MBS = Medicare Benefits Scheme; PBS = Pharmaceutical Benefits Scheme; B = B cohort; K = K cohort. +Significant at 10%. *significant at 5%. **significant at 1%..

3.7.2.1 Interactions with carers' benefits

A limitation of the analysis is the inability to explore persistence and severity of language difficulties. It is possible that there may be additional language-specific costs for children whose carers are eligible for a carers' benefit (Carer Allowance or Carer Payment). As discussed in Chapter 2.1.3 (see Table 4), on average, the primary carers of 4 per cent of children with language difficulties are eligible for Carer Allowance and a further 2.5 per cent for Carer Payment. To explore this further, an interaction between language difficulties and carers' benefits was considered. The analysis found no significant differences in expenditure between children with language difficulties whose carers receive a carers' benefit and children with additional impairments whose carers receive a carers' benefit (results not reported).

3.7.2.2 GP bulk-billing incentives and the Extended Medicare Safety Net

One of the limitations of the LSAC-linked Medicare data is that only the Medicare benefit is reported, and as a result, out-of-pocket costs were estimated. Over the period of these data (from January 2003 until December 2014), bulk-billing represented between 69 per cent and 85 per cent of GP visits and 29.5 per cent of non-GP visits[130]. As medical services are the main driver of utilisation for children with language difficulties, these assumptions provide a potential source of uncertainty in the analyses. For the purposes of the analysis, bulk-billing incentive payments and patients' concessional status are used as bulk-billing flags[xxii].

GP bulk-billing incentives were first introduced in February 2004[xxiii]. This flag provides a robust measure of GP bulk-billed attendances from February 2004. From January 2003 until January 2004 inclusive, which represents the period before the implementation of the bulk-billing incentive, concessional status is used as an approximation for GP bulk-billing. In 2002, GP bulk-billing rates of concessional patients were ~80 per cent[130], so it provides a reasonable proxy of bulk-billing practices during this time. The concessional status flag is also applied to a second period, from April 2013 until December 2014 inclusive, when an anomaly in the data revealed that

[xxii] It was assumed that non-GP visits were bulk-billed if the patient had concessional status. Non-GP visits were not subject to bulk-billing incentives.
[xxiii] Discussed in detail in Section 3.3.

the bulk-billing incentives are omitted from the dataset[xxiv].

However, the concessional status of individuals is subject to missing observations. Based on the concessional status flag, 67 per cent of all GP services were assumed to be bulk-billed for both of these time periods (January 2003 until January 2004, April 2013 until December 2014 inclusive) in this analysis. Given that national bulk-billing rates were 69 per cent in 2002, when incentives were first introduced[131,132], this may be considered a reasonable assumption for Wave 1. As the cohort of interest is children, bulk-billing rates are likely to be higher than the national average. Further, bulk-billing rates increased significantly until 2012 (Wave 5). Using concessional status as a proxy for bulk-billing may be an underestimate. To test the robustness of this approach, a conservative sensitivity analysis was conducted, assuming that 100% of eligible GP services were bulk-billed from January 2003 until January 2004 and from April 2013 until December 2014, inclusive. This resulted in bulk-billing rates of 82 per cent and 97 per cent for Wave 1 and Wave 6 respectively. The results showed that this assumption produces lower estimates of healthcare expenditure for the K cohort (~$32 lower), when compared to the base case assumption and lower out-of-pocket expenses (see Table 29) (~$18 lower). Overall, these findings support consistent healthcare cost differences.

Patient's concessional status was also used to define bulk-billing practices for non-GP visits. In 2002, non-GP bulk-billing represented 29.5 per cent of non-GP visits nationally. In our dataset, 35 per cent of non-GP visits were assumed to be bulk-billed, which is reasonable given the cohort of interest is children. Due to data limitations, it is not possible to determine how non-GP bulk-billing changed over time.

Additionally, during this period between 2004 and 2014, the Medicare Safety Net was extended, referred to as the Extended Medicare Safety Net (EMSN). The EMSN, which covered the difference between the Medicare Schedule fee and the Medicare benefit once an annual threshold had been met, was extended to reimburse 80 per cent of out-of-pocket expenses (the difference between the fee charged by the doctor and the Medicare benefit), when an annual threshold of medical spending was reached in any

[xxiv] It is assumed that all other MBS and PBS services are included in the linked dataset.

calendar year. In the LSAC-linked Medicare dataset, there is no information about children who had reached the EMSN, and as a result, it was not possible to make robust assumptions about which families had reached the EMSN in any one calendar year. The threshold for the EMSN is based on family expenditure; at that time, it was $555 for concession card holders and recipients of Family Tax Benefit A, and $1,111 for all other patients[133]. The descriptive statistics in Table 7 show that the mean two-year expenditure for a child in the K cohort was ~$1,950, of which ~$400 was an out-of-pocket expense. It is possible that the out-of-pocket costs are overestimated for some children whose families reached the safety net in any one calendar year. There is some uncertainty associated with the bulk-billing assumptions in the model.

3.7.2.3 Missing observations

The sample is subject to missing observations. The variables that were missing in more than 5 per cent of the sample included language and income. This study explored whether an underlying mechanism determines missing observations for each of these variables. Using logistic regression models, there is evidence that the variables missing are correlated with each other (results not reported) and that they are not missing completely at random. Under this assumption, complete record analysis is not recommended[134]. If observations are missing at random, valid inferences can be obtained using inverse probability weighting, ad hoc methods or multiple imputations.

Ad hoc methods were employed, whereby missing observations represented an additional category in the equation for categorical variables or a separate missing dummy variable if the variable was continuous. For the language variable, a mean imputation method was employed, whereby an individual mean value of the standardised score for non-missing waves was obtained and imputed into the missing waves.

The justification for this alternative method was that it would facilitate all types of analysis throughout the thesis and maintain a consistent approach. For example, using the ad hoc methods employed above in the multilevel modelling to come (see Chapter 4) was not possible as model convergence could not be achieved. To test the robustness of this approach, a sensitivity analysis was conducted using the minimum and maximum individual scores in non-missing observations[135] in the K cohort.

As shown in Table 28, using a minimum standardised language score for imputation increased the prevalence of children with language difficulties to 11 per cent, and using the maximum score for imputation reduced the prevalence to 8.6 per cent. Table 29 shows the impact of using the minimum and maximum values on overall health utilisation in the K cohort. The outcome variable was most sensitive to the minimum value imputation and remained consistent for the maximum value imputation. Although this method allows for a consistent approach throughout, some caution should be exercised regarding the validity of the estimates from this analysis.

Table 28: Prevalence of language difficulties with imputation – sensitivity analysis

Definition	Mean[a]	Min[a]	Max[a]
	Prevalence (No.)		
1 if language difficulty	9.5 (436)	11.7 (539)	8.8 (406)

[a] refers to imputed values of standardised language scores (Z-scores) at individual level for non-missing

Table 29: Sensitivity analysis – exploring heterogeneity in language difficulties and healthcare expenditure ($)

Definition	Base case[a]		Language definitions[b]		Missing language observations[c]				Attrition[d]		Bulk-billing[e]	
					Lower CI		Upper CI		No weights			
	Health-care expend	Health-care OOP	Health-care expend	Health-care OOP	Health-care expend	Health-care OOP	Health-care expend	Health -care OOP	Health-care expend	Health-care OOP	Health-care expend	Health-care OOP
						FE						
1 if language difficulty	$246.8** ($89.5)	$66.0** ($22.9)	$246.9** ($86.6)	$40.9* ($20.8)	$240.6** ($79.0)	$59.4** ($20.6)	$247.4** ($78.8)	$62.2** ($20.4)	$232.8** ($62.4)	$57.6** ($16.2)	$214.3** ($76.4)	$49.1** ($17.9)
Number of observations	15275	15275	18338	18338	18338	18338	18338	18338	23697	23697	18341	18341
Chi-squared	0.080	0.098	0.079	0.098	0.081	0.099	0.081	0.099	0.079	0.096	0.064	0.063
Log-likelihood	−138508	−119673	−165916	−143061	−165893	−143051	−165893	−143051	−214093	−184568	−165693	−141897
Sigma_u	2083	528	1947	466	1927	467	1927	467	1813	440	1921	444.7
Sigma_e	2348	684	2254	648	2252	648	2252	648	2262	651	2224	607.8
rho	0.440	0.373	0.427	0.341	0.423	0.342	0.423	0.342	0.391	0.314	0.427	0.349
AIC	277068	239399	331880	286172	331839	286155	331839	286154	428237	369186	331436	283847
BIC	277267	239598	332068	286368	332042	286358	332042	286357	428438	369387	331631	284050

Note. Robust standard errors in parentheses. CI = confidence interval; OOP = out-of-pocket; FE = fixed effects, AIC = Akaike information criterion; BIC = Bayesian information criterion.
[a] Base case regressions include two dummy variables for mothers from a non-English speaking background, who are Aboriginal or Torres Strait Islander, one variable categorising whether the child has language difficulties (language difficulties, no language difficulties, 'unknown'), other medical condition with language, other non-language medical conditions, one dummy variable using mother's educational attainment (mothers who completed Year 12), one dummy variable indicating mother's health status (long-term medical conditions), one dummy variable indicating health shocks (relatives who suffered serious injury), one dummy variable indicating whether the mother has a resident partner, one dummy variable indicating whether the household receives a carers' benefit, the number of siblings (0, 1, 2 or more), health status of the child (excellent, very good and average), gross income of the household, equivalised for the number of people in the household and categorised into quintiles, plus an 'unknown' category for missing income, and five dummy variables indicating observations in 2006, 2008, 2010, 2012 and 2014. Model is weighted for attrition. [b]Assumes one language Definition 1 (see Table 2). [c] Imputes minimum and maximum individual scores in non-missing waves[135] for missing observations. [d]Model without attrition weights and assuming cohort mean values for missing observations. [e]Assumes all eligible GP visits were bulk-billed from January 2003 to February 2004, and March 2013 until December 2014, inclusive.
+Significant at 10%; *significant at 5%; **significant at 1%.

3.7.2.4 Attrition

The analysis discussed in this chapter uses LSAC-derived population weights (pweights) to consider attrition. Details on the creation of attrition weights for the LSAC are provided in one of the LSAC technical papers[102]

3.8 Discussion

This chapter has investigated the cross-sectional and longitudinal relationships between healthcare utilisation, costs and children's language difficulties, using the 2004–2014 LSAC. The first set of findings is that in the K cohort, there is a consistent positive relationship between language difficulties and healthcare utilisation and expenditure in both cross-sectional and longitudinal analyses.

Among children with language difficulties, those who are aged 4 to 7 years and 10 to 11 years are more likely to increase their healthcare utilisation than those aged 0 to 3 years, 8 to 9 years and 12 to 13 years. The demand for additional medical services at 4 to 7 years is consistent with the identification of language difficulties during the preschool years or as the child starts school. There are higher GP visits and rates of referral to paediatricians, other specialists and speech pathologists, which leads to higher health costs and higher out-of-pocket costs. The findings are consistent with the literature, which found that children with language difficulties are commonly referred to a wide range of services for diagnosis and treatment[91,103].

The second set of findings is that in the B cohort, there is a consistent positive relationship between language difficulties and pharmaceutical prescription usage, which can be linked with increased rates of sensory pharmaceuticals. In contrast, the K cohort does not show any significant change in their mean pharmaceutical prescription usage at the onset of language difficulties. However, as evidenced in the publication by Cronin et al (Appendix C), mean pharmaceutical expenditure may be disguising important age differences. The literature suggests that there may be downstream costs to the health system due to difficulties that develop as a by-product of the impairment, such as emotional problems or behavioural difficulties. In a recent meta-analyses, Yew et al.[104] found that children with language difficulties are approximately twice as likely as children without language difficulties to exhibit emotional problems (RR = 1.84; 95% CI: 1.04, 3.25) and more than twice as likely to have behavioural difficulties (RR = 2.66; 95% CI: 1.66, 3.08). The healthcare-related costs for these children are likely to be considerable.

Another set of findings is that total healthcare costs for children with language difficulties compared with those without are higher than the literature estimates. Sciberras et al.[62] estimated that the difference in biennial healthcare costs for children with and without language difficulties at age 4 to 5 years was $206 (95% CI: $90, $321). The estimates from the current study of between $440 and $383 (see Table 26) suggest that the Sciberris et al estimates may have been an underestimation. This difference is largely explained by the inclusion of out-of-pocket expenses, which account for between $113 and $131 (B cohort and K cohort respectively[xxv]) or approximately 30 per cent of the total healthcare cost at this age. Comparatively, healthcare costs associated with language difficulties are not as high as more visible conditions, such as ADHD, which costs $2,636 per child per year, with a range from $790 to $5,518[136], and ASD, with annual costs of $3,020 (95% CI: $1,017, $4,259)[24].

Children with language difficulties severe enough for their carers to receive a carers' benefit incur significantly higher medical services and pharmaceutical costs at the onset of their condition, which suggests that these children have complex health needs.

The strengths of this study include the use of language measures from a nationally representative longitudinal study with individual linkage to medical, pharmaceutical and hospital expenditure and calculated out-of-pocket costs. The costs associated with language difficulties at six time points—from early childhood to the onset of the teenage years—were examined, and condition severity was considered.

These results have improved on the findings of previous studies based on cross-sectional analysis. More-sophisticated modelling techniques were used in this study, with the inclusion of possible confounders and lagged variables in an attempt to

[xxv] Results not reported in Table 27.

disentangle the effects of language difficulties and healthcare utilisation. It is likely that cross-sectional data provide spurious positive correlations because of unobserved child or household characteristics that are correlated with both health utilisation and the child's language difficulties. Longitudinal fixed effects regression techniques allowed the analysis to control for observed, as well as unobserved, time-invariant characteristics in assessing the relationship between children's language and total health care.

3.8.1 Limitations

Validated and widely used parent reports, teacher reports and direct assessments of language difficulties were used, allowing assessment of a broad range of language difficulties. However, it is acknowledged that one of the difficulties in calculating healthcare utilisation based on language acquisition screening tools is attributing healthcare costs to an additional language healthcare need. Medicare does not provide information about the reason for healthcare visits, and as a result, it was not possible to identify services and pharmaceuticals received specifically for the assessment and/or treatment of language difficulties. While the fixed effects models control for time-invariant covariates, several studies have demonstrated that time-varying sociodemographic, child and family and cultural characteristics can play a role in patterns of healthcare utilisation. It is well documented that disparities due to social disadvantage exist in accessing and utilising health care[113-116,137], and children with social disadvantage are at higher risk of language acquisition and processing difficulties[138,139] and of lower rates of language acquisition growth (Taylor et al[105]). It is possible that there are unobserved characteristics that ultimately affect health utilisation and that these may reflect resources in the home or personal preferences.

From a policy perspective, there is some evidence that GPs and other medical providers are also responding to high-needs groups, possibly through improved bulk-billing practices for families with concessional status. However, one of the limitations of this study is the availability of data to measure the impact of all the policy initiatives implemented in 2004. Further research should investigate the impact of the Extended Medicare Safety Net on out-of-pocket costs. It is likely that these measures will provide further financial support for language-related healthcare needs.

A second limitation is how this study relied on different measures to define language difficulties at each age. Using mutually exclusive categories for language and other medical conditions (factors that might drive additional healthcare needs), strengthens the definition of language. This produced prevalence estimates of between 7 per cent and 11 per cent, which is consistent with prevalence estimates reported in the literature [18]. Additional supplementary analysis undertaken in this study provided consistent results across language measures. Overall, these findings support healthcare cost differences irrespective of the measure used to define language difficulties.

A third limitation of this study is that the LSAC-linked Medicare data excludes total service fees for Medicare items. Therefore, as part of the analysis, total service fees were determined by calculating patient co-payments using the Australian Medical Association's published medical services fees and the private health insurance gap schedules published by Medibank Private, a large private health insurance provider in Australia[124,127], which introduces some uncertainty into the analysis. As a consistency check, the study compared the calculated out-of-pocket costs (as a proportion of total healthcare costs) with published AIHW estimates, and it was found that the assumptions were consistent for the population of interest.

Finally, it is possible that the analysis has not captured all the healthcare costs for these groups. However, the analysis does improve on previous studies in this respect with the inclusion of out-of-pocket costs. It captures MBS-funded speech pathology, early intervention services and allied health when referred by GPs. However, there is a ceiling on the number of allied health and speech pathology services that can be claimed under Medicare in any calendar year. If families are accessing state-funded community, hospital or educationally based providers after exhausting Medicare services, the overall healthcare costs will be underestimated. Equally, it is likely that children from higher income families may access private services, which are also not accounted for in this analysis. Further research is required to quantify these additional costs.

3.9 Conclusion

Overall, the findings from this study show that language difficulties are associated with increased healthcare costs at key developmental milestones, notably during early childhood and as a child approaches the teenage years. Although the cost of language difficulties is not as high as other conditions such as ADHD and ASD, policy measures serve to reduce the burden of health care for children with severe and persistent conditions. This study provides estimates of direct healthcare costs to inform a COI model discussed in Chapter 6.

Chapter 4: Education

4.1 Introduction

Children with language difficulties are at increased risk of starting school not 'developmentally ready', and research shows that children with language difficulties who lag behind their peers when they commence school are more likely to repeat years and drop out of school[7]. In the short term, children with language difficulties achieve lower academic grades[6] and often require additional remedial services[5]. In the long term, they complete fewer years of formal education and are more likely to be in less skilled employment[7]. The evidence suggests that the residual effects of an early language difficulty may be lifelong, impacting educational achievement, occupation, and ultimately SES[13,14].

Schools play an important role in bridging learning gaps that arise from impairment and social disadvantage, although there is debate in the literature over the extent of this role. Several studies have looked at the effects of schools on academic outcomes in the areas of literacy, numeracy and reading. Rothman et al.[140] estimated a 16 per cent school-level variation for literacy and numeracy scores, with more than half the effect being attributed to the SES of the school. Similarly, an OECD report found a 13% variation in school reading, linked to school SES[141].

Lee et al.[140] and Marks et al.[141] suggested that the effect of school academic achievement was more strongly related to the selection effect—that is, higher performing students in more advantaged schools—rather than the creation of more-favourable school environments[142,143]

A large body of literature discusses academic achievement and health differentials between children with and without language difficulties[5,7,14.] However, the impact of school academic achievement on long-term outcomes for a child with language impairment within the Australian context is less clear.

Understanding the effect of school academic achievement on achievement and future

LFP among children with language difficulties and additional impairments is important for current Australian policy. Language impairment can be expected to affect a child's employment prospects in the long term because of the child's low literacy and numeracy.[3,140]. This in turn affects adult LFP [30-41]. A child with language impairment may start school with a lower level of human capital, and this may be exacerbated where parental investments are lower. If school achievement is low, there may be a reduction in school investment or technology that reduces academic achievement as the child accumulates human capital at a reduced rate. Third, school achievement may contribute to the child's impairment being identified late, leading to a lower rate of human capital accumulation, as there are critical time periods in development and the value of investments depreciates over time. The accumulated human capital can then lead to lower labour force participation or less skilled jobs.

Government education policy has the potential to positively affect a child's future LFP through the provision of equal access to quality education[141]. International comparisons of academic performance have shown that although Australia ranks as one of the highest performers among OECD countries according to the Programme for International Student Assessment, there are several equity dimensions in which the Australian school system does not compare favourably, notably for students from low socioeconomic backgrounds, for Indigenous students and for students with disabilities[141]. To address these equity problems, a better understanding of the relationship between childhood impairment and LFP is required.

Addressing the importance of the issue to Australian policy and the lack of prior research, this chapter examines how school achievement affects a student's academic achievement, emotional and behavioural health, expectations of school completion and attendance in NAPLAN, with a particular focus on the impact of individual language difficulties.

This chapter makes a number of contributions to the literature on how children's language difficulties and other impairments affect labour force participation. First, the analysis fills a literature gap by providing evidence on the role of schools in developing human capital for high-risk groups. Specifically, the primary focus of this study is to examine whether a school's academic achievement affects a student's academic achievement, emotional and behavioural health, expectations of school completion and attendance in NAPLAN, based on individual language difficulties status.

Second, the study uses propensity score models to examine the selection question that 'more advantaged' (either by wealth or academic advantage) children with language difficulties select 'more advantaged' schools. Third, the study considers the impact of non-cognitive skills of school engagement. Fourth, it highlights the potential impact of early identification on the development of cognitive and non-cognitive skills of children with language difficulties. and last, this is the first ever study that estimates the costs of adult forgone income related to 1) language impairment; 2) systemic costs of low school achievement and 3) gains associated with early identification (Chapter 7).

This chapter is structured as follows. Section 4.2 reviews the empirical literature, which focuses on the education and communication impairment literature and includes the theoretical reasons for reduced human capital among children with language difficulties and discusses the policies that are relevant to children with DLD. Section 4.3.1 describes the LSAC data and sample; Sections 4.3.2 and 4.4 present the empirical approach adopted in this study, including the development of the school academic achievement measure. Sections 4.4.2.1 to 4.4.2.5 present the final equations for the outcome variables: literacy and numeracy, non-cognitive skills, expectations for education, and NAPLAN attendance. Section 4.9 presents the empirical results, which use the measure of school academic achievement to explore the effects of language difficulties on a range of outcomes across different levels of school academic achievement. Sections 4.10 and 4.11 conclude the chapter with a discussion.

4.2 Existing evidence

4.2.1 Education policy in Australia

International comparisons of Australia's academic performance show that Australia ranks highly in educational outcomes for 15 year olds and it has a number of inclusive policies that are conducive to an equitable education system. These include comprehensive schooling until 16 years of age and high rates of upper secondary education. However, there are several dimensions in which the Australian school system does not compare favourably. For example, there are high rates of young adults (15-29 year olds) who are not in any education or not employed (11.5 per cent). Additionally, students from low socio-economic backgrounds are over-represented in low achievers and the rate of Year 12 (final year) completion for these students is comparatively low (52 per cent versus 78 per cent). Additionally, the differences in education attainment between Indigenous and non-Indigenous students are substantial (10 per cent vs. 78 per cent) [144]. Addressing inequity in education is critical in reducing economic and social disparities later in life [37].

4.2.1.1 Education provision

Currently, in Australia, there are essentially two models of school provision, which vary in terms of pupil selection and fee payment. The first is the government-school model, in which schools generally serve local communities and where selection is largely based on catchment area rather than student ability. Although there are exceptions, government schools are characterised as universally non-selective, without explicit curriculum specialisations and as mixed gender. They are also largely government funded, with minimal parental contributions. The second is the parental-choice model (non-government schools), in which schools selectively admit pupils based on ability to pay, religious persuasion or academic ability, regardless of where they live. In this model, parental preference and school selection are the deciding factors. These schools are fee paying and partially government funded, and have independent governance.

While the government-school model remains the most dominant form of provision in Australia (66 per cent), Australia also has one of the largest percentage of students attending non-government schools worldwide (34 per cent)[144]; this includes 20 per cent attending Catholic schools, with the remaining 14 per cent attending independent schools (which includes other faith-based schools).

Traditionally, schools operating in model one (government-school) are limited in their capacity to attract and admit students outside of the catchment area, and do not attract additional funding by doing so. As a result, incentives for improvement in these schools may be weak[77,145]. Arguably, there is competition in large urban areas, where there are non-government and government schools in the same or overlapping catchment areas. However, under this model, loss of students to competing schools has little impact on school revenue and even less on outcomes for teachers or principals[145].

4.2.1.2 Policies relevant to children with developmental language disorder

For student with disabilities there have been three policy initiatives in the last 15 years which are relevant for children with DLD. These include the introduction of the Disability Standards for Education in 2005; wide-scale education reforms introduced in 2008; and the NDIS, which commenced in 2010.

The Disability Standards (under the Disability Discrimination Act) were introduced in 2005 to improve access to mainstream education[69]. The Standards provided a framework 'to ensure that students with disability are able to access and participate in education on the same basis as other students and considers that all people with disability have the right to participate as fully as possible in community life and is committed to increasing fair access to education and training for all groups'[69,(piii].

In 2008, the Australian Government introduced wide-scale educational reforms to improve educational outcomes for disadvantaged groups and to strengthen accountability and transparency in the education system. These groups include Indigenous Australians, students from low socioeconomic backgrounds, new migrants, homeless young people and people with disability[70]. New targeted policies have included the introduction of the Smarter Schools National Partnership for Low Socio-economic Status School Communities, which focuses on the learning and wellbeing of disadvantaged students to support their transitions to further education, work and community participation[71]; the Aboriginal and Torres Strait Islander Education Action Plan aimed at closing the gap between Aboriginal and Torres Strait Islander peoples and their peers[72]; and the National Early Childhood Development Strategy aimed at giving every child 'the best start in life'[73,p4].

Broad national reforms were also introduced; the key features included a national curriculum, national testing and public reporting. These features, which are based on the principles of a market-oriented framework, focus on school choice and competition, an approach that has received increasing support from policymakers internationally[146-149]. The philosophy of market-oriented frameworks provides powerful incentives for schools (both independent and government schools) to be efficient and effective, thereby improving school performance.

The introduction of market-oriented principles places pressure on policies that encourage equal access to high-quality education. In 2010, the National Disability Strategy was announced, which included a comprehensive review of education policies regarding equity. The review found that the Disability Standards for Education of 2005 had assisted people to access education to a 'varying degree'[78, p58]. However, considerable improvements were needed to ensure equality for students with disability. Some of the issues raised included the increased pressure on resources in providing supports to the additional students with disability who were now attending mainstream schools, the difficulties in accessing necessary support, and the state-by-state differences in the interpretation of eligibility criteria meant there was inconsistent access to services. There were examples of schools refusing to enrol students with *disability*, with schools arguing that there was a cap on the number of students with learning disability who could be supported. A number of submissions reported that students with disability were offered only part-day or part-week attendance as a result of inadequate resources or limited access to support staff[78,p. 20)].

This qualitative evidence of discrimination was substantiated in a report by Lamb et al.[150] who found large disparities in the academic quality of schools that children attend. The authors found some evidence of students who lagged behind at one stage, catching up at another stage. For example, approximately 12 per cent of children were not ready for school, but met academic benchmarks by Year 7 (at 12 years of age) and almost 16 per cent of students lagged behind in the middle years, but remained to complete Year 12 or equivalent by age 19. However, there is also evidence of students lagging further and further behind. The authors note 'recurring systematic patterns of failure that point to features of the education system that fail to work for certain groups of Australians'

[150, p53]These school-level effects were over and above the individual risk-factor effects, most notably regarding access to educational opportunities in the early to middle years of learning[150, p53]. For children who are lagging behind, SES—at both the school and individual level—is the most powerful predictor in determining students' chances of getting back on track[37,150-153].

The NDIS review also raised concerns that the national curriculum, national assessment and national reporting did not adequately meet the needs of children with disability, resulting in unnecessary exclusion[78]. Internationally, there is a considerable body of literature reporting on the impact of these types of reforms, in particular the impact of national testing and the public reporting of results on school and teacher behaviour. In the UK, where public reporting in the form of league tables was first introduced in the early 1990s, numerous studies have reported that the introduction of league tables had created perverse incentives[154,155]. They noted that schools had moved away from being 'learning orientated' towards being 'performance orientated' and that there was evidence of educational triage, whereby schools had focused significantly more resources on students, where the greatest gains in school averages could be made, at the detriment of low- and high-performing students. In a study of ethnic minority students in 1996, Gillborn[149] found evidence of increased exclusions from national testing, either through reclassification of low-performing students into special streams or through 'constructive exclusion' where low-performing students were encouraged to leave the school voluntarily. This finding was supported in a full UK education system review completed in 2011[156].

In the USA, several studies have investigated teacher and school behaviour as a result of increased school accountability[157]. Jacob and Levitt[158] found large increases in special education placement (i.e., exemption from testing) and increased rates of grade retention among low-performing students. There was also evidence of explicit teacher cheating on testing days in classes with low-performing students.

4.2.1.3 Other predictors of success

Academic test scores do not provide a complete measure of human capital because non-cognitive skills part of human capital accumulation, and can be acquired in schools. These include skills such as emotional, behavioural and intellectual engagement[159]. Emotional skills are measured by the level of school attachment and relationships with peers and teachers. Behavioural skills include measures such as class attendance, homework completion and involvement in extracurricular activities[160]. Intellectual skills, which are most closely linked to academic achievement, also include a positive approach to learning[161,162]. Lamb et al. [150] report that one way of measuring engagement is through attendance. They report a strong link between overall school attendance and school NAPLAN scores, which is independent from school SES. However, engagement at school extends beyond attendance, and there is strong evidence that student-level attributes—belonging, self-efficacy, conscientiousness, persistence and educational aspirations—are associated with better educational and employment outcomes[163,164]. Parental investments are also important, and one of the indicators of these investments is positive expectations for education. In fact, parental expectations for children's academic achievement predict educational outcomes better than any other measure of parental involvement[165-169]. Children with high parental expectations have been found to have higher levels of student motivation, academic and social resilience, and aspiration to attend university[170,171]. Furthermore, high parental expectations serve to mitigate the effects of low teacher expectations on student achievement[172].

Children with DLD are at high risk of educational failure without appropriate support. It is therefore of policy value that the process that leads to worse outcomes be better understood and that adequate predictors be developed to inform the prevention of educational failure.

4.2.2 Communication impairment research

A large body of literature has reviewed the impact of language difficulties on individual long-term outcomes, with the majority of the research coming from the UK. In these studies, the link between language skills and literacy development is seen as fundamental to educational achievement, emotional and behavioural health, occupational success and, ultimately, SES[5,13,14].

Several researchers using longitudinal studies have found that children with SLCN without remediation have lower levels of exam completion and lower rates of education than typical language children, and are subsequently at higher risk of lower wages and of reliance on welfare[7]. They have also been found to have higher levels of redundancy, underemployment and workplace conflict[56].

In contrast to the international literature, the effect of DLD on adult health, LFP and wages has received little attention in Australia. There is only one study of note, which examined the burden of communication impairment on the rates of mental health issues that develop as a consequence of non-cognitive deficits. As discussed in Chapter 3.1, Goh Kok Yew et al.[104] found that children with language difficulties are at higher risk of emotional, behavioural health problems. This is likely to have a considerable impact on their educational outcomes.

There is a lack of prospective, longitudinal data using robust econometric methods, and the research does not consider the accumulation of cognitive and non-cognitive skills or the impact of increased investment at critical time periods on long-term outcomes.

4.3 Methods

4.3.1 Data and sample

This analysis focuses on the LSAC K cohort to capture young children's transition into primary school and high school. The LSAC is individually linked to NAPLAN and My School datasets. Full details on the LSAC are discussed in Chapter 2.

4.3.1.1 NAPLAN and My School

NAPLAN is a national annual assessment for all students in Years 3, 5, 7 and 9 in Australia. The tests cover skills in reading, writing, spelling, grammar and punctuation, and numeracy. Individual NAPLAN scores are available for four waves of data: 2008, 2010, 2012 and 2014, when the children are 8 to 9 years, 10 to 11 years, 12 to 13 years and 14 to 15 years respectively. My School is a dataset that compiles NAPLAN results at school, state and national level, and it includes school demographics, student attendance, teacher ratios and funding arrangements[173]. My School data are available for three waves of data: 2008, 2010 and 2012.

Additionally, the LSAC asks whether the child has changed schools between waves. Using the responses to this question, it was possible to identify the schools that children attended in 2006 and 2014, when the children were 6 to 7 years and 14 to 15 years respectively[xxvi]. In 2004, only 16.5 per cent of parents reported that their child had started school and therefore this wave was excluded from the analysis. From a total sample size of 4,983, there was school identification information available for 4,431 individuals. Appendix F provides a snapshot of the prevalence of language difficulties among different demographic groups in the Australian population. Appendix G outlines the definitions of the variables used in this analysis. Appendix H summarises the modelling approach used in this analysis.. As a supplement, Appendix I discusses the effect of market oriented policies on the education markets.

4.3.1.2 Measures used to assess language

Definition 2 – persistence and timing is used in this chapter. Full details of the definitions used in this thesis are discussed in Chapter 2. Briefly the definition of language difficulties used in this Chapter is outlined in Table 30.

[xxvi] School identification was possible in 2006 and 2014, provided the child had not changed schools—that is, their school identifier remained consistent from 2006 to 2008 and from 2012 to 2014, respectively.

Table 30: Language difficulties persistence and timing – Definition 2

Timing	Definition	Ages data available	
		B cohort	K cohort
Typical language	No language difficulties at any age	0–11 years	4–15 years
LD1_0–3 years	Language difficulties identified at one time only, between 0–3 years of age	0–3 years	N/A
LD1_4–7 years	Language difficulties identified at one time only, between 4–7 years of age	4–7 years	4–7 years
LD1_≥8 years	Language difficulties identified at one time only, at 8 years or older	8–11 years	8–15 years
LD2_0–3 years	Language difficulties identified twice, the first time at 0–3 years of age	0–3 years	N/A
LD2_4–7 years	Language difficulties identified twice, the first time between 4–7 years of age	0–7 years	4–7 years
LD2_≥8 years	Language difficulties identified twice, the first time at 8 years or older	8–11 years	8–15 years
LD3_0–3 years	Language difficulties identified three or more times, the first time between 0–3 years of age	0–3 years	N/A
LD3_4–7 years	Language difficulties identified three or more times, the first time between < 8 years of age	0–7 years	4–7 years
LD3_≥8 years	Language difficulties identified three or more times, the first time at 8 years or older	N/A	8–15 years

Note. For the age range of 0 to 3 years, identification in the B cohort relates to two waves of data: at 0 to 1 years and at 2 to 3 years. The age range 4 to 7 years relates to when the children were 4 to 5 years and 6 to 7 years, and identification at 8 years or older relates to when children were 8 to 9 years and 10 to 11 years. In the K cohort, the first age range was 4 to 7 years, relating to when the children were 4 to 5 years and 6 to 7 years. Identification at 8 years or older for the K cohort relates to four waves of data: at 8 to 9 years, 10 to 11 years, 12 to 13 years and 14 to 15 years. As a result of this approach, the sample of B cohort children with LD3_≥8 years (identification at 8 years or older with condition in more than two waves) and K cohort children with LD (1, 2, 3) _0–3 years (identification between birth and 3 years) is not available in these data and therefore not considered. N/A = not available in the data.

4.3.2 School academic achievement measure

The first step in the analysis was to estimate the school academic achievement coefficient.

The literature is mixed regarding how to define school academic achievement[151,153,174-176]. This analysis adapts the method employed by Gemici et al.[177] which identified the school attributes that influence young people's transition to university over and above their individual background characteristics. A continuous measure of academic school achievement was created, by combining the predicted academic achievement (literacy and numeracy) of each student and then generating a mean estimate based on all the students in the cohort from the same school. Intuitively, this represents an estimate of the school's mean academic scores having controlled for individual background characteristics and the school level variable that are unrelated to quality. By controlling for these factors the estimated academic scores can be more confidently be attributed to academic school achievement. To validate this approach, the derived school achievement measure was validated against a second measure, defined by Currie and Thomas 2000 [178], whereby school achievement was defined as the mean values of academic testing results for all children in the sample from the same school (see Appendix H: Approach to Multilevel Modelling)

This measure is expanded further by considering non-cognitive skills (approaches to learning) affecting school engagement because there is evidence that learners may internalise the institutional (school) view of their abilities in the younger years, potentially creating a self-perpetuating expectation of success or failure. It is feasible that schools that foster non-cognitive skills serve to support students in both academic achievement and in the development of lasting life skills[163].

The final specified model includes school academic achievement as continuous literacy and numeracy variables. The school academic achievement of an individual i nested in school j is modelled by:

(4.3.2.1)

$$School\ quality_{ij} = B_0 + B_2 X_{ij^n} + \mu_{0ij} + \mu_{1ij} + \mu_{1j} time_{ij}$$
$$+ e_{ij}$$
$$n = 1,2,$$

Fixed effects

Random effects

where $school\ quality_{ij}$ is the dependent variable for school academic achievement for individual i in school j, measured by the individual student's literacy and numeracy scores[xxvii]. This was represented by an average Z-score for the time periods of 2006–

[xxvii] Numeracy includes the same model specification as literacy with the substitution of school mean NAPLAN numeracy scores for school mean NAPLAN literacy scores and the inclusion of a class size fixed effect. Note: NESB and schoolwork environment were removed as non-significant fixed effects.

2007, 2008–2009, 2010–2011, 2012–2013 and 2014–2015[xxviii] .

X_{ij^n} are the explanatory variables of the school $(n = 1)$ and child/family $(n = 2)$ starting with the school characteristics. X_{ij^1} is determined by school location variables, which includes school sector (government, Catholic, independent) and school region (indicated by state-level variables, categorised by large metropolitan centre, small metropolitan centre, large regional centre and small regional centre). School demographics are also considered and include class size (indicated by total enrolments divide by the number of full-time equivalent [FTE] teaching staff), a continuous variable indicating the school mean NAPLAN literacy and numeracy scores, gender mix (single gender, co-educational), school SES (indicated by the Index of Community Socio-Educational Advantage [ICSEA]), and mean school attendance rate. School resources and capacity are measured by the mean school income per student and the number of students per non-teaching staff member. Academic orientation of the school is approximated by a lagged approach to learning[xxix] and expectations for education[xxx]. The school's ability to provide for their students' needs, also known as the 'ethos' of the school, is measured by teacher efficacy and teacher rating of the school environment.

X_{ij^2} includes the following student-level attributes: gender, Indigenous status, socioeconomic position (SEP)[xxxi] and whether the child is from a non-English speaking background. It is well established that these individual background characteristics strongly influence student outcomes[140,141,143,179]. The random effects μ and μ_1 included random intercepts for individuals μ_{1j} over random slope of time $time_{ij}$ plus random intercepts for schools μ_{oj} plus the residual error term. The measures are described in

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[xxviii] The results for Wave 1 (2002–2004), when the children are 4 to 5 years, are not reported because 86 per cent of children in Wave 1 have not started formal school.

[xxix] 'Approach to learning' is a teacher-reported variable, which represents the mean value of 6 sub-questions (from age 6–11) and 10 sub-questions (from age 12–15) on the child's organisation, adaptability, persistence, and eagerness to learn.

[xxx] This is a parent-reported question asking how far the parent expects the child will go in education. 1 = leave school before finishing secondary school; 2 = complete secondary school; 3 = complete a trade or vocational training course; 4 = go to university and complete a degree; 5 = obtain postgraduate qualifications at a university (e.g. master's degree or doctoral degree). It is asked at 6 to 7 years, 8 to 9 years, 12 to 13 years and 14 to 15 years. Assume 8 to 9 years = 10 to 11 years expectations.

[xxxi] SEP is defined as a composite measure developed for the LSAC, encompassing both resource-based factors and factors based on social status. Resource-based factors include income, wealth and educational attainments, while factors based on social status include the prestige and status associated with different occupations. The concept is tied closely to human capital[178].

detail in Appendix H.

4.3.2.1 School academic achievement coefficients

Table 31 shows the results for school-level predictors of academic achievement (literacy and numeracy). Full equation results are reported in Table 89 in Appendix H. The effect of any given predictor in the table is expressed through its coefficient, which captures the increase/decrease in literacy and numeracy for each one-unit change in that predictor's unit of measurement. The results showed that school-level variance is driven largely by school region, school NAPLAN results, school-level attendance and academic orientation.

Table 31: Results of school-level explanatory variables on academic outcomes from 6 to 15 years (%)

		Literacy		Numeracy	
School attribute	Categories	Coefficient	SE	Coefficient	SE
School location					
School sector	Government	Reference category		Reference category	
	Independent	−0.079	−0.037	−0.054	−0.039
	Catholic	−0.096	−0.028	−0.0825**	−0.030
School region	NSW	Reference category		Reference category	
	NSW Xmet large	0.041	−0.038	0.074+	−0.041
	NSW Xmet small	0.165	−0.113	0.287*	−0.119
	Vic. Met large	−0.010	−0.036	0.057	−0.040
	Vic. Met small	0.111	−0.169	0.199	−0.188
	Vic. Xmet large	0.047	−0.050	0.090	−0.055
	Vic. Xmet small	0.118	−0.092	0.197*	−0.100
	Qld Met	−0.010	−0.047	0.102*	−0.051
	Qld Xmet large	−0.002	−0.045	0.068	−0.049
	Qld Xmet small	−0.026	−0.088	0.183+	−0.094
	SA Met large	0.061	−0.051	0.000	−0.055
	SA Xmet large	0.069	−0.089	0.074	−0.097
	SA Xmet small	0.058	−0.178	0.197	−0.196
	WA Met large	−0.044	−0.047	−0.019	−0.051
	WA Met small	−0.008	−0.161	0.017	−0.167
	WA Xmet large	0.018	−0.074	0.133+	−0.080
	WA Xmet small	0.143	−0.102	0.268*	−0.111
	Tas. Met	0.064	−0.089	0.015	−0.095
	Tas. Xmet	−0.028	−0.076	−0.013	−0.082
	NT Met	−0.297**	−0.114	−0.130	−0.125
	NT Xmet large	0.004	−0.113	0.042	−0.121
	ACT	−0.074	−0.062	−0.051	−0.067
School demographics					
NAPLAN literacy	Continuous	0.281**	−0.041	−0.015	−0.045
NAPLAN numeracy	Continuous	−0.032	−0.038	0.325**	−0.042
Gender mix	Co-ed, Female, Male	Reference category		Reference category	
	Female	0.037	−0.059	−0.036	−0.060
	Male	−0.080	−0.054	−0.060	−0.055
LBOTE	Proportion	0.002	−0.061	0.091	−0.067
School SES	Continuous	0.000	0.000	0.000	0.000
Attendance	Continuous	0.008*	−0.003	0.008*	−0.004
Resources					
Class size	Number of students per FTE teaching staff	0.001	0.000	0.001	0.000
Income	$ per student	0.00000756+	0.000	0.000	0.000
Number of students/FTE non-teaching staff	Number of non-teaching staff per student	0.00871+	−0.005	0.004	−0.006

		Literacy		Numeracy	
School attribute	Categories	Coefficient	SE	Coefficient	SE
Provide for student needs					
Teacher effectiveness	Quantile 1	Reference category		Reference category	
	Quantile 2	−0.016	−0.041	0.008	−0.050
	Quantile 3	0.124	−0.156	−0.258	−0.195
Academic achievement of school environment	Continuous	0.007	−0.010	0.010	−0.012
Academic orientation					
Approach to learning	Quantile 1	Reference category		Reference category	
	Quantile 2	0.200**	−0.019	0.155**	−0.022
	Quantile 3	0.334**	−0.021	0.258**	−0.024
Year 12 plans (parent)	Leave school before completion	reference category		reference category	
	Complete Year 12	0.278**	−0.054	0.215**	−0.065
	Complete trade or vocational training	0.294**	−0.054	0.226**	−0.064
	Go to university and complete a degree	0.583**	−0.054	0.530**	−0.064
	Obtain postgraduate qualifications at university	0.714**	−0.058	0.701**	−0.069
Year 12 plans (child at 15 years)	Leave school before completion	Reference category		Reference category	
	Complete Year 12	0.156+	−0.023	0.057*	−0.027
	Complete trade or vocational training	0.073	−0.025	0.083**	−0.029
	Go to university and complete a degree	0.498**	−0.027	0.135**	−0.031
	Obtain postgraduate qualifications at university	0.229**	−0.031	0.237**	−0.035
N		9592		9496	
LL		−9303		−10532	
AIC		18740		21199	
BIC		19220		21679	

Note. SE = standard error; FTE = full-time equivalent; Xmet = regional centre; Co-ed = co-educational; LBOTE = language background other than English; SES = socioeconomic status; FTE = full-time equivalent; N = number of observations; LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion. +significant at 10%. *significant at 5%. **significant at 1%.

The estimates from the academic school achievement equation were used as an instrumental variable in the subsequent equations. Using the continuous outcome variable, with normal distribution (discussed in Appendix H: Approach to Multilevel Modelling), academic school achievement is defined by separating schools into the lowest 25%, middle 50% and highest 25% of schools. This is a slightly broader definition than in the literature[177], which used +/− 1 SD away from the mean. As this analysis is focused on language, the sample sizes needed to be larger to achieve model convergence.

4.3.3 Long-term outcomes based on academic school achievement

The literature suggests that children who lag behind have the potential to catch up and schools can influence these effects, over and above the individual risk factor effects, through access to additional educational opportunities[150]. In this section, the analysis addresses the question of whether a child with language difficulties who attends a high academic achievement school can have better outcomes that a child without language difficulties, in a poor performing school. Specifically, the analysis focuses on: academic achievement; attendance in national testing; NAPLAN; higher expectations for education beyond school; and better emotional and behavioural health.

4.4 Econometric framework

4.4.1 Modelling approach

The sampling strategy of the LSAC is stratified by geographical area and clustered by postcode to ensure the sample was distributed across metropolitan and regional areas. Children in very remote parts[xxxii] of Australia were excluded from the sampling because of the high data-collection costs. This strategy means that individuals who live in the same postcode are similar with regard to relevant background characteristics and are likely to attend schools of similar academic achievement. To account for this structure, multilevel (mixed or nested) models are the most appropriate technique; that is, multilevel or nested models are used to model the effects of individuals within schools, allowing for individuals who attend the same school (and a school of the same academic achievement). Mixed models allow a covariance structure to be fitted at the school level. Details on the multilevel model are provided in Appendix H: Approach to Multilevel Modelling. Additionally, the analysis needed to consider that language difficulties in the educational attainment (Eq. 4.4.1), emotional and behavioural health (Eq. 4.4.2), parents' and child's expectations (Eq. 4.4.3 and Eq. 4.4.4) and NAPLAN attendance (Eq. 4.4.5) equations are not exogenous. The endogeneity derives from a number of sources. First, it may result from omitted variables bias. The language variable in the educational attainment, the emotional and behavioural health and the

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[xxxii] Accessibility Remoteness Index Australia (ARIA)[83].

parental expectations equations are likely to be correlated with the error terms that capture individuals' unobserved motivation, and preferences. Second, the endogeneity may be the result of reverse causality. Higher-SES households could influence language development through additional opportunities. For example, individuals who possess higher income or parents with higher expectations may be more likely to have more human capital investment, resulting in higher language acquisition. Similarly, in the emotional and behavioural health equation, it is not known whether a child's emotional and behavioural health is driven by his or her approach to learning or whether his or her approach to learning is driven by emotional and behavioural health.

In order to correct for the endogeneity of the language measures in all equations, a method based on propensity scores is used to help remove potential selection bias and, at the same time, account for relevant individual background characteristics[180]. The propensity score estimates the probability of an individual having a language difficulty. By controlling for these propensities, any differences in the outcome variable can be more confidently attributed to language difficulties, after controlling for background characteristics. In this analysis, covariate adjustment methods are used, whereby the effect of treatment (propensity score) is included as a covariate in the second-stage model. The advantage of this method is that it involves a complete set of observations to be used[134,181] [xxxiii]. Details on the calculation and use of propensity scores in creating the weights are provided in Appendix H: Approach to Multilevel Modelling.

The second-stage model entails regressing the outcomes of interest—academic achievement (cognitive outcomes), emotional and behavioural health (non-cognitive outcomes), expectations for education, and NAPLAN attendance—on individual language status and school academic achievement, together with their corresponding interactions[xxxiv]. The inclusion of these interactions is the basis of this chapter—that is, whether the impact of school academic achievement varies by language difficulties

[xxxiii] The model attempted to weight for the probability of being selected into the sample and for attrition (using the longitudinal weights provided with the data) but the model including this weight would not converge.
[xxxiv] The equation includes a dummy variable for whether children change schools plus the propensity score weight.

status[xxxv]. For the academic outcomes, the remaining background characteristics for individuals and schools were accounted for via the use of propensity scores and the use of the school academic achievement variable at the school level. For the non-cognitive and expectations for education outcomes, the remaining background characteristics are outlined.

4.4.2 Final equations

4.4.2.1 Cognitive skills

Academic test scores are the most obvious measure of human capital and conceptually this model explores the importance of academic school achievement on cognitive skills for children with language difficulties. The final specified model of cognitive skills includes continuous literacy and numeracy variables. $Numeracy_{ij=}$ includes the same model specification as literacy, with the substitution of school mean NAPLAN numeracy scores for school mean NAPLAN literacy scores.

The cognitive skills of an individual i nested in school j are modelled by:

(4.4.2.1)

Fixed effects

$$Cognitive\ skills_{ij} = B_0 + B_1 H_{ij} + B_2 X_{ij^n}$$

$$\mu_{0ij} + \mu_{1ij} + \mu_{1j} time_{ij} + e_{ij}$$

Random effects

$$n = 1{,}2,$$

where $Cognitive_{ij}$ is the dependent variable for literacy and numeracy[xxxvi]. H_{ij} is the language difficulty variable described in Eq. 4.4.1. X_{ij^n} are the explanatory variables of the school $(n = 1)$ and the propensity score $(n = 2)$ starting with the school characteristics. X_{ij^1} are the explanatory variables, which include an interaction between school academic achievement, time and H_{ij} . School academic achievement is defined

[xxxv] Note that the school-achievement variable is constructed using the literacy and numeracy individual scores. Thus, the results for these two outcomes need to be considered by only the interactions between school achievement and language and achievement.

[xxxvi] Non-English speaking background and schoolwork environment were removed as non-significant fixed effects.

as a standardised value of the average school academic achievement scores (categorised as the lowest 25 %, median 50%, and highest 25%). Time is an indicator variable for children at 6 to 7 years, 8 to 9 years, 10 to 11 years, 12 to 13 years, and 14 to 15 years. X_{ij^2} is the propensity score covariate adjustment (in quintiles). The random effects μ and μ_1 included random intercepts for individuals μ_{1j} over random slope of time $time_{ij}$ plus random intercepts for schools μ_{oj} plus the residual error term e_{ij}.

4.4.2.2 Non-cognitive skills

Academic test scores do not provide a complete measure of human capital and this model explores the importance of non-cognitive skills in human capital accumulation for children with language difficulties. Emotional and behavioural health is defined by five outcome variables. These include subscales of paediatric achievement of life scores (PEDS) functioning: physical, emotional, school and psychosocial, and parental strengths and difficulties questionnaire (PSDQ) (see Appendix G for detailed explanation), which includes subscales of hyperactivity, emotional, peer and conduct problems[xxxvii].

The emotional and behavioural health of an individual i in a school j is modelled by:

(4.4.2.2)

$$\left. Emotional\ and\ behavioural\ health_{ij} = B_0 + B_1H_{ij} + B_2X_{ij^n} \right\} \text{Fixed effects}$$
$$\left. \mu_{0ij} + \mu_{1ij} + \mu_{1j}time_{ij} + e_{ij} \right\} \text{Random effects}$$
$$n = 1,2,3$$

where $emotional\ and\ behavioural\ health_{ij}$ is the dependent variable for non-cognitive skills. H_{ij} is the language difficulties status, X_{ij^n} are the explanatory variables of the school (n = 1) and child (n = 2) and family (n = 3) and the propensity score (n = 4) starting with the school characteristics. X_{ij^1} is an interaction between school academic achievement and H_{ij}. Time is not significant in this interaction and is removed from the final equation. In addition to the individual variables that contribute

[xxxvii] Convergence was not achieved with the population weights. Missing observations are considered using dummy variables.

to a child's academic scores (and are captured in the school academic achievement variable), there are characteristics that influence non-cognitive skills.. X_{ij^2} are the child's variables, which include whether the child has additional disabilities, the child's gender, Indigenous status, health status (excellent, very good and good or below) and the child's approach to learning. X_{ij^3} are family variables, which include the number of siblings in the family (range 0–11), a dummy variable indicating whether the mother works, a continuous measure for the mother's mental health[xxxviii], whether there has been an illness of a relative or friend in the last six months (health shock and family SEP). Lagged mental health and health shocks were also considered[xxxix]. X_{ij^4} is the propensity score. The random effects μ and μ_1 included random intercepts for individuals μ_{1j} over random slope of time $time_{ij}$plus random intercepts for schools μ_{oj} plus the residual error term ε_{ij}. The mixed model is estimated using maximum likelihood estimation (MLE), with unstructured covariance matrix and using Stata 14 command XTMIXED.

4.4.2.3 Parents' expectations for education

Parental expectations for children's academic achievement are strongly correlated with educational outcomes involvement [165-169] and this model explores the importance of parental expectations for children with language difficulties. A choice set of parent educational expectations is defined by a collapsed set of two alternatives: (1) go to university or (0) not[xl]. This collapsed variable is defined for two reasons. The first is that the expectation of university attendance is the main driver of parental expectations. The second reason is that while the alternatives ([1] leave school before completion, [2] complete secondary school, [3] complete a trade or vocational course, [4] go to

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[xxxviii] Mother's mental health is based on the K–6 depression scale that looks at the sub-scales of nervousness, hopelessness, restlessness, effort, sadness, worthlessness. Scores are reported as mean values on a Likert scale (all of the time, most of the time, some of the time, a little of the time, none of the time).

[xxxix] In order to correct for the endogeneity of the health and engagement variables in Eq.

(4.4.2.2)

, non-cognitive skills (PSDQ) and functioning measures are modelled in cross-lagged models using structural equation modelling to test the direction of effect (results not reported) and subsequently add lagged independent variables for mothers depression, if a relative has an injury or illness and child's approach to learning to our model. The PSDQ total score and functioning measures are modelled on 4 waves of data (due to loss of one wave due to lagged variables).

[xl] The primary carer in the LSAC is most commonly the mother.

university and complete a degree, [5] obtain a postgraduate qualification) show an ordered pattern, it is possible that a parent may expect that their child to complete a trade or vocational course and finish Year 12 or, alternatively, not finish Year 12.

This nuance in the categories means that neither the ordered logit nor the multinomial logit provides the best specification of these data. Due to convergence issues, it was not possible to categorise language difficulties in terms of severity and timing for this equation. For this analysis, language difficulties is defined by a dummy variable indicating 1 if the child has language difficulties and 0 if the child has no language difficulties. Educational expectations are defined by two outcome variables: parental expectations for education from age 6 to 15 years, and child expectations at 15 years.

The parental educational expectations[xli] of an individual i in a school j is modelled by:

(4.4.2.3)

$$Expectations\ of\ education_{p_{ij}} = B_0 + B_1 H_{ij} + B_2 X_{ij^n} \quad \text{Fixed effects}$$
$$\mu_{0ij} + \mu_{1ij} + e_{ij} \quad \text{Random effects}$$
$$n = 1,2,3$$

where $expectations\ of\ education_{P_{ij}}$ is the dependent variable for parental expectations. H_{ij} is the language status. X_{ij^n} are the explanatory variables of the school $(n = 1)$ and child/family $(n = 2)$ and the propensity score $(n = 3)$ starting with the school characteristics. X_{ij^1} is the interaction between school academic achievement, time and H_{ij} . X_{ij^2} includes the child's variables: approach to learning, literacy scores, IQ, and strengths and difficulties. Family variables include SEP. X_{ij^3} is the propensity score. The random effects μ and μ_1 included random intercepts for individuals μ_{1j} plus random intercepts for schools μ_{oj} plus the residual error term e_{ij}. The mixed model was estimated using Stata 14 command XTMELOGIT.

[xli] Equations are modelled using XTMELOGIT in Stata 14. By default, Stata uses MLE estimation with adaptive quadrature with 7 integration points. The model was refitted with up to 15 integration points. The estimates were consistent and 7 integration points was adequate. Convergence was not achieved with the population weights. Missing observations are considered with dummy variables.

4.4.2.4 Child's expectations for education

Engagement at school is a measure of educational aspirations that have also been found to be associated with better educational and employment outcomes [163,164] and this section explores the importance of expectations of education for children with language difficulties. A choice set of child's educational expectations was defined by two alternatives: (1) go to university or (0) not. The child's educational expectations are specified by:

(4.4.2.4)

$$\left.\begin{array}{l} Expectations\ of\ education_{cp_{ij}} = B_0 + B_1 H_{ij} + B_2 X_{ij^n} \end{array}\right\} \text{Fixed effects}$$

$$\left.\begin{array}{l} \mu_{0ij} + \mu_{1ij} + e_{ij} \end{array}\right\} \text{Random effects}$$

$n = 1,2,3$

where $expectations\ of\ education_{c_{ij}}$ is the dependent variable for the child. H_{ij} is the language status. X_{ij^n} is consistent with Eq. 4.4.3 above with the inclusion of parents' expectations for the child (defined above). The random effects μ and μ_1 included random intercepts for individuals μ_{1j}[xlii] plus random intercepts for schools μ_{oj} plus the residual error term ε_{ij}.[xliii]

4.4.2.5 NAPLAN Attendance

The model explores whether children with language difficulties are overrepresented in groups that are excluded or absent from NAPLAN testing. A set of NAPLAN attendance is defined by four alternatives: (1) attend all assessments, (2) absent for some but not all, (3) absent for all, (4) exempt. The collapsed binary sets are defined by Set 1: (1) attend all assessments, (2) absent for some but not all; Set 2: (1) attend all assessments, (2) absent for all; Set 3: (1) attend all assessments, (2) exempt. These data represent attendance in 2006–2007 when the children are in Year 3 and first sit a NAPLAN test, in 2008–2009, in 2010–2011, and in 2012–2013 when the children are in

[xlii] The equation for expectations for education is three level random intercept models. LR tests determined that random slopes for time did not improve the model fit (xtmelogit). The equation for the child's expectations for education is estimated using Wave 6 data only and uses two level random intercept models (xtmelogit).

Year 9. On average, 94% of students attend all NAPLAN assessments.

The NAPLAN attendance[xliv] of an individual i nested in school j is modelled by:

(4.4.2.5)

$$NAPLAN_{ij} = B_0 + B_1 H_{ij} + B_2 X_{ij^1} + B_2 X_{ij^2} \quad \text{Fixed effects}$$

$$\mu_{0ij} + \mu_{1ij} + e_{ij} \quad \text{Random effects}$$

$$n = 1,2,3$$

where $NAPLAN_{ij}$ is the dependent variable. H_{ij} is the language status. X_{ij^n} are the explanatory variables of the school (n = 1) and child/family (n = 2) and the propensity score (n = 3) starting with the school characteristics. X_{ij^1} is the interaction between school academic achievement and H_{ij}. The other school variable is school sector (government, independent and Catholic). X_{ij^2} includes the child's variables: health status, three variables for other medical conditions (sensory/learning, physical, emotional and behavioural and other), and whether the child is from a non-English speaking background. X_{ij^3} is the propensity score. The random effects μ and μ_1 included random intercepts for individuals μ_{1j} plus random intercepts for schools μ_{oj} plus the residual error term ε_{ij}.

4.5 Results

The next section discusses the results of the models.

4.5.1 Initial variance components

The results from an initial variance components model are first considered to explore

[xliv] Equations are modelled using XTMELOGIT in Stata 14. Observations for the dependent variable that were 'no match' or missing were excluded. Missing observations in the independent variables were considered using dummy variables. The study attempted to use the generalised linear and latent mixed models (GLLAMM) specification, which allows unordered categorical dependent variables, in a nested structure and using longitudinal data. However, convergence could not be achieved. To facilitate estimation, the categories are collapsed into three separate binary models, allowing use of the mixed model XTMELOGIT.

what proportion of the variance in the outcomes of interest are related to school level factors. This unconditional model showed that student-background factors were responsible for most of the variation across outcomes. Nonetheless, school attributes accounted for 8 per cent to 40 per cent of the variation in outcomes, which indicates that schools and their attributes play a role. Table 32 Table 35 show the goodness of fit statistics in the modelling strategy. For each outcome, a log-likelihood ratio (LR) test was performed. The LR test statistic ($p < 0.05$) indicates that each model has outperformed the preceding simpler model. Where possible, models were weighted for the probability of being selected into the sample and for attrition (using the longitudinal weights provided with the data). Models that did use longitudinal weights had similar coefficients and standard errors to unweighted models.

Table 32: Goodness of fit statistics – literacy model

	School-level variance	Individual variance	Residual	Log-likelihood	df	LR test
Null model	0.25	0.44	0.31	−16197	0	
Unweighted school academic achievement model	0.02	0.56	0.40	−14189	112	P < 0.05
School academic achievement with PS covariate	0.02	0.49	0.40	−13441	115	P < 0.05
School academic achievement weighted with attrition	Convergence not achieved					

Note. df = degrees of freedom; LR = log-likelihood ratio; PS = propensity score.

Table 33: Goodness of fit statistics – PSDQ total score model

	School-level variance	Individual variance	Residual	Log-likelihood	df	LR test
Null model	0.08	0.56	0.35	−66006	0	
Unweighted school academic achievement model	0	0.60	0.40	−31534	75	p < 0.05
School academic achievement with PS covariate	0	0.60	0.40	−31189	79	p < 0.05
School academic achievement weighted with attrition	Convergence not achieved					

Note. PSDQ = Parental Strengths and Difficulties Questionnaire; df = degrees of freedom; LR = log-likelihood ratio; PS = propensity score.

Table 34: Goodness of fit statistics – expectations for education

	School-level variance	Residual	Log-likelihood	df	LR test
Parents' expectations for education					
Null model	0.31	0.69	−8874	0	
Unweighted school academic achievement model	0.00	1.00	−7798	8	$p < 0.05$
School academic achievement weighted with PS	0.00	1.00	−5505	20	$p < 0.05$
Child's expectations for education					
Null model	0.22	0.78	−1478	0	
Unweighted school academic achievement model	0.00	1.00	−1324	3	$p < 0.05$
School academic achievement with PS covariate	0.00	1.00	−880	7	$p < 0.05$

Note: df = degrees of freedom; LR = log-likelihood ratio; PS = propensity score.

Table 35: Goodness of fit statistics – NAPLAN attendance

	School-level variance	Residual	Log-likelihood	df	LR test
NAPLAN attendance					
Null model (MLOGIT)	NA	NA	−3784	20	NA
Null model (GLLAMM)	0.15	0.85	−3245	8	NS
Null model (XTMELOGIT) [a]	0.26	0.74	NA	0	NA
Null model (XTMELOGIT; Outcome: absent for part of NAPLAN)	0.40	0.60	−1687	3	$p < 0.05$
School academic achievement with PS covariate	0.27	0.73	0	20	$p < 0.05$

Note. Null model variance is mean values of three separate null models, df = degrees of freedom; LR = log-likelihood; PS = propensity score.
[a] Models were specified as three subgroup binary models (base case = attend all, 1 = exempt, 2 = absent for part, 3 = absent for all) using XTMELOGIT.

For ease of reading the next section is structured as follows: Section 4.5.2 discusses the descriptive results for Eq. 4.4.2.1 through to Eq. 4.4.2.4 and then these results are discussed in detail in Section 4.5.3 through to Section 4.5.5 NAPLAN attendance (Eq.4.4.5) is then discussed as a sub-chapter in Section 4.5.6.

4.5.2 Descriptive statistics

Table 36 shows a cross-tabulation of language persistence, timing of identification and school academic achievement. The first section of the table shows that children with

language difficulties were more likely to attend schools of the lowest academic achievement. These children were typically from lower socioeconomic families; their mothers were less likely to be high school graduates or to have a postgraduate qualification and their family incomes were lower than population averages. At each school academic achievement level, there appears to be a linear relationship between language difficulties persistence, timing and disadvantage. That is, as language persistence increased and identification occurred later, levels of socioeconomic disadvantage also increased.
The results also show that this relationship was more pronounced in schools of the highest academic achievement.

Panel C of Table 36 shows that the differences in background are reflected in differences in child outcomes. NAPLAN tests students in two areas: literacy and numeracy over four age groups (8 to 9 years, 10 to 11 years, 12 to 13 years, and 14 to 15 years)[173]. The test scores are expressed as mean scores over these age groups. The table shows that children from schools of the lowest academic achievement typically lag approximately 30 points behind children in schools of median academic achievement, and between 60 and 85 points behind children in schools of the highest academic achievement. Within each school academic achievement band, children with the most severe language difficulties lagged between 70 and 100 points behind their normal-language peers. Children with severe language difficulties and social disadvantage were between 150 and 160 points behind their peers with typical language from socially advantaged backgrounds. The table suggests that the effect of having a language difficulty is equivalent to the effect of socioeconomic disadvantage on educational outcomes. The effect of having a language difficulty and socio-economic disadvantage is compounded leading to a is two-fold lag.

In terms of non-cognitive skills, PEDS functioning and PSDQ were assessed over five age groups (6 to 7 years, 8 to 9 years, 10 to 11 years, 12 to 13 years and 14 to 15 years). The questionnaire scores were expressed as mean continuous scores over these age groups. PEDS functioning scores range from 0–100, with higher functioning scores indicating higher levels of function. PSDQ scores range from 0–35, with higher scores indicating more difficulties.

Table 36 shows that children from the lowest quantile of school achievement typically lag between 2 and 6 points behind children in schools of median academic achievement, and between 2 and 9 points behind children in schools of the highest academic achievement. Within each school academic achievement band, children with the most severe language difficulties lagged between 3 and 16 points behind their normal-language peers, with the greatest deficits being in school and social functioning. Children with severe language difficulties and social disadvantage were between 6 and 18 points behind their peers with typical language from socially advantaged backgrounds. The results suggest that the effect of having a language difficulty is up to three times greater than the effect of socioeconomic disadvantage alone on emotional and behavioural outcomes. There appears to be weak evidence for any additional effects for a child with language difficulties and social disadvantage.

In terms of expectations for education, parents were asked at each age group what their expectations were for their child with regard to education (6 to 7 years, 8 to 9 years, 10 to 11 years, 12 to 13 years and 14 to 15 years). Children were asked this question at 14 to 15 years only. On average, 36 per cent of parents of children with typical language in schools of the lowest academic achievement expected their child to go to university (Column 1, Table 36a,), compared with 65 per cent of parents of children with typical language in schools of median academic achievement (Column 1, Table 36b), and 73 per cent of parents of children with typical language in schools of the highest academic achievement (Column 1, Table 36c).Within each school academic achievement band, parents of children with the most severe language difficulties typically had lower expectations for their child's education than did the parents of children with typical language. On average, 14 per cent of the parents of children with severe language difficulties attending schools of the lowest academic achievement expected their child to go to university (Column 7, Table 36a) compared with 26 per cent for schools of median academic achievement (Column 7, Table 36b) and 40 per cent for schools of the highest academic achievement (Column 7, Table 36c).

Table 36: Means of key variables by language difficulty severity, timing (percentage unless otherwise stated)

36 a: Low school academic achievement

Variable	Lowest 25% school academic achievement						
Measurement	Typical language	LD-One wave		LD-Two waves		LD-Three or more waves	
Panel A. Child and family characteristics		*4-7 years*	*>= 8 years*	*4-7 years*	*>= 8 years*	*4-7 years*	*>= 8 years*
Number of observations	2,616	241	797	127	383	109	441
Male	51.30	70.12	66.37	58.27	64.75	74.31	60.77
Indigenous	5.28	4.56	8.78	1.57	10.97	8.26	21.77
Non-English speaking background	5.31	14.94	1.88	9.45	9.14	21.10	15.19
Equivalised gross income ($)[a]	43221	41608	42449	33235	35667	33490	32502
Mother completed Year 12	44.30	42.32	38.77	20.47	29.77	35.78	31.97
Mother has postgraduate degree	22.63	13.69	12.92	8.66	12.01	12.84	11.11
Intelligence quotient (Z-score)	−13.03	−45.37	−51.20	−53.89	−81.18	−99.62	−88.23
Panel B. School variables							
School type							
Government	81.27	79.67	78.04	83.46	83.03	77.98	83.22
Independent	4.89	6.22	5.77	9.45	6.27	6.42	2.49
Catholic	13.84	14.11	16.19	7.09	10.70	15.60	14.29
Panel C. Individual characteristics							
NAPLAN literacy (score)[ab]	497.55	469.47	450.58	444.47	429.90	410.04	408.68
NAPLAN numeracy (score)[ab]	494.86	469.59	457.90	449.78	447.96	428.94	422.98
PEDS physical function (score)[a]	80.81	81.97	78.76	77.28	77.28	74.13	71.25
PEDS emotional function (score)[a]	73.10	74.23	72.50	68.28	71.61	71.13	66.48
PEDS social function (score)[a]	78.39	75.91	76.27	73.88	72.19	74.55	65.89
PEDS school function (score) [a]	73.08	72.65	67.99	69.85	64.97	63.84	62.35
Strengths and difficulties (score)[a]	8.61	9.18	10.14	11.26	11.18	11.85	12.63
Parental expectations for education[a]							
Leave school before completion	3.29	7.47	5.27	9.45	7.83	12.84	13.61
Complete Year 12	23.93	19.50	28.36	22.05	31.85	37.61	38.10
Complete a trade or vocational	27.94	31.12	36.39	36.22	36.55	30.28	26.08
Complete undergraduate degree	37.81	31.12	27.98	25.98	20.63	13.76	17.01
Obtain postgraduate qualification	4.82	6.22	1.38	3.15	1.31	2.75	1.36
Child expectations for education at 15 years[a]							
Leave school before completion	2.03	4.98	4.89	0.00	12.79	2.75	4.76
Complete Year 12	20.18	21.58	30.24	16.54	22.19	16.51	24.04
Complete a trade or vocational	21.64	16.18	30.36	22.83	27.68	19.27	16.78
Complete undergraduate degree	27.79	18.67	17.94	29.13	11.23	10.09	8.39

36 b: Median school academic achievement (percentage unless otherwise stated)

Variable	Median 50% school academic achievement						
Measurement	Typical language	LD- One wave		LD- Two waves		LD-Three or more waves	
Panel A. Child and family characteristics		*4-7 years*	*>= 8 years*	*4-7 years*	*>= 8 years*	*4-7 years*	*>= 8 years*
Number. of observations	7025	524	919	199	339	103	340
Male	44.71	60.88	55.50	46.73	67.85	62.14	65.59
Indigenous	1.27	0.95	2.61	1.51	0.59	8.74	4.12
Non-English speaking background	6.41	24.05	7.73	13.57	15.34	34.95	12.65
Equivalised gross income($)[a]	53528	48890	51901	46057	45709	41807	42268
Mother completed Year 12	64.20	59.54	56.04	58.79	52.21	34.95	41.76
Mother has postgraduate degree	46.02	33.78	40.04	41.21	35.10	15.53	20.88
Intelligence quotient (Z-score)	16.27	4.69	−31.96	−21.44	−63.13	−41.82	−68.10
Panel B. School variables							
School type							
Government	55.09	63.74	57.56	57.79	56.64	74.76	60.88
Independent	16.04	13.17	14.25	14.57	14.45	13.59	12.94
Catholic	28.87	23.09	28.18	27.64	28.91	11.65	26.18
Panel C. Individual Characteristics							
NAPLAN literacy (score)[ab]	534.30	510.83	485.63	506.90	460.24	439.91	431.89
NAPLAN numeracy(score)[ab]	532.93	525.52	488.52	508.68	469.55	460.48	448.16
PEDS physical function (score)	83.27	81.94	82.55	80.84	76.13	77.11	79.06
PEDS emotional function (score)	75.14	76.11	74.35	76.58	69.92	71.09	73.20
PEDS social functioning (score)	82.79	81.03	80.73	77.43	74.38	75.54	74.77
PEDS school functioning (score)[a]	78.16	76.14	71.76	74.61	67.03	66.48	66.55
Strengths and difficulties (score)[a]	6.68	7.68	8.21	7.36	10.27	10.17	10.34
Parental expectations for education[a]							
Leave school before completion	0.77	0.76	1.85	2.51	4.13	3.88	7.06
Complete Year 12	9.92	13.36	17.95	15.08	25.96	22.33	25.88
Complete a trade or vocational	13.74	17.18	22.74	19.60	30.09	33.98	33.82
Complete undergraduate degree	66.36	58.78	52.77	55.28	36.58	25.24	25.00
Obtain postgraduate qualification	7.89	8.40	3.92	7.04	2.36	4.85	3.53
Child expectations for education at 15 years [a]							
Leave school before completion	0.84	1.15	1.31	0.00	0.59	0.97	1.47
Complete Year 12	10.98	14.50	19.70	12.56	22.71	7.77	12.06
Complete a trade or vocational	8.91	9.16	16.00	13.57	29.50	39.81	15.29
Complete undergraduate degree	60.43	51.15	48.31	60.80	28.61	25.24	26.76

Note: School academic achievement is a continuous variable that has been categorised into three quantiles (< 25%, 25–75%, > 75%). 4–7 years refers to initial diagnosis between 4 and 7 years; ≥ 8 years refers to initial diagnosis at 8 years or older. Number of observations is indicative of a cross-sectional analysis across all waves.
[a]The sample is subject to missing observations. [b]NAPLAN scores refer to mean scores over the four years that the children sat NAPLAN: at 8 to 9 years, 10 to 11 years, 12 to 13 years and 14 to 15 years.

36 c: High school academic achievement (percentage unless otherwise stated)

Variable	Highest 25% school academic achievement						
Measurement	Typical language	LD- One wave		LD- Two waves		LD-Three or more waves	
Panel A. Child and family Characteristics		*4-7 years*	*>= 8 years*	*4-7 years*	*>= 8 years*	*4-7 years*	*>= 8 years*
Number of observations	4034	204	298	53	75	17	46
Male	47.55	56.86	60.07	47.17	74.67	35.29	43.48
Indigenous	0.30	0.00	0.67	0.00	0.00	0.00	4.35
Non-English speaking background	15.27	32.35	17.79	30.19	13.33	35.29	69.57
Equivalised gross income($)[a]	78156	63834	69334	56557	72531	47211	30511
Mother completed Year 12	85.65	83.33	80.54	75.47	77.33	23.53	63.04
Mother has postgraduate degree	89.96	58.33	72.82	54.72	60.00	5.88	32.61
Intelligence quotient	42.47	32.45	−1.09	21.04	−33.73	−66.17	−36.18
Panel B. School variables							
School type							
Government	49.63	48.04	43.29	56.60	34.67	47.06	47.83
Independent	32.87	30.88	29.19	18.87	41.33	29.41	30.43
Catholic	17.50	21.08	27.52	24.53	24.00	23.53	21.74
Panel C. Individual characteristics							
NAPLAN literacy (score)[ab]	560.97	527.71	506.03	495.76	490.53	426.52	482.75
NAPLAN numeracy(score)[ab]	568.84	545.33	514.07	488.75	516.08	415.83	481.33
PEDS physical function (score)[a]	83.54	80.03	81.11	79.14	82.01	68.75	66.81
PEDS emotional function (score)[a]	75.41	74.27	76.23	78.04	75.38	66.00	71.52
PEDS social function (score)[a]	83.50	79.39	81.19	78.67	76.37	53.33	64.68
PEDS school function (score)[a]	79.75	74.24	73.74	72.86	68.64	68.33	57.94
Strengths and difficulties (score)	5.86	6.88	7.22	7.90	9.40	15.20	10.73
Parental expectations for education[a]							
Leave school before completion	0.05	0.00	0.00	0.00	1.33	0.00	4.35
Complete Year 12	2.97	5.39	8.39	7.55	12.00	11.76	23.91
Complete a trade or vocational	4.09	14.22	13.42	18.87	28.00	52.94	15.22
Complete undergraduate degree	72.71	65.69	72.15	54.72	52.00	35.29	39.13
Obtain postgraduate qualification	18.54	13.73	6.04	16.98	4.00	0.00	8.70
Child expectations for education at 15 years[a]							
Leave school before completion	0.20	0.98	0.34	0.00	0.00	0.00	0.00
Complete Year 12	3.45	0.00	8.72	7.55	14.67	0.00	6.52
Complete a trade or vocational	2.31	2.94	8.72	5.66	4.00	29.41	4.35
Complete undergraduate degree	79.52	69.12	71.81	52.83	58.67	35.29	43.48

Note: School academic achievement is a continuous variable that has been categorised into three quantiles (< 25%, 25–75%, > 75%). 4–7 years refers to initial diagnosis between 4 and 7 years; ≥ 8 years refers to initial diagnosis at 8 years or older. Number of observations is indicative of a cross-sectional analysis across all waves.
[a]The sample is subject to missing observations. [b]NAPLAN scores refer to mean scores over the four years that the children sat NAPLAN: at 8 to 9 years, 10 to 11 years, 12 to 13 years and 14 to 15 years.

Table 37 shows further exploration of the relationship between language difficulties persistence, timing of diagnosis and school academic achievement status. In order to measure the effects of school academic achievement alone, the hypothesis that children with higher achievement language attend higher performing schools is tested. The table shows the marginal effects of linear probability models, in which the dependent variable is a categorical variable of school academic achievement, equal to 0 for school of low academic achievement, 1 for school of median academic achievement and 2 for school of high academic achievement. The independent variables are not listed here (refer to Appendix J: Equation Specification. In the models shown, the school academic achievement relevant to each child was measured using the academic achievement variable discussed in Section 4.3.2. It is important to note that measures of language difficulties status are correlated to the school academic achievement measure by design. The differential effects of persistence and timing of language difficulties is the focus of the analysis—that is, the difference between children with and without language difficulties in the same schools, controlling for background characteristics. Table 37 shows that among children with language difficulties, as severity increased and late diagnosis occurred, the probability of attending a school of higher academic achievement decreased, conditional on observable family characteristics. However, while this suggests that the children with the most severe language difficulties were concentrated in the schools of lowest academic achievement, they attended schools in which there remained differences between children with language difficulties and children with typical language as well as differences between children with typical language across school academic achievement. That is, as suggested by Gemici et al.[177], there was a disadvantage effect and a language difficulty effect.

Table 37: Probability of children with language difficulties being in schools defined by academic achievement

		Typical language	One wave		Two waves		Three or more waves	
School academic achievement			4–7 years	≥ 8 years	4–7 years	≥ 8 years	4–7 years	≥ 8 years
Lowest 25%	Mean	0.232	0.243	0.266	0.176	0.258	0.302	0.260
	SE	0.004	0.012	0.008	0.019	0.013	0.031	0.015
Median 50%	Mean	0.531	0.536	0.521	0.568	0.558	0.506	0.567
	SE	0.004	0.016	0.012	0.029	0.021	0.043	0.028
Highest 25%	Mean	0.237	0.221	0.213	0.257	0.185	0.192	0.173
	SE	0.003	0.010	0.009	0.009	0.016	0.032	0.024

Note: School academic achievement is a continuous variable that has been categorised into quantiles (< 25%, 25–75%, > 75%). 4–7 years refers to initial diagnosis between 4 and 7 years; ≥ 8 years refers to initial diagnosis at 8 years or older.

The next question is whether a given child in one of these schools would do better if he or she were moved to a better school. While it is not possible to answer this question directly using the LSAC data, which is observational, it is possible to answer the question: "do children with language difficulties who happen to be in better schools do better than similar children in lower achievement schools?" Given that children with language difficulties in high achievement schools may be positively selected, that is there are more academically able language difficulty children in higher achievement schools, they should be doing at least as well as typical language children in lower achievement schools. To address this question the full mixed model is discussed in the next section. The section focuses initially on language difficulties overall and then discusses the results in terms of persistence and timing of identification. The primary focus of the analysis is on whether children with language difficulties benefit to a greater or lesser extent from attending high academic achievement schools when compared with their language typical peers. This is addressed initially by looking at language difficulties overall and then with consideration of persistence and timing of identification to address a second question; does school achievement have a differential effect on achievement for some children? These results are discussed in further detail in the next section.

4.5.3 Literacy and numeracy results

The coefficients for Eq. 4.4.1 are summarised in Table 38, Table 39 and Table 40 . These three tables comprise the interaction effects of school academic achievement by language difficulties status and the outcomes of interest. The tables are split into three separate panels, which differentiate students by school academic achievement, with the panel on the left indicating low school academic achievement (< 25 per cent), the central panel indicating median school academic achievement (middle 50 per cent) and the panel on the right indicating high school academic achievement (> 75 per cent). The body of each panel represents the language status of individual students[xlv]. It is important to consider both the statistical significance and the clinical significance in the interpretation of the results. The confidence intervals for some coefficients are wide, notably in the high academic achievement group, which is largely due to the small sample sizes in these groups. However, intuitively, this is unlikely to indicate no effect and may lead to erroneous conclusions[182].

Table 38 and Table 39 show the average literacy and numeracy scores for children with and without language difficulties at 6 to 7 years[xlvi] of age and then again at 14 to 15 years. These results are presented to illustrate the academic skill level at the commencement of school and again at 14 to 15 years. The first panel of each table shows that typically developing children started school with significantly higher literacy and numeracy scores than children with language difficulties ($p < 0.001$). For example, a child aged 6 to 7 years with typically developing language when they entered a median academic achievement school had a standardised literacy score of 0.014 compared with a child with LD3_≥8 attending a school of the same academic achievement and who had a standardised literacy score of −0.599 ($p < 0.05$). Children with typically developing language also appeared to have higher achievement scores if they started in schools of a higher academic achievement. This group had a standardised

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[xlv] LD1_0–3 refers to language difficulties identified at one time only, between 0–3 years of age. LD1_4–7 refers to language difficulties identified at one time only, between 4–7 years of age. LD1_≥8 refers to language difficulties identified at one time only, at 8 years or older. LD2_0–3 refers to language difficulties identified twice, the first time between 0–3 years of age. LD2_4–7 refers to language difficulties identified twice, the first time between 4–7 years of age. LD2_≥8 refers to language difficulties identified three or more times, the first time at 8 years or older. LD3_0–3 refers to language difficulties identified three or more times, the first time between 0–3 years of age. LD3_4–7 refers to language difficulties three or more times, the first time between 4–7 years of age. LD3_≥8 refers to language difficulties identified three or more times, the first time at 8 years or older.

[xlvi] 6 to 7 years represents the wave where all children have started formal schooling.

literacy score of −0.130 if they attended a school of low academic achievement, 0.014 if they attended a school of median academic achievement and 0.076 if they attended a school of high academic achievement.

For children with language difficulties, there was evidence of a persistence gradient in achievement. That is, as persistence increased and identification became ‘later’, the achievement scores were lower, even after controlling for endogeneity. This is shown in Table 38, where the effects of school academic achievement on achievement at 6 to 7 years are demonstrated. The results showed that for typically developing children, literacy scores increased by 0.2 points as school academic achievement increased from low to high. This means that higher performing children with typical language, were selected into higher performing schools. However, for children with language difficulties, these effects were more heterogeneous.

Panel B of Table 38 shows the achievement scores of children by language status and school academic achievement at 14 to 15 years. The results showed that children with typically developing language had literacy scores at 14 to 15 years of −0.262 if they attended schools of low academic achievement, 0.154 if they attended schools of median academic achievement and 0.613 if they attended schools of high academic achievement ($p < 0–01$). For children with language difficulties at one age, identified between 4 and 7 years (LD1_4–7), their literacy scores at 14 to 15 years were −0.526 ($p < 0.01$) if they attended schools of low academic achievement, 0.069 (not significant) if they attended schools of median academic achievement and 0.437 ($p < 0.05$) if they attended schools of high academic achievement. For children with LD3_≥8, their literacy scores at 14 to 15 years were −1.478 ($p < 0.01$) if they attended schools of low academic achievement, −1.261 ($p < 0.01$) if they attended schools of median academic achievement and −0.239 (not statistically significant) if they attend schools of high academic achievement. Numeracy scores followed a similar pattern to literacy scores and are summarised in Table 39. The second question to address is ‘Does school academic achievement have a differential effect on achievement for some children?’ The next section addresses this question by exploring cognitive gains.

Table 38: Mean literacy scores (at 6 to 7 years and 14 to 15 years) by language difficulties status (selection effect) (Z-scores)

	Low academic achievement school		Median academic achievement school		High academic achievement school	
	Z-score	95% CI	Z-score	95% CI	Z-score	95% CI
Panel A	Mean literacy scores 6–7 years					
Language						
Typical language	−0.130**	[−0.190,−0.071]	0.014	[−0.021,0.049]	0.076**	[0.030,0.122]
LD1_4–7	−0.086	[−0.300,0.128]	−0.023	[−0.154,0.107]	−0.115	[−0.323,0.094]
LD1_≥8	−0.368**	[−0.475,−0.262]	−0.276**	[−0.376,−0.176]	−0.236**	[−0.400,−0.073]
LD2_4–7	−0.456**	[−0.763,−0.150]	−0.167	[−0.378,0.045]	−0.324+	[−0.694,0.046]
LD2_≥8	−0.560**	[−0.710,−0.410]	−0.512**	[−0.679,−0.345]	−0.227	[−0.610,0.155]
LD3_4–7	−0.545**	[−0.861,−0.229]	−0.593**	[−0.910,−0.275]	−1.154+	[−2.353,0.045]
LD3_≥8	−0.599**	[−0.752,−0.446]	−0.589**	[−0.772,−0.405]	−0.361+	[−0.749,0.028]
Panel B	Mean literacy scores 14–15 years					
Language						
Typical language	−0.262**	[−0.347,−0.178]	0.154**	[0.107,0.201]	0.613**	[0.550,0.676]
LD1_4–7	−0.526**	[−0.822,−0.231]	0.069	[−0.115,0.253]	0.437**	[0.153,0.722]
LD1_≥8	−0.926**	[−1.075,−0.777]	−0.523**	[−0.649,−0.397]	−0.189	[−0.429,0.0503]
LD2_4–7	−0.675**	[−1.095,−0.254]	−0.227	[−0.509,0.0550]	0.034	[−0.714,0.781]
LD2_≥8	−1.258**	[−1.503,−1.013]	−1.016**	[−1.232,−0.799]	−0.153	[−0.634,0.328]
LD3_4–7	−1.879**	[−2.449,−1.308]	−1.049**	[−1.481,−0.617]	Not estimable	
LD3_≥8	−1.478**	[−1.734,−1.222]	−1.261**	[−1.543,−0.978]	−0.239	[−0.936,0.458]

Note. Model controls for language, time, school academic achievement, change in schools and propensity score. CI = confidence interval. Not estimable = sample size too small to predict coefficients.
+ p < 0.10. * p < 0.05. ** p < 0.01.

Table 39: Mean numeracy scores (at 6 to 7 years and 14 to 15 years) by language difficulties status (selection effect) (Z-Scores)

	Low academic achievement school		Median academic achievement school		High academic achievement school	
	Z-score	95% CI	Z-score	95% CI	Z-score	95% CI
Panel A	Mean numeracy scores 6–7 years					
Language						
Typical language	0.061	[−0.0176,0.140]	0.218**	[0.172,0.265]	0.320**	[0.260,0.379]
LD1_4–7	0.203	[−0.0796,0.485]	0.332**	[0.160,0.504]	0.12	[−0.151,0.399]
LD1_≥8	−0.396**	[−0.538,−0.255]	−0.205**	[−0.336,−0.0735]	−0.131	[−0.347,0.0855]
LD2_4–7	−0.494*	[−0.901,−0.0857]	−0.094	[−0.373,0.185]	−0.052	[−0.538,0.435]
LD2_≥8	−0.749**	[−0.951,−0.547]	−0.689**	[−0.908,−0.469]	−0.515*	[−1.020,−0.0106]
LD3_4–7	−0.458*	[−0.894,−0.0209]	−0.778**	[−1.196,−0.359]	−0.831	[−2.376,0.714]
LD3_≥8	−0.750**	[−0.953,−0.546]	−0.612**	[−0.850,−0.374]	−0.375	[−0.884,0.134]
Panel B	Mean numeracy scores 14–15 years					
Language						
Typical language	−0.375**	[−0.468,−0.282]	0.0715**	[0.0206,0.122]	0.620**	[0.552,0.688]
LD1_4–7	−0.543**	[−0.870,−0.215]	0.205*	[0.00435,0.405]	0.492**	[0.184,0.800]
LD1_≥8	−0.799**	[−0.964,−0.634]	−0.416**	[−0.550,−0.281]	−0.090	[−0.347,0.167]
LD2_4–7	−0.746**	[−1.229,−0.263]	−0.149	[−0.458,0.159]	0.176	[−0.585,0.936]
LD2_≥8	−0.919**	[−1.196,−0.642]	−0.813**	[−1.044,−0.581]	−0.104	[−0.656,0.448]
LD3_4–7	−1.248**	[−1.878,−0.617]	−0.636**	[−1.113,−0.159]	Not estimable	
LD3_≥8	−1.096**	[−1.399,−0.793]	−0.872**	[−1.199,−0.544]	0.003	[−0.760,0.765]

Note. Model controls for language, time, school academic achievement, change in schools and propensity score. CI = confidence interval. Not estimable = sample size too small to predict coefficients.
+ $p < 0.10$. * $p < 0.05$, ** $p < 0.01$.

Table 40 focuses on the gains that children make, holding initial scores constant, in order to remove any selection effects. The results showed that children in schools of low academic achievement progressed at a slower rate, irrespective of their language status. However, for children with language difficulties, the effect of schooling of low academic achievement appeared to have had a greater negative impact on literacy than for typically developing children. For example, children with typically developing language in a school of low academic achievement made literacy gains of −0.132 between 6 to 7 years and 14 to 15 years, compared with literacy gains of −0.440, ($p < 0.01$) for children with LD1_4–7, and literacy gains of −0.879 for a child with the most severe language difficulties (LD3_≥8) in a school of the same academic achievement.

For children with the most severe language difficulties, their negative progress at 14 to 15 years of age equates to more than four times the negative progress for a child with typical language development in a school of the same academic achievement. In contrast, while the children with any level of language difficulty in a school of median academic achievement make 'negative progress' over time, the effects are mitigated somewhat, in that the effects are 'less negative'. These children made literacy gains of 0.140 between 6 to 7 years and 14 to 15 years if they had typical language, compared with literacy gains of −0.247 for LD1_≥8, and literacy gains of −0.672 for a child with the most persistent language difficulty (LD3_≥8) ($p < 0.01$). For children in schools of high academic achievement, their literacy gains were 0.527 ($p < 0.01$) for children with typical language, 0.36 (not significant) for children at LD2_≥8 and 0.121 at LD3_≥8 years. Overall, the results showed differential effects in literacy and numeracy across school academic achievement and across language severity and timing of diagnosis.

The third question to address is whether there were any significant differences in achievement by timing of identification. While there is no 'intervention' per se, nor a diagnostic tool in these data, this measure captured the differential effects for children with the same language difficulties persistence, who are identified at an earlier age compared with those identified at a later age. Using marginal effects, significant differences were observed for children with LD1 language difficulties—that is, those who were diagnosed before 8 years of age, compared with children who were diagnosed after 8 years of age. Those children who were identified earlier gained approximately

0.118 more in literacy scores in a school of low academic achievement and approximately 0.505 more in a school of high academic achievement. Children with persistent language difficulties who have difficulties before 8 years of age (LD2_4–7) compared with children who have difficulties after 8 years (LD2_≥8) of age gained approximately 0.38 (see Table 40 [−0.698 + −0.218]) more in literacy scores in a school of low academic achievement and ~ 0.401 more in a school of median academic achievement but −0.142 in a school of high academic achievement.

Table 40: Gains in literacy and numeracy between 6 to 7 years and 14 to 15 years (school academic achievement effect) (Z-scores)

	Low academic achievement school		Median academic achievement school		High academic achievement school	
	Z-score	95% CI	Z-score	95% CI	Z-score	95% CI
Gains in literacy scores from 6–7 years to 14–15 yrs						
Language						
Typical language	−0.132**	[−0.228,−0.0366]	0.140**	[0.0867,0.193]	0.537**	[0.468,0.606]
LD1_4–7	−0.440**	[−0.774,−0.107]	0.09	[−0.111,0.296]	0.552**	[0.231,0.873]
LD1_≥8	−0.558**	[−0.725,−0.391]	−0.247**	[−0.394,−0.0992]	0.047	[−0.225,0.319]
LD2_4–7	−0.218	[−0.712,0.275]	−0.06	[−0.383,0.263]	0.36	[−0.476,1.192]
LD2_≥8	−0.698**	[−0.970,−0.426]	−0.504**	[−0.753,−0.254]	0.074	[−0.464,0.612]
LD3_4–7	−1.334**	[−1.971,−0.697]	−0.456+	[−0.951,0.0396]	Not estimable	
LD3_≥8	−0.879**	[−1.161,−0.597]	−0.672**	[−0.992,−0.353]	0.121	[−0.616,0.859]
Gains in numeracy scores from 6–7 years to 14–15 yrs						
Language						
Typical language	−0.436**	[−0.551,−0.321]	−0.147**	[−0.211,−0.0832]	0.300**	[0.218,0.382]
LD1_4–7	−0.745**	[−1.153,−0.338]	−0.127	[−0.371,0.116]	0.368+	[−0.0186,0.754]
LD1_≥8	−0.403**	[−0.605,−0.200]	−0.211*	[−0.388,−0.0338]	0.041	[−0.282,0.363]
LD2_4–7	−0.253	[−0.866,0.361]	−0.055	[−0.446,0.336]	0.228	[−0.675,1.130]
LD2_≥8	−0.17	[−0.502,0.162]	−0.124	[−0.423,0.174]	0.411	[−0.267,1.089]
LD3_4–7	−0.790*	[−1.548,−0.0323]	0.141	[−0.456,0.739]	Not estimable	
LD3_≥8	−0.346+	[−0.698,0.00531]	−0.260	[−0.648,0.128]	0.378	[−0.490,1.246]

Note. Model controls for language, time, school academic achievement, change in schools and propensity score. CI = confidence interval.
* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

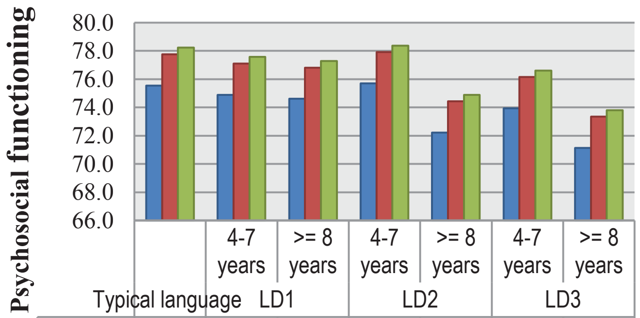
In terms of numeracy gains from 6 to 7 years to 14 to 15 years, these were consistent with the trends observed for literacy, with the largest gains made for children with LD1 language difficulties and those in schools of the highest academic achievement.

4.5.4 Emotional and behavioural health

Figure 5 measures language difficulties and non-cognitive skills by language persistence, timing of diagnosis and school academic achievement (Eq. 4.4.2). The marginal effects are presented as mean values measured from 6 to 15 years because there was no evidence of any significant changes over time. The coefficients are presented in bar charts for ease of interpretation. The bar charts comprise the separate effects of school academic achievement and language difficulties status and the outcomes of interest. differentiate outcomes, and includes three functioning measures (psychosocial, social and school) and a strengths and difficulties measure (representing the sum of mean values of hyperactivity, emotional, peer and conduct problems scales). These bar charts represent the measures where significant effects were observed. Each panel contains three bars that represent school academic achievement, across four groups of language difficulties (x-axis): LD1 4–7, ≥ 8 (1 wave); LD2 4–7, ≥ 8 (2 waves); and LD3 4–7, ≥ 8 (3 or more waves). The y-axis represents the outcome of interest, illustrated in total scores. Higher functioning (PEDS) is represented by higher scores. More difficulties (PSDQ) are represented by higher scores. The significance of the factors is indicated by the results presented ($p < 0.05$). Results that are not statistically significant are not reported.

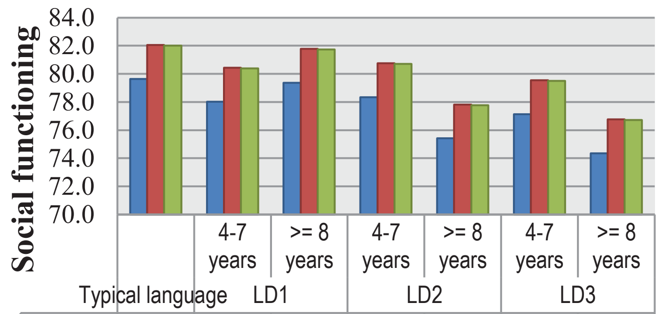
Overall, the results showed that children with higher levels of functioning and fewer difficulties presented in academically higher schools. On average, children attending schools of low academic achievement had functioning scores approximately 3 points lower (with ~2 points greater in reported difficulties) than children attending schools of median academic achievement, and functioning scores approximately 7 points lower (with ~4 points greater difficulties) than children attending schools of high academic achievement. This effect was consistent across all measures. With each category of school academic achievement, children with language difficulties had up to approximately 1.5 points more difficulties and up to approximately 4 points lower functioning, depending on language severity and timing of diagnosis. Children with the most severe language difficulties, with a late identification ($\geq$ 8 years), had the worst emotional and behavioural health outcomes.

Psychosocial functioning



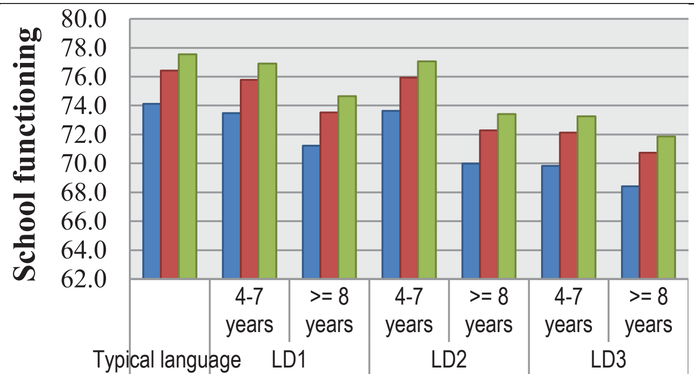
	Typical language	LD1 4-7 years	LD1 >= 8 years	LD2 4-7 years	LD2 >= 8 years	LD3 4-7 years	LD3 >= 8 years
Low	75.55	74.89	74.60	75.69	72.22	73.93	71.13
Median	77.76	77.10	76.81	77.90	74.43	76.14	73.34
High	78.22	77.57	77.28	78.36	74.89	76.60	73.80

Social functioning



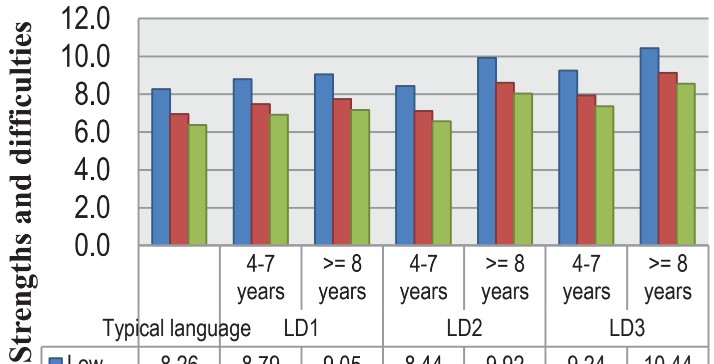
	Typical language	LD1 4-7 years	LD1 >= 8 years	LD2 4-7 years	LD2 >= 8 years	LD3 4-7 years	LD3 >= 8 years
Low	79.65	78.03	79.37	78.35	75.42	77.14	74.36
Median	82.05	80.44	81.77	80.76	77.82	79.55	76.77
High	82.00	80.39	81.73	80.71	77.77	79.50	76.72

School functioning



	Typical language	LD1 4-7 years	LD1 >= 8 years	LD2 4-7 years	LD2 >= 8 years	LD3 4-7 years	LD3 >= 8 years
Low	74.12	73.47	71.23	73.63	69.98	69.82	68.42
Median	76.42	75.78	73.53	75.93	72.29	72.13	70.73
High	77.55	76.90	74.66	77.05	73.41	73.25	71.85

PSDQ total score



	Typical language	LD1 4-7 years	LD1 >= 8 years	LD2 4-7 years	LD2 >= 8 years	LD3 4-7 years	LD3 >= 8 years
Low	8.26	8.79	9.05	8.44	9.92	9.24	10.44
Median	6.95	7.48	7.74	7.13	8.61	7.93	9.13
High	6.38	6.91	7.17	6.55	8.04	7.36	8.56

Figure 5: Emotional and behavioural health (scores)

4.5.5 Parents' and child's expectations for education

Expectations for education are presented in three analyses. The first comprises the interaction effects of school academic achievement, language difficulties status and education expectations[xlvii] (Eq. 4.4.3 and Eq. 4.4.4). The second analysis considers parents' expectations with an additional interaction term for time, and the third analysis considers parents' expectations with an additional interaction term for SEP.

Table 41 shows the parents' expectation of the child's further education by language and school academic achievement, measured from 6 to 7 years to 14 to 15 years. Due to convergence issues, it was not possible to categorise language difficulties in terms of severity and timing. The table presents the predicted probability of the outcome of interest (to attend university or not).

Overall, the results showed that parents whose children have language difficulties had lower expectations for university attendance than parents of children with typical language, irrespective of school academic achievement. In schools of low academic achievement, the parents of children with typical language had higher expectations for a university education than parents of children with language difficulties (0.27 compared with 0.14, $p < 0.05$) respectively. In schools of median academic achievement, parents of children with typical language had higher expectations for a university education than parents of children with language difficulties (0.64 compared with 0.36, $p < 0.05$) respectively. In schools of high academic achievement, parents of children with typical language had higher expectations for a university education than parents of children with language difficulties (0.94 compared with 0.75, $p < 0.01$) respectively.

[xlvii] Child's expectations are asked at 14 to 15 years only.

Table 41: Parents' and child's expectations for education, 6 to 7 years to 14 to 15 years (probability)

		School of low academic achievement		School of median academic achievement		School of high academic achievement	
		Predicted probability	SD	Predicted probability	SD	Predicted probability	SD
Panel Aa	Probability of attending university (parents' expectations at 6–15 years)						
Language							
	Typical language	0.27	0.36	0.64	0.41	0.94	0.18
	Language difficulty	0.14***	0.26	0.36***	0.40	0.75**	0.37
Panel Bb	Probability of attending university (child's expectations at 15 years)						
Language							
	Typical language	0.68	0.31	0.88	0.22	0.99	0.06
	Language difficulty	0.65	0.30	0.81**	0.26	1.00	0.01

Note. SD = standard deviation.

[a] Model controls for language; school academic achievement; time; child's gender, Indigenous status, non-English speaking background, literacy, approach to learning, intelligence quotient, and strengths and difficulties total score; family SEP; and propensity score.

[b] Model controls for language, school academic achievement, SEP, literacy, parents' expectations for education and propensity score.

* p < 0.05. ** p < 0.01. *** p < 0.001

When time was considered, there was some evidence that parents' expectations declined as the children got older, which is consistent with the literature[183], and notably, this effect appears to be stronger for children with language difficulties. Figure 6 shows that for parents whose children have typical language, their expectations for university attendance remains largely consistent over time. For example, for a child with typical language in a school of high academic achievement, parental expectations were 0.94 at 6 to 7 years and 0.95 at 14 to 15 years ($p = 0.30$). Similarly, in schools of median academic achievement, for children with typical language, compared with children with language difficulties, parental expectations for university attendance remained largely unchanged over time. In schools of low academic achievement, for children with typical language, compared with children with language difficulties, parent's expectations for university attendance was 0.31 and 0.26 respectively ($p = 0.05$).

However, for some children with language difficulties, parent's expectations for university attendance declined over time. For example, a child with language difficulties in a school of low academic achievement at 6 to 7 years had a predicted probability of 0.21 for attending university, and a predicted probability of 0.09 at 14 to 15 years ($p < 0.001$). For children with language difficulties in schools of median academic achievement, the largest decline in parents' expectations occurred between 8 to 9 years and 10 to 11 years, the age at which children start secondary school (0.51 and 0.25 respectively, $p < 0.05$). For children with language difficulties in schools of high academic achievement, while there appeared to be a decline in mean expectations, the sample sizes are small and, as a result, the confidence intervals are very wide.

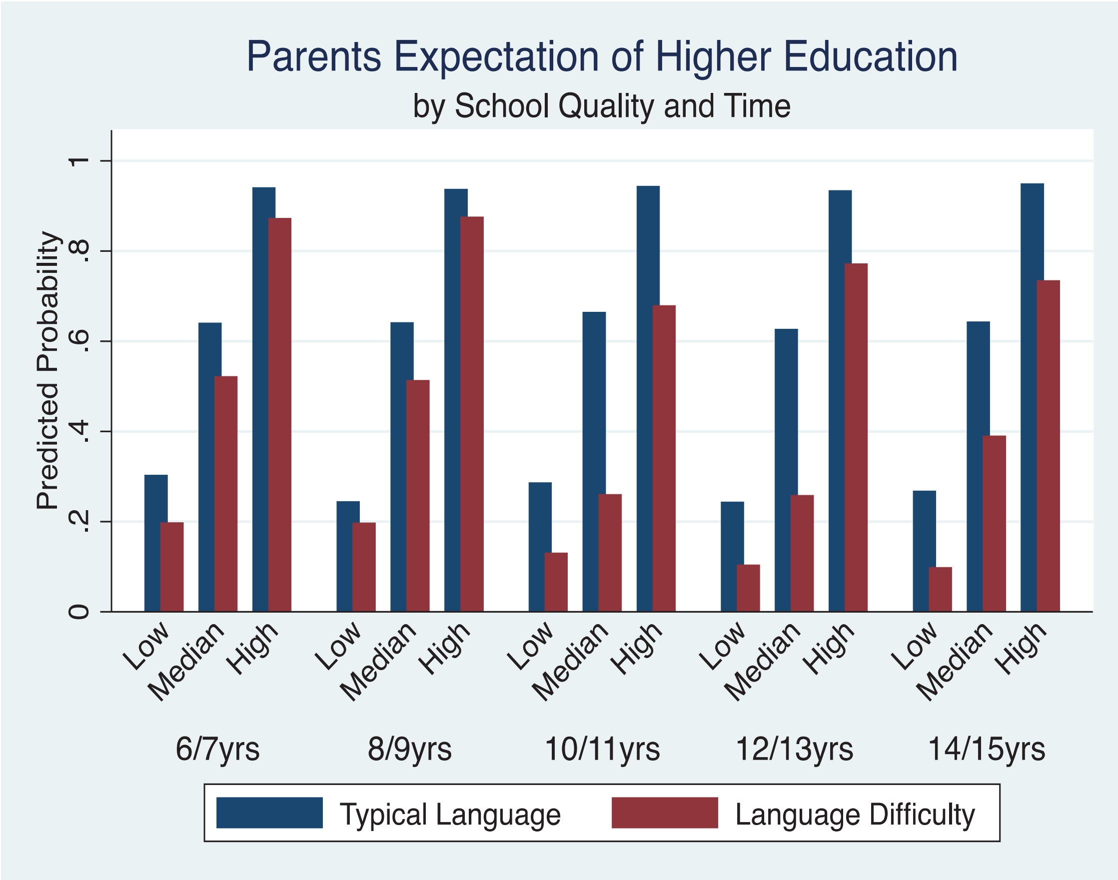


Figure 6: Parents' expectations for education by language, school academic achievement and time (probability)

When the household SEP was considered, the results showed that parents who lived in low socioeconomic areas and who chose to send their children to schools of higher academic achievement had higher expectations than parents in low socioeconomic areas..

Figure 7 shows the differential effects of SEP and school academic achievement on the predicted probability of parents' expectations for their child attending university. For children with typical language who attended schools of high academic achievement, the predicted probability of their parents expecting university attendance was above 80 per cent, across all quintiles of SEP. For children with language difficulties who attended schools of high academic achievement, the predicted probability of their parents expecting university attendance was between 50 per cent 95 per cent, across the quintiles of SEP. In contrast, parents in high SEP households who sent their children to schools of low and median academic achievement had lower expectations for university attendance. For children living in high SEP households and attending schools of low academic achievement, the predicted probability of their parents expecting university attendance was 46 per cent for children with typically developing language and 38 per cent for children with language difficulties ($p < 0.56$).

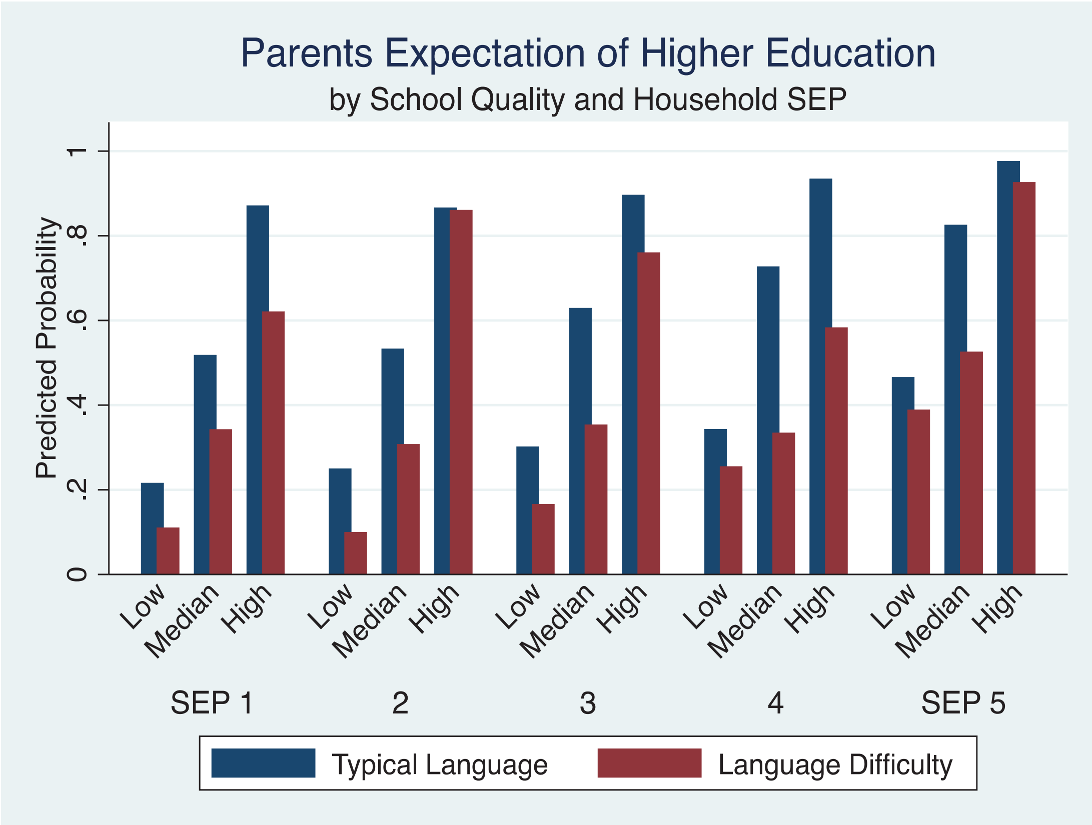


Figure 7: Parents' expectations of for education by language, school academic achievement and SEP (probability)

Overall, the results showed that a child's expectations for education were considerably higher than the parents' expectations. Additionally, the results showed no material difference between the expectations for education of children with language difficulties and children without language difficulties. The main driver of a child's expectations for education was the parents' expectations for education (not reported) and school academic achievement, which is consistent with Yu et al.'s findings[166]. Notably, almost all children from the school with the highest academic achievement expected to attend university, irrespective of their language difficulties status.

So far, the analysis has explored the impact of school academic achievement on cognitive skills, non-cognitive skills and the expectations of the parents and the child.

The results in Eq. 4.4.2.1 show significant differential effects in literacy and numeracy scores (for students with language difficulties across school academic achievement).

In Eq. 4.4.2.2, significant overall effects in emotional and behavioural health were found for students with language difficulties and differences between students in different academic achievement schools. However, there were no additional interaction effects in emotional and behavioural health for language difficulties across school achievement or over time.

In Eq. 4.4.2.3, significant overall effects in the expectations for educational achievement were found across school academic achievement and over time. That is, as school academic achievement increased, parents' expectations for attendance at university increased. For children with language difficulties in the schools of lower academic achievement, parents' expectations were lower. However, for children in the schools of higher academic achievement, parents expected their children to attend university, irrespective of their language difficulties status.

In Eq. 4.4.2.4, similar effects were observed, in that school academic achievement was the main driver of the child's expectations for education.

The next section explores the impact of school academic achievement on NAPLAN attendance for children with language difficulties.

4.5.6 NAPLAN attendance

Table 42 illustrates a cross-tabulation of language difficulty and NAPLAN attendance. Due to the small sample sizes, it was not possible to categorise language difficulties in terms of severity and timing. For this analysis, language difficulties were defined by a dummy variable indicating 1 if the child has language difficulties and 0 if the child has no language difficulties. Table 4 shows that overall differences in background were reflected in differences in NAPLAN attendance. Compared with children who attended all NAPLAN tests, those who had some form of absence were more likely to be male, Indigenous, from an English-speaking background and attending a government school, and to have lower household income levels. These children attended schools that have NAPLAN scores 0.15 to 0.36 SD lower than their peers.

For children with language difficulties, there was an additional effect on NAPLAN attendance. Within each NAPLAN category, children with language difficulties appeared to be attending schools of lower academic achievement (between 0.20 and 0.40 lower) and to have lower NAPLAN literacy and numeracy scores, lagging between 0.7 and 1.3 SD behind their peers with typical language in the same NAPLAN category. The data in Table 41 suggests that the effect of having a language difficulty on NAPLAN attendance is greater than the effects of socioeconomic disadvantage alone.

Table 42: Means of key variables by language difficulty and NAPLAN attendance (percentage unless otherwise stated)

	NAPLAN attendance							
Variable Measurement	Attended all		Absent but not for all		Absent all		Exempt	
Panel A. Child and family characteristics	No_LD	LD	No_LD	LD	No_LD	LD	No_LD	LD
Number of observations	12256	1,073	337	76	188	40	69	42
Proportion	95.38	8.35	2.62	0.59	1.46	0.31	0.54	0.33
Male	49.62	62.72	51.63	60.53	52.66	57.50	59.42	69.05
Indigenous	2.03	9.79	3.26	14.47	4.26	12.50	2.90	9.52
Non-English speaking background	10.02	12.86	4.45	9.21	5.32	10.00	5.80	11.90
Equivalised gross income ($)[a]	58381	44074	52434	38473	51688	40555	46457	41213
Mother completed Year 12	64.43	44.36	45.40	26.32	54.26	40.00	50.72	42.86
Intelligence quotient (Z-score)	0.10	−0.56	−0.15	−0.60	−0.12	−0.72	0.00	−1.66
Panel B. School variables								
School attendance up to Year 10	93.04	92.01	91.81	90.75	91.50	90.61	90.78	91.65
School type								
Government	54.01	60.02	60.24	67.50	66.49	0.68	0.75	0.64
Independent	18.73	12.02	14.84	7.50	11.70	7.50	13.04	11.90
Catholic	21.59	18.36	17.21	15.00	11.17	15.00	5.80	4.76
Standardised school academic achievement	4.23	−0.38	−0.12	−0.47	−0.21	−0.47	−0.28	−0.46
Panel C. Individual characteristics								
Literacy (Z-score)[b]	0.11	−1.10	−0.43	−1.37	NA	NA	−1.13	−1.84
Numeracy (Z-score)[b]	0.84	−0.87	0.92	−1.22	NA	NA	−0.93	−0.87

Note. LD = language difficulties; No_LD = typical language.
[a]Equivalised for number of members in the household $AUD. [b]Literacy and numeracy presented as age standardised Z-scores.

The results of the cross-sectional and panel methods are first explored in Table 43. Using the most efficient model, NAPLAN attendance was then explored in two-way interaction between school academic achievement and language difficulties status (Eq.4.4.2.5

The first column in Table 43 shows the coefficients for the relationship between NAPLAN attendance and the child's language difficulty based on cross-sectional pooled models: multinomial logit. The cross-sectional results (MLOGIT) showed that children with language difficulties were more likely than children with typical language to be exempted from NAPLAN 0.02 vs. 0, ($p < 0.01$) and to be absent for part of the testing 0.05 vs. 0.02, ($p < 0.01$). The results of the multilevel nested model (XTMELOGIT Column 3, Table 43) were consistent with the cross-sectional results that children with language difficulties were more likely than children with typical language to be exempted from NAPLAN 0.001 vs. 0, ($p < 0.01$) and more likely to be absent for part of the testing 0.04 vs. 0.01, ($p < 0.001$).

Table 43: NAPLAN attendance – cross-sectional and nested results (probability)

		MLOGIT		XTMELOGIT	
		Predicted probability	SE	Predicted probability	SE
Panel A[a]		Probability of NAPLAN exemption			
Language					
	Typical language	0.004	0.001	0.00007	0.000
	Language difficulty	0.020*	0.005	0.001*	0.001
Panel B[a]		Probability of being absent for some NAPLAN tests			
Language					
	Typical language	0.025	0.001	0.013	0.000
	Language difficulty	0.050*	0.006	0.04***	0.001
Panel C[a]		Probability of being absent for all tests			
Language					
	Typical language	0.013	0.001	0.007	0.000
	Language difficulty	0.019	0.004	0.014^{+}	0.001

Note. Estimated using XTMELOGIT. SD = standard deviation.
[a]Model controls for language; school academic achievement; time; child's health status, medical conditions other than language, medical conditions with language, and non-English speaking; and propensity score.
+p < 0.1, *p < 0.05, **p < 0.001.

When school academic achievement was considered, it could be seen that these effects were largely driven by schools of low academic achievement. Figure 8 shows the predicted probability of NAPLAN attendance by school academic achievement. The results showed that children with language difficulties were more likely than typical-language children in schools of low academic achievement to be exempted from NAPLAN (0.002 vs. 0.0002, $p < 0.01$) and absent from some NAPLAN tests (0.05 vs. 0.02, $p < 0.001$). In schools of median academic achievement, children with language difficulties were more likely than typical-language children to be exempted from NAPLAN (0.00008 vs. 0.00004, $p < 0.001$) and to be absent from some NAPLAN tests (0.03 vs. 0.01, $p < 0.05$). In schools of high academic achievement, children with language difficulties were more likely than typical-language children to be absent from some NAPLAN tests (0.014 vs. 0.006, $p < 0.001$).

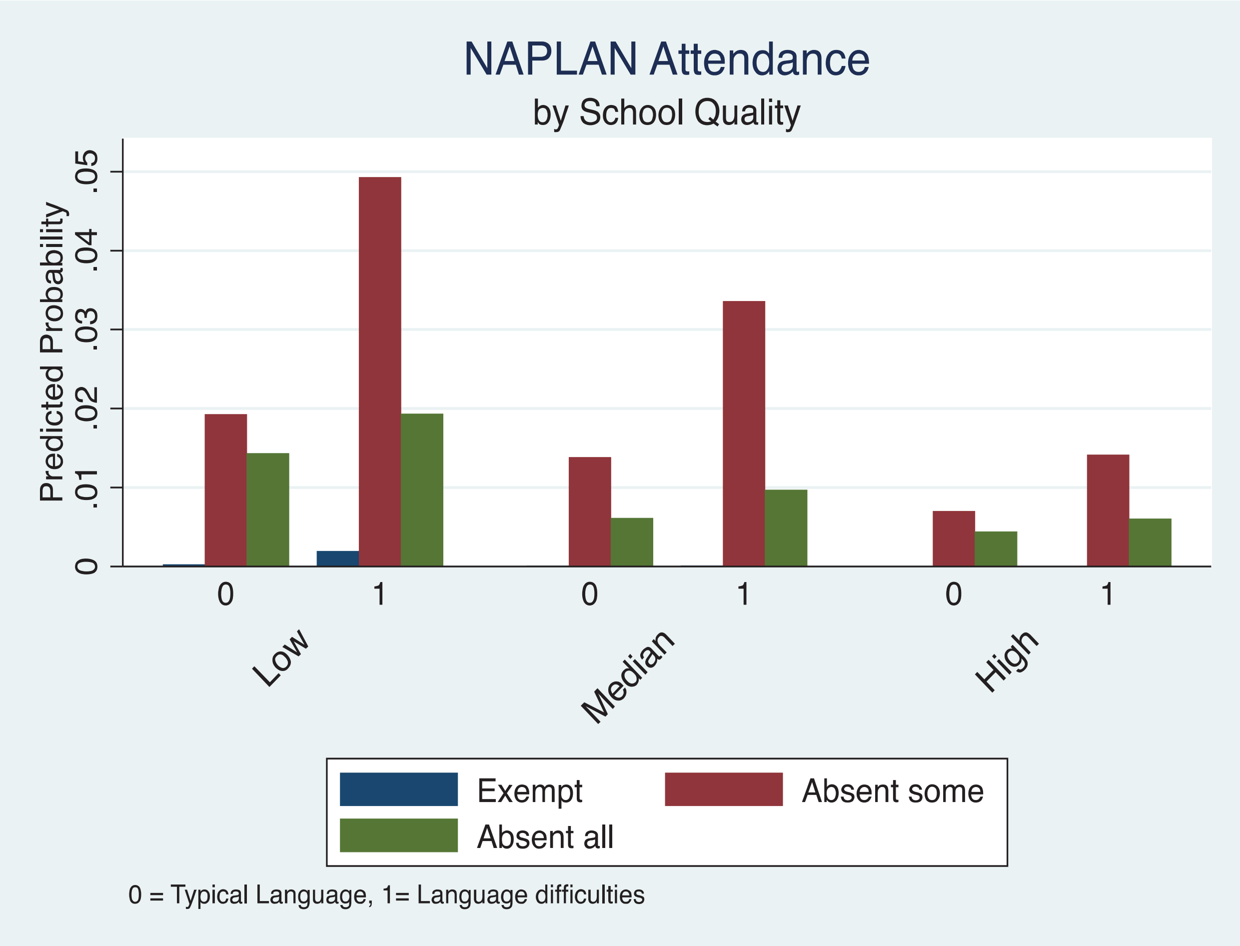


Figure 8: NAPLAN attendance by school academic achievement (probability)

Overall, across all levels of school academic achievement, significant differential effects in NAPLAN attendance were observed for students with language difficulties compared with those children with typical language.

To explore this further, NAPLAN attendance is descriptively compared with children's overall attendance in the same school. The school attendance level for children in schools of lowest academic achievement was 91.5 per cent and 92.8 per cent for children with language difficulties and children with typical language respectively. This was a differential of 1.3 per cent compared with a NAPLAN attendance differential of 3 per cent, in the same schools. For children in schools of median academic achievement, school attendance was 93.2 per cent and 93.1 per cent for children with language difficulties and children with typical language respectively. This was a differential of −0.1 per cent, compared with a NAPLAN attendance differential of 1.9 per cent. For children in schools of high academic achievement, school attendance was 94.2 per cent compared to 94.3 per cent for children with language difficulties and children with typical language respectively. This was a differential of 0.1 per cent, compared with a NAPLAN attendance differential of 0.7 per cent.

4.6 Heterogeneity associated with school academic achievement

There are a number of sources of heterogeneity in these data. This section discusses the issue of attrition.

Given that the LSAC is a longitudinal survey, there is a chance that different groups of respondents will drop out of the survey at different rates, which may lead to attrition bias. As discussed in Section 4.3, My School data are available for three waves of data: 2008, 2010 and 2012 (Waves 3, 4 and 5). Additionally, the LSAC asks whether the child has changed schools between waves. Using the responses to this question, it was possible to identify the schools that children attended in 2006 and 2014, when the children were 6 to 7 years and 14 to 15 years respectively[xlviii]. The Wave 6 longitudinal weights used in this analysis applied to those who responded to all waves (1 to 6). Therefore, the inclusion of pweights in the analysis would mean that observations were omitted if the school identification variable was missing (in multilevel models) or the

[xlviii] School identification was possible in 2006 and 2014, provided the child had not changed schools—that is, their school identifier remained consistent from 2006 to 2008 and from 2012 to 2014, respectively.

Wave 6 was missing. Within these data restrictions, model convergence could not be achieved with pweights. As a sensitivity analysis, OLS models were estimated with literacy being the dependent variable, comparing a weighted and unweighted sample (see Table 44). The results showed that the weighted model had generally larger coefficients, and except for school gender, the significance of the coefficients was largely consistent.

Table 44: Weighted and unweighted OLS (Z-scores)

	Literacy (OLS unweighted)		Literacy (OLS weighted)	
	Coefficient	95% CI	Coefficient	95% CI
LDsev_timing	−0.220***	[−0.231, −0.210]	−0.233***	[−0.247, −0.218]
School literacy	0.003***	[0.002,0.004]	0.002*	[0.0005,0.003]
School numeracy	−0.002**	[−0.003,−0.0006]	−0.001	[−0.002,0.0007]
schgender1	0.029	[−0.041,0.0996]	0.019	[−0.066,0.103]
schgender2	0.145**	[0.0462,0.244]	0.106	[−0.0147,0.226]
schtype1	0.027	[−0.012,0.065]	0.008	[−0.037,0.053]
schtype2	0.079***	[0.0325,0.125]	0.054	[−0.001,0.108]
NSW	0.098*	[0.0117,0.185]	0.112*	[0.00756,0.216]
Vic.	0.111*	[0.0224,0.199]	0.117*	[0.0106,0.224]
Qld	−0.158***	[−0.249, −0.067]	−0.177**	[−0.286, −0.069]
SA	−0.021	[−0.122,0.0810]	0.025	[−0.095,0.145]
WA	−0.088	[−0.183,0.008]	−0.090	[−0.207,0.026]
Tas.	−0.019	[−0.132,0.094]	−0.081	[−0.220,0.058]
NT	−0.322***	[−0.475, −0.169]	−0.533***	[−0.784, −0.282]
2.ps_quintile	−0.372***	[−0.416, −0.327]	−0.384***	[−0.435, −0.333]
3.ps_quintile	−0.608***	[−0.654, −0.562]	−0.618***	[−0.670, −0.566]
4.ps_quintile	−0.774***	[−0.822, −0.727]	−0.758***	[−0.813, −0.702]
5.ps_quintile	−1.047***	[−1.099, −0.995]	−1.047***	[−1.113, −0.981]
N	11,366		9,617	

Note. CI = confidence interval; NSW = New South Wales; Vic. = Victoria; Qld = Queensland; SA = South Australia; WA = Western Australia; Tas. = Tasmania; NT = Northern Territory; N = total number of cases.
+p < 0.1, *p < 0.05, **p < 0.001.

4.7 Discussion

This chapter has explored whether students with language difficulties benefit to a greater or lesser extent from attending schools of high academic achievement when compared with their peers with typical language. The discussion focuses on the interpretation of results of Eq. 4.4.1 to Eq. 4.4.4 in the first section and then discusses the implication of NAPLAN attendance (Eq. 4.4.5).

The first set of findings is that many children with language difficulties start school not 'developmentally ready', in that their literacy and numeracy skills are significantly lower than average and they significantly lag behind their peers. For some of these children, there is evidence that they catch up[184]. However, a large proportion remain mean benchmarks, and in many cases, they lag even further behind at 14 to 15 years, which results in a significant wage differential in adulthood. Educational achievement at 15 years is highly predictive of school completion[150], and this finding is consistent with other longitudinal studies that report higher rates of school dropout for children with language difficulties[7].

The second set of findings is that there is some evidence that children with language difficulties attending schools of higher academic achievement are positively selected, even after controlling for the background characteristics of these children in the propensity score model. It is possible that it is the child's experience, outside of any schooling, that ultimately affects the child's outcomes, and these experiences reflect resources in the home and in the neighbourhood or personal preferences. It is well recognised in the literature that language difficulties are heterogeneous with considerable variability in outcomes and considerable variability in developmental trajectories[28]. It is possible that the analysis is capturing some of this heterogeneity in personal preferences that cannot be explained by background characteristics of individuals or severity categorisation. However, if this were the case, one would expect the differential between children with and without language difficulties at each school academic achievement level to be constant, and the results suggest otherwise.

An alternative explanation is that the results are showing evidence of a highly segregated education system where those parents who fail to, or are unable to, engage in the educational market through 'active choice', either because they are unable to pay costly school fees or because their children are not 'attractive' enough in terms of their potential to boost average academic achievement, are being segregated into disadvantaged schools. Perhaps what we are observing is the compounding effects of having more-disadvantaged children in disadvantaged schools (discussed further in Section 7.2).

The third set of findings is that some schools do not serve children with language difficulties as well as they serve children with typical language, perhaps because of differences in school academic achievement. The flip side of this is that children with language difficulties have higher achievement in higher achieving schools, and, in fact, school academic achievement appears to be a driver in bridging the achievement gap over time. The findings suggest that schools can mitigate some of the effects of the developmental disadvantage associated with DLD. This finding is consistent with Gemici et al.'s (2013) finding that the effect of school academic achievement is more important for children with low SES than it is for children with high SES.. For students suffering from multiple risk factors, notably language difficulties and socioeconomic disadvantage, it may be that a school of high academic achievement will lead to better outcomes compared with a student with fewer risk factors in a low-performing school. The findings show that school academic achievement may have a critical impact on school completion and ultimately long-term LFP.

Further, there is evidence that early identification can have a positive impact on academic achievement and, ultimately, LFP. Within the limitations of these data—in that there is no identified 'early intervention' per se in the LSAC—what can be measured is the differential effects on subsequent academic achievement and earnings of the identification of language difficulties before 8 years of age compared with the identification after 8 years of age for children with the same severity of language difficulties.

To date, there has been little evidence available regarding the long-term effects of interventions, with a number of studies suggesting that the benefits of early interventions in high-risk populations may ‘fade out’ as children move through school[178,185]. There is significant heterogeneity in the developmental trajectories and researched outcomes for this group[28]. While the short-term effects of interventions for children with language difficulties show improvements[186-189], there is little evidence regarding the long-term effects of interventions outside of clinical populations. This study suggests that if language difficulties are not identified early, for some children this can have significant effects on their outcomes as they progress through school and ultimately on their LFP (measured indirectly in Chapter 6) and health status, and this effect is analogous to the effect of socioeconomic disadvantage. Following Heckman’s equation, investment in early childhood education and development will build the skills necessary for future success in life[30,31,34,39]. Claessens et al.[185] point to a need for sustained interventions to capitalise on early progress. They conclude that while many Australian children are achieving strong results in the early years of schooling, the substantial decline in the proportion of learners meeting milestones at Year 5 suggests that these efforts must be sustained.

Parents play a key role in driving the aspirations of their children. Research has shown that parental expectations for children’s academic achievement predict educational outcomes more than any other measures of parental involvement[165]. In line with the principles of school choice in the Australian education system, the findings show that there are parents from disadvantaged areas who invest more than other parents in their children by choosing to send their children to schools of high academic achievement.. These parents tend to have higher expectations for university enrolment, expectations that commence when their child is very young, and these expectations remain consistent over time. However, there was also evidence that some parents’ expectations decline over time, most notably for children with language difficulties and children in the schools of lowest academic achievement. The high-risk period for changing expectations is between 8 to 9 years and 10 to 11 years, when children transition to secondary school. According to Lamb et al.[150] this age represents the ‘risk’ period in that it is the age when learning opportunities decrease and ‘gaps’ between children become established. In other words, there are fewer opportunities for children to ‘catch up’.

Last, there is evidence that exemptions in NAPLAN tests are positively associated with children with language difficulties. These results are consistent with current NAPLAN policy for exemptions, which states that students can obtain exemptions if they have a significant or complex disability or if they are from a non-English speaking background and have arrived in Australia less than one year before the test[173]. Additionally, schools of low academic achievement are more likely to apply for exemptions for their students with language difficulties than schools of median academic achievement or schools of high academic achievement (controlling for other background characteristics). The descriptive analysis in Table 42 indicates that children with LD3_≥8 difficulties are more likely to attend schools of low academic achievement, and would therefore be more eligible for exemptions. This study finds little evidence to support the literature that national testing creates incentives to 'reclassify' students into 'exemption' categories[149].

Partial absenteeism in NAPLAN is negatively associated with school academic achievement and a child's language difficulties. It is possible that these results are being driven by overall school attendance, which is lowest in schools of low academic achievement. However, if this were the full explanation, it would be expected that the NAPLAN attendance differential for children with language difficulties and children with typical language would be consistent with differences in overall school attendance. In Australia, the introduction of market-oriented principles has received considerable criticism from educators, with suggestions that national testing and the publication of the results at a school level, while designed to help students, is being deployed in ways that may have a negative impact on the most vulnerable students[75,76]. It is possible that these students are encouraged to be 'absent' on testing days[149]. In the UK, where much of the literature is focused, a number of studies have reported evidence of educational triage. Wiggin et al.[155] examined the dysfunctional effects of key performance indicators in the UK and found that some schools focused significantly more resources on borderline students, where the greatest gains in school averages could be made, at the detriment of low- and high-performing students. These findings suggest that children with language difficulties are over-represented in the partial absentee group, and this finding is evident across all levels of school academic achievement. Indeed, this finding supports the idea that the testing environment is creating perverse incentives.

4.8 Conclusion

The results demonstrated that school academic achievement and early identification of language difficulties exert a positive influence on emotional and behavioural health, educational attainment and expectations for future education for children. Academic achievement at 15 years of age has been found to be strongly correlated with school completion[177] and with post-education labour force outcomes[150], and schools play a critical role in mitigating gaps in learning by accelerating the rate of accumulation of both cognitive and non-cognitive skills, largely through increased investment. There is strong evidence that investment beyond resources, and policies linked to facilitate student engagement and student support, are linked to successful outcomes[190]. National government education policies also have the potential to affect a child's long-term LFP through equal access to quality education.

Chapter 5: Maternal Labour Force

5.1 Introduction

In this chapter, the impact of language difficulties on the labour supply and productivity of the mother is explored.

A large body of international literature has found LFP differentials between carers of children with disability and carers of children without disability[4,47-53]. The impact of a child's disability on the carer's LFP and wages within the Australian context is less clear. To date, very few studies have examined the effect of disability caring on Australian women's LFP and wages, taking account of the type and severity of the disability and considering unobserved heterogeneity. Language difficulties, despite their high prevalence, have largely been ignored in the labour force literature.

Understanding the effect of children's language and other impairments on LFP and women's wages is important to current Australian policy. To understand the impact of children's language and other impairments on labour market outcomes for mothers, it is useful to consider a household production function framework, as illustrated in Figure 9.

A child's wellbeing contributes to the utility of the family and parents make decisions about what to purchase (goods and services), and how much time they spend caring for their children (household production), to invest in the human capital of the children and ultimately increase the overall utility of the family. On the investment side, parents make decisions on whether and how much to work (both paid and unpaid) based on the specific needs of the family. For a family with a child with language difficulties, the specific needs of the child may require greater investment, either in the form of household production or purchased goods and services. Figure 9 illustrates how informal care responsibilities can impact upon labour supply. Foremost, a child with an impairment may require additional commitment of carer time which reduces the time available for paid work. Time required for activities such as providing transport, attending appointments and providing additional social, emotional and academic support may have negative effects on maternal employment. Reduced labour force participation (either time not in the labour force or reduced hours available limiting full time work) may then limit the job opportunities available to carers because of the constrained hours they are available to work. However, the impacts are not straightforward. On the other hand, the financial demands related to increased health care utilisation for a medically intensive condition may lead to increased labour force participation [191]. Further, the emotional demands of caring for a high needs dependent may motivate an individual to participate in the labour force to seek some respite, with this desire being over and above the normal financial gains associated with employment [192].

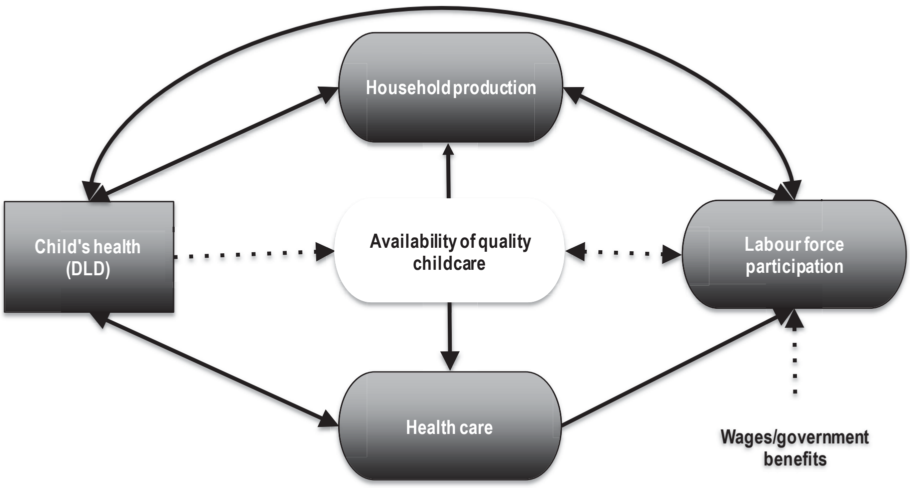


Figure 9: Labour force participation of mothers of children with DLD

Adapted from Stabile et al.[3]

Government policies with respect to provision of income support may also affect women's labour force participation decisions [64,193]. On the one hand current labour market policies are focused on counteracting the economic effects of an ageing population by focusing on increasing birth rates while maintaining high levels of female LFP[194-197]. On the other hand there are simultaneously increased pressure on family members, from the health system to provide unpaid care [68]. With the increasing rates of childhood disability and impairment[198,199], it is therefore important to determine how caring for children with disabilities affects the labour force participation and labour market outcomes (including earnings) for parents. This chapter focuses on the impact of language difficulties on female carers, as they typically have primary responsibility for caring in the LSAC.

In recognition of the importance of the issue for Australian policy and the lack of prior research, this chapter examines whether mothers who are carers of children with language difficulties and additional impairments, on average, earn lower hourly wages and have different LFP than non-carers. For the purposes of this chapter, mothers of children with language difficulties and additional impairments will be compared to mothers of children with typical language.

The relationship between children's disabilities and mother's work is complicated by the endogeneity of labour force decisions. By failing to take account of individual unobserved heterogeneity such as preferences for caring and career ambition, an analysis based on ordinary least squares (OLS) regressions may overestimate the impact of a child's disability on LFP [200,201]. To address this, dynamic random effects estimates are obtained using a panel from six waves of the LSAC. The random effects models are compared to OLS and Heckman corrected models to determine the extent of heterogeneity and selection bias. By exploiting the mother's pre-birth labour force behaviour[xlix] as a source of exogenous variation in pre-caring LFP, this study investigates the causal effect of having a child with language impairment on LFP and individual wages. The analysis also investigates whether the LFP and wage differentials differ by types of disabilities, by caring intensity or by household structure (single parents, number of children).

The chapter is structured as follows. Section 5.2 reviews the literature and discusses the theoretical reasons for reduced LFP among carers, and a wage penalty associated with caring, and describes the LSAC data.(Section 5.3) and Section 5.4 presents the empirical approach adopted in this chapter. Section 5.5 presents the empirical results, Section 5.6 explores the impact of heterogeneity and whether there are differences in LFP for single mother households, non- English speaking households and by number of siblings. Section 5.7 and Section 5.8 presents the discussion and conclusion.

[xlix] 'Pre-birth' relates to the period before the birth of the child with disability.

5.2 Existing evidence

According to human capital theory, there are a number of reasons why a LFP and wage differential may exist between mothers of children with language difficulties and mothers of typical language children [29,202]. First, the frequency and duration of career disruptions may reduce human capital through depreciation of skills and qualifications Becker, 1986 #307;Budig, 2001 #1033}. Second, time out of the labour force reduces the opportunity to seek promotion or advancement Becker, 1986 #307;Budig, 2001 #1033}. Third, anticipation of caring responsibilities may lead to reduced investment less in labour market human capital and accumulation Becker, 1986 #307;Budig, 2001 #1033}. Fourth, there is a higher opportunity cost of labour market participation (because of caring responsibilities) which reduces the likelihood of choosing participation at given wage offer as well as having less available options in the labour market[29,202] (see Figure 10).

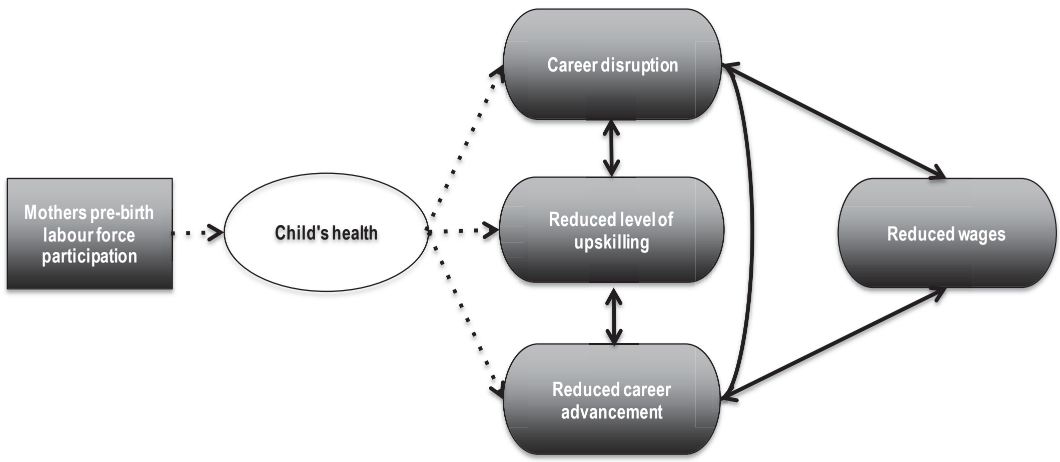


Figure 10: Mothers' accumulation of human capital

In addition, mothers with caring responsibilities who therefore seek more flexible working arrangements, either through part-time work or more flexible work hours may have fewer opportunities for paid work, and may need to accept lower paid jobs.. International studies show that part-time work explains much of the wage differential between women with and without children. However, in Australia the literature is mixed, with some studies finding evidence of a wage differential for mothers[203,204], while others do not[205]. These impacts on labour supply and earnings observed for mothers are likely to be exacerbated for mothers with additional caring responsiblilities related to their child's impairment.

The effort required to raise a high-needs child may also reduce LFP and wages. Following Becker's[29]'worker effort' theory, this suggests that carers are less productive than non-carers because they are 'tired' from the demands of raising a child, particularly one with high-level needs[29]. In addition, carers may be presented with fewer opportunities or with jobs with lower wages if employers perceive that they will be less productive.

A large body of international literature has examined whether carers have lower participation in the workforce than non-carers. A significant differential has been found in the USA[4,47-53], Canada[54] and Denmark[55]. In general, the literature has found that a mother with a child with disability is between 3 and 15 percentage points less likely to be active in the labour force[4,47,49,50,53,206]. For those who are in the labour force, they will work fewer hours per week[4,47,206] and earn lower wages[4,48,51]. Several researchers have noted that the relationship is conditional on the severity[51,54], the type of disability [4,47,55,207] and the household structure[4,207].

Using the 1997 Panel Study of Income Dynamics (PSID) – Child Development Supplement, Gould et al. [191] predicts that children with time-intensive illnesses and those with unpredictable illnesses negatively influence mothers' labour supply, whereas children with illnesses with a strong financial component have a positive effect on mothers' labour supply. Single mothers work fewer hours if their child has a time-intensive illness, and married mothers are less likely to work, and work fewer hours, if their child has a severe condition with an unpredictable time component.

In terms of difference by types of disability, Wasi et al.[44] used cross-sectional data from the 2000 US Census and found a LFP differential between carers and non-carers of children aged 3 years with physical and sensory disabilities, but no effect was observed for mental/emotional/cognitive disabilities. Wehby et al.[213] looked at older children, where the effect of physical and mental disabilities was observed for single mothers and for African American mothers.

In contrast to the international literature, the effect of caring on LFP and wages has received little attention in Australia. Using cross-sectional data from the 2003 Survey of Disability, Ageing and Carers, Lu et al. [208] found an 8 per cent differential in LFP in non-married women, with no effect observed for married women. Brandon et al. [209] used the 1997 Australian Time Use Survey to analyse part-time and full-time hours of work for parents of children with profound limitations and found that the impact of the disability was observed for married mothers but not for married fathers. Similarly, Lee et al. [210] observed reduced LFP in middle-aged carers in repeated cross-sectional analysis of two years of data from the Australian Longitudinal Study on Women's Health. However, the results from these studies are potentially biased by unobserved heterogeneity[211]. In cross-sectional analysis, a carer's LFP or wage differential may be overestimated if there are unobserved factors, such as work motivation, which are negatively correlated with caring and positively associated with LFP and wages. Equally, the effect of caring on LFP will be underestimated if those carers most likely to have lower wages are also less likely to be employed. To account for these sources of bias, international studies have typically used panel data to estimate fixed and random effects models. Using this approach, Yamauchi [96]found an 8 percentage point decrease in LFP but no income differential. However, one of the limitations of their study was the omission of key explanatory variables[1]. Yamauchi's [96] models do not control for pre-caring LFP or other income and/or government benefits. If carers are less likely to work and they earn lower wages, the coefficient on caring may be biased upwards. Similarly, if other income and/or government benefits are high, carers may be less likely to work, and government benefits may provide a wage penalty offset, which is then not identified in the model.

This chapter makes a number of contributions to the literature on how children's language difficulties and additional impairments affect mothers' LFP. First, the analysis

[1] OLS estimates may be biased. For example, parents' traits (e.g., genetic factors and health problems) may influence their participation in paid work and their risk of having a child with disability. Yamauchi's models do not control for pre-caring LFP or other income and/or government benefits; if carers are less likely to work and earn lower wages, the coefficient on caring may be biased upwards. Similarly, if other income and/or government benefits are high, carers may be less likely to work, and government benefits may provide a wage penalty offset, which is then not identified in the model.

compares Heckman selection models and dynamic random effects models to better account for selection and time-invariant heterogeneity in caring for a child with language difficulties. Second, this study exploited mothers' pre-birth labour force behaviour as the source of exogenous variation in pre-caring LFP[li]. Third, severity and type of disability are considered by categorising children's disabilities into four groups (including language difficulties, which are the main explanatory variable of interest) and including severity indicators to explore how these affect carers' employment differently. Fourth, longitudinal data on two different-aged cohorts (LSAC B and LSAC K) are utilised, which follows children from birth until 15 years of age, along with their families. This allows consideration of the labour force attachment for carers and younger and older children, as well as consideration of both the immediate and long-term impacts of language difficulties on LFP. Fifth, the results will be used to calculate the opportunity costs of forgone earnings, which will inform an aggregated cost model in Chapter 6. Finally, subgroup analyses are explored, comparing single mothers with mothers in two-parent households, English speaking with non-English speaking background as well as transitions from a single-child household to multiple child household.

5.3 Methods

5.3.1 Data and sample

5.3.1.1 Measures of informal care

There are no direct measures of informal care, such as caring hours, in the LSAC data. However, the data permit approximations of the degree of carers commitment by specifying the type of disability and the severity/persistence of the condition. Definition 2- language difficulties persistence and timing is used in these analyses (Table 45) Full details are available in Chapter 2.

[li] Available for the LSAC B cohort.

Table 45: Language difficulties persistence and timing – Definition 2

Timing	Definition	Ages data available	
		B cohort	K cohort
Typical language	No language difficulties at any age	0–11 years	4–15 years
LD1_0–3 years	Language difficulties identified at one time only, between 0–3 years of age	0–3 years	N/A
LD1_4–7 years	Language difficulties identified at one time only, between 4–7 years of age	4–7 years	4–7 years
LD1_≥8 years	Language difficulties identified at one time only, at 8 years or older	8–11 years	8–15 years
LD2_0–3 years	Language difficulties identified twice, the first time at 0–3 years of age	0–3 years	N/A
LD2_4–7 years	Language difficulties identified twice, the first time between 4–7 years of age	0–7 years	4–7 years
LD2_≥8 years	Language difficulties identified twice, the first time at 8 years or older	8–11 years	8–15 years
LD3_0–3 years	Language difficulties identified three or more times, the first time between 0–3 years of age	0–3 years	N/A
LD3_4–7 years	Language difficulties identified three or more times, the first time between < 8 years of age	0–7 years	4–7 years
LD3_≥8 years	Language difficulties identified three or more times, the first time at 8 years or older	N/A	8–15 years

Note. For the age range of 0 to 3 years, identification in the B cohort relates to two waves of data: at 0 to 1 years and at 2 to 3 years. The age range 4 to 7 years relates to when the children were 4 to 5 years and 6 to 7 years, and identification at 8 years or older relates to when children were 8 to 9 years and 10 to 11 years. In the K cohort, the first age range was 4 to 7 years, relating to when the children were 4 to 5 years and 6 to 7 years. Identification at 8 years or older for the K cohort relates to four waves of data: at 8 to 9 years, 10 to 11 years, 12 to 13 years and 14 to 15 years. As a result of this approach, the sample of B cohort children with LD3_≥8 years (identification at 8 years or older with condition in more than two waves) and K cohort children with LD (1, 2, 3) _0–3 years (identification between birth and 3 years) is not available in these data and therefore not considered. N/A = not available in the data.

5.4 Econometric framework

It is assumed that a mother's decision to participate in the labour market is based on maximisation of her utility function subject to by her budget constraint. The mother can allocate her time to paid work, leisure or household production[212]. Household production includes both activities that generate utility for the family or investment in human capital for the child. This will be determined by the child health production function

The utility function of the mother is defined as:

$$U = (l - \overline{l})^{\alpha_1}(x - \bar{x})^{\alpha_2} \qquad (5.4.1)$$

where l is leisure, $\bar{l}$ is the minimum amount of leisure, x is consumption of a composite commodity, with $\bar{x}$ being the minimum amount of the composite commodity, H is the child's health.

The health of the child H is defined as:

$$H = (c - \overline{c})^{\alpha_3}(s - \bar{s})^{\alpha_4} \qquad (5.4.2)$$

Where c is the total time spent on the child's disability by the parents, $\bar{c}$ is the minimum parent input required to care for a child without a disability, s is the purchased inputs for the child's health and $\overline{s}$ is the minimum purchased child health inputs required.

If T is the total number of hours in the day, the mother's time can be allocated between leisure, l, time allocated for caring for the child' condition, c, and paid employment, which is defined as $T - l - c$. It is assumed that parents can either work in paid employment, participate in leisure activities or take care of the child, and that the child can be cared for a parent or by a carer other than the parents. Therefore parental labour supply is jointly determined by the amount of unpaid parental care time c, other care time C and leisure.

N is defined as the number of siblings in the household,. The price of purchased disability care is p. The price of the consumption is normalised to 1. Therefore the overall budget constraint is defined where

$$(T - l - c)wT + y \qquad (5.4.3)$$

Is the total income of the household which includes w as the gross wage rate and y is any additional household income.

$$ps + (x + C(N)) \qquad (5.4.4)$$

is the purchased consumption (based on investment in the utility of the family, which is dependent on the family size) so the optimisation problem for each mother is defined as:

$$\max_{l,c,x,s}(l-\bar{l})^{\alpha_1}(x-\bar{x})^{\alpha_2}(c-\bar{c})^{\alpha_3}(s-\bar{s})^{\alpha_4} \tag{5.4.4}$$

subject to $ps+w(l+c)+x=wT+y$

$T-l-c\geq 0$

The hours worked h^* is dependent on the minimum time commitment required due for caring $\bar{c}$ and leisure $\bar{l}$, the required inputs due to investment and purchased goods and services and conditional on hourly wage rate of other carers.

$$h^*=T-\frac{\alpha_1+\alpha_3}{W}A-\bar{l}-\bar{c} \tag{5.4.5}$$

Where A represents the optimum levels of inputs to meet the minimum demands of caring and consumption

$$A=wT+y-w\bar{l}-\bar{x}=w\bar{c}-ps \tag{5.4.6}$$

The analysis assumes that, the additional household income y is greater than the minimum time commitment and consumption required $\overline{(x+C)}+p\bar{s}$ to ensure all women have a minimum outside income source to cover the minimum purchase inputs. Women who require greater than the minimum of parental time $\bar{c}$, will have lower desired paid employment hours and may seek more flexible work arrangements, such as casual or part-time employment (substitution effect). In contrast, women who require higher than the minimum of purchased inputs $\bar{s}$ will desire greater paid employment hours (income effect). For example, as previously discussed children with time-intensive illnesses and those with unpredictable illnesses negatively influence mother's labour supply, whereas children with illnesses with a strong financial component may have a positive effect on mother's labour supply, particularly if the mother is more established in the workforce, in permanent employment, or in higher status occupations[213]. This chapter examines whether this hypothesis is empirically supported.

5.4.1 Pooled models

This study first examines whether labour supply of mothers of children with language difficulties is different from the labour supplied by typical language mothers, using pooled analysis from 10 years and using the following specification:

$$Y_{it} = B_0 + B_1 CC_{n_{it}} + B_2 X_{it^n} + e_{it} \qquad (5.4.1\ 1)$$

$$n = 1,2,3$$

where Y_{it} is the dependent variable for the household probability of work (probit), wage rate (OLS) and hours of work (tobit) i at time t. $CC_{n_{it}}$ is the language difficulty or other impairment status of the child, being an approximation of the level of caring (defined as LDpersistance_timing, sens_learncondition, physmentalemot_condition, other_ conditions and Mcarers_A, Mcarers_P[lii]). X_{it^n} is the explanatory variables of the mother, child and household. X_{it^n} is the vector of independent variables starting with background characteristics X_{it^1}, whether the mother is from a non-English speaking background, a variable indicating the mother's anxiety and depression, three dummy variables indicating whether two biological parents live in the household, if the mother is a single parent or has a non-biological partner, five dummy variables for observations in Wave 2 to Wave 6 (biennial waves from 2004–2014). Regional differences in average earnings are accounted for by a set of 22 dummy variables (state, metropolitan, large and small regional centres). Labour-market shocks due to childbirth are accounted for using two variables (number of siblings, age of the youngest child)[liii]. X_{it^2} includes the mother's human capital, determined by the level of skill, defined by five dummy variables (mothers who did not complete Year 12 but have other trade qualification, mothers who completed Year 12 with and without a trade qualification, mothers with a bachelor's degree or postgraduate degree). The mother's work experience is approximated by the mother's age and a squared quadratic age term. X_{it^3} includes other income and government benefits, and the family's SES. The mother's pre-birth income is considered in the B cohort equation as an approximation for pre-birth labour force attachment.

[lii] Detailed definitions are presented in Table 95, Appendix G
[liii] Probability of work and hours equations only.

The error term e_{it} captures unobserved time-invariant heterogeneity, such as maternal preferences for paid work and care and parents' unobserved characteristics. It also captures unobserved time-varying heterogeneity, such as changes in disability policy and in time and location varying economic conditions, which may alter parental labour force opportunities. The error term is assumed to be homoscedastic across mothers and the household[110]. One of the limitations of pooled models is that the estimates can be biased if the X_{it} is correlated with the error term e_{it}[liv]. The model assumes that carers who were suddenly relieved from their caregiving would have the same LFP as non-carers. However, interpreting such correlations in the data as causal effects is made problematic by the likelihood that carers who have children with *disability* are different from non-carers in ways that are unobservable and potentially correlated with wages and LFP. To account for these biases, international studies have typically used Heckman's two-stage selection model and fixed and random effects models. The next section discusses these models in greater detail.

5.4.2 The Heckman two-stage selection model

The basic premise of the Heckman model is to estimate the unobservable wage offers of non-participants and include these wages as an instrumental variable (IV) in the participation equation. The likelihood of working (the likelihood of the wage being observed) is therefore a function of a number of explanatory variables that predict participation and (implicitly) the wage (via the wage equation). The Heckman selection model is specified in two stages. Stage 1 is a labour participation/supply equation. Stage 2 is a wage equation conditional on participation.

The first stage of the model specified working (Eq. 5.4.2.1) as a function of the level of caring (LDpersistance_timing, sens_learncondition, physmentalemot_condition and, other_conditions, MCarers_A and MCarers_P[lv]) and other independent variables that influence LFP. The probability of working (WORK) is specified as a probit model with a value of one for those who are actively in the labour force (working, or on maternity

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[lv] Detailed definitions are presented in Table 95, Appendix G

leave), and zero (unemployed, not in labour force) otherwise:

$$WORK = f(\alpha_1 + \alpha_2 CC_1 + \beta_1 X_i + \varepsilon > 0) \qquad (5.4.2.1)$$

where the probability that the mother is working is a function $f(.)$ of her level of caring (CC_1). X_i is a vector of independent variables, which is consistent with the specification in Eq. 5.4.1.1. It includes two key variables (number of siblings, age of the youngest child) that act as an instrument in the selection equation. These impact the likelihood of the mother working but do not affect the wage rate. δ is the residual error term associated with the decision to work.

The first stage of the model generates an inverse Mill's ratio *lambda* (λ) that is used as an IV[lvi] in the second stage to correct for the potential selection bias. Second-stage linear equations are estimated for the mother's wage (Eq. 5.4.2.2), participation (Eq. 5.4.2.3) and hours of work (Eq. 5.4.2.4)[lvii].

It is assumed that informal care and availability of formal child care[lviii] has a direct impact on earnings. This accounts for differences in the background characteristics of carers and non-carers and the potential selection effects of those with more-limited labour-market opportunities taking on caring roles[215,216].

The equation is defined as:

$$M\_WAGE = \alpha_1 + \alpha_2 CC_1 + \beta_1 + \beta_2 X_W + \lambda + \epsilon_1 \qquad (5.4.2.2)$$

where M_WAGE is the log of the mother's income divided by the hours worked.. The

[lvi] The IV represents the wage rate of non-working members of the sample had they been working and, in doing so, accounts for the potential selection bias associated with unobserved differences in the working and non-working sample. Known broadly as the 'Heckman correction term', the use of this IV is a well documented method for the correction of such biases[214]

[lvii] Second-stage equations exclude the variables used as an instrument in the first stage equation (number of siblings and age of the youngest child), variables which are predicted of participation of the workforce and not wages. These variables are included in OLS and RE models.

[lviii] Availability of formal child care is considered in the LSAC for the B cohort. Parents most commonly report that children are not in formal child care due to 1) not needing it 2) lack of availability of places or 3) parents available to care for the child.

LSAC presented the mother's income as one measure of gross wages plus other income, including government benefits. To account for non-wage related income, β_1 represents indicators of income that are unrelated to working: number of other sources of income, number of government benefits (excluding carers' benefits). These included Disability Support Pension, Parenting Payment Single, Youth Allowance, Family Tax Benefit Part A and Part B, Rent Assistance, Health Care Card, Child Care Benefit, and Austudy. It is therefore assumed that the estimated income rate of the mother is equivalent to the mother's wage rate and will be defined as 'wages' accordingly. With the exception of the instrumental variables identified in Eq. 5.4.2.1, the wage equation is otherwise consistent with Eq. 5.4.2.2 above.

$$WORK/WORK\ HOURS = \alpha_1 + \alpha_2 CC_1 + \beta_3 X_H + WAGEFIT + \epsilon_2 \quad (5.4.2.3)$$

$WORK$ is the probability of working, specified as a probit model with a value of one for those who are actively in the labour force (working, or on maternity leave), and zero for those who are unemployed or who choose not to be active in the labour force. $WORK\ HOURS$ are the mother's regular weekly work hours, specified as a tobit model with a value greater than zero for those who are actively in the labour force. X_H is the vector of the mother's human capital, and $\alpha_2 CC_3$ is the measure of the level of caring (LDpersistance_timing,sens_learncondition,physmentalemot_condition,other_conditions and Mcarers_A, Mcarers_P[lix]). $WAGEFIT$ is the predicted market wage, generated from the ϵ_1 residuals from Eq. 5.4.2.2 to capture the selection bias, and ϵ_2 is the residual error term for Eq. 5.4.2.3.

5.4.3 Dynamic Random Effects Probit

While the Heckman model provides a method of accounting for selection biases, it does not allow for panel data specification or for unobserved individual effects. The next section explores two panel model specifications commonly used for unobserved individual effects, specified as fixed and random effects. Recall that the dependent variables of interest are both linear (wages) and non-linear (probability of working,

[lix] Detailed definitions are presented in Table 95, Appendix G

work hours) in nature. Unconditional fixed effects models provide a method of dealing with time-invariant heterogeneity in linear specifications. However, this option is problematic in a non-linear setting (xtprobit), and can result in inconsistent estimates[217]. A conditional fixed effects model (xtlogit) provides one method of dealing with this issue. However, this model makes interpretation difficult, as it is not possible to compute marginal effects. The standard random effects framework is an alternative model; however, it also presents two estimation problems.

The first problem with the standard random effects framework is that it is based on the unrealistic assumption that the individual effects u_i are uncorrelated with the vector X_{it^n}. In the dynamic random effects framework, this is resolved with the inclusion of a correction proposed by Mundlak in 1978 [218].

The relationship between u_i and the means of the time-varying X_{it^n} is defined as:

$$u_i = \bar{X}_i'\delta + \epsilon_i \tag{5.4.3.1}$$

where $\epsilon_i \sim iid$ is normally distributed and is independent of X_{it^n} and e_{it} for all i and t. In practice, Mundlak corrections can be applied by including the individual means (over time) of the time-varying explanatory variables on the right-hand side of the equation[218].

The second problem that arises with the standard random effects framework is known as the 'initials-conditions-problem', whereby the inclusion of lagged dependent variables in the right-hand side of the equation may be correlated with the error terms. This issue was first examined by Heckman in 1981[219] and then by Arulampalam et al.[220] and Wooldridge [221][lx]. For the purposes of this chapter, the method of Wooldridge is used by incorporating a linear approximation of the latent dependent variable at the initial time period t_1, to account for the observed sequence of an individual's experiences, given the individual effect u_i. This is combined with the Mundlak method and lagged dependent variable to estimate the following equation:

[lx] Arulampalam and Stewart (2009) explored Heckman and other estimators and found consistent estimates could be obtained with less computation-intense estimators in combination with the Mundlak correction.

$$WORK_{it} = Y_1 WORK_{it-1} + B_1 CC_{n_{it}} + B_2 X'_{it} + \bar{X}'_i \delta + WORK_{i1} + \varepsilon_i + u_{it}$$
(5.4.3.2)

where $WORK$ is the dependent variable for LFP (probability of work) i at time t. $CC_{n_{it}}$ is the language difficulty, other impairment or carers' benefit status of the mother, and X'_{it} is the explanatory variables of the mother, child and household, discussed above[lxi]. $\bar{X}'_i \delta$ represents the time-varying means (Mundlak). $WORK_{i1}$ is the first observation of the dependent variable for individual i. $WORK_{i1-1}$ is the lagged observation of the dependent variable for individual i. ε_i are the individual effects for each mother, child and household, and u_{it} is the unobserved explanatory variables. While there is the possibility of bias from the time-variant heterogeneity, the overall bias is reduced as time-invariant heterogeneity is accounted for in the dynamic random effects specification, allowing exploration of the causal relationship between the onset of language difficulties and the labour force decisions of mothers.

This specification is considered further with dependent variables: log of income and the mother's hours of work. The dependent variable in Eq. 5.4.3.3 is the logarithm of hourly income. The lasting effect of previous LFP is captured by two dummy variables indicating the work status for the current $(\alpha_1 WORK_{it})$ and the past wave$(\alpha_1 WORK_{it-1})$. The remaining specification is consistent with Eq. 5.4.3.2.

[lxi] $X_{it^n}$is the vector of independent variables, starting with background characteristics X_{it^1}, whether mother is from a non-English speaking background; a variable indicating the mother's anxiety and depression; three dummy variables indicating whether two biological parents live in the household and whether mother is single parent or has a non-biological partner; and five dummy variables for observations in Wave 2 to Wave 6 (biennial waves from 2004–2014). Regional differences in average earnings are accounted for by a set of 22 dummy variables (state, metropolitan, large and small regional centres [REGION]). Labour-market shocks due to childbirth are accounted for using two variables (number of siblings, age of the youngest child). X_{it^2} includes the mother's human capital, determined by the level of skill, defined by five dummy variables: mothers who did not complete Year 12 but have other trade qualification, mothers who completed Year 12 with and without a trade qualification, mothers with a bachelor's degree and postgraduate degree; mother's work experience, approximated by mother's age and mother's age squared. X_{it^3} includes other income and government benefits. The mother's pre-birth income is considered in the B cohort equation as an approximation for pre-birth labour force attachment. Finally, socioeconomic differences in earnings are captured by the variable SEP.

$$M\_WAGE_{it} = \alpha_0 + \alpha_1 WORK_{it} + \alpha_1 WORK_{it-1} + B_1 CC_{n_{it}} + B_2 X'_{it} + \bar{X}'_i \delta + WORK_{i1} + \varepsilon_i + u_{it} \qquad (5.4.3.3)$$

The dependent variable in Eq. 5.4.3.4 is the mother's weekly hours of work. The specification is consistent with Eq. 5.4.3.2. The lagged variable in this equation is indicated by $Y_1 HOURS_{it-1}$. The initial conditions are specified as $HOURS_{i1}$.

$$HOURS\ OF\ WORK\ _{it} = Y_1 HOURS_{it-1} + B_1 CC_{n_{it}} + B_2 X'_{it} + \bar{X}'_i \delta + HOURS_{i1} + \varepsilon_i + u_{it} \qquad (5.4.3.4)$$

5.5 Results

The following section discusses the summary statistics for the two cohorts. Sections 5.5.2 and 5.5.3 focus on three regression analysis results: the B and K cohort and the measure of language difficulties (LDtiming_persistence), additional impairments (defined by sensory learning, physical/mental/emotional and other conditions), and Carer Payment (defined by Mcarers_A and Mcarers_P)[lxii].

5.5.1 Descriptive statistics

The baseline characteristics for the sample for the outcome variables are shown in Section A. Table 46 (see Appendix G: Variable Definitions for detailed definitions). In B cohort, 65 per cent of mothers were working. Of those mothers who were working, the average number of hours worked per week was 16, with an average wage rate of $32.90 per hour. In comparison with the B cohort, mothers in the K cohort were more likely to be working (73 per cent) and worked, on average, 4 more hours per week (20 hours per week) at a wage rate of $31.88 per hour.

Employment status outcomes were used as dependent variables in the analysis to determine which types of employment arrangements are most compatible with a mother's caring responsibilities. Maternal gross annual income[lxiii], which includes

[lxii] Detailed definitions are presented in Table 95, Appendix G.
[lxiii] Annual disposable income was calculated from weekly before tax amounts, which was inflated to 2014 dollars using the wage rate of Australian Consumer Price Index and multiplied by 52 weeks. After

government benefits, was between $33,563 and $37,562 (in 2014 prices) for B cohort and K cohort respectively. Total household gross income—defined as the sum of maternal income, resident partner's income and the income of any other employed person present in the household—equivalised by the number of members in the household was between $51,697 and $52,860 (in 2014 prices), on average[lxiv], for B cohort and K cohort respectively. Approximately 4 per cent of the sample received Carer Allowance, an income supplement paid to carers who provide additional daily care and attention for someone with a long-term disability or medical condition, and a further 2 to 3 per cent received Carer Payment[lxv].

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tax annual income was calculated using tax rates from 2013/2014 tax year. Income was then scaled using the international square root approach.

[lxv] To be eligible for Carer Allowance, a carer must provide additional daily care and attention to a person with a long term (of at least 12 months) disability or medical condition and meet the residence requirements. Carer Allowance is not income- and asset-tested and can be paid in addition to wages or other income support payments, such as Carer Payment or Age Pension.

Table 46: Baseline characteristics

Variable	Measurement	B cohort Mean	B cohort SD	K cohort Mean	K cohort SD
Section A. Outcome variables					
Mother works	Dummy variable 1 = Yes, 0 = No	65.19	0.48	73.0	0.45
Mother’s hours of work	Average weekly hours of work	16	16	20	17
Mother’s income	Annual disposable mothers income	33563	37636	37562	35414
Mother’s income rate	Average hourly income rate	32.90	2.04	31.88	1.91
Section B. Child’s characteristics					
Language definitions					
Language difficulties only	Dummy variable 1 = Yes, 0 = No	11.26	31.61	8.23	27.48
Missing language	Dummy variable 1 = Yes, 0 = No	0.20	4.43	0.13	3.56
Language by persistence and timing of identification					
LD1_0–3 years	One age identified for the first time between 0–3 years of age	7.34	26.08	NA	NA
LD1_4–7 years	One age identified for the first time between 4–7 years of age	7.92	27.01	6.28	24.27
LD1_≥8 years	One age identified for the first time at 8 years or older.	6.13	23.99	9.62	29.49
LD2_0–3 years	Two ages identified for the first time between 0–3 years of age	5.86	23.49	NA	NA
LD2_4–7 years	Two ages identified for the first time between 4–7 years of age	2.59	15.89	2.06	14.20
LD2_≥8 years	Two ages identified for the first time at 8 years or older	0.61	7.77	3.77	19.06
LD3_0–3 years	Three or more ages identified for the first time between 0–3 years of age	5.34	22.49	NA	NA
LD3_4–7 years	Three or more ages identified for the first time between 4–7 years of age	0.67	8.19	1.71	12.95
LD3_≥8 years	Three or more ages identified for the first time at 8 years or older	NA	NA	4.06	19.74
Other impairment definitions					
Sensory/learning	Dummy variable 1 = Yes, 0 = No	4.16	19.97	4.16	19.97
Missing sensory learning	Dummy variable 1 = Yes, 0 = No	0.39	6.20	0.39	6.20
Physical/emotional/ behavioural	Dummy variable 1 = Yes, 0 = No	3.31	17.88	3.31	17.88
Missing physical/emotional/ behavioural	Dummy variable 1 = Yes, 0 = No	0.39	6.20	0.39	6.20

		B cohort		K cohort	
Other	Dummy variable 1 = Yes, 0 = No	5.91	23.58	5.91	23.58
Missing other	Dummy variable 1 = Yes, 0 = No	0.39	6.20	0.39	6.20
Section C. Mother's characteristics					
Mother's age	Range 15–57 years. Three age categories defined	36	6	40	6
	30 years and under	18.60	38.91	7.28	25.98
	31 years to 40 years	56.24	49.61	47.93	49.96
	Older than 40 years	25.16	43.40	44.79	49.73
Mother speaks another language at home	Dummy variable 1 = Yes, 0 = No	12.70	33.30	13.89	34.58
Mother is Indigenous	Dummy variable 1 = Yes, 0 = No; Includes Aboriginal and Torres Strait Islanders	2.31	15.01	2.04	14.15
Mother completed Year 12	Dummy variable 1 = Yes, 0 = No	70.23	45.73	61.74	48.60
Mother did not complete Year 12 and completed trade qualification	Dummy variable 1 = Yes, 0 = No	18.05	38.46	22.69	41.88
Mother completed Year 12 and completed trade qualification	Dummy variable 1 = Yes, 0 = No	23.34	42.30	20.47	40.35
Mother has bachelor's degree	Dummy variable 1 = Yes, 0 = No	20.19	40.14	16.32	36.95
Mother has postgraduate degree	Dummy variable 1 = Yes, 0 = No	51.86	75.25	46.90	74.49
Mother's level of anxiety and depression	1–5 with 5 being lowest level on anxiety and depression	4.47	0.57	4.43	0.61
Mother has partner who is biological parent	Dummy variable 1 = Yes, 0 = No	85.07	35.64	79.93	40.05
Mother is single parent	Dummy variable 1 = Yes, 0 = No	3.42	18.17	5.91	23.58
Mother has partner other than child's biological parent	Dummy variable 1 = Yes, 0 = No	11.51	31.92	14.16	34.87
Section D. Other income sources					
Household Income	Dummy variable 1 = Yes, 0 = No	51697	38007	52860	38077
Mother receives Carer Allowance	Dummy variable 1 = Yes, 0 = No	3.66	18.79	3.92	19.40
Mother receives Carer Payment	Dummy variable 1 = Yes, 0 = No	1.83	13.41	2.60	15.92
Mother receives Parenting Payment Single	Dummy variable 1 = Yes, 0 = No	5.87	23.51	7.83	26.86
Mother receives Disability Support Pension	Dummy variable 1 = Yes, 0 = No	0.60	7.70	0.79	8.84
Mother receives one other welfare payment	Dummy variable 1 = Yes, 0 = No	9.14	28.82	7.60	26.50
Mother receives two or more other welfare payments	Dummy variable 1 = Yes, 0 = No	3.49	18.36	2.90	16.78
Mother receives one other income sources (other than wages)	Dummy variable 1 = Yes, 0 = No	5.16	22.13	5.80	23.37

		B cohort		K cohort	
Mother receives two or more other income sources (other than wages)	Dummy variable 1 = Yes, 0 = No	1.25	11.10	1.88	13.59
Section E Mother's characteristics pre-birth					
Mother is in permanent position	Dummy variable 1 = Yes, 0 = No	0.94	−1.00	NR	
Mother is in casual employment	Dummy variable 1 = Yes, 0 = No	18.24	38.62	NR	
Mother is in fixed-term employment	Dummy variable 1 = Yes, 0 = No	45.73	49.82	NR	
Mother's usual work hours per week	Fewer than 10 hours per week	36.04	48.01	NR	
	10–19 hours per week	37.10	32.40	NR	
	20–29 hours per week	18.39	38.74	NR	
	30–34 hours per week	17.88	38.32	NR	
	35–39 hours per week	16.99	37.55	NR	
	40–49 hours per week	16.44	37.06	NR	
	50 or more hours per week	15.75	36.43	NR	
Mother's salary before tax $2,000 or more per week	Dummy variable 1 = Yes, 0 = No	14.55	35.26	NR	
Mother's salary before tax $1,500–$1,999 per week	Dummy variable 1 = Yes, 0 = No	0.00	0.00	NR	
Mother's salary before tax $1,000–$1,499 per week	Dummy variable 1 = Yes, 0 = No	20.15	40.11	NR	
Mother's salary before tax $700–$999 per week	Dummy variable 1 = Yes, 0 = No	10.23	30.31	NR	
Mothers salary before tax $500–$699 per week	Dummy variable 1 = Yes, 0 = No	46.82	49.90	NR	
Section F. Household characteristics					
Socioeconomic position	Standardised score	0.01	−1.00	0.02	0.99
Number of biological siblings the child has	Only child	18.24	38.62	11.49	31.90
	1 biological sibling	45.73	49.82	47.02	49.91
	2 or more siblings	36.03	48.01	41.49	49.27
Age of the youngest child in household	Range 0–15 years	4	3	7	4
Wave	Wave 1 (child aged 0–1 yrs [B] 4–5 yrs [K])	18.39	38.74	18.62	38.92
	Wave 2 (child aged 2–3 yrs [B] 6–7 yrs [K])	17.87	38.31	17.92	38.35
	Wave 3 (child aged 4–5 yrs [B] 8–9 yrs [K])	16.99	37.55	17.39	37.90
	Wave 4 (child aged 6–7 yrs [B] 10–11 yrs [K])	16.44	37.06	16.56	37.17
	Wave 5 (child aged 8–9 yrs [B] 12–13 yrs [K])	15.76	36.43	15.65	36.33
	Wave 6 (child aged 10–11 yrs [B] 14–15 yrs [K])	14.56	35.27	13.87	34.56
Sample size		4,768 individuals, 25,486 observations		4,586 individuals, 24,375 observations	

Note. Unweighted sample. B = birth cohort; K = kindergarten cohort; SEIFA = Socio-Economic Indexes for Areas.

Table 47 and Table 48 show the descriptive statistics of mother's work status by type of care. Overall, mothers in the B cohort were less likely to be working than were mothers in the K cohort. There were some differences in working behaviour observed among the mothers, according to the type of condition. In the B cohort, mothers who were carers of children with language difficulties were less likely to be working (range from 47 per cent to 68 per cent) than non-carers (68 per cent). For these children, the mother's labour supply was further reduced if the child had a persistent language difficulty (LD3) (47 to 51 per cent) or was severe enough to meet the eligibility for Carer Allowance (64 per cent) or Carer Payment (43 per cent). In the K cohort, between 48 per cent and 73 per cent of were working, compared with 77 per cent of non-carers. In contrast to the B cohort, carers of K cohort children with physical /emotional /behavioural conditions did not further adjust their LFP, with the exception of those who met the eligibility for Carer Allowance (58 per cent) and Carer Payment (47 per cent). Unemployment rates—that is, mothers who were searching for work—were largely consistent across the B and K cohorts. In the B cohort, the unemployment rates were highest for mothers of children with sensory/learning conditions (5 per cent) and of mothers of children with persistent language conditions, identified between 0 and 3 years of age (LD3_0–3) (5 per cent). In the K cohort, unemployment rates were highest for mothers of children with persistent language conditions (LD3) (5 per cent). Although it is not possible to consider unemployment in isolation in the modelling, it may be important to consider when interpreting the results.

Overall, the descriptive statistical results suggest there is some heterogeneity in the active labour force behaviour of mothers, thus increasing the potential for bias.

Table 47: Cross-tabulation of mothers' labour supply and other conditions

Variable	Non-carer	LD1_0–3	LD1_4–7	LD1_≥8	LD2_0–3	LD2_4–7	LD2_≥8	LD3_0–3	LD3_4–7	LD3_≥8
B cohort										
Mother is employed	0.68	0.65	0.65	0.67	0.55	0.60	0.66	0.51	0.47	
Mother is unemployed	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.05	0.01	
Mother is not in the labour force	0.29	0.33	0.31	0.30	0.42	0.37	0.30	0.44	0.53	N/A
Mother's hours of work	17.08	15.89	16.69	17.30	14.32	15.56	19.14	13.48	11.70	
Mother's income rate	43.41	45.82	40.36	42.53	39.74	42.30	33.03	34.16	51.38	
Mother's log income rate	3.52	3.50	3.47	3.49	3.41	3.43	3.34	3.30	3.51	
K cohort										
Mother is employed	0.77		0.72	0.73		0.69	0.65		0.53	0.48
Mother is unemployed	0.02		0.04	0.03		0.04	0.03		0.05	0.05
Mother is not in the labour force	0.21	N/A	0.25	0.24	N/A	0.27	0.32	N/A	0.42	0.47
Mother's hours of work	21.16		19.96	20.25		18.78	18.66		14.52	13.13
Mother's income rate	37.92		34.81	35.54		31.73	35.53		38.24	34.40
Mother's log income rate	3.48		3.39	3.43		3.32	3.39		3.42	3.36

Note. Unweighted sample. LD1_0–3 = language difficulties identified at one age for the first time between 0–3 years of age; LD1_4–7 = language difficulties identified at one age for the first time between 4–7 years of age; LD1_≥8 = language difficulties identified at one age for the first time at 8 years or older; LD2_0–3 = language difficulties identified at two ages for the first time between 0–3 years of age; LD2_4–7 = language difficulties identified at two ages for the first time between 4–7 years of age; LD3_4–7 = language difficulties identified at two ages for the first time at 8 years or older; LD3_0–3 = language difficulties identified at three or more ages, for the first time between 0–3 years of age; LD3_4–7 = language difficulties identified at more than two ages, for the first time between 4–7 years of age; LD3_≥8 = language difficulties identified at three or more ages, for the first time at 8 years or older.

Table 48: Cross-tabulation of mothers' labour supply and language difficulties

Variable	Sensory /learning carer	Physical /emotional /behavioural	Other	Any impairment with Carer Allowance	Any impairment with Carer Payment
B cohort					
Mother is employed	0.62	0.64	0.59	0.64	0.43
Mother is unemployed	0.05	0.02	0.02	0.02	0.01
Mother is not in the labour force	0.33	0.34	0.39	0.34	0.56
Mother's hours of work	14.54	16.40	15.93	16.40	9.66
Mother's income rate	44.88	43.85	38.59	43.85	44.46
Mother's log income rate	3.59	3.60	3.34	3.60	3.49
K cohort					
Mother is employed	0.69	0.76	0.64	0.58	0.47
Mother is unemployed	0.03	0.03	0.04	0.03	0.04
Mother is not in the labour force	0.27	0.21	0.32	0.39	0.49
Mother's hours of work	18.31	21.63	16.79	14.47	11.23
Mother's income rate	39.99	36.67	37.15	39.95	39.12

Note. Unweighted sample.

Sections 5.5.2 to 5.6.3 show the results of the income and labour supply models. The first section, Section 5.5.2, (see Table 49 to Table 57) report the impact of language difficulty caring and other impairment caring on mothers' labour supply in the B cohort. These results include and a log transformed income rate, active participation in the labour force (probability of working) and hours of work. The results in section 5.5.3 (see Table 58 to Table 66) report the results for the K cohort.

5.5.2 The effects of language difficulty caring on labour supply – B cohort

5.5.2.1 Wages

LFP was first explored by comparing cross-sectional estimates (OLS) with a Heckman-adjusted wage specification. The cross-sectional model assumes that the decision to work or not to work is randomly decided, and, as such, the unobserved wages (for those who are not working) can be ignored. Such an assumption, however, is unlikely to be true. Women who have low potential wages/wage offers may be unlikely to choose to work, and thus the sample of observed wages is biased upward. The likelihood of working (the likelihood of the wage being observed) is therefore a function of a number of explanatory variables that predict participation and (implicitly) the wage (via the wage equation).

The Heckman equation is based on the assumption of an independent relationship between informal care and income rate (as defined in Eq. 5.4.2.2). This assumption means that the predicted market wage rate is not constrained to being the same mothers of children with language difficulties and otherwise similar mothers of typical language children. The predicted market wage rate is then used as an IV in earnings equation (as defined in Eq. 5.4.2.3 and Eq. 5.4.2.4). These are then compared to a dynamic random effects specification (Eq. 5.4.3).

Table 49 shows the results of the participation wage for the B cohort. The pooled cross-sectional model (see Table 49) showed a significant raw difference in wages between mothers of children with language difficulties and mothers of typical language children. After controlling for the level of language difficulty caring (in b), the coefficients increased in size from language difficulty caring level LD2_0–3 (transient language difficulties identified between 0 and 3 years of age) to LD3_0–3 (persistent language difficulties in three or more ages, between 0 and 3 years of age) ($p < 0.05$). The inclusion of carers' benefits (c) did not impact the size of the coefficients. The penalty became smaller when mothers' experience and pre-birth LFP and education were considered. In the final OLS models, there remains a significant wage penalty of 8 per cent[lxvi] for maternal LFP for a child with LD2_0–3, a wage penalty of 12 per cent for LD2_>8(persistent language difficulties at two ages, at 8 years of age older) and an 8 per cent wage penalty for LD3_0–3. There were no significant effects for mothers who were carers of children with additional disabilities or impairments.

[lxvi] The exponential of coefficient (0.101) = 1.11 or 11 per cent increase.

Table 49: Wages – B cohort (OLS) (log wages)

	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience (including pre-birth LFP)	+ Education	Other income/welfare/all controls
	a	b	c	d	e	f	g
				OLS			
LDnocond = 1	−0.094** (0.023)						
LD1_0–3 = 1		0.027 (0.0286)	0.027 (0.029)	0.043 (0.028)	0.056* (0.027)	0.055* (0.027)	0.058* (0.027)
LD1_4–7 = 1		−0.018 (0.024)	−0.018 (0.024)	−0.036 (0.024)	−0.022 (0.023)	−0.002(0.023)	−0.0008 (0.023)
LD1_≥8 = 1		−0.032 (0.027)	−0.032 (0.027)	−0.038 (0.027)	−0.020 (0.027)	−0.021 (0.027)	−0.014 (0.027)
LD2_0–3 = 1		−0.121** (0.034)	−0.121** (0.034)	−0.133** (0.035)	−0.102** (0.035)	−0.092** (0.035)	−0.080* (0.035)
LD2_4–7 = 1		−0.119* (0.048)	−0.119* (0.048)	−0.131** (0.048)	−0.090+ (0.047)	−0.089+ (0.047)	−0.068 (0.047)
LD2_≥8 = 1		−0.181** (0.061)	−0.181** (0.061)	−0.156** (0.060)	−0.158** (0.054)	−0.130* (0.052)	−0.118* (0.051)
LD3_0–3 = 1		−0.184** (0.032)	−0.183** (0.033)	−0.153** (0.033)	−0.111** (0.033)	−0.098** (0.033)	−0.079* (0.033)
LD3_4–7 = 1		−0.015 (0.083)	−0.015 (0.083)	−0.039 (0.086)	0.021 (0.086)	0.063 (0.087)	0.079 (0.083)
senslearn_condition = 1	0.089+ (0.046)	0.116* (0.046)	0.116* (0.0463)	0.111* (0.0451)	0.094* (0.045)	0.086+ (0.044)	0.078+ (0.044)
physmentalemot_condition = 1	−0.035 (0.040)	−0.029 (0.040)	−0.029 (0.040)	0.014 (0.039)	0.009 (0.036)	0.020 (0.037)	0.023 (0.036)
other_condition = 1	−0.022 (0.041)	−0.017 (0.041)	−0.017 (0.042)	−0.012 (0.041)	−0.015 (0.040)	−0.014 (0.040)	−0.020 (0.040)
Mcarers_A			0.005 (0.040)	0.002 (0.040)	0.032 (0.039)	0.032 (0.039)	−0.004 (0.041)
Mcarers_P			−0.021 (0.076)	−0.026 (0.078)	0.009 (0.077)	0.023 (0.077)	0.005 (0.078)
N	12897	12897	12897	12422	12422	12422	12422
LL	−13777	−13751	−13751	−13045	−12645	−12564	−12511
AIC	27574	27537	27541	26184	25421	25269	25181
BIC	27648	27664	27682	26533	25904	25789	25768

Note. Includes pweights for attrition. LD = language difficulties; OLS = ordinary least squares; LD1_0–3 = language difficulties identified at one time only, between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD2_≥8 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations; LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion. + significant at 10%; *significant at 5%; **significant at 1%

Estimation results of the Heckman model with the selection problem are provided in Table 50. The selection equation represents whether the mother was working or not working. The equation includes all controls defined in Table 49 (g). The estimate for *rho* indicated a positive correlation between selection and the employment outcome ($\hat{p}$ = 0.099). The associated Wald test of independence of equations was statistically significant (chi^2 = 23.29) with a p-value = 0.0000. This showed evidence of sample selection bias due to mothers not working. The model showed that the Heckman-corrected wage penalty for carers of LD3_0–3 children was 1.6 per cent lower than the pooled OLS results (see Table 49) and became not significant for LD2_0–3 and LD3_4–7 children. Mothers who select into paid employment are more likely to have higher wages; therefore, failure to account for selection will overstate the true wages of people not in the labour force. Refer to Appendix K for a full interpretation of the Heckman model.

Table 50: Wages – B cohort (Heckman) (log wages)

Definition	Wages	Selection
LD1_0–3 = 1	0.057 (0.037)	−0.071 (0.068)
LD1_4–7 = 1	0.007 (0.030)	0.044 (0.062)
LD1_≥8 = 1	−0.001 (0.036)	0.049(0.066)
LD2_0–3 = 1	−0.072 (0.045)	−0.167* (0.070)
LD2_4–7 = 1	−0.054 (0.062)	0.036 (0.101)
LD2_≥8 = 1	−0.103 (0.068)	−0.039 (0.206)
LD3_0–3 = 1	−0.084* (0.043)	−0.036 (0.079)
LD3_4–7 = 1	0.115 (0.105)	−0.135 (0.212)
senslearn_condition = 1	0.069 (0.044)	−0.079 (0.084)
physmentalemot_condition = 1	0.021 (0.037)	−0.121 (0.077)
other_condition = 1	−0.028 (0.043)	−0.065 (0.070)
Mcarers_A	−0.004 (0.051)	−0.096 (0.076)
Mcarers_P	−0.015 (0.077)	−0.409** (0.102)
N	19309	
rho	0.099**	
Wald test of independent equation (chi^2) = 23.29		
Probability > chi^2 = 0.00000		

Note. Includes pweights for attrition. LD1_0–3 = language difficulties identified at one time only, between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD2_≥8 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; LD3_≥8 = language difficulties identified three or more times, the first time at 8 years or older; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations. + significant at 10%; *significant at 5%; **significant at 1%

The dynamic random effects raw estimates revealed a smaller wage penalty for language difficulty caregiving (see Table 51) when compared with OLS and Heckman. In the final random effects model (h), there was no significant income effect for language caregiving. For mothers who were carers of children with sensory/learning conditions, there was evidence of a higher wage for these mothers compared with mothers of typical children. However, this result was not consistently observed across all three model specifications.

Overall, the results showed evidence of not only a selection bias but also endogeneity in caring and other time-invariant variables. This implies that carers do differ from non-carers in terms of unobservable productivity characteristics, other than whose which affect selection into employment. The dynamic random effects model is the most conservative.

Table 51: Wages – B cohort (dynamic random effects) (log wages)

	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience (including pre-birth LFP)	+ Education	Other income/welfare/ all controls	All controls+ Mundlak
	a	b	c	d	e	f	g	h
	Dynamic RE							
LDnocond = 1	−0.053** (0.018)							
LDnocond = 20	−0.102 (0.188)							
LD1_0–3 = 1		0.007 (0.035)	0.007 (0.035)	0.020 (0.034)	0.032 (0.033)	0.033 (0.032)	0.036 (0.032)	0.042 (0.045)
LD1_4–7 = 1		−0.053 (0.033)	−0.053 (0.033)	−0.066* (0.0329)	−0.055+ (0.031)	−0.040 (0.031)	−0.037 (0.031)	−0.028 (0.044)
LD1_≥8 = 1		−0.026 (0.037)	−0.026 (0.038)	−0.020 (0.037)	−0.017 (0.035)	−0.016 (0.035)	−0.009 (0.035)	−0.0032 (0.046)
LD2_0–3 = 1		−0.108** (0.040)	−0.110** (0.040)	−0.108** (0.040)	−0.081* (0.038)	−0.071+ (0.038)	−0.057 (0.037)	−0.032 (0.077)
LD2_4–7 = 1		−0.068 (0.058)	−0.069 (0.058)	−0.090 (0.058)	−0.047 (0.055)	−0.045 (0.055)	−0.029 (0.054)	−0.017 (0.082)
LD2_≥8 = 1		−0.123 (0.119)	−0.123 (0.119)	−0.138 (0.118)	−0.168 (0.112)	−0.152 (0.111)	−0.146 (0.110)	−0.149 (0.125)
LD3_0–3 = 1		−0.222** (0.044)	−0.229** (0.044)	−0.208** (0.044)	−0.159** (0.042)	−0.144** (0.042)	−0.125** (0.041)	−0.085 (0.123)
LD3_4–7 = 1		0.055 (0.118)	0.057 (0.118)	0.042 (0.118)	0.0939 (0.113)	0.120 (0.113)	0.127 (0.112)	0.155 (0.148)
senslearn_condition = 1	0.089* (0.039)	0.104** (0.039)	0.098* (0.039)	0.100* (0.040)	0.096* (0.039)	0.096* (0.039)	0.094* (0.039)	0.089* (0.041)
physmentalemot_condition = 1	0.043 (0.036)	0.047 (0.036)	0.046 (0.036)	0.075* (0.037)	0.076* (0.037)	0.078* (0.037)	0.078* (0.036)	0.085* (0.038)
other_condition = 1	−0.053+ (0.032)	−0.048 (0.032)	−0.052 (0.032)	−0.049 (0.033)	−0.048 (0.032)	−0.047 (0.032)	−0.047 (0.032)	−0.047 (0.034)
Mcarers_A			0.053 (0.036)	0.039 (0.037)	0.044 (0.036)	0.045 (0.036)	0.028 (0.037)	0.028 (0.038)
Mcarers_P			0.047 (0.053)	0.021 (0.054)	0.036 (0.053)	0.038 (0.053)	0.033 (0.053)	0.038 (0.054)
N	15389	15389	15389	14646	14646	14646	14646	14646
sigma	0.738	0.737	0.737	0.723	0.705	0.702	0.699	0.697
rho	0.394	0.393	0.393	0.377	0.346	0.342	0.338	0.334

Note. Includes pweights for attrition. LD = language difficulties; RE = random effects; 20 = missing; LD1_0–3 = language difficulties identified at one time only, between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD2_≥8 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations. + significant at 10%; *significant at 5%; **significant at 1%

5.5.2.2 Probability of working

In this section, the relationship between language difficulty caring and participation in work is explored in a number of specifications. The hypothesis that the demands of caring may restrict the job opportunities available to carers is examined; for example, whether employers perceive that these carers will be less productive.

The analysis explored the probability of work by comparing cross-sectional estimates with estimates that include the Heckman correction term (WAGEFIT). As discussed in Section 5.4, WAGEFIT represented the wage rate of non-working members of the sample had they been working and, in doing so, accounts for the potential selection bias associated with unobserved differences in the working and non-working sample. The equation used to determine WAGEFIT is based on the assumption of an independent relationship between caring and wage rate. These estimates are then compared to a dynamic random effects specification.

The pooled cross-sectional model presented in Table 52 showed a significant raw difference in working between mothers of children with language difficulties and mothers of typical language children. After controlling for the level of language difficulty caring (b), the coefficients increased in size from language difficulty caring level LD1_0–3 (language difficulties at one age identified between 0 and 3 years) to LD3_4–7 (language difficulties at three or more ages identified between 4 and 7 years) ($p < 0.05$). When carers' benefits were considered (c), the size of the coefficient for all types of caregiving reduced slightly, with the exception of the most severe language difficulty variable (LD3_4–7), which increased in size. Both a and b demonstrate an incremental effect of increasing language difficulty caring commitment but the carers' benefits may be slightly better for explaining the effect of caring commitment than the severity/timing variables. The penalty became smaller, when mothers' experience and pre-birth LFP were considered. In the final OLS models, there remained a significant working penalty of 18.9 per cent for maternal LFP for a child at LD2_0–3 (a language difficulty at two ages, identified for the first time between 0 and 3 years of age). However, this was not consistently observed across all language difficulty levels. The coefficient for Carer Payment (Mcarers_P) was large, negative and highly significant, which is unsurprising considering Carer Payment is an income support payment for carers who, because of the demands of their caring role, are unable to fully participate in the labour force. Interestingly, the coefficient for Carer Allowance (Mcarers_A) was also large and negative. Carer Allowance is a smaller fixed payment—an income supplement—which is not means tested or based on any level of LFP and aims to help carers who are looking after a child with high care needs. The payment of Carer Allowance, with or without the payment of Carer Payment, results in a reduction in the probability of the mother being in paid work, which suggests that the dominant influence is the demands of time spent caring for children with high-level needs. There were no significant effects observed for mothers who were carers of children with additional disabilities or impairments.

Table 52: Participation in work – B cohort (probability)

	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience (including pre-birth LFP)	+ Education	Other income/welfare/all controls
	a	b	c	d	e	f	g
				PROBIT			
LDnocond=1	−0.308** (0.034)						
LDnocond=20	−1.228+ (0.662)						
LD1_0-3=1		−0.134** (0.042)	−0.133** (0.042)	−0.106* (0.042)	−0.057 (0.045)	−0.047 (0.046)	−0.032 (0.046)
LD1_4-7=1		−0.118** (0.040)	−0.110** (0.040)	−0.110** (0.042)	−0.045 (0.044)	−0.014 (0.044)	−0.010 (0.045)
LD1_>=8=1		−0.085* (0.043)	−0.080+ (0.043)	−0.023 (0.046)	0.029 (0.048)	0.052 (0.048)	0.076 (0.048)
LD2_0-3=1		−0.432** (0.045)	−0.409** (0.046)	−0.358** (0.047)	−0.219** (0.050)	−0.194** (0.050)	−0.189** (0.051)
LD2_4-7=1		−0.317** (0.065)	−0.297** (0.065)	−0.223** (0.068)	−0.029 (0.074)	−0.011 (0.075)	0.004 (0.080)
LD2_>=8=1		−0.308* (0.121)	−0.276* (0.120)	−0.163 (0.120)	−0.117 (0.122)	−0.116 (0.122)	−0.118 (0.125)
LD3_0-3=1		−0.534** (0.046)	−0.475** (0.047)	−0.416** (0.050)	−0.170** (0.054)	−0.119* (0.055)	−0.058 (0.056)
LD3_4-7=1		−0.630** (0.120)	−0.647** (0.120)	−0.532** (0.123)	−0.228+ (0.128)	−0.113 (0.129)	−0.111 (0.130)
senslearn_condition=1	−0.202** (0.072)	−0.115 (0.072)	−0.025 (0.075)	0.004 (0.075)	−0.059 (0.081)	−0.067 (0.081)	−0.054 (0.083)
physmentalemot_condition=1	−0.204** (0.069)	−0.192** (0.069)	−0.145* (0.070)	−0.186* (0.073)	−0.146+ (0.075)	−0.127+ (0.075)	−0.135+ (0.077)
other_condition=1	−0.336** (0.060)	−0.309** (0.059)	−0.239** (0.060)	−0.182** (0.061)	−0.157* (0.064)	−0.147* (0.064)	−0.107+ (0.065)
Mcarers_A			−0.314** (0.056)	−0.269** (0.059)	−0.302** (0.063)	−0.305** (0.063)	−0.153* (0.065)
Mcarers_P			−0.669** (0.081)	−0.703** (0.085)	−0.595** (0.093)	−0.597** (0.094)	−0.465** (0.094)
N	20246	20246	20246	19349	19349	19349	19305
LL	−12721	−12600	−12530	−11183	−9460	−9368	−9057
AIC	25467	25238	25103	22465	19054	18881	18277
BIC	25562	25389	25269	22850	19581	19447	18914

Note. Includes pweights for attrition. LD = language difficulties; 20 = missing; LD1_0–3 = language difficulties identified at one time only, between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD2_≥8 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = number of observations; LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion. + significant at 10%; *significant at 5%; **significant at 1%

Estimation results of the Heckman model with WAGEFIT are provided in Table 53. The Heckman-corrected raw estimates for carers of children with language difficulties (a) were smaller (~10 percentage points) than the pooled results. For caregiving of children with additional disabilities, the Heckman-corrected estimates were between 0 and 3 percentage points higher than the raw OLS estimates. When Carer Payment was considered (c), the coefficients for all types of disability reduced slightly. As was evident in the pooled model, the background characteristics explained most of the LFP effects. The effect of language difficulties on LFP in the final equation (g) became not significant at a p-value of 0.05 for all levels of language difficulties, with the exception of mothers with children who have a LD2_0–3 (language difficulties identified two times, the first time between 0 and 3 years of age) language difficulty. For these children, mothers were 28.3 per cent less likely than non-carers to be working. For carers who are eligible for carers' benefits, the coefficients are ~ 1 percentage point lower than the OLS estimates for those eligible for Mcarers_A (Carer Allowance) and ~5 percentage points lower for those eligible for Mcarers_P (Carer Payment).

Table 53: Participation in work – B cohort (Heckman) (probability)

Definition	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience (including pre-birth LFP)	+ Education	Other income/welfare/all controls
	a	b	c	d	e	f	g
				PROBIT with Heckman			
LDnocond = 1	−0.202** (0.0356)						
LDnocond = 20	−0.996 (0.649)						
LD1_0-3=1		−0.152** (0.043)	−0.152** (0.043)	−0.116** (0.042)	−0.054 (0.045)	−0.024 (0.046)	0.012 (0.053)
LD1_4-7=1		−0.128** (0.041)	−0.121** (0.041)	−0.098* (0.043)	−0.049 (0.044)	0.005 (0.045)	0.034 (0.052)
LD1_>=8=1		−0.033 (0.046)	−0.028 (0.046)	−0.006 (0.047)	0.027 (0.048)	0.043 (0.04)	0.074 (0.048)
LD2_0-3=1		−0.316** (0.047)	−0.297** (0.047)	−0.226** (0.048)	−0.221** (0.051)	−0.272** (0.052)	−0.283** (0.075)
LD2_4-7=1		−0.195** (0.067)	−0.175** (0.067)	−0.085 (0.069)	−0.032 (0.075)	−0.10 (0.077)	−0.090 (0.095)
LD2_>=8=1		−0.168 (0.126)	−0.132 (0.125)	−0.019 (0.122)	−0.119 (0.123)	−0.221+ (0.123)	−0.268+ (0.152)
LD3_0-3=1		−0.358** (0.049)	−0.295** (0.050)	−0.265** (0.051)	−0.167** (0.056)	−0.195** (0.057)	−0.148+ (0.075)
LD3_4-7=1		−0.422** (0.125)	−0.441** (0.124)	−0.362** (0.124)	−0.230+ (0.129)	−0.198 (0.129)	−0.200 (0.140)
senslearn_condition=1	−0.249** (0.0744)	−0.186* (0.0749)	−0.091 (0.077)	−0.075 (0.076)	−0.051 (0.082)	0.011 (0.083)	0.044 (0.10)
physmentalemot_condition=1	−0.228** (0.0721)	−0.222** (0.0714)	−0.171* (0.072)	−0.203** (0.074)	−0.145+ (0.075)	−0.103 (0.076)	−0.105 (0.079)
other_condition=1	−0.307** (0.0616)	−0.288** (0.0614)	−0.214** (0.062)	−0.168** (0.061)	−0.160* (0.064)	−0.164* (0.064)	−0.150* (0.069)
Mcarers_A			−0.330** (0.058)	−0.283** (0.060)	−0.303** (0.063)	−0.271** (0.064)	−0.166* (0.065)
Mcarers_P			−0.685** (0.087)	−0.667** (0.085)	−0.597** (0.0931)	−0.598** (0.094)	−0.496** (0.096)
N	19305	19305	19305	19305	19305	19305	19305
LL	−11630	−11576	−11507	−10959	−9433	−9323	−9057
AIC	23286	23192	23058	22019	19003	18792	18277
BIC	23388	23349	23231	22412	19538	19367	18914.

Note. Includes pweights for attrition. LD = language difficulties; 20 = missing; LD1_0–3 = language difficulties identified at one time only, between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD2_≥8 = language difficulties identified at twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; Mcarers_A = Carer Allowance, Mcarers_P = Carer Payment; N = Number of observations; LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion. + significant at 10%; *significant at 5%; **significant at 1%

The dynamic random effects estimation (Table 54) brought about significant differences to the coefficients. Whereas the cross-sectional approach highlights the differential between carers and otherwise-similar non-carers, the panel random effects model follows individuals over time. In this way, it is possible to observe how LFP patterns change over time when an individual takes on caring responsibilities. Based on the raw estimates only (Table 54, Column a), the results suggested that the cross-sectional model provides biased estimates of the causal impact of caring on employment. The Heckman selection models deal with selection biases. However, this model does not allow for time-invariant heterogeneity and panel data specification.

The first six columns of Table 54 (a–h) present a standard random effect framework. When all of the controls were considered, the LFP for a carer of a child at LD2_0–3 and LD3_0–3 was 14.9 and 17 percentage points lower than for a non-carer, respectively (column g) although this was not significant at a p-value of 0.05. Although the background characteristics explained most of this effect, it is important to also consider the two estimation problems associated with random effects (discussed in Section 5.3). The Mundlak correction and lagged dependent variables (d_lag) were considered in (g) and (h) respectively, and the language difficulty carer effects became not significant. Similarly, for mothers who were carers of children with additional disabilities or impairments, there were no significant effects on LFP in the final random effects model. Only those carers who received Carer Payment reduced their LFP (34 percentage points), when compared with non-carers. This showed that, in contrast to the OLS and the Heckman results, the effects of language difficulty caring on LFP appeared to be driven by a small number of carers, who are caring for children with high care needs.

Table 54: Participation in work – B cohort (dynamic random effects) (probability)

Definition	LD	LD severity	Carer Allowance and Carer Payment	Family background	Experience (including pre-birth LFP)	All controls	All controls + MUNDLAK	All controls + MUNDLAK + d_lag
	a	b	c	d	e	f	g	h
				DYNAMIC RE PROBIT				
LDnocond = 1	−0.224** (0.040)							
LD1_0–3 = 1		−0.140 (0.094)	−0.135 (0.093)	−0.080 (0.093)	−0.023 (0.080)	−0.007 (0.079)	0.032(0.099)	0.041 (0.082)
LD1_4–7 = 1		−0.137 (0.091)	−0.134 (0.090)	−0.134 (0.090)	−0.040 (0.077)	−0.008 (0.076)	0.046 (0.095)	0.001 (0.078)
LD1_≥8 = 1		−0.088 (0.104)	−0.078 (0.103)	−0.030 (0.102)	−0.0078 (0.087)	0.008 (0.087)	0.083 (0.102)	0.045 (0.084)
LD2_0–3 = 1		−0.560** (0.100)	−0.537** (0.10)	−0.471** (0.100)	−0.185* (0.086)	−0.149+ (0.086)	−0.023 (0.157)	−0.043 (0.130)
LD2_4–7 = 1		−0.367* (0.152)	−0.346* (0.151)	−0.309* (0.150)	−0.079 (0.127)	−0.070 (0.127)	0.061 (0.171)	−0.071 (0.142)
LD2_≥8 = 1		−0.185 (0.323)	−0.168 (0.321)	−0.132 (0.319)	−0.226 (0.267)	−0.230 (0.265)	−0.084 (0.277)	−0.220 (0.220)
LD3_0–3 = 1		−0.772** (0.107)	−0.708** (0.107)	−0.643** (0.108)	−0.255** (0.092)	−0.170+ (0.092)	0.166 (0.242)	0.008 (0.206)
LD3_4–7 = 1		−1.044** (0.289)	−1.065** (0.288)	−0.964** (0.287)	−0.446+ (0.240)	−0.308 (0.241)	0.0006 (0.299)	−0.110 (0.242)
senslearn_condition = 1	−0.381** (0.082)	−0.322** (0.082)	−0.265** (0.082)	−0.202* (0.087)	−0.256** (0.085)	−0.260** (0.085)	−0.212* (0.089)	−0.134 (0.091)
physment_condition = 1	−0.126+ (0.077)	−0.114 (0.077)	−0.090 (0.077)	−0.127 (0.080)	−0.066 (0.080)	−0.054 (0.080)	−0.059 (0.083)	−0.033 (0.085)
other_condition = 1	−0.298** (0.067)	−0.275** (0.067)	−0.229** (0.067)	−0.225** (0.071)	−0.201** (0.070)	−0.201** (0.070)	−0.144+ (0.074)	−0.106 (0.082)
Mcarers_A			−0.448** (0.074)	−0.394** (0.078)	−0.410** (0.075)	−0.404** (0.076)	−0.154* (0.077)	−0.069 (0.071)
Mcarers_P			−0.629** (0.097)	−0.645** (0.101)	−0.581** (0.098)	−0.575** (0.098)	−0.364** (0.098)	−0.342** (0.09)
N	25479	25479	25479	23856	23856	23856	23798	19699
LL	−12754	−12725	−12692	−11540	−10534	−10461	−10164	−7691
rho	0.667	0.664	0.661	0.647	0.532	0.527	0.487	0.246
AIC	25534	25490	25428	23181	21204	21068	20521	15578
BIC	25640	25653	25607	23585	21754	21658	21305	16351

Note. Sample sizes are larger in RE models as pweights are not possible. RE = random effects; LD = language difficulties; 20 = missing; LD1_0–3 = language difficulties identified at one time only, between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD2_≥8 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations; LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion. + significant at 10%; *significant at 5%; **significant at 1%

5.5.2.3 Weekly hours of work

In this section, the relationship between language difficulty caring and hours of work is explored. So far, there is little evidence to show that mothers of children with language difficulties adjust their participation in the workforce or their wages unless the condition is severe enough for the carer to receive Carer Payment. For these mothers, Carer Payment provides a disincentive to work. This section further tests the hypothesis that the demands of caring may restrict the job opportunities available to carers because, for example, they may seek more-flexible working arrangements or part-time hours.

The analysis explored hours of work by comparing cross-sectional estimates with estimates that include the Heckman correction term (WAGEFIT) and then dynamic random effects. This is consistent with the approach used in the work participation equation.

From the raw cross-sectional results in Table 55 (a), it can be seen that mothers of children with language difficulties work 2.228 fewer hours than mothers of typical language children. After controlling for language severity and timing (b), the size of the coefficients increased at caring level LD1_0–3, LD2_0–3 and LD3_0–3. Including carers' benefits in (c) reduced the size of the language caregiving coefficients. The coefficients for Carer Allowance (Mcarers_A) and Carer Payment (Mcarers_P) were large and negative. The inclusion of mothers' experience and pre-birth LFP brought about significant changes to the coefficients, which shows that pre-birth LFP explains much of the reduction in hours for new mothers, and this is unrelated to disability/impairment caregiving. In the final model (g), working hours were significantly higher for language carers at LD1_≥8 (language difficulties identified at one time only, at eight years or older) and recipients of Carer Allowance (Mcarers_A) and Carer Payment (Mcarers_P).

Table 55: Hours of work – B cohort

Definition	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience (including pre-birth LFP)	+ Education	Other income/welfare/all controls
	a	b	c	d	e	f	g
				TOBIT			
LDnocond = 1	−2.228** (0.417)						
LD1_0–3 = 1		−1.857** (0.487)	−1.841** (0.484)	−1.561** (0.453)	−0.749+ (0.410)	−0.691+ (0.408)	−0.691+ (0.408)
LD1_4–7 = 1		−0.759 (0.485)	−0.655 (0.481)	−0.366 (0.472)	0.276 (0.414)	0.633 (0.414)	0.633 (0.414)
LD1_≥8 = 1		−0.020 (0.515)	0.038 (0.513)	0.528 (0.516)	1.097* (0.452)	1.253** (0.448)	1.253** (0.448)
LD2_0–3 = 1		−3.284** (0.577)	−2.985** (0.577)	−2.132** (0.554)	−0.351 (0.495)	−0.0991 (0.491)	−0.099 (0.491)
LD2_4–7 = 1		−2.146** (0.779)	−1.878* (0.772)	−1.436+ (0.761)	1.074 (0.683)	1.199+ (0.673)	1.199+ (0.673)
LD2_≥8 = 1		0.078 (1.802)	0.494 (1.765)	1.954 (1.743)	3.062* (1.548)	3.030+ (1.563)	3.030+ (1.563)
LD3_0–3 = 1		−4.551** (0.550)	−3.807** (0.559)	−3.234** (0.560)	−0.120 (0.503)	0.404 (0.500)	0.404 (0.500)
LD3_4–7 = 1		0.078 (1.802)	0.494 (1.765)	1.954 (1.743)	3.062* (1.548)	3.030+ (1.563)	3.030+ (1.563)
senslearn_condition = 1	−2.864** (0.859)	−2.144* (0.860)	−1.077 (0.865)	−0.530 (0.833)	−1.261+ (0.746)	−1.340+ (0.737)	−1.340+ (0.737)
physment_condition = 1	−1.540+ (0.864)	−1.457+ (0.854)	−0.876 (0.849)	−1.188 (0.850)	−0.702 (0.749)	−0.506 (0.745)	−0.506 (0.745)
other_condition = 1	−3.109** (0.722)	−2.837** (0.716)	−1.952** (0.712)	−1.466* (0.695)	−0.911 (0.620)	−0.806 (0.614)	−0.806 (0.614)
Mcarers_A			−3.663** (0.677)	−2.761** (0.653)	−2.701** (0.612)	−2.684** (0.602)	−2.684** (0.602)
Mcarers_P			−8.344** (0.856)	−8.144** (0.873)	−6.479** (0.861)	−6.434** (0.856)	−6.434** (0.856)
N	20246	20246	20246	19349	19349	19349	19349
LL	−82405	−82345	−82278	−76487	−74480	−74374	−74374
sigma	16.02** (0.081)	15.98** (0.082)	15.92** (0.082)	15.26** (0.084)	13.70** (0.085)	13.62** (0.085)	13.62** (0.085)

Note. Includes pweights for attrition. LD = language difficulties; 20 = missing; LD1_0–3 = language difficulties identified at one time only, between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD2_≥8 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = number of observations; LL = log-likelihood. + significant at 10%; *significant at 5%; **significant at 1%

Estimation results of the Heckman's hours model with WAGEFIT are provided in Table 56. The Heckman-corrected estimates for carers of children with language difficulties (a) were smaller (~1.2 hours) than the pooled results (Table 55) but remained negative, which is consistent with the hypothesis that caring demands reduce work hours. For carers of children with additional disabilities, the Heckman-corrected estimates were negative and larger than the raw pooled estimates, for mothers of children with sensory/learning conditions (~0.2 hours) and smaller for mothers with physical/mental/emotional and other conditions (~0.07 hours and 0.6 hours respectively). When Carer Payment was considered (c), the coefficients for all types of disability reduced slightly. When family background, human capital and other income/welfare were considered (column g) , the results became not significant at a p-value of 0.05. For carers receiving carers' benefits, there were no significant effects for Mcarers_A (Carer Allowance) and significant negative effects for Mcarers_P (Carer Payment). Carers who receive carers' benefits are also eligible for other welfare benefits[lxvii]. One explanation is that when the effect of welfare payments is considered, the residual hours' effect is in response to Carer Payment being insufficient to create a disincentive to work. Alternatively, the negative residual hours' effects for carers who receive the payment are unsurprising. The AIFS reports that only 13 per cent of Carer Payment recipients have income from paid employment that is sufficient to reduce the amount of payment received. For these carers, the substitution effect dominated.

[lxvii] The Australian Institute of Family Studies reports that over half of Carer Allowance recipients also receive other forms of income support, such as Carer Payment, Age Pension, Parenting Payment or Disability Support Pension. [68,p9]

Table 56: Hours of work – B cohort (Heckman [WAGEFIT])

	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience (including pre-birth LFP)	+ Education	Other income/welfare/all controls
	a	b	c	d	e	f	g
	Heckman TOBIT (WAGEFIT)						
LDnocond = 1	−1.062** (0.362)						
LD1_0–3 = 1		−2.131** (0.449)	−2.127** (0.447)	−1.685** (0.432)	−0.724+ (0.394)	−0.379 (0.392)	−0.652 (0.427)
LD1_4–7 = 1		−0.723+ (0.429)	−0.626 (0.427)	−0.228 (0.413)	0.254 (0.376)	1.001** (0.376)	0.772+ (0.410)
LD1_≥8 = 1		0.553 (0.454)	0.609 (0.452)	0.794+ (0.438)	1.074** (0.399)	1.105** (0.396)	1.248** (0.390)
LD2_0–3 = 1		−1.767** (0.482)	−1.528** (0.481)	−0.459 (0.467)	−0.484 (0.431)	−1.352** (0.433)	−0.499 (0.571)
LD2_4–7 = 1		−0.683 (0.658)	−0.424 (0.656)	0.303 (0.635)	0.926 (0.585)	−0.271 (0.587)	0.597 (0.678)
LD2_≥8 = 1		2.393* (1.202)	2.838* (1.199)	3.751** (1.156)	2.898** (1.060)	1.328 (1.055)	2.350* (1.194)
LD3_0–3 = 1		−2.421** (0.491)	−1.635** (0.495)	−1.302** (0.478)	−0.203 (0.445)	−0.886* (0.448)	0.234 (0.565)
LD3_4–7 = 1		−2.256+ (1.268)	−2.477* (1.263)	−0.850 (1.223)	−0.189 (1.120)	−0.197 (1.114)	0.668 (1.146)
senslearn_condition = 1	−3.204** (0.783)	−2.803** (0.785)	−1.672* (0.789)	−1.595* (0.760)	−1.104 (0.694)	−0.141 (0.692)	−0.789 (0.784)
physment_condition = 1	−1.761* (0.740)	−1.749* (0.739)	−1.132 (0.738)	−1.394* (0.710)	−0.658 (0.647)	−0.098 (0.642)	−0.452 (0.640)
other_condition = 1	−2.651** (0.626)	−2.493** (0.625)	−1.580* (0.628)	−1.235* (0.605)	−0.956+ (0.551)	−1.040+ (0.547)	−0.390 (0.563)
Mcarers_A			−3.825** (0.611)	−2.877** (0.590)	−2.701** (0.538)	−2.126** (0.535)	−0.279 (0.540)
Mcarers_P			−8.396** (0.821)	−7.600** (0.792)	−6.508** (0.722)	−6.444** (0.716)	−4.500** (0.725)
WAGEFIT	11.98** (0.523)	11.64** (0.537)	11.47** (0.535)	12.70** (0.563)	−1.021 (0.952)	−14.89** (1.373)	−3.814 (6.039)
N	19305	19305	19305	19305	19305	19305	19305
LL	−76901	−76873	−76806	−76062	−74307	−74144	−73773
sigma	15.77** (0.084)	15.75** (0.083)	15.69** (0.083)	15.07** (0.080)	13.70** (0.073)	13.58** (0.072)	13.31** (0.071)

Note. Includes pweights for attrition. LD = language difficulties; 20 = missing; LD1_0–3 = language difficulties identified at one time only, between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, the first time between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD2_≥8 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations; LL = log-likelihood. + significant at 10%; *significant at 5%; **significant at 1%

The dynamic random effects estimation shown in Table 57 brought about significant differences to the coefficients. The panel model with corrections (i) provided further evidence that the results from the cross-sectional model are biased. The panel model showed that, in contrast to the OLS and the Heckman results, the effects of language difficulty caring on work hours was consistently negative for children identified between birth and 3 years of age. The negative effects observed for recipients of the Carer Payment (Mcarers_P) in the pooled and Heckman equations remained consistent with the random effects results. LR tests showed that the random effects with corrections provided the best model fit when compared with the OLS and Heckman models. The random effects model was the most conservative.

Overall, the results of all models for the B cohort showed evidence of biases related to the selection of carers in caring roles and due to time-invariant predictors. Carers of younger children with language difficulties were seeking more-flexible hours than non-carers, even after controlling for pre-birth labour force behaviour. For mothers whose children had conditions that met the eligibility criteria for Carer Payment, the benefits were effective in providing a disincentive to be active in the labour force. The mothers who did work were working fewer hours.

Table 57: Hours of work – B cohort (dynamic random effects)

	No controls (+ time)	LD severity	+ Carers Allowance and payment	+ Family background	+ Experience (including pre-birth LFP)	Other income/welfare/all controls	All controls + MUNDLAK	All controls + MUNDLAK+ d_lag
	a	b	c	d	e	f	g	h
	DYNAMIC RE PROBIT							
LDnocond=1	-0.435 (0.278)							
LD1_0-3=1		-1.785* (0.846)	-1.772* (0.842)	-1.643* (0.814)	-0.703 (0.690)	-0.670 (0.666)	-2.572** (0.990)	-2.182* (0.944)
LD1_4-7=1		-0.783 (0.813)	-0.720 (0.810)	-0.552 (0.781)	0.224 (0.662)	0.706 (0.639)	-0.933 (0.966)	-0.891 (0.923)
LD1_>=8=1		-0.004 (0.858)	0.021 (0.854)	0.321 (0.826)	0.992 (0.700)	1.211+ (0.676)	-0.691 (0.993)	-0.506 (0.949)
LD2_0-3=1		-3.318** (0.900)	-3.144** (0.896)	-2.653** (0.867)	-0.559 (0.737)	-0.224 (0.713)	-3.674* (1.642)	-3.107* (1.571)
LD2_4-7=1		-2.196+ (1.238)	-2.048+ (1.233)	-2.051+ (1.189)	0.726 (1.012)	0.851 (0.983)	-3.329+ (1.767)	-2.710 (1.689)
LD2_>=8=1		0.192 (2.241)	0.449 (2.232)	1.032 (2.153)	2.782 (1.825)	2.522 (1.759)	-1.022 (2.254)	-1.639 (2.148)
LD3_0-3=1		-4.661** (0.893)	-4.161** (0.892)	-3.938** (0.867)	-0.602 (0.743)	0.337 (0.727)	-5.509+ (2.879)	-5.211+ (2.752)
LD3_4-7=1		-5.095* (2.366)	-5.200* (2.357)	-3.389 (2.282)	-0.570 (1.938)	1.159 (1.873)	-4.323 (2.948)	-3.971 (2.813)
senslearn=1	-1.996** (0.585)	-1.822** (0.583)	-1.498* (0.584)	-1.043+ (0.593)	-1.365* (0.584)	-1.297* (0.580)	-1.010+ (0.588)	-0.609 (0.584)
physment=1	-0.997+ (0.546)	-0.967+ (0.546)	-0.823 (0.546)	-1.471** (0.555)	-1.234* (0.546)	-1.188* (0.541)	-1.094* (0.551)	-0.832 (0.553)
other_cond=1	-1.825** (0.484)	-1.751** (0.482)	-1.459** (0.483)	-1.264** (0.490)	-1.092* (0.481)	-0.727 (0.477)	-0.713 (0.492)	-0.758 (0.530)
Mcarers_A			-2.903** (0.538)	-1.898** (0.545)	-2.204** (0.529)	-0.670 (0.535)	0.117 (0.534)	0.755 (0.539)
Mcarers_P			-4.176** (0.684)	-4.069** (0.695)	-4.086** (0.677)	-2.796** (0.678)	-2.328** (0.675)	-1.749** (0.675)
N	20246	20246	20246	19349	19349	19305	19305	16247
LL	-77975	-77954	-77927	-72819	-72137	-71683	-71499	-59697
sigma	11.94** (0.167)	11.86** (0.166)	11.81** (0.165)	11.24** (0.161)	9.212** (0.143)	8.795** (0.140)	8.290** (0.134)	7.691** (0.137)
rho	0.553	0.550	0.548	0.533	0.439	0.421	0.393	0.381

5.5.3 The effects of language difficulty caring on labour supply – K cohort

The next section repeats the analysis from Section 5.5.2 but for the K cohort. LFP was first explored by comparing cross-sectional estimates with a Heckman-adjusted wage specification and then dynamic random effects. All equation specifications are consistent with the B cohort, with the exception of the exclusion of pre-birth labour force explanatory variables.

Table 58 shows the results of the participation wage for the K cohort. The pooled cross-sectional model showed a significant negative raw difference in LFP between language difficulty carers and non-carers. After controlling for the level of language difficulty caring in (b), the coefficients increased in size from language difficulty caring level LD1_≥8 to LD3_≥8 ($p < 0.05$). The inclusion of carers' benefits (c) did not impact the size of the coefficients. The penalty became smaller when mother's experience and pre-birth LFP and education were considered. In the final OLS models, there remained a significant wage penalty of 7.4 per cent and 8.7 per cent[lxviii] for maternal LFP for a child at LD1_4–7 and LD2_4–7 respectively. This effect was not observed across all language difficulty levels. There were no significant effects for mothers who were carers of children with additional disabilities or impairments. These heterogeneous effects are largely consistent with the OLS wage results from the B cohort (Table 49).

[lxviii] Exponential (0.074) = 1.077; exponential (0.087) = 1.091.

Table 58: Wages – K cohort (OLS) (log wages)

	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience	+ Education	Other income/welfare/all controls
	a	b	c	d	e	f	g
LDnocond = 1	−0.098** (0.0279)						
LD1_4–7 = 1		−0.108** (0.0247)	−0.108** (0.0247)	−0.111** (0.025)	−0.096** (0.025)	−0.079** (0.025)	−0.074** (0.024)
LD1_≥8 = 1		−0.054* (0.021)	−0.052* (0.021)	−0.061** (0.021)	−0.049* (0.021)	−0.009 (0.021)	−0.003 (0.021)
LD2_4–7 = 1		−0.140** (0.0407)	−0.145** (0.0407)	−0.154** (0.040)	−0.154** (0.041)	−0.096* (0.039)	−0.087* (0.039)
LD2_≥8 = 1		−0.132** (0.0361)	−0.133** (0.0360)	−0.117** (0.037)	−0.110** (0.037)	−0.073* (0.0373)	−0.064+ (0.037)
LD3_4–7 = 1		−0.105 (0.0721)	−0.110 (0.0721)	−0.114 (0.078)	−0.099 (0.079)	−0.031 (0.079)	−0.027 (0.080)
LD3_≥8 = 1		−0.104+ (0.0616)	−0.115+ (0.0617)	−0.131* (0.063)	−0.112+ (0.063)	−0.049 (0.062)	−0.037 (0.062)
senslearn_condition = 1	0.018 (0.033)	0.038 (0.033)	0.025 (0.034)	0.039 (0.033)	0.038 (0.032)	0.033 (0.032)	0.025 (0.031)
physmentalem_condition = 1	0.005 (0.0393)	0.0036 (0.039)	−0.0002 (0.039)	0.022 (0.039)	0.024 (0.039)	0.018 (0.039)	0.024 (0.038)
other_condition = 1	−0.026 (0.0322)	−0.020 (0.032)	−0.029 (0.032)	−0.034 (0.033)	−0.029 (0.033)	−0.021 (0.032)	−0.029 (0.032)
Mcarers_A			0.084* (0.037)	0.099** (0.037)	0.093* (0.037)	0.101** (0.037)	0.077* (0.0378)
Mcarers_P			0.063 (0.049)	0.061 (0.050)	0.053 (0.050)	0.062 (0.047)	0.067 (0.047)
N	13083	13083	13083	12582	12582	12582	12582
LL	−12749	−12729	−12725	−12102	−12059	−11800	−11733
AIC	25519	25489	25484	24295	24214	23706	23590
BIC	25594	25601	25611	24630	24571	24100	24051

Note: Includes pweights for attrition; LD1_0–3 = language difficulties identified at one age for the first time between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD3_4–7 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; LD3_≥8 = language difficulties identified three or more times, the first time at 8 years or older; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations; LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion.

Estimation results of the Heckman model with the selection problem are provided in Table 59. Recall from the B cohort, the selection equation represents whether the mother was working or not. The equation includes all controls defined in Table 58 (g). The estimate for *rho* indicates a positive correlation between selection and the employment outcome ($\hat{p}$ = 0.254). The associated Wald test of independence of equations is statistically significant (chi^2 = 39.67) with a p-value = 0.0000. This showed evidence of sample selection bias due to mothers not working. The model showed that the Heckman-corrected wage penalty for mothers of children at LD1_4–7 was 1.6 per cent higher than the pooled OLS results (see Table 58) and 0.3 per cent lower for recipients of Carer Allowance (Mcarers_A), although this effect was not significant at a p-value of 0.05.

Table 59: Wages – K cohort (Heckman) (log wages)

	Wages	Selection
	a	b
LD1_4–7 = 1	−0.089* (0.036)	−0.128+ (0.074)
LD1_≥8 = 1	0.002 (0.030)	0.029 (0.060)
LD2_4–7 = 1	−0.092 (0.057)	−0.123 (0.116)
LD2_≥8 = 1	−0.099+ (0.051)	−0.373** (0.124)
LD3_4–7 = 1	−0.086 (0.120)	−0.548** (0.166)
LD3_≥8 = 1	−0.083 (0.072)	−0.410** (0.123)
senslearn_condition = 1	0.013 (0.033)	−0.077 (0.068)
physmentalemot_condition = 1	0.010 (0.041)	−0.153* (0.065)
other_condition = 1	−0.032 (0.035)	−0.045 (0.059)
Mcarers_A	0.074+ (0.045)	−0.111 (0.080)
Mcarers_P	0.034 (0.048)	−0.503** (0.086)
N	17854	
rho	0.254	
Wald test of independent equation (chi^2) = 39.67		
Probability > chi^2 = 0.00000		

Note. Includes pweights for attrition. LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD2_≥8 = language difficulties identified twice, the first time at 8 years or older; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; LD3_≥8 = language difficulties identified three or more times, the first time at 8 years or older; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations.

The dynamic random effects estimates did not support a wage penalty for language difficulty caregiving, which is in contrast with the wage penalty observed in the OLS and Heckman models. There remained a wage premium of 10.4 per cent[lxix] for recipients of Carer Payment (Mcarers_P), which supports the hypothesis that mothers who are carers of high-needs children have a wage premium to be in the workforce, to offset any reduction of benefit payment. For these carers, the income or respite effect, dominates. The dynamic RE model provided the best model fit. These results highlight the importance of considering panel data methods to control for biases other than selection.

[lxix] Exponential (0.104) = 1.109.

Table 60: Wages – K cohort (dynamic random effects)(log wages)

	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience	+ Education	Other income/welfare/ all controls	All controls+ Mundlak
	a	b	c	d	e	f	g	h
					Dynamic RE			
LDnocond = 1	−0.029 (0.019)							
LD1_4–7 = 1		−0.075* (0.035)	−0.075* (0.035)	−0.088* (0.035)	−0.081* (0.035)	−0.054+ (0.034)	−0.053 (0.033)	−0.056 (0.045)
LD1_≥8 = 1		−0.044 (0.029)	−0.045 (0.029)	−0.052+ (0.029)	−0.042 (0.029)	−0.007 (0.028)	−0.001 (0.028)	−0.006 (0.038)
LD2_4–7 = 1		−0.141* (0.056)	−0.144** (0.056)	−0.146** (0.056)	−0.141* (0.056)	−0.084 (0.055)	−0.072 (0.054)	−0.069 (0.078)
LD2_≥8 = 1		−0.091+ (0.052)	−0.093+ (0.052)	−0.10+ (0.052)	−0.093+ (0.052)	−0.066 (0.051)	−0.057 (0.050)	−0.051 (0.073)
LD3_4–7 = 1		−0.030 (0.069)	−0.032 (0.069)	−0.051 (0.069)	−0.037 (0.068)	0.014 (0.067)	0.027 (0.066)	0.017 (0.122)
LD3_≥8 = 1		−0.094+ (0.050)	−0.100* (0.051)	−0.104* (0.052)	−0.088+ (0.052)	−0.031 (0.050)	−0.016 (0.050)	−0.023 (0.112)
senslearn_condition = 1	0.048+ (0.026)	0.055* (0.026)	0.052* (0.026)	0.048+ (0.026)	0.046+ (0.026)	0.046+ (0.026)	0.044+ (0.026)	0.044 (0.027)
physmental_condition = 1	0.007 (0.027)	0.008 (0.027)	0.007 (0.027)	0.014 (0.027)	0.014 (0.027)	0.013 (0.027)	0.014 (0.027)	0.020 (0.028)
other_condition = 1	−0.031 (0.022)	−0.029 (0.022)	−0.031 (0.022)	−0.034 (0.023)	−0.034 (0.023)	−0.030 (0.022)	−0.033 (0.022)	−0.041+ (0.024)
Mcarers_A			0.040 (0.032)	0.049 (0.032)	0.050 (0.032)	0.058+ (0.032)	0.054+ (0.032)	0.042 (0.039)
Mcarers_P			0.082* (0.040)	0.10* (0.041)	0.104* (0.041)	0.109** (0.041)	0.107** (0.041)	0.104* (0.047)
N	16187	16187	16187	15369	15369	15369	15369	15369
sigma	0.457	0.457	0.457	0.449	0.445	0.427	0.424	0.649
rho	0.460	0.460	0.460	0.452	0.448	0.428	0.424	0.421

Note. Sample sizes are larger in RE models because pweights are not possible. RE = random effects; LD1_0–3 = language difficulties identified at one time only, between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD3_4–7 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; LD3_≥8 = language difficulties identified three or more times, the first time at 8 years or older; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations.

5.5.3.1 Probability of working

Table 61 shows the results of the participation equations for the K cohort, when mothers of children with language difficulties are considered generally and after controlling for two different interpretations of language difficulty caring and other co-variates. The pooled cross-sectional model in (a) showed a significant raw difference in working between language difficulty carers and non-carers, which is consistent with the results observed in the B cohort, albeit with larger coefficients. After controlling for language severity and persistence in (b), the coefficients increased in size as language severity increased. When carers' benefits were considered, the size of the coefficient for all types of caregiving reduced slightly. The penalty became smaller, when mothers' education, background and experience were considered. In the final pooled models, there remained a significant working penalty of between 11 per cent and 47.6 per cent for maternal LFP for a child with language difficulties and 54.8 per cent for a child whose carer received Carer Payment. These effects were larger than those observed in the B cohort, which suggests that the effects of disability on LFP may be both age and severity specific. The prevalence of certain types of disability is likely to be increase as time progresses and may therefore affect the mother's LFP as the child gets older[199]. There were no significant effects for mothers who were carers of children with additional disabilities/impairments.

Table 61: Participation in work – K cohort (probability)

	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience	+ Education	Other income/welfare/all controls
	a	b	c	d	e	f	g
				PROBIT			
LDnocond=1	−0.410** (0.043)						
LD1_4–7 = 1		−0.169** (0.045)	−0.169** (0.0455)	−0.177** (0.0480)	−0.176** (0.0485)	−0.128** (0.049)	−0.110* (0.0501)
LD1_≥8 = 1		−0.144** (0.038)	−0.133** (0.0383)	−0.0591 (0.0419)	−0.054 (0.042)	−0.016 (0.043)	0.039 (0.043)
LD2_4–7 = 1		−0.170* (0.070)	−0.149* (0.0720)	−0.145+ (0.0777)	−0.142+ (0.078)	−0.099 (0.077)	−0.092 (0.079)
LD2_≥8 = 1		−0.639** (0.063)	−0.613** (0.063)	−0.606** (0.067)	−0.607** (0.067)	−0.505** (0.067)	−0.476** (0.068)
LD3_4–7 = 1		−0.717** (0.090)	−0.654** (0.091)	−0.615** (0.094)	−0.613** (0.095)	−0.484** (0.094)	−0.474** (0.096)
LD3_≥8 = 1		−0.742** (0.072)	−0.661** (0.073)	−0.611** (0.075)	−0.622** (0.076)	−0.521** (0.078)	−0.433** (0.079)
senslearn_condition = 1	−0.296** (0.059)	−0.181** (0.060)	−0.072 (0.062)	−0.020 (0.063)	−0.028 (0.064)	−0.057 (0.064)	−0.083 (0.064)
physmentalemot_condition = 1	−0.175** (0.063)	−0.151* (0.063)	−0.114+ (0.064)	−0.096 (0.069)	−0.095 (0.069)	−0.101 (0.068)	−0.089 (0.068)
other_condition = 1	−0.236** (0.049)	−0.231** (0.049)	−0.147** (0.0489)	−0.109* (0.0521)	−0.096+ (0.052)	−0.090+ (0.053)	−0.062 (0.054)
Mcarers_A			−0.402** (0.057)	−0.338** (0.060)	−0.346** (0.061)	−0.329** (0.061)	−0.120+ (0.064)
Mcarers_P			−0.737** (0.069)	−0.694** (0.071)	−0.708** (0.072)	−0.672** (0.073)	−0.548** (0.072)
N	18828	18828	18828	17878	17878	17878	17852
LL	−10864	−10722	−10610	−9128	−9072	−8844	−8486
AIC	21749	21476	21256	18348	18242	17797	17098
BIC	21836	21601	21397	18706	18624	18218	17589

Note. Includes pweights for attrition. LD = language difficulties; LD1_0–3 = language difficulties identified at one time only, between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD3_4–7 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; LD3_≥8 = language difficulties identified three or more times, the first time at 8 years or older; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations; LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion.

A Heckman-corrected model in Table 62, showed some evidence of selection bias, with the Heckman-corrected penalty for language carers (a) being smaller (~ 1.3 percentage points) than the pooled results. This differential was consistent with the results from the B cohort. For caregiving of children with additional disability, the Heckman-corrected penalty was between 3 and 7 percentage points smaller than the raw pooled estimates. However, when family background, human capital and other income/welfare were considered (g), the work participation penalty for language carers and other carers became not significant. For carers who were eligible for benefits, the final coefficients are ~ 3 percentage points higher than the pooled estimate for those eligible for Mcarers_P (Carer Payment). The differential between the pooled and Heckman models implies that the wage rate for Carer Payment recipients who were not working was significantly lower than for those who were working, which is unsurprising given that the payment is means tested. For those mothers who receive Carer Payment and choose to work, there is a wage rate premium (see Table 59) to offset the benefit payment.

Table 62: Participation in work – K cohort (Heckman) (probability)

	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience	+ Education	Other income/welfare/all controls
	a	b	c	d	e	f	g
				PROBIT with Heckman			
LDnocond = 1	−0.284** (0.046)						
LD1_4–7 = 1		−0.035 (0.048)	−0.031 (0.048)	−0.041 (0.049)	−0.047 (0.049)	−0.164** (0.052)	−0.029 (0.408)
LD1_≥8 = 1		−0.095* (0.040)	−0.079* (0.040)	−0.010 (0.042)	−0.015 (0.043)	−0.018 (0.043)	0.037 (0.044)
LD2_4–7 = 1		−0.004 (0.075)	0.029 (0.077)	0.010 (0.078)	0.017 (0.079)	−0.139+ (0.080)	−0.008 (0.426)
LD2_≥8 = 1		−0.496** (0.067)	−0.459** (0.066)	−0.425** (0.067)	−0.430** (0.067)	−0.555** (0.071)	−0.387 (0.453)
LD3_4–7 = 1		−0.561** (0.095)	−0.493** (0.097)	−0.418** (0.094)	−0.413** (0.095)	−0.527** (0.097)	−0.396 (0.402)
LD3_≥8 = 1		−0.560** (0.077)	−0.461** (0.077)	−0.420** (0.077)	−0.435** (0.077)	−0.557** (0.081)	−0.357 (0.387)
senslearn_condition = 1	−0.294** (0.062)	−0.209** (0.063)	−0.089 (0.064)	−0.054 (0.064)	−0.063 (0.064)	−0.048 (0.064)	−0.095 (0.087)
physmentalemot_condition = 1	−0.128* (0.065)	−0.113+ (0.065)	−0.073 (0.066)	−0.104 (0.069)	−0.107 (0.069)	−0.099 (0.068)	−0.098 (0.082)
other_condition = 1	−0.205** (0.052)	−0.210** (0.052)	−0.112* (0.052)	−0.066 (0.053)	−0.059 (0.053)	−0.096+ (0.053)	−0.033 (0.156)
Mcarers_A			−0.486** (0.058)	−0.435** (0.061)	−0.438** (0.061)	−0.295** (0.063)	−0.187 (0.343)
Mcarers_P			−0.757** (0.071)	−0.711** (0.071)	−0.722** (0.072)	−0.664** (0.073)	−0.579** (0.171)
WAGEFIT	1.080** (0.066)	0.945** (0.068)	0.990** (0.068)	1.072** (0.078)	1.083** (0.0810)	−0.396+ (0.205)	0.907 (4.529)
N	17852	17852	17852	17852	17852	17852	17852
LL	−9824	−9748	−9629	−8992	−8943	−8823	−8485
AIC	19672	19531	19296	18078	17987	17757	17097
BIC	19765	19663	19444	18444	18376	18185	17588

Note. Includes pweights for attrition. LD = language difficulties; LD1_0–3 = language difficulties identified at one time only, the first time between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, the first time between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, the first time at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD3_4–7 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; LD3_≥8 = language difficulties identified three or more times, the first time at 8 years or older; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations; LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion.

The dynamic random effects estimates shown in Table 63 followed a similar pattern to those observed in the B cohort (see Table 54). There was a large negative effect of participation for language difficulty carers in the random effects framework (a–f). When corrections were made to account for the potential biases inherent in the random effects model (discussed in Section 5.3) (g–h), these effects became not significant. The final equation (h) supported a participation penalty of 31.3 per cent for recipients of Carer Payment (Mcarers_P). Overall, the results showed that caregiving intensity was the most important predictor for LFP in carers of both younger and older children.

Table 63: Participation in work – K cohort (dynamic random effects) (probability)

	LD	LD severity	Carers Allowance and payment	Family background	+ Experience	All controls	All controls + MUNDLAK	All controls + MUNDLAK+ d_lag
	a	b	c	d	e	f	g	h
	DYNAMIC RE PROBIT							
LDnocond=1	-0.209** (0.0501)							
LD1_4-7=1		-0.265* (0.110)	-0.254* (0.109)	-0.219* (0.106)	-0.215* (0.106)	-0.113 (0.104)	-0.010 (0.124)	-0.019 (0.093)
LD1_>=8=1		-0.308** (0.0912)	-0.288** (0.0904)	-0.167+ (0.0887)	-0.150+ (0.0883)	-0.064 (0.086)	0.114 (0.104)	0.110 (0.080)
LD2_4-7=1		-0.402* (0.173)	-0.372* (0.172)	-0.312+ (0.167)	-0.295+ (0.166)	-0.158 (0.161)	0.120 (0.208)	0.067 (0.156)
LD2_>=8=1		-0.662** (0.155)	-0.616** (0.154)	-0.616** (0.151)	-0.599** (0.150)	-0.421** (0.148)	-0.199 (0.192)	-0.008 (0.146)
LD3_4-7=1		-1.213** (0.179)	-1.162** (0.177)	-0.912** (0.175)	-0.865** (0.174)	-0.658** (0.170)	-0.193 (0.307)	0.090 (0.240)
LD3_>=8=1		-1.216** (0.134)	-1.130** (0.133)	-0.971** (0.133)	-0.926** (0.133)	-0.671** (0.130)	-0.178 (0.279)	0.099 (0.221)
senslearn=1	-0.155* (0.069)	-0.085 (0.069)	-0.051 (0.069)	-0.058 (0.073)	-0.054 (0.073)	-0.071 (0.073)	-0.072 (0.077)	-0.099 (0.083)
physmental=1	-0.050 (0.075)	-0.032 (0.075)	-0.005 (0.075)	-0.026 (0.079)	-0.028 (0.079)	-0.032 (0.079)	-0.008 (0.081)	0.036 (0.085)
other=1	-0.123* (0.057)	-0.105+ (0.057)	-0.073 (0.057)	-0.084 (0.061)	-0.071 (0.061)	-0.056 (0.061)	0.003 (0.064)	0.061 (0.078)
Mcarers_A			-0.486** (0.079)	-0.393** (0.083)	-0.406** (0.083)	-0.380** (0.082)	-0.127 (0.097)	0.047 (0.106)
Mcarers_P			-0.811** (0.095)	-0.772** (0.098)	-0.779** (0.098)	-0.761** (0.098)	-0.467** (0.114)	-0.313** (0.120)
N	24370	24370	24370	22691	22691	22691	22652	18705
LL	-10780	-10717	-10671	-9480	-9427	-9284	-8942	-6287
rho	0.705	0.699	0.695	0.666	0.662	0.645	0.603	0.296
AIC	21585	21469	21383	19057	18956	18680	18044	12736
BIC	21690	21615	21545	19442	19365	19130	18686	13371

ote. Includes pweights for attrition. LD = language difficulties; LD1_0–3 = language difficulties identified at one time only, the first time between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, the first time between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, the first time at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD3_4–7 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; LD3_≥8 = language difficulties identified three or more times, the first time at 8 years or older; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations; LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion.

5.5.3.2 Weekly hours of work

In this section, the relationship between language difficulty caring and hours of work is explored. The results from the B cohort indicated that the demands of caring for a child with language difficulties leads to mothers' seeking more-flexible work hours. This section tests whether this also holds true for older children. Specifically, are the demands of language difficulty caring age-specific?

Recall from the B cohort analysis that cross-sectional estimates were compared with estimates that include the Heckman correction term (WAGEFIT) and then dynamic random effects.

From the raw cross-sectional results shown in Table 54 (a), it can be seen that mothers who are carers of children with language difficulties work 4.223 fewer hours than their non-caring counterparts. After controlling for language severity and timing (b), the size of the coefficients increased ($p < 0.05$). Including carers' benefits in (c) reduced the size of the language caregiving coefficients. The coefficients for Mcarers_A (Carer Allowance) and Mcarers_P (Carer Payment) were large and negative. In the final model (g), working hours were significantly fewer for language carers at LD2>=8, LD3_4–7 and LD3_≥8 and for recipients of Mcarers_P (Carer Payment). when compared with non-carers These effects are larger than those observed for the B cohort.

Table 64: Hours of work – K cohort

	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience	+ Education	Other income/welfare/all controls
	a	b	c	d	e	f	g
				TOBIT			
LDnocond=1	−4.223** (0.550)						
LD1_4-7=1		−0.952+ (0.565)	−0.920 (0.564)	−0.940+ (0.559)	−0.955+ (0.557)	−0.352 (0.542)	−0.217 (0.533)
LD1_>=8=1		−1.532** (0.449)	−1.385** (0.444)	−0.659 (0.439)	−0.627 (0.440)	−0.0845 (0.434)	0.143 (0.418)
LD2_4-7=1		−1.938* (0.885)	−1.624+ (0.888)	−1.440 (0.879)	−1.415 (0.884)	−0.658 (0.889)	−0.630 (0.873)
LD2_>=8=1		−5.055** (0.877)	−4.608** (0.864)	−4.574** (0.826)	−4.579** (0.824)	−3.274** (0.817)	−2.873** (0.803)
LD3_4-7=1		−7.329** (1.232)	−6.271** (1.228)	−5.625** (1.139)	−5.575** (1.145)	−3.845** (1.103)	−3.973** (1.091)
LD3_>=8=1		−7.967** (0.877)	−6.740** (0.866)	−5.920** (0.817)	−6.047** (0.812)	−4.602** (0.822)	−3.964** (0.809)
senslearn=1	−3.707** (0.725)	−2.586** (0.731)	−1.082 (0.732)	−0.721 (0.703)	−0.758 (0.702)	−1.078 (0.689)	−1.035 (0.667)
physmental=1	−2.095** (0.801)	−1.772* (0.785)	−1.268 (0.773)	−0.914 (0.773)	−0.871 (0.762)	−0.952 (0.744)	−0.734 (0.710)
other=1	−2.613** (0.617)	−2.536** (0.612)	−1.402* (0.603)	−1.283* (0.582)	−1.175* (0.577)	−1.023+ (0.571)	−0.596 (0.552)
Mcarers_A			−5.744** (0.689)	−4.672** (0.676)	−4.722** (0.680)	−4.335** (0.663)	−1.314* (0.656)
Mcarers_P			−9.787** (0.759)	−8.468** (0.766)	−8.521** (0.773)	−7.908** (0.765)	−6.003** (0.722)
N	18634	18634	18634	17710	17710	17710	17684
LL	−75800	−75727	−75603	−69646	−69603	−69337	−68842
sigma	16.61** (0.078)	16.54** (0.079)	16.43** (0.079)	15.56** (0.085)	15.52** (0.085)	15.28** (0.086)	14.93** (0.087)

Note. Includes pweights for attrition. LD = language difficulties; LD1_0–3 = language difficulties identified at one time only, between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD3_4–7 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified three or more times, the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; LD3_≥8 = language difficulties identified three or more times, the first time at 8 years or older; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations; LL = log-likelihood.

Estimation results of the Heckman's hours' model with WAGEFIT are provided in Table 65. The Heckman-corrected estimates for all carers were smaller than the pooled results. However, when family background, human capital and other income/welfare were considered, the estimates for language difficulty carers became larger. For carers who received a carers' benefit, the coefficients for those receiving Carer Payment (Mcarers_P) were large, negative and significant.

Once again, the dynamic random effects estimation shown in Table 57 brought about significant changes to the coefficients. The final model (h) showed 4.026 and 7.392 fewer work hours for carers at LD2_≥8 and LD3_≥8 respectively, and 3.426 fewer work hours for recipients of Carer Payment (Mcarers_P). These results found that the effect of language difficulties on mothers' work hours was largely consistent for younger and older children, which indicates that the effect of language difficulties on LFP is severity specific. Impairments such as persistent language difficulties are likely to affect the child's ability to perform daily activities, and may prevent the child from reaching important developmental milestones without additional support, which in turn will limit the mother's ability find appropriate child care that can accommodate the child's additional needs[222].

Overall the results for the B and K cohorts showed that participation in the labour force was reduced for care giving mothers of children with language difficulties through reduced work hours. For mothers of children who were eligible to receive Carer Payment, labour force participation was reduced by mothers being less likely to work. For these mothers who chose to work, they worked less fewer hours were worked, and for among these mothers with older children, they there was evidence of also earnt a wage premium being required , to offset the reduction of carers' benefits

Table 65: Hours of work – K cohort (Heckman [WAGEFIT])

	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience	+ Education	Other income/welfare/all controls
	a	b	c	d	e	f	g
				Heckman TOBIT (WAGEFIT)			
LDnocond=1	−2.493** (0.462)						
LD1_4-7=1		0.799 (0.500)	0.871+ (0.496)	0.565 (0.479)	0.485 (0.478)	−1.513** (0.494)	−6.280+ (3.597)
LD1_>=8=1		−0.889* (0.396)	−0.664+ (0.393)	−0.0936 (0.380)	−0.147 (0.380)	−0.136 (0.376)	0.282 (0.379)
LD2_4-7=1		0.398 (0.777)	0.846 (0.771)	0.367 (0.743)	0.442 (0.742)	−1.937** (0.750)	−6.903+ (3.759)
LD2_>=8=1		−3.097** (0.673)	−2.530** (0.668)	−2.542** (0.649)	−2.555** (0.648)	−4.697** (0.662)	−9.607* (4.010)
LD3_4-7=1		−5.238** (0.969)	−4.188** (0.964)	−3.394** (0.928)	−3.275** (0.926)	−5.172** (0.928)	−9.837** (3.559)
LD3_>=8=1		−5.544** (0.742)	−4.078** (0.741)	−3.723** (0.717)	−3.856** (0.716)	−5.887** (0.723)	−9.633** (3.411)
senslearn=1	−3.456** (0.635)	−2.768** (0.638)	−1.162+ (0.641)	−1.099+ (0.615)	−1.146+ (0.614)	−0.777 (0.609)	−0.156 (0.791)
physmental=1	−1.398* (0.697)	−1.172+ (0.696)	−0.653 (0.691)	−1.033 (0.664)	−1.033 (0.662)	−0.861 (0.656)	−0.0680 (0.758)
other=1	−2.351** (0.535)	−2.387** (0.534)	−1.114* (0.535)	−0.799 (0.514)	−0.752 (0.513)	−1.297* (0.509)	−2.798* (1.389)
Mcarers_A			−6.817** (0.624)	−5.670** (0.602)	−5.680** (0.601)	−3.199** (0.614)	3.733 (3.029)
Mcarers_P			−9.897** (0.744)	−8.588** (0.716)	−8.634** (0.714)	−7.628** (0.709)	−3.675* (1.539)
WAGEFIT	12.96** (0.687)	12.17** (0.713)	12.59** (0.709)	11.71** (0.762)	12.05** (0.785)	−12.62** (1.810)	−68.11+ (40.01)
N	17684	17684	17684	17684	17684	17684	17684
LL	−70329	−70290	−70153	−69420	−69379	−69206	−68842
sigma	16.32** (0.091)	16.28** (0.091)	16.15** (0.090)	15.45** (0.086)	15.41** (0.086)	15.26** (0.085)	14.93** (0.083)

Note. Includes pweights for attrition. LD = language difficulties;LD1_0–3 = language difficulties identified at one time only, between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD3_4–7 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; LD3_≥8 = language difficulties identified three or more times, the first time at 8 years or older; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations; LL = log-likelihood.

Table 66: Hours of work – K cohort (dynamic random effects)

	No controls (+ time)	LD severity	+ Carers Allowance and payment	+ Family background	+ Experience	Other income/welfare/all controls	All controls + MUNDLAK	All controls + MUNDLAK+ d_lag
	a	b	c	d	e	f	g	h
	DYNAMIC RE PROBIT							
LDnocond=1	-0.773* (0.343)							
LD1_4-7=1		-0.995 (0.939)	-0.967 (0.931)	-0.998 (0.891)	-0.964 (0.889)	-0.239 (0.851)	-0.116 (1.287)	-1.658 (1.149)
LD1_>=8=1		-1.850* (0.745)	-1.724* (0.739)	-1.055 (0.710)	-0.944 (0.710)	-0.182 (0.683)	0.442 (1.174)	-1.445 (1.052)
LD2_4-7=1		-2.119 (1.441)	-1.917 (1.429)	-2.418+ (1.372)	-2.349+ (1.368)	-1.336 (1.311)	-0.292 (2.349)	-3.476+ (2.104)
LD2_>=8=1		-5.262** (1.261)	-4.947** (1.251)	-5.324** (1.200)	-5.253** (1.197)	-3.554** (1.152)	-1.856 (2.288)	-4.026* (2.046)
LD3_4-7=1		-7.645** (1.775)	-6.985** (1.761)	-5.874** (1.696)	-5.653** (1.691)	-3.786* (1.627)	-2.463 (3.907)	-5.779+ (3.512)
LD3_>=8=1		-8.188** (1.377)	-7.373** (1.367)	-7.058** (1.312)	-7.079** (1.308)	-4.942** (1.266)	-2.446 (3.998)	-7.392* (3.579)
senslearn_condition=1	-1.237* (0.487)	-0.950* (0.484)	-0.729 (0.483)	-0.427 (0.488)	-0.392 (0.486)	-0.484 (0.481)	-0.332 (0.490)	-0.385 (0.539)
physmental_condition=1	0.154 (0.500)	0.232 (0.500)	0.254 (0.499)	0.278 (0.501)	0.294 (0.500)	0.343 (0.496)	0.465 (0.500)	0.791 (0.523)
other_condition=1	-0.928* (0.401)	-0.884* (0.400)	-0.634 (0.400)	-0.627 (0.408)	-0.509 (0.407)	-0.234 (0.403)	-0.159 (0.413)	-0.101 (0.497)
Mcarers_A			-3.560** (0.548)	-3.034** (0.552)	-3.172** (0.551)	-1.494** (0.554)	-0.919 (0.600)	-0.112 (0.660)
Mcarers_P			-5.881** (0.643)	-5.744** (0.645)	-5.922** (0.643)	-4.822** (0.640)	-3.882** (0.690)	-3.426** (0.737)
N	18634	18634	18634	17710	17710	17684	17684	17684
ll	-71249	-71217	-71168	-65939	-65889	-65533	-65335	-65333
rho	0.588	0.583	0.579	0.565	0.565	0.543	0.511	0.511

Note. Includes pweights for attrition. LD = language difficulties;LD1_0–3 = language difficulties identified at one time only, between 0–3 years of age; LD1_4–7 = language difficulties identified at one time only, between 4–7 years of age; LD1_≥8 = language difficulties identified at one time only, at 8 years or older; LD2_0–3 = language difficulties identified twice, the first time between 0–3 years of age; LD2_4–7 = language difficulties identified twice, the first time between 4–7 years of age; LD3_4–7 = language difficulties identified twice, the first time at 8 years or older; LD3_0–3 = language difficulties identified the first time between 0–3 years of age; LD3_4–7 = language difficulties identified three or more times, the first time between 4–7 years of age; LD3_≥8 = language difficulties identified three or more times, the first time at 8 years or older; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment; N = Number of observations; LL = log-likelihood.

5.6 Heterogeneity related to child and mother's characteristics

There are a number of sources of heterogeneity in these data. To explore this heterogeneity further interactions and sub-group analysis of the B cohort were considered, looking at household transitions, the birth of additional siblings and Non-English speaking backgrounds. The models with interactions would not converge. The subgroup analysis ran dynamic RE models for work participation, wages and hours of work (Table 97, Table 98, Table 99 Appendix M) Missing observations and sample attrition were also explored.

5.6.1 Non-English speaking backgrounds

One of the challenges with these data is being able to disentangle the effects that are related to a child's language impairment and low language acquisition that is related to that may be related to a child having English as a second language. The dynamic random effects specification controls for biases associated with time-invariant variables such as NESB. This is tested in a subgroup analysis comparing families from NESB with families from English speaking background (Table 96). The first thing to notice is that NESB mothers represent a small sample of the overall B cohort sample. There were significant differences were observed in the likelihood of working for NESB and English speaking mothers of children with language difficulties. Of those mothers who choose to work NESB mothers reduce their work hours more than English speaking mothers at the onset of their child's language difficulties.[223]. Overall the results suggest that the labour force penalties observed for mothers with children with language difficulties is being driven by both NESB and English speaking mothers..

5.6.2 Household structure

A considerable amount of literature has established that single mothers experience greater hardship in terms of LFP behaviours when they have a child with disability[191,206,207] . The literature also shows that these mothers have significantly lower rates of employment [213]. For those mothers who enter the workforce, they may have less flexibility to adapt their LFP to meet the demands of a high-needs child. In addition, single parents are at increased risk of poverty. As disability and poverty are highly correlated, measuring the additional wage and LFP differential could test this hypothesis[202,203,224-227]. This is tested in a subgroup analysis comparing mothers with resident partners, married mothers and single mothers. [208].

For single mothers who care for high need children, they do not adjust their LFP based on the type of disability, which is in contrast to the results from carer's in two parent families, who show some evidence that they reduce their workforce participation and hours of work at the onset of their child's language difficulty (Table 97). If the condition is severe enough to claim Carer Payment, single mothers reduce their LFP more than mothers with resident partners, through reduced work hours.

5.6.3 Number of siblings in the household

An Australian study by Livermore et al.[204] found that mothers experience a wage penalty of approximately 5 per cent following the birth of their first child, and 4 per cent following the birth of subsequent children, which the authors conclude is consistent with more part-time work, possible employee discrimination and reduction in mothers' efforts. For mothers of children with additional needs, this effect may be exacerbated. This was tested in a subgroup analysis comparing families with one child, two children and three or more children. No significant differences were observed in the LFP of carers based on family size (Table 98). Overall, the subgroup analysis revealed weak evidence that any particular group drives the results, when individual effects are considered.

5.6.4 Missing observations

The sample was subject to missing observations. The variables missing in greater than 5 per cent of the sample included language and income. Throughout this thesis, the analysis uses a consistent approach to missing observations, which is discussed in detail in Chapter 3.

5.6.5 Dealing with attrition

The analysis in this chapter uses LSAC-derived population weights (pweights) to consider attrition. Details on the creation of attrition weights for the LSAC are provided in one of the LSAC technical papers[102].

5.7 Discussion

This chapter has investigated the cross-sectional and longitudinal relationships between mothers' labour supply and children's language difficulties and additional disabilities, using the 2004–2014 LSAC. The first set of findings is that there is significant heterogeneity in the labour supply of mothers between children with language difficulties and children with additional disabilities. In the cross-sectional specification, carers of children with language difficulties are less likely to be employed, earn lower wages, and work fewer hours. Inclusion of a Heckman selection adjustment revealed a smaller effect on LFP for mothers of children with language difficulties when the reservation wage of non-workers was considered. That is, mothers who select into paid employment are more likely to have higher wages; therefore, failure to account for selection into employment will overestimate the true wages effect. However, these results are not robust to individual random effects. One explanation for this is that the large effects observed in the cross-sectional models are somewhat driven by individual heterogeneity; that is, a mother with a child with language difficulties has lower levels of labour force attachment, which is unrelated to the child's condition. When individual effects were considered, the causal effect of language difficulties on LFP was reduced.

Based on the dynamic random effects results, for carers of both B cohort and K cohort children there was a negative relationship between their labour supply and their child's language difficulties, through fewer work hours. For these mothers, the substitution effect dominates. When the child's condition is severe or persistent enough to meet the eligibility for Carer Payment, there is an additional negative effect on participation; if the child is an older child, this is in conjunction with a wage rate premium for mothers who chose to work. For these mothers, the substitution effect and the income and respite effects are equally important.

The findings of this study expand on the findings of Yamauchi[96], who reported a 7.8 per cent participation penalty at the onset of the child's condition, based on three years of the LSAC B cohort data (2004, 2006, 2008). Yamauchi. reported the LFP effects of long-term conditions, but one of the strengths of the current study is its capture of impairment by timing of identification and persistence. This study suggests that that both early identification of language difficulties (i.e., from birth to 3 years) and persistence (i.e., difficulties identified two or more times) has an effect on LFP. However, recall from Chapter 2 that children with difficulties in the B cohort may be skewed towards ‘early identification’, solely because they are a participant in the LSAC. For this reason, any conclusions about the timing of early identification in the B cohort should be considered with caution. However, there is strong and consistent effect observed for language persistence in the B cohort. By definition, persistence is a measure over a number of time points or ages, and the results of this study showed that capturing only transient language difficulties would not adequately explain the impact of language difficulties on LFP.

For younger children, it is feasible that the labour force penalty observed in this study is explained by the fact that some mothers who have not fully returned to full working capacity after the birth of their child and, as a result, have a lower attachment to the workforce and perhaps seek more-flexible working arrangements. Internationally, and in one Australian study, part-time work is identified as the main reason for the motherhood wage penalty, notably if the child has a severe condition, and this effect is consistent for married and single mothers[4,47,206].

As children get older, there is a positive association between the child’s age and maternal work supply as there are more care options available, with many children attending preschool and then formal schooling. Mothers of older children are more attached to the workforce and will only have reduced participation if the condition is severe or persistent. Notably, language persistence appears to be better at explaining LFP penalties than Carer Allowance. Carer Allowance is a small fixed payment ($118 per fortnight in 2017 to help carers who are looking after a child with high-care needs; it is not means tested or based on any level of LFP. The level of benefit is likely to be insufficient to influence LFP. Additionally, as it is not asset- or means-tested, Carer Allowance will not create a disincentive to work. Perhaps carers of children with persistent language difficulties have lower LFP because of the specific demands of their caring role, and current disability policy is not meeting the needs of these families. An alternative interpretation is that even after controlling for selection and individual effects, this effect is driven by individual heterogeneity, Recall from Table 47 that carers of children with LD3_0–3 (B cohort), LD3_4–7 and LD3_≤8 (K cohort) had the highest levels of unemployment. It is feasible that these carers have lower LFP as a result of being presented with fewer opportunities rather than it being related to the child's impairment.

In contrast, Carer Payment is a means- and assets-tested income support payment for carers who, because of the demands of their caring role, are unable to fully participate in the labour force. For carers of younger children who are eligible for Carer Payment, they are 33.9 per cent less likely than non-carers to be in active employment, and those who are active in the labour force, work 1.75 fewer hours, even after controlling for selection and individual effect. Carers of older children who are eligible for carers' benefits are 31.3 per cent less likely than non-carers to be in active employment, and those who are active in the labour force work 3.42 fewer hours and demand a wage premium of 11 per cent to offset the loss in benefits. Unsurprisingly, this policy provides an additional incentive to not be active in the labour force as well as to limit work hours.

In contrast to the language effects observed, there was little evidence to support similar LFP effects for additional impairments. One explanation for this is that the impact of caregiving on labour-market outcomes appears to take a number of years to manifest. The measures of other conditions are parent-reported binary variables, indicating whether a child has a long-term medical problem in the last six months. These measures were used in this analysis of the findings because they were consistent with the literature in this area[96]. However, it is possible that they are weak instruments for measuring severe and persistent problems. In the absence of a robust condition-specific measure, Carer Payment may be better at explaining the effect of caring commitment than these variables.

5.8 Conclusion

Overall, this research has highlighted that the indirect costs of language difficulties in terms of maternal LFP are significant. Carers of children with language difficulties work fewer hours and subsequently receive less income than non-carers, which has implications for their current and long-term financial security. When the condition is severe or persistent, they are less likely to be employed, and for older children, carers receive a wage rate premium to remain in the workforce. These results are consistent with international research[195,197,201,215,228,229] but provide the first Australian estimates of the indirect costs associated with maternal LFP for children with language difficulties, aged from birth to 15 years, and in a robust framework that considers both selection effects and time-invariant heterogeneity. These estimates can be used to generate opportunity-cost estimates and inform the COI model in Chapter 8.

Chapter 6: Cost of Illness

6.1 Introduction

According to the AIHW, healthcare spending in Australia in 2013–14 was $156.6 billion, or $6,639 per person[119]. As discussed in Chapter 1, Australia spent approximately 9.7 per cent of GDP on health care and 2 per cent of GDP on disability care. Australia's expenditure on health care approximates the OECD average, but for disability it is less than half that of some OECD countries, such as Denmark, Norway and Sweden, and, as a result, Australia is lagging behind in a number of disability-related measures[65]. Employment rates for people with disability in Australia are approximately 40 per cent, compared with 70 per cent in the top eight OECD countries. In Australia, 45 per cent of people with disability live on or near the poverty line, more than double the OECD average of 22 per cent. This represents a relative poverty risk of 2.6, compared with the OECD average of 1.6 [64]. There is no simple and straightforward solution for improving the outcomes of our most vulnerable populations, but identifying prevalent conditions and trying to alleviate their economic burden, through early intervention and management, is a key component of cost-containment policies.

COI studies measure the economic burden of a condition and estimate the maximum amount that could potentially be saved or gained if a condition was remediated[79,80]. COI studies are widely used by health economists, clinicians and policymakers to set research agendas and allocate resources[79,80,83-85]. In developing early and effective interventions, COI analysis is one of the ways in which policymakers can identify those conditions to prioritise for investment.

A COI study is not in itself sufficient to prioritise resource allocation. For that purpose, effectiveness data is required in addition to cost data. However, COI estimates can contribute to cost-effectiveness analysis by providing upper threshold estimates of the cost savings of effective intervention.

Knowledge of the distribution of costs across different sectors (e.g., medical services, education and labour force) and across subgroups (based on SES and disease severity) also provides information about whether these costs are distributed disproportionately Knowing which sectors and which subgroups incur higher costs can assist policymakers to develop targeted interventions to address these areas.

Data on the economic burden of language disorders is limited. The results discussed in Chapters 3, 4 and 5 show that DLD imposes a significant economic burden to society. A robust COI study for DLD could provide a reliable estimation of the economic burden of this condition. Moreover, identifying the distribution of costs among different subpopulations and sectors would enable policymakers to appropriately target early-intervention programs to reduce costs and burden of disease.

The objective of this study was to develop a better understanding of the costs incurred by people with DLD, their carers, the government and society. The first step in the analysis was to develop an understanding of DLD and its impact on the long-term outcomes for individuals with DLD. Using an analysis from Chapters 3 to 6, this chapter develops an estimate of COI for DLD in Australia.

6.2 Methods

To conduct a COI study, it is necessary to define the condition, the epidemiological approach, type of costs, and study perspective. These methods were described by Drummond et al. [80,81]and are discussed in detail in the following section.

The analysis provides the basis for estimating the following costs:

- health expenditure related to DLD, which provides a measure of current resource needs for individuals with language difficulties.
- reduced productivity, which arises from the diminished future LFP of children with DLD and the diminished LFP of their carers.
- Welfare benefits payable to carers of children with language difficulties.

The analysis makes the following assumptions:

- This study uses a prevalence approach, which estimates the costs incurred by or on behalf of the population of people with DLD in a given year.

- All costs are considered to use resources such as capital and labour, which therefore reduces the economy's capacity to produce and consume goods and services. This means that costs such as income support provided by government are considered to be 'real' rather than 'transfer payments'. Transfer payments, such as lost taxation revenue, are not considered.
- The costs are incremental; that is, they represent the costs incurred for a person with DLD, over and above the costs incurred by a person without DLD. Estimates are predicted at the 'mean', with 95 per cent confidence intervals.
- A bottom-up approach is used, which estimates the average cost per person, and then applies it to the relevant population.

Due to data limitations (discussed in detail throughout Chapters 2 to 5), there were a number of costs that were not captured:

- non-Medicare healthcare and out-of-pocket costs
- reduced quality of life (or non-economic costs) for people with DLD
- early intervention programs and additional educational support services
- comorbidities.

The COI estimates should therefore be considered a conservative estimate of DLD in Australia.

6.2.1 Definition of the condition

The definition of DLD is based on a mutually exclusive definition of language difficulties from the LSAC. Impairment/disorder or difficulty was defined by standardised scores of >1.25 SD away from the mean. The approach used to define language difficulties in this thesis is described in detail in Chapter 2.1. The analysis presents a novel approach by defining language difficulties in terms of persistence and timing of identification. This allows for exploration of the distribution of costs among different subgroups.

6.2.2 Epidemiological approach

COI studies use an incidence or prevalence approach. An incidence approach identifies a cohort of people with the condition over a specified time period (typically a year) and then estimates the lifetime costs for this group (which can then be converted to an annual equivalent cost). Prevalence approaches measure the number of people with a given condition (in this case defined as language difficulties) in a base period and the costs incurred in that base period due to the condition. When the aim of a study is to estimate the economic burden of a condition during a specified period (e.g., one year), a prevalence approach is recommended. If the aim is to determine the economic consequences of various interventions, an incidence approach is preferable[82]. The COI method in this thesis is based on a prevalence approach for determining the affected sample. One of the advantages of a prevalence approach is that, where results are reported longitudinally, trends in the burden of the condition can be explored. This method also avoids the uncertainty surrounding estimates of future treatment costs associated with an incidence approach[80,230].

6.2.3 Perspective

Costs can be categorised a number of ways. A common approach is to distinguish between direct and indirect costs. Direct costs comprise healthcare and non-healthcare expenditure; they include costs incurred by the health system, society, the family and the affected individual. Indirect costs refer to productivity losses that arise as a result of the condition. These may be incurred by the individual or the family. This study uses a societal perspective, which focuses on direct and indirect costs. There are no transfer payments.

6.2.4 Estimating resource consumption

An econometric approach is used throughout this thesis to estimate resource consumption[82]. This method is recommended for estimating costs when individual-level data are available [231]. Estimates obtained using this approach are incremental, which means they are a measure of the additional costs that arise as a consequence of the condition. One of the limitations of this approach is that these estimates are predicted at the ‘mean’, which may mask considerable underlying variability. This study has attempted to consider some of this variability of the developmental trajectories of these children in its approach to DLD definitions.

6.2.5 Valuing indirect costs

Three methods can be used to measure indirect costs: the human capital approach [232], the friction cost method [233] and the willingness-to-pay approach[82]. The human capital approach is employed in this study, as this approach is conducive to longitudinal data. Implicit in this approach is the concept of opportunity cost. The opportunity cost is the forgone benefit associated with the choice. For example, in the case of parents' labour force behaviour, parents are making a choice about where to allocate their scarce resources: to paid employment or to household production. They choose the alternative with the highest benefit at the lowest opportunity cost. Therefore, if a mother chooses not to be in the labour force or to work fewer hours, the opportunity cost is the value of the paid employment that has been forgone. If a mother chooses unpaid employment or fewer hours, the opportunity cost is the value of the paid employment that could have been chosen.

The next section discusses the modelling framework upon which this COI study is based.

6.3 Modelling framework

Conceptually, the costs to society of language difficulties represent the economic burden of DLD and the upper threshold that could be saved or gained if DLD were remediated. Using a COI approach developed by Green[200], the annual societal cost of having a language difficulty is:

$$\sum\left(\left(c_f * prev * popn\right) + \left(c_g * prev * popn\right)\right)_{ld} \qquad (6.3.1)$$

where c is the cost per child per year to family (individual and mother) and government, $prev$ is the prevalence of language difficulties, and $popn$ is the number of children in Australia aged 0 to 15 years.

c_f includes the direct costs incurred by the family as a result of increased health services utilisation (see Chapter 3) and the indirect costs related to the future forgone income of the child (see Chapter 4) and the mother's labour supply (Chapter 5). c_g includes government costs incurred as a result of additional health and welfare expenditure: Medicare expenditure and carers' benefits.

Section 6.3.1 calculates the annual health utilisation costs, Section 6.3.2 estimates the extrapolated labour force outcomes for children with language difficulties, and Section 6.3.3 estimates the indirect costs of LFP of the mothers as the primary carers of children with language difficulties. Section 6.4 calculates an overall societal cost of a child with language difficulties. Whether the societal cost differs by persistence and timing of language difficulties (Section 6.5.1) and by school academic achievement (Section 6.3.2.2) is also investigated. A threshold analysis is used to test the robustness of the assumptions in the model (Appendix N).

6.3.1 Health utilisation costs associated with language difficulties

The out-of-pocket costs associated with health utilisation make up a component of c_f. The Medicare rebate costs make up a component of c_g. In Chapter 3, biennial healthcare costs and out-of-pocket costs were predicted for the B and K cohorts, and these are presented in Table 67. From these costs, it was possible to calculate an individual (out-of-pocket) and government (total healthcare costs minus out-of-pocket) cost for a child with language difficulties, which was weighted by the cohorts and then annualised. The language difficulty cost (labelled *base cost*) represents the costs for children who have language difficulties but do not meet the eligibility criteria for carers' benefits. The carers' benefits costs (labelled *Carer Allowance* and *Carer Payment*) represent the additional costs that are incurred for a proportion of children whose carers received carers' benefits as a result of the child's condition (see Table 68)

Table 67: Predicted biennial healthcare expenditure and out-of-pocket costs

	B cohort				K cohort			
	Healthcare expenditure		Out-of-pocket		Healthcare expenditure		Out-of-pocket	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Language difficulties	$233**	−$66	$48**	−$16	$245**	-$78	$62**	-$20

Mcarers_A	$663**	−$246	$175**	−$63	$715**	-$233	$132*	-$58
Mcarers_P	$918**	−$283	$132*	−$63	$744**	-$211	$118*	-$54

Note. Coefficients from Chapter 3: Table 19, Table 20, Table 22 and Table 23. SE = standard error; Mcarers_A = Carer Allowance; Mcarers_P = Carer Payment.
+ p < 0.10. * p < 0.05. ** p < 0.01.

The base cost is defined by the language difficulties cost in Table 67. The carers' benefits are defined as:

$$(McarersA/P) * \; Prop\_LD_{McarersA/P} \tag{6.3.1.1}$$

where $McarersA/P$ is the coefficient for Carer Allowance and Carer Payment (see Table 67) respectively, and $Prop\_LD_{McarersA/P}$ is the proportion of children with language difficulties who meet the eligibility requirements for Carer Allowance and Carer Payment respectively (see Table 68)

Table 68: Proportion of children with language difficulties who meet the eligibility criteria for carers' benefits (B and K cohorts)

	B cohort				K cohort			
	Carer Allowance		Carer Payment		Carer Allowance		Carer Payment	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Language definitions								
Typical language	0.033	−26.25	0.016	−18.37	0.035	−27.29	0.023	−21.95
Language difficulties only	0.066	−18.85	0.033	−13.26	0.077	−17.80	0.053	−14.90
Language by persistence and timing of identification								
LD1_0–3 years	0.032	−7.43	0.018	−5.71	N/A		N/A	
LD1_4–7 years	0.028	−6.68	0.019	−6.33	0.046	−9.28	0.028	−6.95
LD1_≥8 years	0.035	−7.32	0.022	−6.63	0.055	−13.83	0.035	−10.71
LD2_0–3 years	0.056	−1.64	0.032	−9.29	N/A		N/A	
LD2_4–7 years	0.055	−7.50	0.030	−5.82	0.048	−5.56	0.040	−5.65
LD2_≥8 years	0.052	−3.44	0.039	−3.61	0.051	−8.04	0.063	−12.09
LD3_0–3 years	0.120	−3.80	0.059	−16.22	N/A		N/A	
LD3_4–7 years	0.006	0.41	0.000	0	0.111	−11.71	0.101	−13.02
LD3_≥8 years	N/A		N/A		0.106	−17.33	0.071	0.23

Note. SE = standard error; N/A = not available in the data.

For example, consider a child with language difficulties from the B cohort whose carer is not in receipt of Carer Allowance (Mcarers_A) or Carer Payment (Mcarers_P); in this scenario, the base biennial healthcare expenditure cost is $233 (95% CI: $104, $362) Table 69).

The additional costs include the Carer Allowance and Carer Payment costs. Healthcare costs for a child with language difficulties whose condition meets the eligibility criteria for the mother to receive Carer Allowance is $663 (Table 67) multiplied by the proportion of children of language difficulties receive Carer Allowance $Prop\_LD_{McarersA}$ (0.066)(Table 68), which is equal to $42.

Healthcare costs for a child with language difficulties whose mother receives Carer Payment is $918 (Table 67) multiplied by the proportion of children of language difficulties receive Carer Payment $Prop\_LD_{McarersP}$ (0.033)(Table 68), which is equal to $29. The total health expenditure cost is then $233 + $42 + $29 = $304 (95% CI: $127, $482). Similarly, the out-of-pocket costs are calculated as a base cost $48 (95% CI: $18, $179) (Table 67) plus a Carer Allowance cost ($7 [95% CI: $1, $14]) plus a Carer Payment cost ($4 [95% CI: $1, $7]). The total out-of-pocket biennial cost is $60 (95% CI: $20, $99).Table 69 presents the calculated biennial costs for the B cohort.

Table 69: Calculation of biennial costs – B cohort

	Healthcare expenditure											
	Base costs			Carer Allowance[a]			Carer Payment[a]			Total		
	Mean	95% CI		Mean	95% CI		Mean	95% CI		Mean	95% CI	
LD	$233	($104	$362)	$42	($12	$73)	$29	($11	$46)	$304	($127	$482)
	Out-of-pocket											
LD	$48	($18	$79)	$7	($1	$14)	$4	($1	$7)	$60	($20	$99)

Note. LD=Language difficulties. Base costs represent costs calculated from the impairment coefficients. Base case is typical-language children.
[a]cost for carers who claim benefits.

Table 70 shows the calculation of the biennial costs for the K cohort. For a child with language difficulties from the K cohort whose mother is not in receipt of Carer Allowance or Carer Payment the base biennial healthcare expenditure cost is $245 (95% CI: $92, $399) (Table 67).

Healthcare costs for a child with language difficulties whose carer receives Carer Allowance is $715 (Table 67) *$Prop_LD_{McarersA}$ (0.077) (Table 68) = $55.

Healthcare costs for a child with language difficulties whose carer receives Carer

Payment is \$744 (Table 67) * $Prop\_LD_{McarersP}$ (0.053)(Table 68) = \$39. The total health expenditure cost is \$304 (95% CI: \$127, \$482). Similarly, the out-of-pocket costs are calculated as a base cost of \$62 (95% CI: \$22, \$101) (Table 67) plus a Carer Allowance cost (\$10 [95% CI: \$1, \$19]) plus a Carer Payment cost (\$6 [95% CI: \$1, \$12]). The total out-of-pocket biennial cost is \$78 (95% CI: \$24, \$132).

Table 70: Calculation of biennial costs – K cohort

	Healthcare expenditure											
	Base costs			Carer Allowance[a]			Carer Payment[a]			Total		
	Mean	95% CI		Mean	95% CI		Mean	95% CI		Mean	95% CI	
Language difficulties	$245	($92	$399)	$55	($20	$90)	$39	($17	$61)	$339	($129	$550)
	Out-of-pocket											
Language difficulties	$62	($22	$101)	$10	($1	$19)	$6	($1	$12)	$78	($24	$132)

Note. Base costs represent costs calculated from the impairment coefficients. Base case is typical-language children. Carers' benefits (Allowance and Payment) = probability that a language difficulty carer will claim carers' benefits. CI = confidence interval.
[a]cost for carers who claim benefits.

Medicare rebate costs are calculated as the healthcare expenditure minus out-of-pocket costs and then annualised (divided by 2). Table 71 shows the annual Medicare and out-of-pocket costs (weighted B and K cohort[lxx]). The annual Medicare and out-of-pocket costs for a child with language difficulties are $127 (95% CI: $53, $200) and $34 (95% CI: $11, $58) respectively. As there is no persistence or timing estimates in this study the mean costs are assumed to be the same for all children with language difficulties.

Table 71: Calculation of mean annual costs (Medicare and out-of-pocket)

	Medicare costs			Out-of-pocket		
	Mean	95% CI		Mean	95% CI	
Language difficulties	$127	($53	$200)	$34	($11	$58)
LD < 4–7	$127	($53	$200)	$34	($11	$58)
LD≥8	$127	($53	$200)	$34	($11	$58)

Note. Medicare = total health care – out-of-pocket (weighted B and K cohort) / 2; It is assumed that the timing measures are = LDnocond measures; CI = confidence interval.

6.3.2 Individual forgone income associated with uncorrected language difficulties

The analysis in Chapter 4 can be used to calculate future forgone income for children with uncorrected language difficulties. Intuitively, this is measuring the burden of uncorrected language difficulties in terms of lost income when the child reaches adulthood. This is the second component of c_f.

[lxx] weighting = (((sample size B cohort / Total sample size)* B cohort cost)+ ((sample size K cohort / Total sample size)* K cohort cost)))/2. 95% CI are calculated in the same way.

As the data extends to 15 years of age only, extrapolation methods are required to determine what the effects in adulthood will be. Academic achievement at 15 years of age has been found to be strongly correlated with school completion[177] and post-education labour force outcomes[150,234-237].

6.3.2.1 Extrapolating cognitive skills to labour force outcomes

A few studies have directly estimated the impact of skills on labour force outcomes by using literacy and numeracy measures in the Australian Bureau of Statistics (ABS) International Adult Literacy Survey (1996) and the Adult Literacy and Life Skills Survey (2006). These studies have demonstrated a positive association between literacy and numeracy and labour-market outcomes, including wages and employment[238-241].

The Productivity Commission has recently analysed literacy and numeracy data from the ABS survey Programme for the International Assessment of Adult Competencies Australia, 2011–12 (PIACC), and its results confirm a positive association between literacy and numeracy skills and both employment and wages. However, it cautions against a causal interpretation, noting the likelihood of upward bias of their estimates due to reverse causation and possible bias from unobserved effects. While the most recent literature in this area, also conducted by the Productivity Commission, recognises the complexity of the relationship between human capital skills and labour force outcomes, this has not been considered in the Commission's econometric modelling [236,p34]

A recent study by Mu et al.[242] has examined the links between literacy and numeracy at 15 years of age and employment status and health status in adulthood, using individual-level data from the PIAAC and by applying structural equations modelling (SEM) to estimate the complex relationships between the variables to reduce the bias present in existing studies. The PIAAC was conducted throughout Australia from October 2011 to March 2012 and collected information on skills and competencies of people aged 15 to 74. Mu et al. found that every 1 SD increase in literacy and numeracy score is associated with an increased employment probability of 4.1 percentage points from a mean employment rate of 0.722(refer to Appendix 0 for full explanation of methods)

Using the predictions from the current study and income estimates from the ABS[243], the future forgone earnings for a child with language difficulties were estimated. Using this approach, the opportunity costs of having a language difficulty in terms of expected forgone earnings are:

$$(\omega * p_w)_{pa} - (\omega * p_w)_{ldperstiming} \qquad (6.3.2.1)$$

where ω is the wage rate[lxxi], $p_{w_{pa}}$ is the mean employment rate for the average population, and $p_{w_{ldperstiming}}$ is the mean employment rate for children with language difficulties[lxxii]. Table 72 to Table 75 summarises the assumptions used to calculate the indirect costs (forgone income) by school academic achievement and language difficulties status.

Table 72: Assumptions used to calculate individual forgone income of children with uncorrected language difficulties

	Assumption	Estimate	Reference
1	Mean employment rate	0.722	242
2	Employment penalty	0.041(95% CI: 0.01,0.07)	242
3	National mean wage	$51,896[a]	243
4	Mean literacy and numeracy at 15 years calculated as (predicted (Z-score Literacy 15 years + Z-score numeracy 15 years)/2)	Table 73	
5	Probability of being employed = (mean employment rate + [mean literacy and numeracy at 15 years – employment penalty])	Table 74	
6	Forgone income = national mean wage – (probability of being employed/mean employment rate* national mean wage)	Table 75	

Note. [a]0% discount rate was assumed for the results that were extrapolated from 15 to 18 years of age (defined as adulthood) as a result of negligible inflation during the years 2014–2017. Extrapolation beyond 18 years of age should consider a discount rate of 3%.

For example, for a child with LD3_≥8 language difficulties in school of low academic achievement (Column 1, Table 73), then the probability or working $p_{wldperstiming}$ is the mean sample employment rate (Row 1, Table 72) plus the (literacy and numeracy Z-score [Column 1, Table 73] multiplied by the employment penalty [Row 2, Table 72]).

[lxxi] [243]Mean wage 2014
[lxxii] [242] Assume mean sample probability of working = 0.722, employment penalty = 0.041 for every 1 standard deviation away from the sample mean in literacy and numeracy.

For the LD3_≥8 child this is specified as 0.722 + (−1.29 * 0.041) = 0.669. The wage $\omega_{ldperstiming}$ is the national mean wage (Row 1, Table 72) minus the work participation penalty $\frac{p_{wldperstiming}}{mean\ employment\ rate}$, multiplied by the national mean wage $51,896 (in 2017) For the LD3>8 child this is specified as [(0.669/0.722) * 51896] = $3,793.

Table 73: Mean literacy and numeracy at 14–5 years (Z-scores)

	School of low academic achievement			School of median academic achievement			School of high academic achievement		
	Z-score	(95% CI)		Z-score	(95% CI)		Z-score	(95% CI)	
	Mean literacy and numeracy scores, 14 to 15 years								
Language	1	2	3	4	5	6	7	8	9
Typical language	−0.32	(−0.41	−0.23)	0.11	(0.06	0.16)	0.62	(0.55	0.68)
LD1_4–7	−0.53	(−0.85	−0.22)	0.14	(−0.06	0.33)	0.46	(0.17	0.76)
LD1_≥8	−0.86	(−1.02	−0.71)	−0.47	(−0.60	−0.34)	0.00	(0.00	0.00)
LD2_4–7	−0.71	(−1.16	−0.26)	0.00	(0.00	0.00)	0.00	(0.00	0.00)
LD2_≥8	−1.09	(−1.35	−0.83)	−0.91	(−1.14	−0.69)	0.00	(0.00	0.00)
LD3_4–7	−1.56	(−2.16	−0.96)	−0.84	(−1.30	−0.39)	Not estimable		
LD3_≥8	−1.29	(−1.57	−1.01)	−1.07	(−1.37	−0.76)	0.00	(0.00	0.00)

Note. Coefficients p ≥ 0.05 assume Z-score = population mean (0). CI = confidence interval; not estimable = sample size too small to predict coefficient.

Table 74: Probability of working

	School of low academic achievement			School of median academic achievement			School of high academic achievement		
	Z-score	95% CI		Z-score	95% CI		Z-score	95% CI	
	Probability of working								
Language									
Typical language	0.709	(0.705	0.713)	0.727	(0.725	0.729)	0.747	(0.745	0.750)
LD1_4–7	0.700	(0.687	0.713)	0.728	(0.720	0.735)	0.741	(0.729	0.753)
LD1_≥8	0.687	(0.680	0.693)	0.703	(0.697	0.708)	0.722	(0.722	0.722)
LD2_4–7	0.693	(0.674	0.711)	0.722	(0.722	0.722)	0.722	(0.722	0.722)
LD2_≥8	0.677	(0.667	0.688)	0.685	(0.675	0.694)	0.722	(0.722	0.722)
LD3_4–7	0.658	(0.633	0.683)	0.687	(0.669	0.706)	0.722	(0.722	0.722)
LD3_≥8	0.669	(0.658	0.681)	0.678	(0.666	0.691)	0.722	(0.722	0.722)

Note. Marginal effects are determined by coefficients that are significant at p< 0.05 level. Population mean is used when the coefficient is not statistically significant (refer to Table 72 for full assumptions). CI = confidence interval..

Table 75 shows the calculated forgone income for children with and without language difficulties, across each level of school academic achievement. It is important to note that opportunity costs are a function of achievement scores at 14 to 15 years using predicted marginal effects at a p-value of < 0.05. This can be interpreted as the incremental cost of a child having language difficulties, compared with a typical-language child, holding all other variables at their mean values[lxxiii].

[lxxiii] Values are presented in tables rounded to 2dp. Calculations undertaken up to 10dp.

Table 75: Indirect cost by school academic achievement and language difficulties status (forgone income)

	Low achievement school			Median achievement school			High achievement school		
	Mean	(95% CI)		Mean	(95% CI)		Mean	(95% CI)	
Language	1	2	3	4	5	6	7	8	9
Typical language	$939	($1,201	$678)	-$332	(-$188	-$476)	-$1,817	(-$1,624	-$2,010)
LD1_4-7	$1,575	($2,493	$657)	-$404	($163	-$970)	-$1,369	(-$497	-$2,243)
LD1_>=8	$2,542	($3,004	$2,079)	$1,384	($1,767	$999)	$0	($0	$0)
LD2_4-7	$2,094	($3,424	$762)	$0	($0	$0)	$0	($0	$0)
LD2_>=8	$3,208	($3,977	$2,439)	$2,695	($3,354	$2,033)	$0	($0	$0)
LD3_4-7	$4,608	($6,376	$2,836)	$2,483	($3,822	$1,143)	Not estimable		
LD3_>=8	$3,793	($4,616	$2,969)	$3,143	($4,040	$2,243)	$0	($0	$0)

To calculate the forgone income for a child with language difficulties, the median school academic achievement values were used from Table 75. The forgone income was then calculated as the median school achievement indirect cost (Table 75,col 4).multiplied by the proportion of children with language difficulties that are in each LD persistence and timing group (Table 76, col1). The cost for each category of language difficulties was calculated as sum of all of forgone income:

$$\sum ld\ (Median\ school\ indirect\ cost) *\ (proportion) \qquad (6.3.2.2)$$

For example, the proportional cost for a child with LD1_4–7 is −\$404 multiplied by 0.22 = −90. The total individual language difficulties costs (in terms of forgone income) for a child with uncorrected language difficulties is the sum of LD1_4-7 to LD3>=8 which is equal to \$1,325 (95%CI: \$1,713, \$743) for a child with a language difficulty, in 2017 dollars. These estimates will be used to inform the COI model in Section 6.5.

Table 76: Individual language difficulties costs (forgone income)

Proportion (1)	(2)	Weighted by proportion (3)	95% CI (4)	
0.22	LD1_4-7	-\$90	(\$36	-\$215)
0.33	LD1_>=8	\$463	(\$592	\$335)
0.07	LD2_4-7	\$0	(\$0	\$0)
0.12	LD2_>=8	\$336	(\$418	\$25)3
0.08	LD3_4-7	\$0	(\$0	\$0)
0.17	LD3_>=8	\$519	(\$667	\$370)
1.00	TOTAL	**\$1,325**	**(\$1,713**	**\$743)**

Language cost =sum(Median lost income (Table 24) * proportion))

6.3.2.2 Systemic school academic achievement

From the estimates in Table 75, it is also possible to calculate the systemic effects of low academic school achievement (compared to high academic school achievement).The estimates of school achievement are calculated as the difference between the mean high achievement indirect costs (Table 75, Col 7) and mean low achievement school costs.(Table 75, Col 1) For a child with typical language this is defined by Eq. 6.3.2.3. For a child with language difficulties this is defined by Eq. 6.3.2.4

$$(high\ quality)_{tl} - (low\ quality)_{tl} \tag{6.3.2.3}$$

where high achievement = (Column 7, Table 75) and low achievement = (Column 1, Table 75), and tl represents typical-language children.

$$(high\ quality)_{ldpers\_timing} - (\ low\ quality)_{ldpers\_timing} \tag{6.3.2.4}$$

where high achievement = (Column 7, Table 75) and low achievement = (Column 1, Table 75) and $ldpers\_timing$ represents children with language difficulties.

This means there are two estimates that can be used to inform the long-term costs for a child with language difficulties: the individual cost of a child with language difficulties and the systemic cost related to school academic achievement. The estimate of language difficulties is a measure of forgone income for children with language difficulties, irrespective of school academic achievement, and this is achieved by measuring the forgone income at the school academic achievement median. This estimate is used in the overall estimate of societal costs. The estimates based on academic school achievement represent the differential in forgone income between high and low academic school academic achievement, irrespective of the language status, which can be used as a comparative measure and is discussed in Section 6.5.1.

Based on the forgone income (Table 77), the opportunity cost associated with school academic achievement was calculated as $2,755 (95% CI: $2,825, $2,688) for a child with typical language (known as the SES effect) and $2,916 (95% CI: $3,455, $2,377)[lxxiv] for a child with language difficulties.

[lxxiv] Weighted average.

Table 77: School academic achievement opportunity cost

School of low academic achievement	Mean	95% CI	
SES effect	\$2,755	(\$2,825	\$2,688)
Language effect	\$2,916	(\$3,455	\$2,377)
Language effect, disaggregated			
LD1_4–7	\$2,944	(\$2,990	\$2,900)
LD1_≥8	\$2,542	(\$3,004	\$2,079)
LD2_4–7	\$2,094	(\$3,424	\$762)
LD2_≥8	\$3,208	(\$3,977	\$2,439)
LD3_4–7		Not estimable	
LD3_≥8	\$3,793	(\$4,616	\$2,969)

Note: School academic achievement cost = high-achievement mean – low-achievement mean (Table 75). CI = confidence interval; not estimable = sample size too small to predict coefficients.

6.3.3 Maternal labour force penalties associated with language difficulties

Based on the results observed in Chapter 5, it is possible to calculate the forgone income or opportunity costs of the carer burden associated with having a child with language difficulties[200]. This is the third component of c_f. In this case mothers choose to be in paid employment or household production (which includes caring). If mothers choose household production or to work fewer hours, then the opportunity cost is the value of the foregone paid employment, as measured by the marginal productivity of labour.

Using this approach, the opportunity costs associated with caring for a child with language difficulties in terms of expected foregone earnings are essentially the difference in LFP between a mother whose child has language difficulties and a mother with whose child has typical language, with consideration for the proportion of mothers who claim carers' benefits. This is defined as:

$$(\omega * p * hr)_{tl} - (\omega * p * hr)_{ldperstiming} \qquad (6.3.3.1)$$

Where ω is the predicted wage rate, p is the predicted probability of working and hr is the hours of work for carers of typical language (tl) children and carers of language difficulty children$(ldperstiming)$, respectively

The opportunity cost includes a base cost, which is defined as the cost for carers of children with language difficulties and who are not eligible for carers' benefits, plus a carers' benefit cost for the proportion of language difficulty children, whose mothers claim carers' benefits. The results in Chapter 5 showed a significant effect on LFP by language difficulty status and by carers' benefits (as indicated by the carers' benefit coefficients). The base cost are then defined as

$$(\omega * p * hr)_{tl} - (\omega * p * hr)_{ldpers\_timing} \quad (6.3.3.2)$$

Where ω_{tl} is the predicted wage rate p_{tl} is the predicted probability of working and hr_{tl} is the hours of work for a typical language child. ω_{ldpers_timing} is the predicted wage rate, p_{ldpers_timing} is the predicted probability of working and hr_{ldpers_timing} are the hours of work for a mother of a child with language difficulties.

The carers' benefits are defined as:

$$((\omega * p * hr)_{McarersA/P}) * prob_{lMcarersA/P})_{ldpers\_timing} \quad (6.3.3.3)$$

Where $\omega_{nMcarersA/Pc}$ is the predicted wage rate, $P_{lMcarersA/P}$ is the predicted probability of working and $hr_{McarersA/P}$ is the hours of work mother who receives carers' benefits and $prob_{lMcarersA/P}$ is the probability that a language difficulties child is eligible for the Carers' Allowance and Carers' Payment, respectively. Table 78 to Table 84 summarise the assumptions used to calculate maternal forgone income. The estimates were obtained using marginal effects[lxxv] for wages (Row 2, Table 78), hours (Row 3, Table 78) and work participation (Row 1, Table 78).

[lxxv] Language difficulty marginal effects calculated at Mcarers_A = 0, carers' benefits marginal effects calculated, holding all other variables at their mean values.

Table 78: Assumptions used to calculate maternal forgone income

	Assumption	Cohort	Mean Estimate[a]	Reference
1	Probability of work	B	Table 79	Chapter 5, Table 51
		K	Table 80	Chapter 5, Table 63
2	Wage rate	B	Table 79	Chapter 5, Table 51
		K	Table 80	Chapter 5, Table 60
3	Hours of work	B	Table 79	Chapter 5, Table 57
		K	Table 80	Chapter 5, Table 66
3	Weeks in a year		52	
4	Base cost = (probability of work * wage rate * hours)		Table 79, Table 80	D
5	Cost carers = {indirect cost [Mcarers_A (Table 79/ Table 80)] * probability of receiving Mcarers_A (Table 68)+. Indirect cost [Mcarers_P (Table 79/ Table 80)] * probability of receiving Mcarers_P (Table 68)}			E
6	Opportunity cost = D + E			

Note. [a]Estimates are marginal effects of coefficients. (Base case for language coefficients is typical-language children who are not eligible for carers' benefits. Base case for carers' coefficients is non-carers.D=Base cost, E=Cost of carers

Table 79 shows the calculated annual base costs for the B cohort, or the difference in LFP between a mother of a child with language difficulties and a mother of a child with typical language. Consider a LD1_0–3 years child, the annual base cost is calculated as the weekly base costs [(0.71 * $33.9 * 15.86)[lxxvi] minus the weekly base costs of typical language children [(0.70 * $33 * 18.36)] multiplied by 52 weeks in a year which is equal to $2,158 (94% CI: $2,694, $26). Similarly, the annual base costs for a LD2_0–3 years child is [(0.69 * $31.80 * 15.34)- [(0.70 * $33 * 18.36)] * 52 = $4,396 (95% CI: $6,686, $937).

The confidence intervals for the annual base costs and maternal costs are wide for some groups, which is largely due to the small sample sizes in these groups. A conservative approach is used to assign a zero incremental cost to coefficients that were not significant[182].

[lxxvi] Values in tables rounded to 2dp, Calculations undertaken to 6dp.

Table 79: Calculation of annual base costs – B cohort

	Probability of work			Wage rate ($)			Hours			Indirect Cost ($)[a]		
	Mean	(95% CI)		Mean	(95% CI)		Mean	(95% CI)		Mean	(95% CI)	
Language persistence and timing												
Typical language	0.70	(0.68	0.71)	$33.0	($31.5	$34.5)	18.36	(17.15	19.56)	$0	($0	$0
LD1_0–3	0.71	(0.68	0.73)	$33.9	($31.7	$36.2)	15.86	(14.59	17.13)	$2,158	($2,694	$1,411
LD1_4–7	0.70	(0.67	0.72)	$31.9	($30.0	$34.0)	17.74	(16.53	18.95)	$1,352	$1,740	$808
LD1_≥8	0.71	(0.68	0.74)	$32.6	($30.4	$35.0)	17.81	(16.53	19.10)	$0	$0	$0
LD2_0–3	0.69	(0.65	0.73)	$31.8	($28.2	$35.8)	15.34	(13.05	17.63)	$4,396	$6,686	$937
LD2_4–7	0.68	(0.63	0.74)	$31.6	($27.6	$36.2)	15.20	(12.57	17.84)	$4,798	$7,660	$308
LD2_≥8	0.67	(0.58	0.76)	$28.7	($22.7	$36.3)	16.30	(12.45	20.15)	$0	$0	$0
LD3_0–3	0.70	(0.63	0.78)	$29.9	($24.2	$36.8)	12.88	(8.19	17.57)	$0	$0	$0
LD3_4–7	0.65	(0.55	0.75)	$37.0	$28.2	$48.6)	14.49	(9.43	19.56)	$0	$0	$0
Mcarers_A	0.67	(0.63	0.71)	$34.9	($31.9	$38.1)	17.39	(16.18	18.60)	$0	($0	$0)
Mcarers_P	0.64	(0.59	0.69)	$34.7	($30.7	$39.1)	16.04	(14.56	17.52)	$0	($0	$0)

Note. Base costs represent costs calculated from the impairment coefficients. Estimates are predicted marginal effects (base case for language coefficients is typical-language children, who are not eligible for carers' benefits; base case for carers' coefficients is non-carers). Carers' benefits (Carer Allowance and Carer Payment) = probability that a language difficulty carer will claim carers' benefits * lost income for carers who claim benefits (refer to Table 72 for full assumptions); CI = confidence interval. Non-significant coefficients are assumed to incur 0 cost.
[a]Annualised.

Table 80 and Table 80 repeat the same calculations for the K cohort. Consider a LD2_>=8years child, the annual base cost is calculated as the weekly base costs (0.74*$32*21.72) minus the weekly base cost of typical language children (0.70*$31.2*14.3) multiplied by 52 weeks in a year, which is equal to $7,051 (95%CI $11,197,$885). **Error! Reference source not found.** includes the annual base costs from and then calculates the additional cost associated with language caring for those carers who claim benefits. The Carer Payment costs for a LD2->= 8years child is the Mcarers_P base cost $4,501 multiplied by the proportion of LD2->= 8years children who are eligible for Carer Payment from (5.1 per cent). The Carer Payment costs is equal to $280. The total annual cost for this child is the base cost ($7,501 plus the plus the Carer Payment cost ($280), which is equal to $7,330 (95%CI $11,491,$1,133).

Table 80: Calculation of annual base costs – K cohort

	Probability of work			Wage rate			Hours			Indirect Cost[a]		
	Mean	(95% CI)		Mean	(95% CI)		Mean	(95% CI)		Mean	(95% CI)	
Language persistence and timing												
Typical language	0.74	(0.72	0.75)	$32.0	($30.9	$33.0)	21.72	(20.76	22.68)	$0	($0	$0)
LD1_4–7	0.73	(0.70	0.77)	$30.2	($28.2	$32.4)	20.06	(18.45	21.67)	$3,504	($5,228	$1,271)
LD1_≥8	0.75	(0.73	0.78)	$31.8	($30.0	$33.6)	20.27	(18.92	21.63)	$0	($0	$0)
LD2_4–7	0.75	(0.69	0.81)	$29.8	($26.1	$34.1)	18.24	(14.85	21.64)	$0	($0	$0)
LD2_≥8	0.70	(0.64	0.76)	$30.4	($26.8	$34.4)	17.69	(14.44	20.94)	$7,051	($11,197	$885)
LD3_4–7	0.70	(0.60	0.80)	$32.5	($26.2	$40.4)	15.94	(9.85	22.03)	$0	($0	$0)
LD3_≥8	0.70	(0.62	0.79)	$31.2	($25.7	$38.0)	14.33	(8.14	20.51)	$0	($0	$0)
Mcarers_A	0.71	(0.68	0.75)	$33.1	($30.7	$35.7)	20.76	(19.48	22.04)	$0	($0	$0)
Mcarers_P	0.65	(0.61	0.70)	$35.2	($32.1	$38.6)	17.54	(16.10	18.99)	$4,501	($4,738	$3,993)

Note. Base costs represent costs calculated from the impairment coefficients. Estimates are predicted marginal effects (base case for language coefficients is typical-language children, who are not eligible for carers' benefits; base case for carers' coefficients is non-carers). Carers' benefits (Carer Allowance and Carer Payment) = probability that a language difficulty carer will claim carers' benefits * lost income for carers who claim benefits (refer to Table 72 for full assumptions). CI = confidence interval. Non-significant coefficients incur 0 costs. [a]Annualised.

From the estimates shown in Table 79 and Table 80**Error! Reference source not found.**, it was possible to calculate a maternal indirect cost. Using a similar weighted proportion approach employed in Section 6.3.2. Table 82 shows the weighted language costs for the B cohort. Table 83 shows the weighted language costs for the K cohort. A weighted mean by cohort was then calculated to determine the annual maternal labour cost of language difficulties ($1,217 + $4,734)/2 = $$2,976 (95% CI: $6647, −$280). This estimate will be used to inform the COI model in Section 6.4. The disaggregated costs will be used in the subgroup analysis.

Table 81: Calculation of maternal indirect costs – K cohort

	Base costs			Carer Allowance			Carer Payment			Total		
	Mean	(95% CI)		Mean	(95% CI)		Mean	(95% CI)		Mean	(95% CI)	
Language persistence and timing												
Typical language	$0	($0	$0)	$0	($0	$0)	$58	($140	$52)	$58	($140	$52)
LD1_4–7	$3,504	($5,228	$1,27)1	$0	($0	$0)	$94	($99	$83)	$3,598	($5,327	$1,354)
LD1_≥8	$0	($0	$0)	$0	($0	$0)	$90	($95	$80)	$90	($95	$80)
LD2_4–7	$0	($0	$0)	$0	($0	$0)	$110	($116	$97)	$110	($116	$97)
LD2_≥8	$7,051	($11,197	$885)	$0	($0	$0)	$280	($294	$248)	$7,330	($11,491	$1,133)
LD3_4–7	$0	($0	$0)	$0	($0	$0)	$241	($254	$214)	$241	($254	$214)
LD3_≥8	$0	($0	$0)	$0	($0	$0)	$0	($0	$0)	$0	($0	$0)

Note. Base costs represent costs calculated from the impairment coefficients. Estimates are predicted marginal effects (base case for language coefficients is typical-language children, who are not eligible for carers' benefits; base case for carers' coefficients is non-carers). Carers' benefits (Carer Allowance and Carer Payment) = probability that a language difficulty carer will claim carers' benefits * lost income for carers who claim benefits (refer to Table 72 for full assumptions). Non-significant coefficients incur 0 costs. [a]Annualised.

Table 82: Maternal indirect cost – B cohort (annual)

Proportion (1)	LD (2)	Weighted by proportion (3)	(95% CI) (4)	
0.20	LD1_0–3	$434	($542	$284)
0.22	LD1_4–7	$294	($378	$176)
0.17	LD1_≥8	$0	($0	$0)
0.16	LD2_0–3	$707	($1,075	$151)
0.07	LD2_4–7	$341	($545	$22)
0.02	LD2_≥8	$0	($0	$0)
0.15	LD3_0–3	$0	($0	$0)
0.02	LD3_4–7	$0	($0	$0)
N/A	LD3_≥8	N/A	N/A	N/A
1	TOTAL	$1,776	$2,539	$632

Note. Language cost = sum (total annual forgone income * proportion). CI = confidence interval.

Table 83: Maternal indirect cost – K cohort (annual)

Proportion (1)	LD (2)	Weighted by proportion (3)	(95% CI) (4)	
0.23	LD1_4–7	$822	($1,217	$309)
0.35	LD1_≥8	$31	($33	$28)
0.07	LD2_4–7	$8	($9	$7)
0.14	LD2_≥8	$1,006	($1,577	$155)
0.06	LD3_4–7	$15	($16	$13)
0.15	LD3_≥8	$0	($0	$0)
1	TOTAL	$1,882	$2,851	$513

Note. Language cost = sum (total annual forgone income * proportion). CI = confidence interval.

Table 84: Combined maternal indirect costs (annual)

	Mean costs	(95% CI)	
Language difficulties			
LD	$1,829	($2,695	$433)
Language persistence and timing			
LD1_4–7	$775	($1,068	$384)
LD1_≥8	$16	($17	$14)
LD2_4–7	$528	($814	$90)
LD2_≥8	$503	($788	$78)
LD3_4–7	$7	($8	$7)
LD3_≥8	$0	($0	$0)

Note. Weighted mean (B and K cohort). Disaggregated numbers do not exactly equal the mean, as a result of rounding. CI = confidence interval.

There are some differences in costs observed across the two cohorts at the same age. However, it is difficult to make any conclusions about these differences as they are largely driven by the conservative assumption of assuming zero cost for non-significant results. The limitation of this approach, while conservative in a statistical sense, is that it does not consider that intuitively there is an effect that needs to be estimated. Assuming a zero effect in this instance may underestimate the true indirect cost [182].

6.4 Results: calculating societal results

The next step in the COI was to calculate the remaining costs associated with c_g. The government costs incurred due to additional health and welfare expenditure; specifically Medicare, were derived directly from Section 6.3.1 (Table 71).

The final component of c_g is the calculation of carers' benefits associated with caring for a child with language difficulties. In the COI literature, government costs associated with carers' benefits, or safety net payments, are sometimes considered 'transfer payments'[1] and therefore not include in calculations of overall welfare losses Under this assumption the costs associated with any reduced labour force participation are captured in the participation and wage estimates and including this and any carer payments would be considered double counting. In this instance the Carers' Payment is a supplement that is means tested so it is targeted at low income earners who have impaired children. The results in this study showed a labour force penalty for all carers of children with language difficulties, so any double counting would only be for the small proportion of carers of children with language difficulties, who also claim carers' benefits. Additionally, it is unclear whether the levels of carers benefits fully cover the LFP penalty. According to a recent study by the AIFS, the current carers' benefits scheme meets the needs of only 20 per cent of carers[68]. For this study, the government costs associated with carers' benefits are included in the overall costs, which is consistent with other COI studies[24]. These are calculated by the rate of benefits in 2017 and the proportion of children with language difficulties whose carer received Carer Payment. The maximum Carer Payment is assumed as the AIFS estimates that only 13% of people who receive Carer Payment are not paid the maximum benefit[68].

Table 85 summarises all of the assumptions used in the COI calculation, derived from Section 6.3.1 to Section 6.3.3. The population of children aged from birth to 15 years is sourced from the ABS and the prevalence of language difficulties is based on literature estimates[18-22]. The estimated annual cost to society is the annual cost multiplied by the prevalence of language difficulties multiplied by the total population of Australian children. Costs are categorised as; individual, family and government, (in bold) and represent the categories in the pie charts Figure 11 to Figure 13.

Table 85: Assumptions used to calculate societal costs

	Assumption		Reference		Estimate
1	Healthcare expenditure				
	OOP costs **(Family)**	= Weighted Mean [(B_OOP + K_OOP) + Mean (B_Mcarer_A * probability of Carer Allowance + K_Mcarer_A * probability of Carer Allowance) + (B_Mcarer_P * probability of Carer Payment + K_Mcarer_P * probability of Carer Payment)] / 2	Chapter 3 Table 20, Table 23	A	Table 71
	Medicare benefits **(Government)**	= Weighted Mean [(B_OOP + K_OOP) + Mean (B_Mcarer_A * probability of Carer Allowance + K_Mcarer_A * probability of Carer Allowance) + (B_Mcarer_P * probability of Carer Payment + K_Mcarer_P * probability of Carer Payment)] / 2	Chapter 3 Table 19,Table 22		
2	**Family** labour supply of mother	Indirect cost K cohort	Chapter 5, Table 60 Table 63, Table 66	B	Table 84
3	**Individual** reduced future earnings	Extrapolated future earnings based on literacy and numeracy scores at 15 years * probability of employment * mean annual income	Chapter 4,Table 38	C	Table 76
4	**Government** – Carer Allowance	Weighted average (probability of Carer Allowance * 118 rate at 2015 * 26 fortnights)	Table 68[244]	D	Section 6.4
5	**Government** – Carer Payment	Weighted average (probability of Carer Payment * 601 * 26 fortnights)	Table 68[245]	E	Section 6.4
6	Systemic cost of schooling	Weighted average (opportunity cost of high-achievement school – opportunity cost low-achievement school)	Table 77	F	Section 6.5.2
7	Population of children aged 0–15 years	4,470,222	[27]	G	
8	Prevalence of language difficulties	0..07 (range 0.07–0.17)	[18,20-23]	H	
9	**Society annual cost**	Estimated annual cost * prevalence * number of Australian children		= (A − F) * G * H	Table 84

Note. Maximum Carer Payment is assumed Carer Allowance = \$118 per fortnight; Carer Payment = \$601 per fortnight based on single payment in couple [245]. OOP = out-of-pocket. Mcarer_A = Carer Allowance, Mcarer_P = Carer Payment, K = kindergarten cohort, B = birth cohort.

Overall, the annual costs per child with language difficulties were $4,353 (95% CI: $5,653, $2,307). Productivity losses accounted for the largest proportion of the total cost estimate. Productivity losses per child were $1,325 (95% CI: $1,713, $719) (30 per cent) and mother $1,829 (95% CI: $2,695, $433) (42 per cent). These were calculated as the sum of reduced LFP related to low literacy and numeracy, and household labour penalties due to reduced LFP, respectively. The remaining 27 per cent were largely costs to the health and welfare system, comprising $841 (95% CI: $260, $836)[lxxvii] in Carer Payment, $197 (95% CI: $58, $11)[lxxvii] in Carer Allowance, $127 (95% CI: $200, $53) in Medicare benefits and $34 (95% CI: $11, $58) in out-of-pocket MBS and PBS expenditure. This estimate of total costs, however, does not incorporate the negative impacts associated with individual and family health and wellbeing or health system costs incurred in community state-based services. Therefore, it is a conservative estimate. Based on a prevalence estimate of 7 per cent, the total cost to society of language difficulties was estimated to be $1.362 billion per year (95% CI: $1,769, $722m). Of this, $997 million represents costs to families, which includes $572 million f foregone productivity for the mother and $414 million of reduced future lifetime earnings for the child. The remaining 27 per cent comprises $364 million costs to the health and welfare system.

[lxxvii] 95% CI is calculated at the mean.

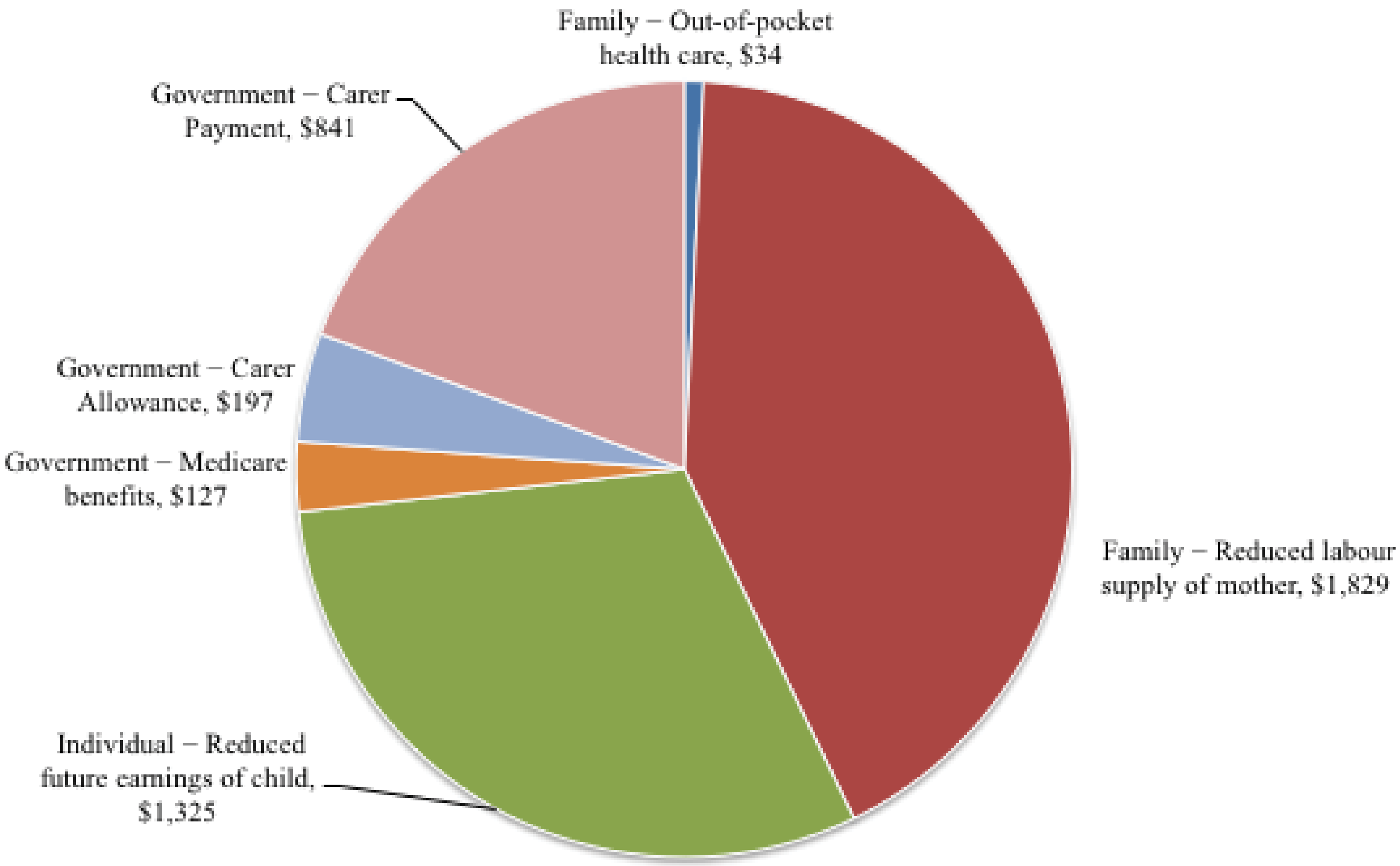

Figure 11: Societal costs per child per annum

6.5 Subgroup analysis related to language definitions and school achievement.

The approach taken in this analysis allows exploration of how overall costs vary with the nature of the language difficulty, in particular, with respect to persistence and timing of identification. The systemic impact of low school achievement is also explored.

6.5.1 Persistence and timing of identification of language difficulties

Figure 12 and Figure 13 present the subgroup analysis by identification and persistence.

6.5.1.1 Subgroup analysis

The subgroup analysis showed that for children who were identified at 7 years or younger, the annual costs per child were $3,323 (95% CI: $4,922, $1,285). For these children, direct productivity losses of the mother accounted for 69 per cent of overall costs $2,308 (95% CI: $3,330, $847), followed by Carer Payment $844 (95% CI: $886, $802) (24 per cent). There were no direct productivity losses of the child. These children made productivity gains of $301 (95% CI: -$122, $723), which means that they were more productive than the average child.

For children who were identified with language difficulties at 8 years or older, the annual costs per child were $4,352 (95% CI: $5,662, $2,749) (see Figure 12). Direct productivity losses of the child and mother accounted for the largest proportion of the total costs; productivity losses of the child of $2,094 (95% CI: $2,663, $1,522), followed by productivity losses of the mother of $1,072 (95% CI: $1,665, $190). Carer Payment for these children was consistent with those identified at ≤ 7 years of age: $836 (95% CI: $878, $795).

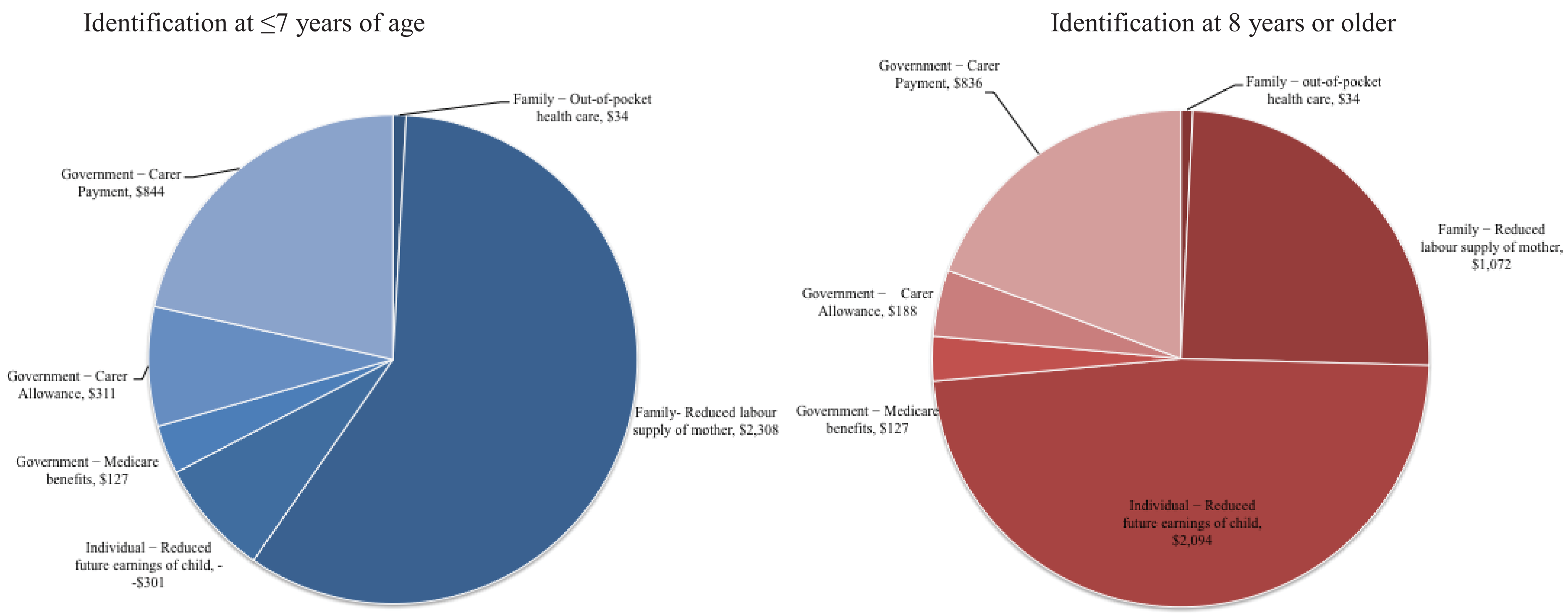

Figure 12: Societal costs per child per annum (early and late identification)

Figure 13 shows the subgroup analysis related to language difficulties persistence. The analysis showed that children with transient language difficulties (identified at one time only) had annual costs of $2,855 (95% CI: $3,918, $1,672). For these children, direct productivity losses of the child and mother accounted for the largest proportion of the total costs; productivity losses of the mother were $1,358 (95% CI: $1,863, $684), followed by productivity losses of the child $677 (95% CI: $1,137, $216). The cost of Carer Payment for these children was consistent with those identified at ≤ 7 years of age $502 (95% CI: $527, $477).

Children who had persistent language difficulties (identified twice) had the highest costs of all subgroups. The annual costs for these children were $5,706 (95% CI: $7,714, $444). The distribution of costs for these children was similar to those children identified with language difficulties at 8 years or older. Productivity losses of the child and mother accounted for the largest proportion of the total costs; productivity losses of the mother were $2,215 (95% CI: $3,434, $372), followed by productivity losses of the child $1,945 (95% CI: $2,469, $1,419). Carer Payment for these children was only slightly higher than the other subgroups at $1,009 (95% CI: $1,060, $959).

Overall, the subgroup analysis showed that children with persistent language difficulties and those identified at 8 years or older were the main drivers of productivity losses.

The levels of Carer Payment were largely consistent across the subgroups. There are a number of explanations for this. First, the analysis assumed the maximum Carer Payment for all eligible children, and, therefore, the results may not be adequately sensitive to eligibility differences determined by severity of the condition.

The analysis showed that for children identified before 7 years of age and those with transient language difficulties, individual productivity losses were small compared with other subgroups. The results suggest gains of between $1,029(95%CI $740, $1,464) (difference between early and late identification) and $2,765 (95%CI $3,575, $1,499) (difference between transient and persistent language difficulties). These estimates are largely descriptive but do provide some evidence on the benefits of early identification. However, further research is required to measure the long-term effectiveness of interventions.

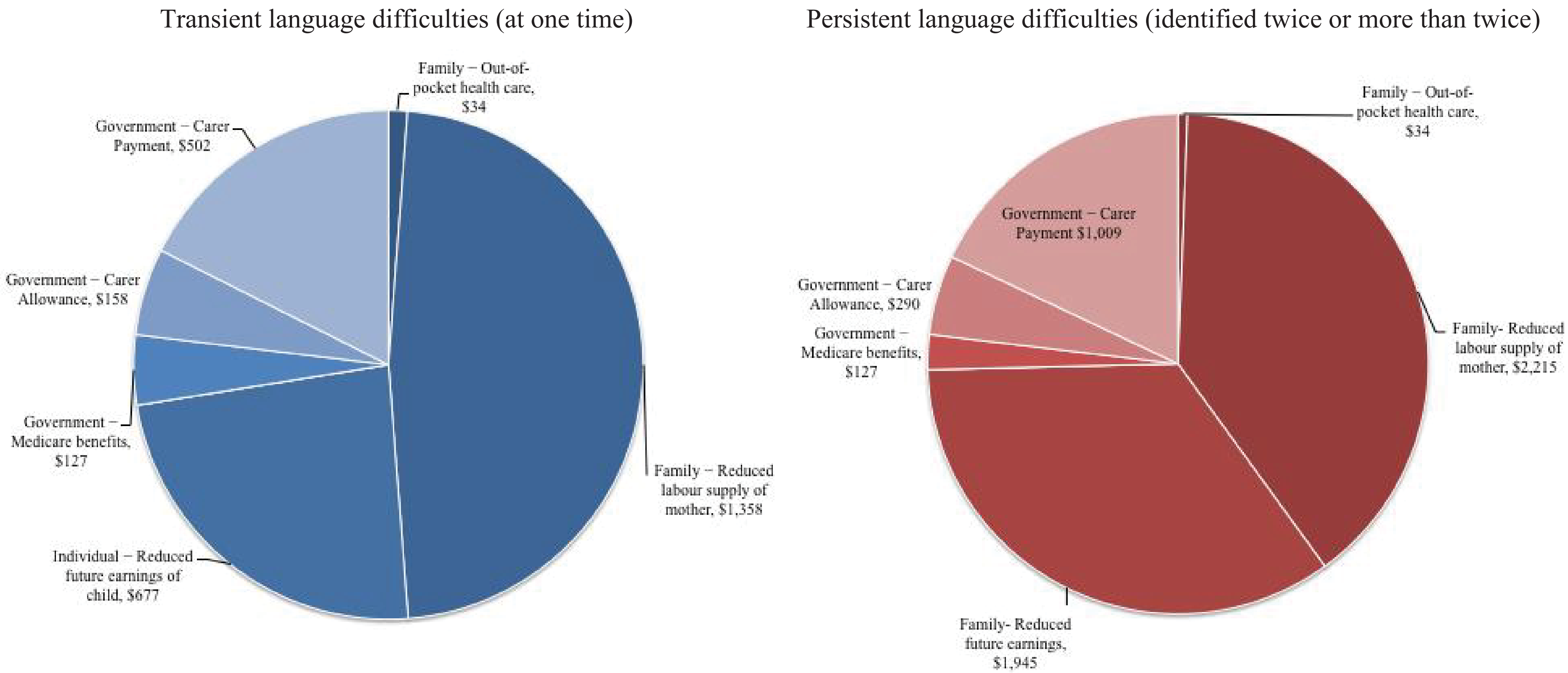

Figure 13: Societal costs per child per annum (persistence)

6.5.1.2 Threshold analysis

A threshold analysis was conducted to test the robustness of the assumptions of the model. These are discussed in Appendix N.

6.6 Discussion

This analysis provides the first comprehensive assessment of societal costs of children with language difficulties in Australia. This study demonstrates the considerable impact of language difficulties in terms of the associated direct and indirect costs. The highest costs are associated with foregone productivity for carers of children with language difficulties, and reduced productivity for the individuals themselves, followed by the costs associated with carers' benefits. This study was not able to capture the intangible effects of language difficulties, such as quality of life, or any special education costs so this estimate is likely to be conservative.

A large proportion of the direct costs were related to direct medical services. Pharmaceutical costs were not a major contributor to overall costs, which is consistent with other studies investigating communication impairments[62]. The finding that indirect costs were much higher than direct costs is consistent with much of the literature assessing the economic impact of impairments that result in reduced ability to work[3].

There is considerable variation in estimates of costs of disability in the literature vary considerably, depending on the severity of the condition and the methods used. In a review of the economic costs of all childhood disability, Stabile et al.[3] reported in 2012 that the combined average annual cost for a child with disability was approximately US$2,000 in lost maternal labour supply, US$1,000 in direct costs, US$1,184 in safety net programs and between US$1,500 and US$5,000 in forgone income of the child—in total, between US$5,584 and US$9,184 per annum (based on 2011 prices). When special education programs were considered, these costs increased to approximately US$30,000 per year. The comparable estimates in this study are higher in terms of lost LFP costs, but lower in direct costs. The individual forgone income and safety net costs are largely consistent. The overall cost estimates of this study are within the estimated range, albeit at the lower end of the range, of US$5,584 and US$9,184[lxxviii].

In the context of other childhood chronic conditions, the burden of childhood asthma is $3.2 billion per year[1], and the COI of ASD is $5.5 billion per year, with an additional $3.9 billion for loss of quality of life[24]. The COI of DLD is smaller than these more visible conditions. However, these estimates are based on a conservative prevalence rate of 7 per cent. The upper-bound estimate of prevalence for DLD is 17 per cent. If the true prevalence rate of DLD were 17 per cent, then the societal costs of the estimates would increase substantially.

This study provides the first Australian estimates of the educational costs of DLD, but in many ways provides only a preliminary estimate of the COI related to education. This is because the study does not consider the costs or benefits associated with early intervention or the costs of special education. The standard early intervention treatment for DLD is speech pathology therapy. Speech pathology is generally conducted one on one, and as a result is a cost intensive intervention. Treatment is dependent on the severity and type of diagnosis and there is evidence that early intervention is more cost effective (requiring less sessions with better outcomes) [21]. The costs of early intervention overlap both health and education policy and schools play a critical role.

Studies from the USA estimate that the annual cost of special education are between ASD USD$10,830/per pupil and up to USD $30,000 or more if they attended fully specialised education schools [63]. While there are inherent differences in the schooling system between the USA and Australia, there are also a number of similarities. The proportions of students who attend mainstream schooling (93.5 per cent) are similar between the two systems [24,150] and these children are entitled to individualised learning plans to facilitate equal access and participation in education for all children [69]. Using linked national data from the Medical Expenditure Panel survey (MEPS), The National Health Interview Study and study specific survey, Lavelle et al[24] estimated that the annual cost of specialist education relating to ASD was USD $8,610 (95%CI $4,595, $10,421). This estimate included individualised plans in mainstream schooling (50.5 per cent of ASD), combined and special education schooling (37.1 per cent) and specialist

[lxxviii] Assuming $1 in the USA in 2011 is equivalent to $1 in Australia in 2014.

education only (12.1 per cent). The results emphasise the economic burden placed on this sector and the need for policies to ensure that resources are available to the school system to provide necessary services. In Australia, children with language disorders and other disabilities increasingly attend mainstream schools[78]. Students with disabilities are entitled to individualised learning plans but up until recently there have been large state-by-state differences in the eligibility criteria for services and ultimately causing some children to fall through the gaps in service delivery, despite having a diagnosed communication impairment. In a review of current health, education and disability legislation, McLeod and colleagues found “clear policy gaps in the area of communication impairment are causing many children to miss out on appropriate and timely interventions” [2,70]. More needs to be done to improve access and participation to differentiated teaching and supplementary support services. Future research should focus on costing the special education costs of children with DLD.

The strength of this study is that it includes the calculations of both direct and indirect costs in a representative sample of Australian children aged from birth to 15 years. It uses robust econometric methods with individual-level longitudinal data to estimate resource consumption, and it considers the heterogeneity of cost estimates using a number of sensitivity analyses.

There were several limitations to the approach used in this study. First, it used a novel approach to examine the persistence and identification of language difficulties, which was facilitated by the longitudinal nature of the data. Although this allowed the examination of the distribution of costs by subgroups, it is possible that these definitions may be difficult to replicate, which may limit the comparability of this study to other costing studies. This problem is common to COI studies in the area of impairment[80,82,247]. This study adhered to existing COI study guidelines and standards to enhance comparability. Additionally, it considered all possible definitions of the condition from the LSAC. Language difficulties (Definition 1, Chapter 2 [see Table 2]) and the measure of persistence and timing (Definition 2, Chapter 2 [see Table 3]) are both consistent with the language and communication literature[62,91].

A second limitation of this study is that it was not possible to accurately measure the costs of comorbidities and complications that were a direct result of DLD. As discussed in detail in Chapter 2, there is much debate in the literature around definitions of DLD, and this thesis employs a number of methods to distinguish between communication impairment and low language acquisition related to inadequate educational opportunity or neglect or where it exists as a secondary condition—that is, where it co-exists with another condition (discussed in detail in Section 2.1.1)[23lxxix]. However, as discussed in Chapter 5, the measures of comorbidities appear to be weak instruments for measuring severe and persistent problems. In the absence of a robust condition-specific measure, Carer Payment may be better at explaining the effect of co-existing conditions in this study.

Studies have found a greater financial burden for caring for a child with mental and emotional health and quality of life issues when compared to physical health conditions. Notably, the results from Chapter 4 showed that children with language difficulties had significantly lower emotional and behavioural health outcomes and reduced social and school functioning than typical-language children, and this was reduced further with language difficulties persistence and late identification. This finding is consistent with the literature that found a clinically heightened risk of mild-to-moderate levels of emotional and behavioural difficulties in late childhood and adolescence for children with language impairment, and that these develop as a consequence of non-cognitive deficits[104]. It is highly probable that these effects will adversely impact the ability of these children to participate productively in society [136,248,249], which will further contribute to the economic impact of language difficulties[136]. Future research, preferably using longitudinal studies that follow children with communication impairment into adulthood, should examine COI associated with emotional and behavioural health problems that develop as a by-product of language disorders.

Last, the use COI studies as decision-making tools has been widely debated[83-85], and although there are recognised limitations to this approach, they serve a number of purposes for policy[80]. The cost estimates in this study highlight that language

[lxxix] Such as autism, hearing impairment, general developmental difficulties, behavioural or emotional difficulties, neurological impairment, bilingualism, cleft lip or palate, episodic otitis media.

difficulties is a high-cost condition, which has implications for health care, disability, education and labour force policy. These estimates can be used to inform cost-effectiveness analysis for decision-making and resource allocation.

6.7 Conclusion

Language difficulties cause a considerable economic burden for children, their carers and society, which increases with the level of persistence and late identification. There are cost savings that can be achieved with early identification. However, these policies need to be examined within the broader context of the delivery and funding of interventions and of the health system.

Chapter 7: Key Messages

This thesis has examined the economic impact of childhood language difficulties on individuals, families and society. This thesis has explored four different economic aspects of DLD. The first study investigated health care consumption decisions of families with a child with language difficulties. The second study examines the effects of childhood language difficulties on future human capital and economic success. In the third study, labour force decisions of families with a child with language difficulties are explored by measuring the indirect costs associated with reduced maternal labour force participation for children with language difficulties. The final study uses estimates from study one to study three to calculate societal costs of language difficulties in Australia.

7.1 Healthcare policy

Children with language difficulties use services across health, education and disability policy settings. Chapter 3 demonstrated a consistent positive relationship between a child's language difficulties and their increased medical services utilisation. These children use more GP services, and this is observed in conjunction with higher referral rates to paediatrician and speech services. However, Medicare does not provide information about the reason for healthcare attendances, and as a result, it was not possible to identify services and pharmaceuticals received specifically for the assessment and/or treatment of language difficulties. Additionally, there is a ceiling on the number of allied health and speech pathology services that can be claimed under the MBS in any calendar year. If families are accessing state-funded community, hospital or educationally based providers after reaching the Medicare ceiling, the overall healthcare costs will be underestimated. Equally, it is likely that children from higher income families may access private services, which are also not accounted for in these analyses. Further research is required to quantify these additional costs and to differentiate costs associated with various types of healthcare use.

Healthcare utilisation makes up a relatively small portion of the overall costs of language difficulties, and as discussed in Chapter 3 and Chapter 6, it has a smaller impact than other more visible impairments, such as ADHD with annual healthcare costs of $2,636 per child[136] and ASD with annual healthcare costs of $3,020 per child (95% CI: $1,017, $4,259)[24]. Despite this, as suggested in Chapter 3 and Chapter 4, language difficulties are likely to place an increasingly larger burden on the health and welfare system as these children move through school and after they leave school. There is evidence that DLD leads to a number of limitations within multiple domains of life, including psychosocial, social (e.g., lack of empathy and kindness, and volunteering to help) and school functioning (e.g., disruptive in the classroom and poor achievement), and difficulties with peers and conduct (e.g., problems with temper control, disobedience, fighting with or bullying other children, argumentative with adults)[104]. These difficulties may lead to serious limitations in life functioning for the children with language difficulties and have significant flow-on effects for their family, schools and society. [12]

7.2 Education policy

Chapter 4 provided strong evidence of the impact of language difficulties on future earning potential, as a result of low levels of literacy and numeracy. This effect is greater than the effect of socioeconomic disadvantage alone. While many of these children are already behind when they start school, and therefore face an uphill battle, there is some evidence that they are as responsive and, in some cases, more responsive, to changes in school academic quality than the more advantaged children. This implies that, in relative terms, increasing school academic quality could accelerate academic achievement for children with language impairment. The results also showed that early identification and interventions exert a positive effect on both cognitive and non-cognitive skills. Following Heckman's equation, investment in early childhood education and development will build the skills necessary for future success in life[30,31,34,39]. These findings are discussed in more detail in the next section.

7.3 School academic achievement

The results in Chapter 4 highlight a number of issues with the education system in Australia that extends beyond specific issues for DLD children but are relevant in the context of overall educational policy.

The results in Chapter 4 pointed to an increasingly segregated school system in Australia. Indeed, Chapter 4 reported that between 9 per cent and 25 per cent of variation in outcomes is related to the school, and this has been increasing since the educational reforms in 2008. Overall, this variation has been found to be comparable to the USA (25 to 31 per cent) and New Zealand (31 per cent). However, these rates are considerably higher than England and Finland (10 per cent). This means there are more disadvantaged children in disadvantaged schools, which exacerbates inequality in the schooling system. This can be explained in the context of 'educational quasi-markets' (discussed in Appendix I: Educational Quasi-Markets). This study demonstrated that the costs of schooling of low academic achievement when compared with schooling of high academic achievement are significant ($2,735 [95% CI: $2,803, $2,664]) (Table 77). The implication is that targeted policies, such as those identified by the OECD that support disadvantaged students and low-performing schools through increased resourcing and economic assistance, will improve equality and educational outcomes[184].

Additionally, the results in Chapter 4 highlighted that national assessment and national reporting do not adequately meet the needs of children with *disability*, resulting in unnecessary exclusion. Although some allowances are made for children with *disability* who participate in NAPLAN, children with language difficulties were over-represented in the partial absentee group for NAPLAN testing, and this finding was evident across all levels of school academic achievement, which supports the suggestion that the testing environment is creating perverse incentives. The Disability Standards for Education review in 2012 highlighted this practice as 'indirect discrimination', which is contrary to the objectives of the Disability Standards and the National Disability Strategy[78]. A policy response is warranted to eliminate discrimination against people with disability in education.

7.4 Cost of illness

This thesis provides the first Australian estimate of the COI for DLD, distributed across three key policy areas—health care, education and LFP—and with considerable costs in two of the three. The total cost to society of language difficulties is estimated to be between $1.362 million per year and $3.308 billion per year (based on a prevalence range 7 to 17 per cent). The annual cost per child with language difficulties is estimated to be \$4,353. Productivity losses account for the largest proportion of this cost, with 42% attributable to productivity losses of the child's mother, 30% attributable to productivity losses of the child and 28% attributable to costs borne by the health and welfare system.

While the individual costs associated with DLD are not as high as with other childhood conditions, such as ASD and ADHD, its high prevalence and broad impact makes DLD an important public health concern. The total cost to society of language difficulties could be similar in magnitude to the cost of asthma (\$3.6 billion per year [1]) and ASD (\$5.5 billion per year).

7.5 Early intervention

The COI estimates in this study with regard to early intervention are largely descriptive but do provide some evidence of the benefits of early identification. The results reported in Chapter 6 indicate an upper limit of between \$1029 (95%CI \$740, \$1,464) and \$2,765 (95%CI \$3,575, \$1,499) per child per year could be saved through intervention. However, further research is required to measure the long-term effectiveness and costs of interventions. As discussed in Chapter 1 and Chapter 4, a number of studies have found evidence of the benefits of early interventions diminishing over time, notably in high-risk groups[178,185]. Although the current study was unable to measure any benefits or 'fade out' of early intervention, it importantly identified critical time periods for identification of children with language, difficulties as 'skills' output at one stage increases the productivity of investment in subsequent time periods[42].

7.6 Non-cognitive skills

School performance is associated with a range of factors, which go beyond resources, and the results in this study showed that targeting improvements in both cognitive and non-cognitive skills in the school environment are important in facilitating an overall academic climate conducive to academic success. This is the area with the greatest need for further study. Indeed, considerable literature has shown that children with communication impairments have significant problems in these domains, but these outcomes have not been costed. In studies of other childhood conditions, these costs are substantial. One Australian study regarding the cost of ASD estimated that these costs represent an additional $3.6 billion (67 per cent)[250]. A longitudinal study in the UK found that by age 28, children with childhood conduct problems have cost society 3.5 to 10 times more than a comparison group, mainly due to costs associated with crime and education[251]. Policies to facilitate student engagement through the provision of programs, extra-curricular programs and student support policies have been linked to high-achieving schools [190]. Future research investigating this domain should consider both the direct and indirect costs because they are likely to be considerable.

7.7 Labour force policy

The female labour force in Australia has some of the highest rates of highly educated women, when compared to other OECD countries[252]. Yet despite this, female employment participation remains low, notably during child bearing years. Caring responsibilities impose a considerable opportunity cost on families in terms of forgone earnings. Chapter 5 highlights that the additional impact of language disorder on labour force is considerable and represents the largest proportion of overall costs. The results showed that carers of children with language difficulties substituted paid for unpaid work by working fewer hours. When the condition was severe or persistent, they were less likely to be employed, and for older children, carers received a wage rate premium to remain in the workforce. For these carers, the substitution, respite and income effect were equally important.

Government policies on the provision of income support have the potential to affect women's decisions about their LFP. Policies can either encourage women to be in the workforce or discourage such participation by supporting the decision to not participate in the labour force[64,193]. While current labour-market policymakers are focused on counteracting the economic effects of an ageing population[194-197], health systems are simultaneously placing increased pressure on family members to provide unpaid care[68]. The high cost associated with DLD has serious implications for families' current and long term financial security. This study suggests that the current disability support system is not meeting the needs of all language carers, which is consistent with the carers literature[198] One policy response to improving LFP that has received considerable attention is childcare subsidies. Subsidies in child care reduce the substantial cost of preschool child care and provide an incentive to return to work earlier. However, in the current climate, one of the biggest barriers preventing mothers from engaging in the labour force is the shortage of childcare places. For families with children with disability, not only is the additional caregiving responsibility a barrier to LFP, but this may also be further exacerbated by the availability (or lack of) affordable and appropriate childcare facilities. Although child care has not been a topic of this thesis, it highlights that a thorough understanding of the relationship between unpaid and paid work in the context of family needs for children with DLD is required.

7.8 Implications for the cost-effectiveness of effective intervention

The costs associated with DLD have important implications for the intervention of language disorders. Indirect costs associated with education and costs to the family represent close to 80 per cent of all costs. This study provides decision-makers with a picture of the global burden of DLD and, more importantly, of the major cost components and the areas where cost-containment policies would have the greatest impact and should therefore be prioritised. These estimates can be used to inform cost-effectiveness models of effective interventions for children with DLD.

This study suggests that there would be potential to reduce costs through effective intervention, but it is then important to be able to identify what those interventions are. Broad-based language enrichment programs may be more cost-effective because they can be implemented for all children with low literacy and implemented by differential teaching, but they may be inadequate to meet the specific needs of children with DLD [2,253], and would consequently result in a smaller reduction in COI. Alternatively, some more-targeted programs, though more expensive in the initial stages, may have longer term benefits[254]. Even a relatively expensive treatment such as one-on-one speech pathology therapy may be cost-effective because the costs of illness for DLD are clearly several orders of magnitude larger than even the cost of the intervention. This means that while the costs of illness should be considered as an upper limit for what society might save through intervention, the benefits—even of an effective program—are likely to depend on the mediating mechanism that is targeted. Which interventions would be more cost-effective in the long run is a key empirical question that has not yet been answered.

Multiple policy domains are involved in the burden of DLD, which emphasises the need for a multidisciplinary approach in ongoing research and management of DLD. The magnitude of this COI estimate highlights the public health importance of DLD for families, schools, healthcare providers and society. In line with the recommendations from the national Senate inquiry, this COI analysis substantiates the need for expansion of evidence-based services for DLD and an ongoing government commitment to fund research that compares the relative costs and effectiveness of specific evidence-based interventions and to fund national health and education policy initiatives that positively affect children with communication impairments.

Appendix A: Human Capability Framework[42]

A child possesses an initial vector of capabilities (genetic and environmental) denoted θ_1. *A parent invests in the child, denoted* h. *Let* I_t *denote parental investment in child capabilities at time* $t = 1,2, \ldots\ldots.., T$. *At each stage* t *let* θ_t *denote the accumulating vector of capabilities. The technology of capability production when a child is* t *years old is*

$$\theta_{t+1} = f_t\,(h, \theta_t, I_t\,)\ [1]$$

Substituting in Eq. 1 for θ_t, θ_t, θ_{t-1}, ……. *repeatedly, the stock of capabilities at stage* $t+1, \theta_{t+1}$ *as a function of all past investments.*

$$\theta_{t+1} = m_t\left(h, I_{t,}, \ldots\ldots\ldots.., I_t\right), t = 1, \ldots\ldots\ldots, T.[2]$$

Dynamic complementarity arises when $\partial^2 f_t\,(h, \theta_t I_t\,)/\,\partial\theta_t\,\partial I_t' > 0$*, i.e., when stocks of capabilities make investment in period* $t(I_t\,)$ *more productive. Self productivity arises through a multiplier effect* $\partial^2 f_t\,(h, \theta_t I_t\,)/\,\partial\theta_t > 0$, *i.e., the age-specific weights create higher levels of capabilities in subsequent periods. The output of the investment process is the child's cognitive and non-cognitive skill vector. The joint effects of self-productivity and dynamic complementarity help to explain that the return on investment is greatest at early stages of childhood development, particularly illustrated in children with disadvantage or disorders for whom the stock of capability may be low, and hence the complementarity is low.*

The adult stock of capability, h' *(=*θ_3 *) is a function of parental characteristics, initial conditions and investments during childhood* I_1 and I_2:

$$h' = m_2\,(h, \theta_t I_1 I_2\,)\ [3]$$

The effects of early and late investment can be explained in the constant elasticity of substitution (CES) production function

$$h' = m_2\left(h, \theta_t[\gamma(I_1\,)^{\phi} + (1-\gamma)(\,I_2\,)^{\phi}\,]^{\frac{1}{\phi}}\right)[4]$$

for $\phi \ \leq 1$ and $\phi \leq \gamma \geq 1$, *where* ϕ *is a measure how well late inputs substitute early inputs* . $1/(1-\phi)$ *is called an elasticity of substitution. When* $\phi = 1, I_1$ and I_2 *are perfect substitutes. When* $\phi = -\infty, I_1$ and I_2 *are perfect complements.*

The CES share parameter γ *is a capability multiplier. Early investment boosts* h' *directly (self-productivity) and increases the productivity of* I_2 *by increasing* θ_2 *through investments in the earlier time periods. Therefore* I_1 *directly increases* θ_2 *which subsequently effects the productivity of* I_2 *in forming* h' . γ *captures the net effect of* I_1 *on* h' *through self-productivity and direct complementarity. This explains why returns on investment are highest in the early years. As the degree of complementarity decreases, the role of the capability multiplier increases and the higher the multiplier, the more the investment should focus on the early years.*

When $\phi = 1$ *early and late investments are perfect substitutes so it is possible to remediate disadvantage or disorder However, in economics terms this may not be feasible. This is because the price of early investment is \$1 and the price of late investment is* $\$1/(1+r)$ *where r is the interest rate and* $1/(1+r)$ *is the discount factor. The amount of human capital produced from one unit of* I_1 *is* γ, *whereas as* I_2 *produces* $(1+r)(1-\gamma)$. *High productivity in initial investment drives the parents to invest early whereas the interest rate drives parents to invest late. Optimal conditions if* $\gamma > (1-\gamma)(1+r)$ *is early investment.*

The complementarity also explains that when ϕ *is small, high early investment should be followed up with higher later investment. When* $\phi = -\infty$, *the optimal investment strategy is* $I_{21} = I_2$ *and the ratio of early and late investment becomes important. Where* $-\infty < \phi < 1$ *the optimal ratio of investment is defined:* $\frac{I_1}{I_2} = \left[\frac{\gamma}{(1-\gamma)(1+r)}\right]^{\frac{1}{1-\phi}}$

42,255,256

Appendix B: Definitions of Common Communication Impairments

	Language	Speech	Reading	Other related conditions/comorbidities
	Speech Language and Communication Needs[a]			
Common terms	Specific/primary language impairment; developmental dysphasia; developmental language disorder/impairment	Phonological disorder; articulation disorder; stuttering; lisp	Developmental dyslexia	Swallowing; feeding; hearing impairment; ASD, ADHD
Defining characteristics	1) Receptive language scores < 1.25SD away from mean 2) Performance IQ ≥ 85 (specific); performance IQ < 85 (non-specific) 3) Primary condition, whereby it cannot be accounted for by any known aetiology 4) 'Transient' or 'persistent'	1) Child substitutes or omits sounds from words more than same-aged peers 2) Speech production errors	1) Child has significant difficulty learning to read accurately and fluently 2) Performance IQ ≥ 85 3) Adequate opportunity to learn	
Differentiating criteria	Severe neglect, secondary condition where it co-exists with another condition, such as ASD; hearing impairment; general developmental difficulties; behavioural or emotional difficulties; neurological impairment; bilingualism; cleft lip or palate; episodic otitis media; and social disadvantage	Structural abnormality of articulators (e.g., cleft palate) or neurological abnormality, significant hearing impairment, IQ < 70	Inadequate educational opportunity, secondary condition where it co-exists with another condition, such as ASD; hearing impairment; general developmental difficulties; behavioural or emotional difficulties; neurological impairment; bilingualism; cleft lip or palate; episodic otitis media; and social disadvantage	
Prevalence	Depends on the cut-off used (6–8 per cent)		Depends on cut-off used (around 9 per cent)	

Note. Adapted from Pennington et al.[17] [a]Broad term used largely in the UK. Not commonly used in Australia or in the USA.

Appendix C: Publication

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The impact of childhood language difficulties on healthcare costs from 4 to 13 years: Australian longitudinal study

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Abstract

Purpose: This study investigated the relationship between children's language difficulties and health care costs using the 2004–2012 Longitudinal Study of Australian Children (LSAC).
Method: Language difficulties were defined as scores ≤1.25SD below the standardised mean on measures of directly assessed receptive vocabulary (4–9 years) and teacher-reported language and literacy (10–13 years). Participant data were individually linked to administrative data, which were sourced from Australia's universal subsidised healthcare scheme (Medicare).
Result: It was found that healthcare costs over each 2-year age band were higher for children with language difficulties than without in the 4–5-year-age bracket (mean difference = AU$357, 95%CI $59, $659), in the 6–7-year-age bracket (mean difference = AU$602, 95%CI $136, $1068) and in the 10–11-year-age bracket (mean difference = AU$504, 95%CI $153, $854). Out-of-pocket costs, that is the portion of healthcare costs paid for by the family, were also higher for children with than without language difficulties in the 4–5-year-age bracket (mean difference = AU$123, 95%CI $46, $199), in the 6–7-year-age bracket (mean difference = AU$176, 95%CI $74,278) and in the 10–11-year-age bracket (mean difference = AU$79, 95%CI $6, $152). Medical services accounted for 97% of total healthcare cost differences.
Conclusion: Overall the findings from this study suggest that language difficulties are associated with increased healthcare costs at key developmental milestones, notably early childhood and as a child approaches the teenage years.

Keywords: *Language impairment*; *children*; *longitudinal*

Introduction

Language difficulties are one of the most common childhood conditions. The prevalence ranges from 7 to 17% (Law, Boyle, Harris, Harkness, & Nye, 2000; Reilly et al., 2010; Rice, Slegers, Taylor, & Zubrick, 2007; Tomblin et al., 1997) with much higher rates in children from disadvantaged backgrounds (Roy & Chiat, 2013). Language difficulties impact on the day-to-day functioning in many areas of children's lives, including academic achievement, social functioning and overall quality of life (Schoon, Parsons, Rush, & Law, 2010). There is also evidence that children with language difficulties may have long-term negative outcomes, including decreased educational attainment, work performance and occupational stability (Clegg, Hollis, Mawhood, & Rutter, 2005; Felsenfeld & Broen, 1994).

Because of the broad impact and high prevalence, language difficulties are likely to have considerable economic burden for individuals, families and society. As part of a broader enquiry into communication disability, language difficulties have recently been subject to a Senate Enquiry in Australia (Community Affairs References Committee, 2014) whereby they were identified as a priority area. The review concluded that there was an urgent need for the measurement of short, medium and long-term social and economic impacts of speech and language-related disorders (Community Affairs References Committee, 2014).

The long-term costs associated with under-employment and income loss in children with speech, language and communication problems are estimated to be substantial (Ruben, 2000), but little is known about the specific healthcare costs in these populations. The demand for primary care services is likely to be higher in children with language difficulties as they are commonly referred to a wide

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range of services for diagnosis and treatment. These services include speech-language pathology, psychology, paediatrics and early intervention services (Skeat, Gold, Wake, Ukoumunne, & Reilly, 2011; Skeat et al., 2014). Additionally, there may be downstream costs to the health system due to health conditions that develop as a by-product of the difficulties, such as emotional problems or behavioural difficulties, resulting from underlying co-morbidities such as Attention Deficit Hyperactivity Disorder (ADHD) or due to complex health care needs driven by social disadvantage (Yew & O'Kearney, 2013).

A small number of Australian studies indicate higher health care expenditure among families with children with language difficulties. For example, Skeat, Gold, Wake, Ukoumunne, & Reilly (2011) reported both government and out-of-pocket costs for families using the Early Language in Victoria Study (ELVS) (Skeat et al., 2011). This study considered costs at one time point and did not consider other predictors of healthcare utilisation. To date, the longitudinal relationship between health care utilisation and language difficulties has been largely unexplored.

Sciberras et al. (2015) measured the direct healthcare costs associated with language difficulties of children aged between 4 and 8 years using the Longitudinal Study of Australian Children (LSAC) and found that children with language problems compared to those without, have biennial health care expenditures that are on average AU$160 (95%CI 63,$257) higher at age 4–5years (Sciberras et al., 2015). However, in Australia children with language difficulties are more likely to be found in families where English is not the main language spoken (Taylor, Christensen, Lawrence, Mitrou, & Zubrick, 2013). Therefore, it is unclear how much of the increase in healthcare utilisation is due to the child's language difficulties rather than the child being bilingual. It is possible that simple cross-sectional correlation, without consideration of this confounder may provide biased estimates of the impact of a child's language difficulties on healthcare costs. Additionally, Sciberras et al. (2015) considered healthcare costs defined by the government rebate only, without consideration of the portion of total healthcare costs paid for by the family. The Australian Institute of Health and Welfare (AIHW) estimates that in 2010/11, 3.2% of household expenditure related to out-of-pocket healthcare expenses, with considerably higher costs for people with chronic or long-term conditions (Australian Institute of Health and Welfare, 2012). It is likely that the total healthcare costs for a child with language difficulties is considerably higher than the current literature estimates.

The purpose of this study is to explore the longitudinal relationship between language difficulties and healthcare costs, something which has been largely unexplored in the literature to date. By filling this gap, the study advances the literature on children's language and healthcare in Australia. More specifically, this paper draws on four additional years of longitudinal data (up to 13 years). This focuses on the child's progression from early childhood through to teenage years, which represents the age range where key developmental milestones are made. Patient out-of-pocket expenses are calculated to provide a more accurate estimate of the overall healthcare cost. The study utilises longitudinal regression to consider healthcare utilisation over time while simultaneously controlling for attributes of the mother and the household that may influence a child's language acquisition and whether a child seeks medical care.

Method

Longitudinal study of Australian children

The LSAC is a nationally representative, prospective cohort study of children's development in Australia. The LSAC follows two cohorts of children, a Birth (B) cohort and a Kindergarten (K) cohort, each comprising approximately 5000 children. Children were recruited in 2004 and were followed-up every two years. For the purposes of this study, the sample of interest is the K cohort. In 2004, the K cohort represented 4983, 4–5-year old children. These children were then followed up at 6–7 years, 8–9 years, 10–11 years and at 12–13 years. At each survey a face-to-face interview with the primary caregiver is administered, supplemented by a mailed survey with the children's teacher and direct assessments of the children. The sample is broadly representative of all Australian children. Full details of the study design have been previously published (Sanson et al., 2002). Healthcare costs were obtained by linkage with participant's Medicare Australia data. Consent for Medicare data linkage was given at Wave 1 and 93% of the K cohort consented.

Measurement of language acquisition

Table I summarises the language measures used in LSAC. The main measures are the short version of the Peabody Picture Vocabulary Test Third Edition (PPVT-III) (2013) (4–9 years), developed specifically for the LSAC and the Academic Rating Scale-Language and Literacy (ARS total score) (10–13 years) (Australian Institute of Family Studies, 2010; Dunn & Dunn, 1997). Both measures are widely used measures of language and communication skills (McLeod & McKinnon, 2007; Reilly et al., 2014; Sciberras et al., 2015). Children were defined as having language difficulties if their standardised scores were $\leq$1.25SD below the mean on corresponding language measures at each age. At ages 4–5

Table I. Measures of language acquisition used in LSAC- K cohort 2004–2012.

Cohort	Age	Measure	Description
Language acquisition measures			
K	4–9	Peabody Picture Vocabulary test Third edition (PPVT-III)[ab]- short version	Australian adapted short version of the PPVT-III (Dunn & Dunn, 1997) assesses a child's receptive vocabulary. The PPVT-III is a direct assessment in which children are asked to select pictures that correspond to words read out by the examiner. Forty items are administered, consisting of 20 core items and 10 base and ceilings items. Raw scores are converted to scaled scores. This adapted version has a reliability of 0.76 (Rothman, 2003).
K	10–13	Academic rating scale - Language and literacy[ab].	A 9-item teacher completed questionnaire of reading and comprehension (e.g. Conveys ideas clearly, understands and interprets text, reads and comprehends). Teachers report the proficiency of the child on a 5 point scale (Not yet; Beginning; In progress; Intermediate: Proficient) Aims to rate a child's language and literacy skills in relation to other children at the same grade level known by the teacher (Australian Institute of Family Studies, 2010). This measure has validity to assess developmental skill consistent with early literacy acquisition (Bishop & Adams, 1990; Buil-Legaz, Aguilar-Mediavilla, & Rodríguez-Ferreiro, 2016; Leitao & Fletcher, 2004; Lewis et al., 2015)
Supplementary measures			
K	4–7	Parents Evaluation of Developmental Status (PEDS) receptive language	Parent reported question is concern about how the child understands what the parent says (receptive). (No; a little; Yes) (Australian Institute of Family Studies, 2010)

[a]Children were defined as having language difficulties at each age if their standardised language scores were <1.25SD below the mean.
[b]Language scores were standardised using the transformation of continuous raw scores to Z-scores at each age group.

years and 6–7 years the Parents Evaluation of Developmental Status (PEDS) for receptive and expressive language is also available. This second measure has been used in the literature (McLeod & Harrison, 2009) and allowed us to examine whether healthcare cost patterns were consistent when using alternative measures of language.

Healthcare costs

Healthcare in Australia is funded through a combination of state and federal government funding (70%), private insurance (13%) and individual out-of-pocket expenses (17%) (Australian Institute of Health and Welfare (AIHW), 2013). The federal government funds a public insurance scheme for all the Australians (Medicare) to provide subsidised access to medical services provided in the community (Medicare Benefits Scheme (MBS)), free public hospital treatment and subsidised access to pharmaceuticals (Pharmaceutical Benefits Scheme (PBS)) (Tier 1). In addition, a second tier includes privately funded health insurance that covers private hospital services and a portion of allied health services. Co-payments (portion of the total service fee payable by the patient) apply to many services.

The outcome variables considered in the analysis include total healthcare and out-of-pocket costs Total healthcare costs were obtained by linkage with Australian Medicare data. Biennial (2-year) costs for each child were calculated over a 10-year period, that is, calendar years, from 2003 to 2004, 2005 to 2006, 2007 to 2008, 2009 to 2010 and 2011 to 2012. Medical services (MBS) and pharmaceutical (PBS) costs were combined to report total healthcare costs. We report on out-of-pocket costs as the portion of total healthcare costs that are paid for by the family on behalf of the child. Costs in the Medicare linked dataset are reported at an item level and include the MBS/PBS subsidy or government rebate portion of the total service fee only. The total service fee was then determined by the sum of the MBS/PBS subsidy and a calculated co-payment. Total healthcare costs were calculated as the sum of all total service fees. Total out-of-pocket costs were calculated as the sum of all co-payments. Overall, out-of-pocket costs represent approximately 26% of the total healthcare costs in the analysis. The AIHW estimates that individual out-of-pocket costs make up 28% of the total federal government expenditure. Given that the sample of interest is children, whereby there is likely to be a higher rate of bulk billing, the calculated out-of-pocket cost is consistent with the literature. (Australian Institute of Health and Welfare (AIHW), 2013). Full details on the assumptions and methods used to calculate total service fees and co-payments are located in Supplementary material.

In terms of medical services that are particularly relevant to children with language difficulties, under the current policy Medicare provides a subsidy towards unlimited visits to general practitioners, specialist physicians (including paediatrics). For access to Medicare subsidies for speech-language pathology, other allied health services and psychology the primary care physician nominates the number of services, up to a maximum of five per calendar year (Australian Government Department of Health, 2015). State-funded community or educationally based providers and private non-referred health services are not accounted for in these analyses. The AIHW estimates that approximately 10% of all primary health care costs (including referred specialist services) are from community health services and a further 4% are from private non-referred health services (Australian Institute of Health and Welfare (AIHW), 2013).

Descriptive statistics

Table II shows the prevalence of language difficulties amongst different demographic groups in the Australian population. Approximately 9% of children aged between 4 and 13 years were defined as having language difficulties between 2004 and 2012. Prevalence estimates varied according to socio-demographic characteristics of the children and their families. Language difficulties were more prevalent among males (8.3%), when compared to females (6.4%) and among children in the lowest family income quintile (17.1%), compared to the highest (3.7%). Prevalence of language difficulties was higher in children whose mothers spoke a language other than English at home (14.1%) when compared to English speakers (7.5%), in indigenous (19.7%) compared to non-indigenous (8%) children, those children with long-term medical conditions (11.3%) compared to without (7.6%) and those with average or below health status (11.3%) compared to children in excellent health (7.1%). Language difficulties were negatively associated with the presence of private health insurance (4.9%).

Measures

The summary statistics of the explanatory variables considered in the analyses are shown in Panel B-Panel D, Table III below. These statistics are reported biennially (2 years) from 2004 to 2005, 2006 to 2007, 2008 to 2009, 2010 to 2011 and 2012 to 2013. The summary statistics of the outcome variables are shown in Panel A, Table III (see Supplementary material for detailed definitions). These statistics are reported biennially (2 years) from 2003 to 2004, 2005 to 2006, 2007 to 2008, 2009 to 2010 and 2011 to 2012. In a two-year period a child in the K cohort has on average AU $1607 (SD $2467) of healthcare expenditure, of which AU$306 (SD $594) is an out-of-pocket expense.

Child characteristics were used as explanatory variables in the model to determine which types of characteristics contribute to health service

Table II. Prevalence of language difficulties in Australia (reported biennially (2 years)).

	Total sample[a]	No.	% with language difficulties
Panel A[a]			
Language difficulties			
4/5 years	4093	340	8.3
6/7 years	4384	278	6.3
8/9 years	4409	408	9.3
10/11 years	3712	451	12.1
12/13 years	3716	474	12.8
Panel B[b]			
Gender			
Female	2249	144	6.4
Male	2357	196	8.3
Mother speaks another language at home			
NESB	714	147	14.1
English speaking	3892	193	7.5
Child is Indigenous			
Indigenous	172	21	19.7
Non-indigenous	4434	319	8.0
Household income[a]			
Lowest	667	114	17.1
Quintile 2	994	94	9.5
Middle	888	62	7.0
Quintile 4	705	31	4.4
Highest	537	20	3.7
Private health insurance			
Private health insurance	2135	104	4.9
Uninsured	2463	286	11.6
Child's global health status[a]			
Excellent health	2369	169	7.1
Very good/good health	1246	117	9.4
Average and below health	478	54	11.3
Long-term medical conditions[a]			
No medical conditions	3281	248	7.6
Medical conditions	812	92	11.3
Sample size	4606		

NESB: Non-English speaking background; K: kindergarten.
[a]Sample is subject to missing observations. Prevalence is calculated on a total sample size of non-missing observations only.
[b]The sample is indicative of wave 1 only, when participants are 4–5 years old.
See Supplementary material for the definition of variables and description of the sample.
Sources: The 2004, 2006, 2008, 2010 and 2012 Longitudinal Study of Australian Children (K cohort).

Table III. Baseline characteristics (reported biennially (2 years)).

Variable	Measurement	K cohort Mean	SD
Panel A. Outcome variables			
Healthcare costs	Healthcare costs = Medical Services (MBS)+ Pharmaceuticals(PBS)+ Hospital Costs	1607	2467
Out-of-pocket costs (OOP)	OOP = Healthcare costs - Co-payments	306	594
Panel B. Child's characteristics			
Language difficulties[a]	1 = Yes, 0 = No	0.09	0.29
Missing language difficulties[b]	1 = Yes, 0 = No	0.01	0.12
Receptive language concern[a]	1 = Yes, 0 = No	0.10	0.30
Expressive language concern[c]	1 = Yes, 0 = No	0.18	0.39
Long-term medical conditions	1 = Yes, 0 = No		
	Language plus 1 other condition	0.03	0.16
	1 condition other than language	0.08	0.27
	2 or more conditions other than language	0.02	0.29
Child is Indigenous	1 = Yes, 0 = No Includes Aboriginal and Torres Strait Islander	0.04	0.19
Child's global health status	Ordered 1:5 derived 1 = Yes, 0 = No.		
	Excellent health	0.46	0.50
	Very Good/Good health	0.31	0.46
	Average and below Health	0.23	0.42
Wave	Wave 1 (child aged 4–5 years)	0.20	0.40
	Wave 2 (child aged 6–7 years)	0.20	0.40
	Wave 3 (child aged 8–9 years)	0.20	0.40
	Wave 4 (child aged 10–11 years)	0.20	0.40
	Wave 5 (child aged 12–13 years)	0.20	0.40
Panel C. Mother's characteristics			
Mother speaks language other than English at home	1 = Yes, 0 = No	0.15	0.36
Mother has completed Year 12	1 = Yes, 0 = No	0.58	0.49
Mother has a long term medical condition	1 = Yes, 0 = No	0.09	0.29
Mother's relative has suffered a serious illness, injury or assault in the last year	1 = Yes, 0 = No	0.14	0.34
Mother has a resident partner	1 = Yes, 0 = No	0.83	0.37
Panel D. Household characteristics			
Household income	Annual gross household income equivalised	47 223	37 894
Missing household income	1 = Yes, 0 = No	0.05	0.21
Mother receives Carer's benefits	1 = Yes, 0 = No	0.04	0.19
Private health Insurance	1 = Yes, 0 = No	0.50	0.95
Number of siblings the child has	Range 0–11	1.59	1.08
Number of observations (child * year)		23 021	
Number of observations with no missing values for household income		21 908	
Number of observations with no missing values for language difficulties		20 314	
Unique number of observations (child)		4606	

K: kindergarten cohort; MBS: medical benefits scheme; PBS: pharmaceutical benefits scheme; SD: standard deviation.
[a]Children are excluded from the language difficulties group if they reported other long-term medical conditions; [b]Refer to Supplementary material for assumptions about missing observations; [c]Receptive and expressive language measures available from ages 4 to 7 years. These measures are used in a supplementary analysis only.
Note: Refer to Supplementary material for the definitions of the variables and the description of the sample.
Sources: The 2004; 2006, 2008, 2010 and 2012 Longitudinal Study of Australian Children (K cohorts).

utilisation and healthcare cost. Mothers and household characteristics were used as explanatory variables to test whether particular attributes of the mother or household, influence whether a child seeks medical care. Approximately 15% of the mothers speak a language other than English at home and 9% of the mothers have a long-term medical condition. Total household gross income, which was defined to be the sum of maternal income, resident partner's income, and the income of any other employed person who is present in the household and is then equivalised to account for the number of people in the household, was AU $47223 (SD $37894) (in 2014 prices). Approximately 4% of the sample received the Carer's Benefit: an income supplement that is paid to carers who provide additional daily care and attention for someone with a long-term disability or medical condition.

The explanatory variable of interest is the variable indicating whether a child has language difficulties (Panel B, Table III). This is based on a number of child language measures in the LSAC (Table I) and has a prevalence of 9%, when defined in terms of the main language measures.

Final sample for analysis

From the original sample of 4983 children, Medicare records were linked for 4606 children (92.3%). Nine observations were excluded as healthcare cost outliers, defined by individuals with costs over AU$50000 in any two-year period. This criterion is consistent with the literature (Sciberras et al., 2015). T-tests were used to

Table IV. Total 2-year healthcare costs per child by language difficulty status and age: Australia 2003–2012.

Age	Mean: Language difficulty	Mean: No language difficulty	Mean difference (95% CI): Unadjusted (OLS)[a]		OLS + explanatory variables[b]		Adjusted (FE) + explanatory variables[c]	
K cohort	1	2	3		4		5	
4–5 years	1878	1561	316*	[23, 610]	534**	[264, 803]	357*	[59, 659]
6–7 years	1833	1539	294	[−225, 812]	541*	[43, 1039]	602*	[136, 1068]
8–9 years	1376	1613	−237^{+}	[−502, 27]	−33	[−310, 244]	58	[−200, 315]
10–11 years	2276	1750	527*	[99, 954]	581**	[189, 972]	504**	[153, 854]
12–13 years	2198	2341	−143	[−495, 209]	53	[−273, 379]	48	[−250, 346]

Biennial (2-year) costs in 2014 $AUD, rounded to the nearest dollar, 95% confidence intervals (CI) in parentheses, $^{+}p<0.10$; $^{*}p<0.05$; $^{**}p<0.01$.
OLS: ordinary least squares; FE: fixed effects.
[a]Logistic regression (OLS) includes explanatory variables for a child language difficulties at 4–5 years, 6–7 years, 8–9 years, 10–11 years, 12–13 years interacted with time (Wave1, Wave 2, Wave 3, Wave 4, Wave 5) and weighted for attrition.
[b]Logistic regression (OLS) includes explanatory variables for a child with language difficulties at 4–5 years, 6–7 years, 8–9 years, 10–11 years, 12–13 years interacted with time (Wave1, Wave 2, Wave 3, Wave 4, Wave 5), three other variables for the child; whether the child is Aboriginal or Torres Strait Islander, the health status of the child (excellent, very good/good and average/below) and three variables for long-term health conditions the child has (language plus one long-term condition, one long-term condition without language, two or more long-term conditions without language difficulties). Mothers characteristics include the mothers educational attainment (mothers who did/did not complete year 12), one variable indicating mothers health status (long-term medical conditions), one variable indicating health shocks (mother's relatives who suffered serious injury, assault or illness) and one variable indicating if the mother has a resident partner. Household characteristics include the number of siblings the child has, household income levels (equivalised and quintiles determined), whether the mother receives a carer's allowance, a variable for the child's health insurance status and four variables for observations in Wave 2 to Wave 5 (biennial waves form 2004–2012). Model is weighted for attrition.
[c]Fixed affects regression includes explanatory variables as defined in b. Model is weighted for attrition.

compare the differences of baseline characteristics between the full LSAC sample and the reduced Medicare-linked sample. No significant differences were observed (results available on request).

Analysis

Fixed effects regression was used to explore the association between healthcare costs and language difficulties from 4 to 13 years. This method improves on cross-sectional analysis as it provides longitudinal estimates that take into account observed and unobserved confounders of healthcare and language that are time invariant. That is, this type of regression analysis implicitly controls for the effects of particular attributes of the mother or household that might influence whether a child seeks medical care, as well as influencing the child's opportunities to develop language, as long as they do not vary over time. For example, a child whose mother speaks a language other than English at home or the indigenous status of the child. While a possibility of biases due to unobserved time-variant confounders remains, results based on this type of regression are more reliable than those based on cross-sectional analysis. In Table IV, columns 1 and 2 show the mean unadjusted healthcare costs for children with and without language difficulties. In Table IV, column 3 shows the unadjusted (cross-sectional) mean difference in healthcare costs for children with and without language difficulties, across each age-group, without controlling for any explanatory variables. Column 4 repeats the analysis from column 3 while simultaneously controlling for the explanatory variables outlined in Table III (OLS+explanatory variables). In Table IV, column 5 shows the adjusted mean difference in healthcare for children with and without language difficulties using fixed effects regression analysis while simultaneously controlling for the explanatory variables outlined in Table III. The analysis was conducted using STATA 14 SE (College Station, TX).

Result

Table IV shows the estimates for 2-year total healthcare costs for a child with language difficulties. The cross-sectional results (column 3) showed that a child with language difficulties, compared to a child without, had higher healthcare costs between 4–5 years and 10–11 years of age. Once explanatory variables were simultaneously controlled for in the analysis (Table IV, column 4 and 5) this brought about significant changes in the estimates. In this analysis statistically significant differences were found in total healthcare costs for children with language difficulties, compared to those without, at age 4–5 years AU$534 (95%CI $264, $803), at 6–7 years AU$541 (95%CI $43, $1039) and at age 10–11 years AU$581 (95%CI $189, $972). The results of the longitudinal fixed effects methods showed that 2-year healthcare costs for children with language difficulties, when compared to those without, were AU$357 (95%CI $59, $659) higher at age 4–5 years, AU$602 (95%CI $136, $1068) higher at age 6–7years and AU$504 (95%CI $153, $854) higher at age 10–11 years.

[1]Interactions with time are included to capture how the mean effect varies by age. That is, the effect of language difficulties on healthcare costs is shown to significantly differ at 4–5 years, 6–7 years and 10–11years.

Table V. Total 2-year out-of-pocket costs per child by language difficulties status and age: Australia 2003–2012.

	Mean		Mean difference (95% CI)					
Age	Language difficulty	No language difficulty	Unadjusted[a]		OLS + explanatory variables[b]		Adjusted (FE) + explanatory variables[c]	
K cohort	1	2	3		4		5	
4–5 years	290	266	23	[−34, 80]	106**	[50, 161]	123**	[46, 199]
6–7 years	288	279	9	[−95, 113]	111*	[8, 213]	176**	[74, 278]
8–9 years	213	302	−88**	[−136, −40]	−13	[−63, 37]	25	[−33, 83]
10–11 years	321	340	−19	[−86, 48]	41	[−25, 107]	79*	[6, 152]
12–13 years	383	488	−106*	[−188, −23]	−23	[−100, 54]	−21	[−94, 51]

Biennial (2-year) costs in 2014 $AUD, rounded to the nearest dollar, 95% confidence intervals (CI) in parentheses, $+p<0.10$; $*p<0.05$; $**p<0.01$.

OLS: ordinary least squares; FE: fixed effects.

[a]Logistic regression (OLS) includes explanatory variables for a child language difficulties at 4–5years, 6–7years, 8–9years, 10–11 years, 12–13years interacted with time (Wave1, Wave 2, Wave 3, Wave 4, Wave 5) and weighted for attrition.

[b]Logistic regression (OLS) includes explanatory variables for a child with language difficulties at 4–5 years, 6–7 years, 8–9 years, 10–11 years, 12–13 years interacted with time (Wave1, Wave 2, Wave 3, Wave 4, Wave 5), three other variables for the child; whether the child is Aboriginal or Torres Strait Islander, the health status of the child (excellent, very good/good and average/below) and three variables for long-term health conditions the child has (language plus long-term condition, one long-term condition without language, two or more long-term conditions without language). Mothers characteristics include the mothers educational attainment (mothers who did/did not complete year 12), one variable indicating mothers health status (long-term medical conditions), one variable indicating health shocks (mother's relatives who suffered serious injury, assault or illness) and one variable indicating if the mother has a resident partner. Household characteristics include the number of siblings the child has, household income levels (equivalised and quintiles determined), whether the mother receives a carer's allowance, a variable for the child's health insurance status and four variables for observations in Wave 2 to Wave 5 (biennial waves form 2004–2012). Model is weighted for attrition.

[c]Fixed affects regression includes explanatory variables as defined in b.

The portion of healthcare costs paid by the family on behalf of the child (out-of-pocket costs) was also significantly higher for children with language difficulties, compared to those without once explanatory variables were considered. Based on the cross-sectional results with explanatory variables, (Table V, columns 4) the difference in total 2-year out-of-pocket costs for children with than without language difficulties was AU$106 (95%CI $50, $161) at 4–5 years and AU$111 (95%CI $8, $213) at 6–7years. Once longitudinal fixed effects models were considered, statistically significant differences were found in total 2-year out-of-pocket costs for children with language difficulties, compared to those without at age 4–5 years AU$123 (95%CI $46, $199), at age 6–7 years AU$176 (95%CI $74, $278) and at age 10–11 years AU$79 (95%CI $6, $152).

Comparison of healthcare costs by type of health service (Table VI) showed that medical services accounted for 97% of the total healthcare cost differences for children with language difficulties, compared to those without, which was largely driven by general practise visits, speech-language pathology and other allied health services. Medical service costs for children with language difficulties, compared to those without, were AU$381 (95%CI $89, $674) higher in the 4–5 year age bracket, AU$603 (95%CI $160, $1047) higher in the 6–7 age bracket and AU$455 (95%CI $131, $778) higher in the 10–11 year age bracket (Table VI, Column 2). Pharmaceutical costs in the 10–11 year age bracket accounted for the remaining 3% of the total healthcare costs differences (mean difference = AU$49, (95%CI $32, $130)) (Table VI, column 3).

In a supplementary analysis an alternative measure of language difficulties was used to test the consistency of the results. In this supplementary analysis the explanatory variable of interest was based on a language measure in the LSAC indicating whether a mother has concern for her child's receptive or expressive language (Table I). This variable was asked when the child was aged 4–5 years and then 2 years later, at 6–7 years and has been used to identify children's language in previous studies (McLeod & Harrison, 2009). The prevalence of receptive language concern in children aged between 4 and 7 years is largely consistent with the prevalence identified using the main language measures (9%). The fixed effects regression model can only be computed for the waves where the measure is observed which in this case is wave 1 and wave 2, when the child is 4–5 years and 6–7 years. The model simultaneously controls for the explanatory variables outlined in Table III. Statistically significant differences were found in total healthcare costs for children with language difficulties, compared to those without, at age 4–5 years AU$264 (95%CI $16, $512). These results are consistent with the results identified by the main language measures in Table IV.

Discussion

This paper has investigated the cross-sectional and longitudinal relationships between healthcare costs and children's language difficulties using the 2004–2012 LSAC. The first set of findings is that there is a consistently positive relationship between children's language difficulties and their healthcare utilisation in both cross-sectional and longitudinal analyses once background characteristics are accounted for. Children with language difficulties aged 4–7 years, 6–7 years and 10–11 years are more likely to have

Table VI. Total 2-year medical services (MBS) and Pharmaceutical (PBS) costs $AUD per child by language difficulty status.

	Mean difference (95% CI)					
Age	Total healthcare		Medical services[a,b]		Pharmaceuticals[a,b]	
K cohort	1	2	3			
4–5 years	357*	[59, 659]	381*	[89, 674]	−23	[−94, 49]
6–7 years	602*	[136,1068]	603**	[160, 1047]	−1	[−92, 89]
8–9 years	58	[−200, 315]	53	[−189, 295]	5	[−56, 65]
10–11 years	504**	[153, 854]	455**	[131, 778]	49*	[32, 130]
12–13 years	48	[−250, 346]	63	[−219, 346]	−15	[−72, 42]

Biennial (2-year) costs in 2014 $AUD, rounded to the nearest dollar, 95% confidence intervals (CI) in parentheses, *$p<0.05$, **$p<0.01$.

[a]Medical services include hospital attendances.

[b]Fixed affects regression includes explanatory variables for a child with language difficulties at 4–5 years, 6–7 years, 8–9 years, 10–11 years, 12–13 years interacted with time (Wave1, Wave 2, Wave 3, Wave 4, Wave 5), three other variables for the child; whether the child is Aboriginal or Torres Strait Islander, the health status of the child (excellent, very good/good and average/below) and three variables for long-term health conditions the child has (language difficulties plus one long-term condition, one long-term condition without language, two or more long-term conditions without language difficulties). Mothers characteristics include the mothers educational attainment (mothers who did/did not complete year 12), one variable indicating mothers health status (long-term medical conditions), one variable indicating health shocks (mother's relatives who suffered serious injury, assault or illness) and one variable indicating if the mother has a resident partner. Household characteristics include the number of siblings the child has, household income levels (equivalised and quintiles determined), whether the mother receives a carer's allowance, a variable for the child's health insurance status and four variables for observations in Wave 2 to Wave 5 (biennial waves form 2004–2012).

increased healthcare utilisation, relative to children aged 8–9 years or 12–13 years. The demand for additional medical services at 4–5 years is consistent with the identification of language difficulties during pre-school years or as the child starts school. These additional services may include general practitioner referral to speech-language pathology or early intervention services (Skeat et al., 2011). Additionally, there is evidence of downstream medical and pharmaceutical costs to the health system, which supports the literature that long-term conditions develop as a by-product of language difficulties. In a recent meta-analyses Yew & O'Kearney (2013) found that children with language difficulties, compared to those without, are approximately twice as likely to exhibit emotional problems (RR =1.84; 95%CI 1.04,3.25), more than twice as likely to have behavioural difficulties (RR =2.66; 95 CI 1.66,3.08), and are at the 60th percentile (95%CI 52,68) for ADHD symptoms. (Yew & O'Kearney, 2013). Further research is required to disentangle the total medical service costs for these children.

Another set of findings is that total healthcare costs for children with language difficulties compared with those without are higher than previous estimates. Sciberras et al. (2015) estimated that the difference in biennial healthcare costs for children with and without language difficulties at age 4–5 was AU$160 (95%CI 63, $257). The estimate from the current study of AUAU357 (95%CI $59, $659) (Table IV) suggests that this may have been an under estimate. This difference is largely explained by the inclusion of out-of-pocket expenses, which account for AU$123, or approximately 34% of the total healthcare cost at this age.

These results improve on previous studies based on cross-sectional analysis alone. The strengths of this study include the use of language measures from a nationally representative longitudinal study with individual linkage to medical, pharmaceutical and hospital expenditure, and calculated out-of-pocket costs. Longitudinal regression techniques were used to examine the costs associated with language difficulties at five time points, from the early childhood, up to when the child is a teenager. Validated and widely used parent report, teacher report, and direct assessments of language difficulties were used, allowing assessment of a broad range of language difficulties.

Limitations

However, it is acknowledged that one of the difficulties in calculating healthcare utilisation based on language acquisition screening tools is attributing healthcare costs to an additional language healthcare need. Medicare does not provide information about the reason for healthcare attendances and as a result it was not possible to distinguish between services and pharmaceuticals received specifically for the assessment and/or treatment of language difficulties. Several studies have demonstrated that socio-demographic, child and family cultural characteristics play a role in patterns of healthcare utilisation. It is well documented that social disadvantage disparities exist in accessing and utilising healthcare (Fiscella, Franks, Doescher, &

[1]Interactions with time are included to capture how mean differences varies by age. That is, the effect of language difficulties on medical service costs is shown to significantly differ at 4–5 years, 6–7 years and 10–11years. The effect of language difficulties on pharmaceutical costs is shown to differ at 10–11years.

Saver, 2002; Flores, Abreu, & Tomany-Korman, 2005; Flores, Rabke-Verani, Pine, & Sabharwal, 2002; Flores & Tomany-Korman, 2008; Yeo, 2004) and children with social disadvantage are at a higher risk of language acquisition and processing difficulties (Fernald, Marchman, & Weisleder, 2013; Nicholson, Lucas, Berthelsen, & Wake, 2012) and lower rates of language acquisition growth (Taylor et al., 2013). Children from non-English speaking backgrounds when compared to English speakers have been found to perform poorly on receptive language assessments at early ages but have higher rates of language acquisition growth. Yet their parents are less likely to seek help for their child's difficulties (Cooper, Smaje, & Arber, 1998; Fiscella et al., 2002; Flores et al., 2005; Flores & Tomany-Korman, 2008; Skeat et al., 2014; Yeo, 2004). While this study has attempted to disentangle the effects of language difficulties and healthcare utilisation through more sophisticated modelling techniques and the inclusion of possible confounders, it is not possible to distinguish between healthcare received specifically for the assessment and/or treatment of language difficulties and health care received to treat co-morbidities or that may be due to factors that are predictors of language difficulties.

A second limitation is how the study was able to define language difficulties at each age. A number of language screening measures are available in LSAC and these vary appropriately to match the developmental age of the child. For example the PPVT-III is a widely accepted screening tool used in longitudinal studies for children between ages 4 and 9 due to it being a cost-effective method with good reliability (Rothman, 2003). However, one of the limitations of these tools is that they provide insufficient detail to allow classification of children as meeting criteria for diagnosed language impairment (Australian Institute of Family Studies, 2013; Centre for Human Resource Research, & The Ohio State University, 2009). A further limitation is that there is both direct and indirect language screening measures available in the LSAC. For the purposes of this study language difficulties were defined by population standardised scores ($\leq$1.25SD below the mean). This produced prevalence estimates of approximately 8.5% which is consistent with prevalence estimates reported in the literature (Law et al., 2000). Additional supplementary analysis undertaken in this study provided consistent results across language measures. Overall, these findings support healthcare cost differences irrespective of the measure used to define language difficulties.

The LSAC linked Medicare data excludes total service fees for Medicare items. As a result total service fees are calculated as part of the analysis by calculating patient co-payments using published medical services fees from the Australian Medical Association and private health insurance gap schedules from a large private health insurance provider in Australia (Australian Medical Association (AMA), 2014; Medibank Private, 2014), which introduces some uncertainty in the analysis. As a consistency check we compared the calculated out-of-pocket costs (as a proportion of total healthcare costs) with published AIHW estimates and found that our assumptions are consistent for the population of interest.

It is possible that the analysis is not capturing all of the healthcare costs for these groups. The analysis improves on previous studies with the inclusion of out-of-pocket costs. It captures MBS-funded speech pathology, early intervention services, allied health and speech pathology when accessed through primary care providers. However, there is a ceiling on the number of allied health and speech pathology services that can be claimed under Medicare policy in any calendar year. If families are accessing state-funded community or educationally based providers after exhausting Medicare services, the overall healthcare costs will be underestimated. Equally, it is likely that children from higher income families may access private services which are also not accounted for in these analyses. Further research is required to quantify these additional costs.

Conclusion

Overall the findings from this study suggest that language difficulties are associated with increased healthcare costs at key developmental milestones, notably early childhood and as a child approaches the teenage years. The results suggest that there is value in implementing effective early intervention to reduce the downstream costs on the health system.

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Supplementary material available online

Appendix D: Full Estimation Results – Health Expenditure

Table 86: Full estimation results – health expenditure ($) – B cohort

Full estimation results – health expenditure ($) – B cohort																
	Without covariates								With covariates							
	Healthcare expenditure				Healthcare out-of-pocket				Healthcare expenditure				Healthcare out-of-pocket			
	OLS (1)	RE (2)	GLM (3)	FE (4)	OLS (5)	RE (6)	GLM (7)	FE (8)	OLS (1)	RE (2)	GLM (3)	FE (4)	OLS (5)	RE (6)	GLM (7)	FE (8)
1 if child has language difficulties	16.27	55.00	16.54	77.76	−71.94**	−7.298	−22.61+	15.84	179.0**	320.1**	147.2**	232.8**	3.225	51.32**	−1.082	48.16**
	(69.03)	(51.79)	(56.98)	(68.54)	(14.44)	(12.41)	(12.42)	(15.46)	(66.22)	(51.92)	(56.95)	(65.86)	(14.10)	(12.75)	(12.82)	(15.52)
Missing language difficulties	542.4	−962.6**	193.1**		−227.2+	−245.4**	−221.3**		−2141.9*	−392.7	−1075.2**		−631.0**	−90.08+	−283.1**	
	(1166.8)	(127.2)	(35.97)		(123.3)	(24.58)	(8.456)		(860.1)	(239.7)	(67.76)		(100.2)	(49.37)	(10.40)	
Wave 2	−638.7**	−674.5**	−634.1**	−638.2**	−223.1**	−227.9**	−223.0**	−223.8**	−647.3**	−683.9**		−666.4**	−234.9**	−233.3**		−230.5**
	(72.17)	(40.29)	(51.01)	(51.60)	(17.17)	(9.861)	(12.19)	(12.30)	(69.92)	(44.68)		(55.82)	(16.64)	(10.87)		(13.57)
Wave 3	−780.0**	−920.5**	−779.1**	−783.4**	−237.6**	−260.8**	−239.8**	−241.8**	−733.3**	−810.7**		−795.1**	−238.6**	−247.1**		−243.5**
	(71.01)	(45.77)	(57.88)	(58.13)	(16.98)	(11.04)	(13.86)	(13.88)	(69.81)	(52.32)		(66.21)	(16.94)	(12.77)		(16.37)
Wave 4	−808.2**	−983.9**	−823.9**	−810.3**	−215.3**	−244.3**	−218.7**	−214.2**	−916.5**	−960.9**		−919.1**	−246.6**	−246.0**		−237.2**
	(75.00)	(47.91)	(62.57)	(63.35)	(18.53)	(11.89)	(15.09)	(15.49)	(77.66)	(57.23)		(73.49)	(19.16)	(14.13)		(18.54)
Wave 5	−752.1**	−1120.8**	−744.9**	−746.5**	−175.8**	−236.4**	−175.1**	−174.5**	−845.5**	−894.4**		−845.5**	−205.6**	−202.5**		−192.3**
	(78.24)	(50.33)	(68.40)	(68.59)	(19.23)	(12.68)	(16.58)	(16.67)	(76.16)	(58.50)		(75.95)	(19.01)	(14.65)		(18.62)
Wave 6	−204.1*	−850.0**	−222.0**	−206.9**	74.04**	−70.52**	68.09**	74.33**	−390.0**	−417.1**		−359.0**	30.60	38.83*		46.81*
	(86.17)	(54.44)	(74.99)	(75.95)	(23.62)	(14.82)	(19.94)	(20.32)	(85.25)	(65.42)		(81.71)	(23.44)	(18.13)		(21.90)
Language + 1 other condition									34.68	468.4+	74.36	185.5	−90.29	33.11	−11.58	9.043
									(345.7)	(255.4)	(141.7)	(284.9)	(84.59)	(68.93)	(35.86)	(78.17)
1 other condition without language									2188.1**	1444.9**	800.2**	1285.8**	443.3**	317.6**	154.0**	287.7**
									(200.7)	(137.0)	(112.8)	(179.6)	(50.71)	(36.76)	(23.19)	(45.29)
2 or more other conditions without language									2914.9**	1996.0**	889.4**	1566.0**	605.4**	450.6**	190.7**	344.9**
									(336.0)	(258.0)	(162.5)	(307.5)	(88.53)	(72.75)	(38.16)	(81.65)

Full estimation results – health expenditure ($) – B cohort

	Without covariates								With covariates							
	Healthcare expenditure				Healthcare out-of-pocket				Healthcare expenditure				Healthcare out-of-pocket			
	OLS (1)	RE (2)	GLM (3)	FE (4)	OLS (5)	RE (6)	GLM (7)	FE (8)	OLS (1)	RE (2)	GLM (3)	FE (4)	OLS (5)	RE (6)	GLM (7)	FE (8)
Carer Allowance													180.6**	216.6**	104.5**	174.6**
													(43.74)	(49.20)	(31.65)	(63.38)
Carer Payment													124.1*	150.1*	128.4**	132.1*
													(61.20)	(60.16)	(37.93)	(62.98)
Indigenous									−248.3*	−394.3**			−100.2**	−109.9**		
									(110.7)	(94.13)			(23.48)	(20.04)		
NESB									65.33	63.09			−68.74**	−75.20**		
									(58.51)	(65.12)			(13.61)	(15.28)		
Resident partner in the home									0.865	−26.56		−76.68	32.19	38.04+		19.27
									(104.4)	(81.01)		(123.1)	(25.32)	(22.53)		(32.42)
Number of siblings									−213.2**	−159.4**		−17.45	−38.64**	−33.35**		−1.477
									(31.06)	(31.22)		(54.93)	(7.646)	(7.719)		(14.36)
Health insurance									884.9**	1011.4**		−1877.2	270.7**	296.8**		−2764.8
									(48.14)	(56.69)		(.)	(13.24)	(14.47)		(.)
Missing health insurance									515.0	255.1			−55.91	−80.00*		
									(918.7)	(297.3)			(151.9)	(35.38)		
Mother finished Year 12									140.9*	63.52		46.18	40.84*	15.11		12.22
									(66.71)	(47.71)		(64.68)	(17.33)	(13.03)		(16.98)
Recent illness of relative									208.7*	183.4**		148.3	29.70	36.55*		27.30
									(83.62)	(66.10)		(94.65)	(21.27)	(17.96)		(24.75)
Mother has medical condition									−58.42	25.94		74.73	−20.02	4.210		38.85
									(122.1)	(77.77)		(119.9)	(27.74)	(20.16)		(27.59)
Mother is single parent									52.50	54.29		18.29	52.44**	31.24*		4.771

Full estimation results – health expenditure ($) – B cohort																
	Without covariates								With covariates							
	Healthcare expenditure				Healthcare Out-of-pocket				Healthcare expenditure				Healthcare out-of-pocket			
	OLS (1)	RE (2)	GLM (3)	FE (4)	OLS (5)	RE (6)	GLM (7)	FE (8)	OLS (1)	RE (2)	GLM (3)1	FE (4)	OLS (5)	RE (6)	GLM (7)1	FE (8)
									(69.93)	(52.04)		(71.42)	(15.95)	(13.42)		(18.83)
Income Quintile 2									89.89	95.70+		−22.01	86.06**	55.92**		−9.373
									(68.83)	(55.00)		(76.58)	(16.35)	(14.23)		(20.10)
Income Quintile 3									165.7*	74.54		−59.36	119.5**	59.99**		−23.10
									(75.81)	(59.37)		(83.39)	(19.41)	(15.71)		(22.01)
Income Quintile 4									213.2**	97.07		−144.6	144.0**	73.46**		−46.41+
									(80.77)	(68.61)		(99.32)	(20.43)	(18.07)		(27.43)
Income Quintile 5									246.8*	99.54		66.33	107.3**	64.07**		−1.807
									(122.2)	(81.52)		(115.4)	(27.77)	(22.31)		(26.98)
Child has very good health									425.7**	390.4**		341.5**	92.04**	85.26**		77.32**
									(43.57)	(34.95)		(45.61)	(11.19)	(9.209)		(11.93)
Child have has good or health									1283.6**	1092.1**		877.4**	243.5**	226.3**		186.1**
									(82.22)	(69.20)		(82.74)	(20.09)	(18.16)		(19.97)
Number of observations	19510	28651	19495	19510	19510	28651	19495	19510	19510	24631	19495	19510	16254	19510	24631	19495
Chi-squared	0.0126			0.0238	0.0294			0.0496	0.139			0.0673	0.0507	0.129		
Log-likelihood	−182349			−176022	−155850			−150178	−181014			−175578	−145186	−154796		
Sigma_u		1568.7		1928.3		373.0		483.6		1439.0		2228.8	1857.8		311.9	
Sigma_e		2105.8		2196.5		551.8		584.0		2105.2		2148.3	2050.9		570.3	
rho		0.357		0.435		0.314		0.407		0.318		0.518	0.451		0.230	
AIC	364715	.	.	352057	311716	.	.	300369	362088	.	.	351204	290422	309653	.	.
BIC	364778	.	.	352105	311779	.	.	300417	362325	.	.	351393	290615	309890	.	.

Note. OLS = ordinary least squares; RE = random effects; GLM = generalised linear model; FE = fixed effects; Akaike information criterion; BIC = Bayesian information criterion

Table 87: Full estimation results – health expenditure ($) – K cohort

Full estimation results – health expenditure ($) – K cohort																		
	Without covariates								With covariates									
	Healthcare expenditure				Healthcare out-of-pocket				Healthcare expenditure					Healthcare out-of-pocket				
	OLS (1)	RE (2)	GLM (3)	FE (4)	OLS (5)	RE (6)	GLM (7)	FE (8)	OLS (1)	RE (2)	GLM (3)	FE (4)	FE (5) lag	OLS (5)	RE (6)	GLM (7)	FE (8)	FE (9) lag
1 if child has language difficulties	88.90	−15.31	114.8	89.75	−55.88**	−37.71**	0.866	22.11	235.8**	217.6**	253.9**	245.2**	246.8**	21.49	26.19+	39.12*	61.62**	66.03**
	(84.35)	(53.75)	(75.99)	(82.01)	(19.50)	(13.11)	(17.14)	(21.72)	(79.65)	(56.96)	(72.59)	(78.26)	(89.53)	(18.85)	(14.06)	(16.49)	(20.33)	(22.92)
Missing language difficulties		−605.3*				−214.5**				613.6					112.8			
		(288.7)				(45.97)				(662.3)					(124.5)			
Wave 2	−29.67	−47.92	−28.86	−29.65	9.202	5.925	11.22	11.47	68.17	52.54		−19.72		18.94	21.32*		9.710	
	(64.10)	(31.03)	(37.99)	(38.00)	(13.79)	(8.008)	(9.640)	(9.615)	(61.29)	(36.75)		(41.87)		(13.75)	(9.559)		(10.84)	
Wave 3	8.657	−25.27	16.05	18.79	26.67+	21.64*	27.02*	28.06*	154.8*	157.0**		66.53	85.91+	42.08**	50.93**		35.48**	26.75*
	(64.18)	(35.16)	(47.11)	(47.17)	(13.95)	(8.679)	(11.58)	(11.57)	(61.24)	(40.93)		(48.51)	(46.58)	(14.01)	(10.46)		(12.58)	(12.08)
Wave 4	212.0**	130.0**	220.7**	222.0**	70.88**	58.74**	70.92**	70.85**	194.1**	207.9**		163.3**	181.6**	54.99**	64.02**		56.19**	44.93**
	(67.60)	(41.97)	(52.61)	(52.73)	(14.55)	(10.25)	(12.49)	(12.48)	(68.50)	(47.64)		(54.37)	(54.74)	(15.25)	(11.88)		(13.38)	(13.49)
Wave 5	735.8**	326.0**	748.4**	747.9**	209.8**	132.4**	210.2**	210.3**	734.6**	734.9**		727.9**	726.7**	199.1**	205.6**		206.9**	192.7**
	(77.42)	(45.61)	(63.21)	(63.12)	(17.96)	(11.52)	(15.53)	(15.52)	(74.73)	(51.97)		(62.76)	(66.86)	(18.14)	(13.74)		(16.06)	(17.26)
Wave 6	1269.4**	594.6**	1302.7**	1300.5**	489.5**	318.2**	492.3**	492.4**	1234.7**	1336.6**		1277.3**	1280.7**	471.8**	508.8**		490.7**	477.0**
	(87.33)	(57.29)	(77.60)	(77.51)	(25.37)	(17.26)	(23.53)	(23.50)	(84.10)	(71.14)		(77.29)	(80.06)	(24.47)	(22.25)		(23.42)	(23.96)
Language + 1 other condition									249.7	103.0	−23.54	56.99	−10.31	−36.67	−57.76	−6.146	25.14	24.67
									(242.5)	(169.8)	(117.0)	(251.4)	(306.2)	(60.55)	(43.63)	(24.65)	(64.41)	(80.67)
1 other condition without language									1301.5**	970.4**	677.1**	733.6**	747.1**	280.4**	247.9**	145.8**	191.0**	209.7**
									(114.7)	(90.99)	(62.20)	(108.5)	(125.7)	(29.18)	(25.28)	(15.23)	(29.30)	(35.48)
2 or more other conditions without language									1941.6**	1601.6**	753.6**	976.4**	858.9**	308.0**	342.9**	139.1**	180.0**	176.2**

Full estimation results – health expenditure ($) – K cohort

	Without covariates								With covariates										
	Healthcare expenditure				Healthcare out-of-pocket				Healthcare expenditure					Healthcare out-of-pocket					
	OLS (1)	RE (2)	GLM (3)	FE (4)	OLS (5)	RE (6)	GLM (7)	FE (8)	OLS (1)	RE (2)	GLM (3)	FE (4)	FE (5) lag	OLS (5)	RE (6)	GLM (7)	FE (8)	FE (9) lag
									(224.0)	(183.9)	(107.1)	(208.1)	(251.7)	(52.05)	(50.11)	(22.94)	(51.42)	(61.49)
Mother receives Carer Allowance									1191.7**	1140.6**	550.1**	715.1**	553.8*	89.86*	106.9*	59.68**	131.5*	104.8
									(203.4)	(193.0)	(111.8)	(233.4)	(244.8)	(44.08)	(41.49)	(23.00)	(58.19)	(65.78)
Mother receives Carer Payment									995.2**	772.7**	576.6**	744.1**	623.3**	118.6*	65.38	91.75**	118.4*	106.6*
									(221.2)	(164.1)	(129.1)	(211.0)	(215.9)	(52.99)	(42.45)	(29.45)	(53.81)	(51.51)
Indigenous									−203.2*	−346.9**				−101.1**	−105.5**			
									(96.97)	(92.72)				(20.22)	(17.57)			
NESB									123.6+	94.75				−44.46**	−43.76**			
									(65.20)	(70.48)				(16.27)	(16.65)			
Resident partner in the home									220.3**	273.2**		196.5+	102.4	97.11**	97.80**		70.60*	38.06
									(76.57)	(70.79)		(108.9)	(119.8)	(20.01)	(19.38)		(28.02)	(31.66)
Number of siblings 1									−174.3*	−110.0		−44.41	25.95	−24.85	−9.610		−10.41	9.849
									(81.04)	(78.12)		(138.5)	(151.4)	(23.49)	(22.52)		(37.34)	(38.53)
Number of siblings 2 or more									−439.4**	−367.6**		−11.71	76.04	−86.81**	−74.03**		7.404	37.88
									(81.24)	(79.55)		(150.7)	(169.2)	(23.39)	(22.56)		(39.95)	(42.79)
Health insurance									601.1**	626.2**				189.5**	187.8**			
									(51.52)	(59.87)				(13.32)	(14.87)			
Missing health insurance									265.7	271.8		−720.7		21.14	61.84		37.86	
									(311.2)	(243.5)		(5215842.9)		(88.18)	(55.03)		(.)	
Mother finished Year 12									47.25	125.5*		−3.500	−200.9	23.57+	41.25**		−38.39	−78.24
									(45.84)	(53.68)		(398.6)	(432.7)	(12.22)	(13.50)		(90.82)	(94.51)
Recent illness of relative									213.0**	182.7**		127.0*	160.3*	41.27*	41.66**		19.34	31.07
									(68.61)	(52.91)		(64.54)	(76.54)	(17.67)	(14.64)		(18.05)	(21.98)
Mother has medical condition									152.3*	68.42		−81.63	−32.25	2.388	−2.632		−36.37+	−27.65
									(77.02)	(53.28)		(74.12)	(100.4)	(19.33)	(14.70)		(21.09)	(28.58)

Full estimation results – health expenditure ($) – K cohort																		
	Healthcare expenditure				Healthcare out-of-pocket				Healthcare expenditure					Healthcare out-of-pocket				
	OLS (1)	RE (2)	GLM (3)	FE (4)	OLS (5)	RE (6)	GLM (7)	FE (8)	OLS (1)	RE (2)	GLM (3)1	FE (4)	FE (5) lag	OLS (5)	RE (6)	GLM (7)1	FE (8)	FE (9) lag
Mother is single parent									242.1*	211.2**		358.2**	429.5**	43.84+	58.94**		137.7**	147.0**
									(107.5)	(76.88)		(103.3)	(116.5)	(22.56)	(19.80)		(23.53)	(26.05)
Income Quintile 2									152.8*	31.67		1.399	21.96	31.52*	9.129		−13.56	−8.400
									(66.11)	(51.07)		(71.26)	(82.21)	(14.36)	(11.65)		(16.26)	(19.26)
Income Quintile 3									242.1**	46.38		4.431	58.58	90.00**	38.78**		−22.11	−15.84
									(71.00)	(54.80)		(78.80)	(94.55)	(17.47)	(14.13)		(21.10)	(25.85)
Income Quintile 4									329.2**	162.4*		44.10	137.9	153.3**	103.3**		9.264	26.11
									(74.22)	(63.25)		(86.07)	(101.3)	(19.73)	(17.30)		(24.22)	(28.61)
Income Quintile 5									366.0**	95.38		−40.02	28.04	178.4**	109.3**		2.740	3.516
									(81.30)	(72.83)		(107.0)	(124.8)	(22.11)	(19.63)		(29.96)	(35.37)
Missing Income									40.94	−190.8*		−296.4*	−368.1**	33.75	−13.69		−78.45*	−110.5**
									(108.3)	(82.55)		(115.6)	(142.3)	(26.62)	(21.00)		(30.52)	(38.30)
Child has very good health									413.2**	393.3**		295.7**	327.1**	84.30**	89.53**		70.64**	82.17**
									(42.74)	(35.99)		(48.38)	(58.41)	(11.15)	(10.09)		(14.19)	(17.31)
Child has good or health									1253.1**	1234.3**		990.0**	1070.8**	259.7**	277.7**		243.6**	270.6**
									(84.63)	(84.01)		(102.8)	(117.2)	(22.87)	(23.47)		(28.52)	(33.26)
Child has lagged very good health													123.5*					23.87
													(55.63)					(15.89)
Child has lagged good health													164.2+					34.40
													(97.56)					(27.41)
Number of observations	18338	27618	18316	18338	18338	27618	18316	18338	18338	23697	18316	18338	15275	18338	23697	18316	18338	15275
Chi-squared	0.0286			0.0528	0.0509			0.0785	0.129			0.0819	0.0805	0.119			0.0991	0.0980
Log-likelihood	−171674			−166179	−147456			−143258	−170678			−165893	−138508	−146777			−143051	−119673
Sigma_u		1441.0		2031.6		346.5		473.9		1282.7		1927.2	2083.7		237.1		467.3	528.3
Sigma_e		2230.0		2286.0		624.7		655.0		2262.9		2252.1	2348.4		651.0		648.1	684.4
rho		0.295		0.441		0.235		0.344		0.243		0.423	0.440		0.117		0.342	0.373

Appendix E: Data- Chapter 4

Household income

Household income was calculated from parents' reported pre-tax weekly income from all sources (wages/salary, profit/losses, shares in a partnership, property income, dividends/interest, government payments, and child support). Total gross household income was defined as the sum of weekly income reported by mothers and their partners plus any other household members that earned income. Total individual annual income was then calculated by multiplying the pre-tax weekly amount by 52 weeks. The household income variable was then inflated to 2014 dollars using the wage rate of the Australian Consumer Price Index and scaled by the international square root approach[257] in order to account for household size. Quintiles were derived, with 1 indicating the lowest income. A sixth category was created to account for missing observations.

Healthcare need factors other than disability are also considered. One health measure was derived from the parental responses to a question on self-assessed general health status as *excellent*, *very good*, *good*, *fair* or *poor*. The three lowest categories are collapsed into one because the sample has 2% of observations with responses in the categories *very poor* and *poor*. These were then categorised into the variables *excellent*, *good* and *average* self-assessed health.

Additionally, Indigenous status, English as a second language (NESB), gender, age and health insurance status are considered in the analysis.

Carers' benefits

Carers are able to claim two government benefits, known as Carer Allowance (Mcarers_A) and Carer Payment (Mcarers_P). Carers can receive Mcarers_P if they cannot support themselves through paid employment due to their caring responsibility, subject to means and assets testing. Mcarers_A is a supplementary payment, paid to carers who provide daily care in a private home to a person with disability. Eligibility is based on the severity of the condition. In 2015, the rate of Carer Allowance was

$118.20 per fortnight and Carer Payment $601.50 per fortnight[244,245].

Child and parental long-term medical conditions

The other health measure results from the question, 'Does the study child have a medical condition or disability that has lasted or is likely to last greater than 6 months (*yes*/*no*)'. This is categorised to indicate whether the child has a long-term problem. There is evidence that when health conditions are present, individuals with low income are less likely to report them. The prevalence of conditions based on this measure may be a true underestimate of disability in the LSAC[14].

Child's global health

The child's global health was derived from the parental responses to a question on current health status as *excellent*, *very good*, *good*, *fair* or *poor*. The three lowest categories are collapsed into one because the sample has 2% of observations with responses in the category *very poor* and *poor*. These were then categorised into the variables *excellent*, *good* and *average* global health.

Final sample

From the original sample of approximately 10,000 children, 7 per cent were excluded because they had no linked Medicare data. This resulted in 4,778 children in the B cohort and 4,606 children in the K cohort.

Appendix F: Prevalence Snapshot of Analytical Sample

Table 88 shows the prevalence of language difficulties among different demographic groups in the Australian population in 2008 (Wave 3). Wave 3 was chosen because this was the first year that My School data was available. The estimates will vary slightly from the overall estimates in Chapter 2, where the sample was from Wave 1. Table 6 shows that children with language difficulties are slightly under-represented in the reduced sample, when compared with the total sample (8.2 per cent vs. 9.1 per cent respectively). However, the prevalence remains within expected ranges in the literature (7 to 17 per cent)[18-22]. There was a higher rate of children who spoke a language other than English at home (NESB) and of Indigenous children with language difficulties in the modelling sample, when compared with the total sample.

Table 88: Prevalence of language difficulties – Australia, 2008

		Total Sample			Modelled Sample[c]		
		Total	No.	% with language difficulties	Total	No.	% with language difficulties
Language difficulties[b]		4,894	445	9.1	4,238	347	8.2
Gender [a]							
	Female	2,249	205	9.1	2,061	163	7.9
	Male	2,357	240	10.2	2,177	184	8.5
Child speaks another language at home[a]							
	NESB	714	107	14.1	446	70	15.7
	English speaking	3,892	338	7.5	3,792	277	7.3
Child is Indigenous[a]							
	Indigenous	172	44	19.7	126	29	23.0
	Non-Indigenous	4,434	401	8.0	4,112	318	7.7
Household income[ab]							
	Lowest	677	101	14.9	653	98	15.0
	Quintile 2	779	76	9.8	604	74	12.3
	Middle	883	57	6.5	747	56	7.5
	Quintile 4	952	57	6.0	814	57	7.0
	Highest	901	38	4.2	804	38	4.7
Private health insurance[b]							
	Private health insurance	2,273	129	4.9	2,068	116	5.6
	Uninsured	2612	315	11.6	2,165	231	10.7
Long-term medical conditions[ab]							
	Medical conditions	311	49	15.8	297	49	16.5
	No medical conditions	4,013	289	7.2	3,900	283	7.3
Sample size		4,894			4,238		

Note. NESB = non-English speaking background; K = Kindergarten. Sources: The 2006, 2008, 2010, 2014 Longitudinal Study of Australian Children (K cohort) [a]The sample is indicative of Wave 3 only, when participants are 8–9 years of age. [b]Sample is subject to missing observations. Sample size = 4,983 and 4,431 for total and modelled sample respectively. Prevalence is calculated on a total sample size of non-missing observations only. [c]Modelled sample refers to all children who have a recorded school identification number. See Appendix 1 for the definition of variables and description of the sample.

Appendix G: Variable Definitions

Outcome Variables			
Panel A: Academic achievement			
Literacy measures			
LSAC K	4–5	Reading competencies index	A 5-item teacher-completed questionnaire of reading competencies (e.g., interested in books, interested in reading, able to read simple and complex words, is able to read simple sentences (*yes*, *no*). Raw scores are converted to scaled scores (Z-scores).
LSAC K	6–7	Academic Rating Scale: Language and Literacy	A 10-item teacher-completed questionnaire of reading and comprehension (e.g., contributes relevant information; understands and interprets stories; reads words with regular and irregular vowel sounds; reads age-appropriate books; reads age-appropriate books fluently; able to write sentences with > 1 clause; composes beginning, middle and end; understands some print conventions; uses computer). Teachers report the proficiency of the child on a 5-point scale (*not yet*, *beginning*, *in progress*, *intermediate*, *proficient*) Rasch-modelled raw scores are converted to scaled scores (Z-scores).
LSAC K	8–15	Australian National Assessment Program – Literacy and Numeracy (NAPLAN)	Australian National Assessment Program – Literacy and Numeracy (NAPLAN): three domains (reading, writing and language) given to all students in Years 3, 5, 7 and 9. Raw scores are converted to scaled scores (Z-scores).
Numeracy measures			
LSAC K	4–5	Number competency	A 5-item teacher-completed questionnaire of number competencies (e.g., able to sort and classify, able to count objects, able to count to 20, able to recognise numbers, able to do simple addition (*yes*, *no*). Raw scores are converted to scaled scores (Z-scores).
LSAC K	6–7	Maths competency	A 10-item teacher-completed questionnaire of numeracy (e.g., continuing pattern using 3 items, understanding of place value, models whole numbers, counts change, organises data onto graphs, estimates quantities, measures common instruments, uses a variety of strategies to problem solve). Teachers report the proficiency of the child on a 5-point scale (*not yet*, *beginning*, *in progress*, *intermediate*, *proficient*) Rasch-modelled raw scores are converted to scaled scores (Z-scores).
LSAC K	8–15	Australian National Assessment Program – Literacy and Numeracy (NAPLAN)	Australian National Assessment Program – Literacy and Numeracy (NAPLAN): one domain (numeracy) given to all students in Years 3, 5, 7 and 9. Raw scores are converted to scaled scores (Z-scores).

Outcome Variables			
NAPLAN attendance			
LSAC K	8–15	NAPLAN attendance	Categorical variable: 0 = completed all tests, 1 = absent for some tests, 2 = absent for all, 3 = exempt, 4 = no match.
Panel B: Social and Emotional Health			
Functioning			
LSAC K	6–15	Physical functioning	One 23-item parent questionnaire designed to measure paediatric health-related quality of life. 4 scales (physical functioning [8 items], emotional functioning [5 items], social functioning [5 items], school functioning [5 items]) [258]
LSAC K	6–15	Emotional functioning	
LSAC K	6–15	Social functioning	
LSAC K	6–15	School functioning	
Strengths and difficulties questionnaire			
LSAC K	4–15	SDQ Pro-social	Parent questionnaire of 5 items (considerate of others' feelings, shares with children , shows empathy, shows kindness, volunteers to help) (*not true*, *somewhat true*, *certainly true*)
LSAC K	4–15	SDQ Hyperactivity	Parent questionnaire of 5 items (e.g., behaviour of last six months, restless, overactive, fidgeting easily distracted, think before you act) (*not true*, *somewhat true*, *certainly true*)
LSAC K	4–15	SDQ Emotional problems	Parent questionnaire of 5 items (e.g., complained about headaches, stomach aches, illness, has worries, unhappy, nervous, clingy in new situations, easily loses confidence) (*not true*, *somewhat true*, *certainly true*)
LSAC K	4–15	SDQ Peer problems	Parent questionnaire of 5 items (e.g., solitary, has at least one good friend, liked by others, gets on better with adults than with children) (*not true*, *somewhat true*, *certainly true*)
LSAC K	4–15	SDQ Conduct problems	Parent questionnaire of 5 items (e.g., temper, obedient, fights with other children or bullies them, argumentative with adults) (*not true*, *somewhat true*, *certainly true*)
LSAC K	4–15	SDQ total score	Sum of mean values of hyperactivity, emotional, peer and conduct problems scales
Panel C: Education expectations			

		Outcome Variables	
LSAC K	6–15	Expectations about education (parent)	Parent-reported question asking how far the parent expects the child will go in education. 1 = leave school before finishing secondary school, 2 = complete secondary school, 3 = complete a trade or vocational training course, 4 = go to university and complete a degree, 5 = obtain postgraduate qualifications at a university (e.g., master's degree or doctoral degree). Asked 6–7 years, 8– 9 years, 12–13 years, and 14–15 years. Assume 4–5 years = 6–7 years, 8–9 years = 10–11 years' expectations.
LSAC K	14–15	Expectations about education (child)	Child direct report on how far the child will go in education. 1 = leave school before finishing secondary school, 2 = complete secondary school, 3 = complete a trade or vocational training course, 4 = go to university and complete a degree, 5 = obtain postgraduate qualifications at a university (e.g., master's degree or doctoral degree).
		Panel D: Labour force outcomes	
PIACC	Adult	Employment status	1 = employed, 2 = unemployed, 3 = not in the labour force
PIACC	Adult	Health status	1 = good health, 0 = poor health

Key explanatory variables

Approach to learning is a teacher-reported variable, which represents the mean value of six sub-questions (from age 6 to 11) and 10 sub-questions (from age 12 to 15) on the child's organisation, adaptability, persistence, and eagerness to learn.

The SDQ is the Strengths and Difficulties Questionnaire, a behavioural screening questionnaire developed by UK child psychologist Robert Goodman[259] for children from age 2 through to 17 years. It includes five sub-tests covering emotional symptoms, conduct problems, hyperactivity, peer relationship problems and prosocial behaviour.

ICSEA is the Index of Community Socio-Educational Advantage. It was created by the Australian Curriculum, Assessment and Reporting Authority (ACARA) specifically to enable fair comparisons of the National Assessment Program – Literacy and Numeracy (NAPLAN) test achievement by students in schools across Australia. A value on the index corresponds to the average level of educational advantage of the school's student population relative to that of other schools[260].

NAPLAN is the National Assessment Program – Literacy and Numeracy. NAPLAN is a series of literacy and numeracy tests conducted annually across Australia for all students in Years 3, 5, 7 and 9[173].

Teacher efficacy represents the mean of three questions indicating whether the teacher thinks they have a strong effect on academic achievement, are competent dealing with behavioural issues and learning issues, and have high expectations for academic success (1 = *strongly agree*, 2 = *agree*, 3 = *neither agree nor disagree*, 4 = *disagree*, 5 = *disagree*, 6 = *strongly disagree*).

Socioeconomic position (SEP) is defined as a composite measure developed for LSAC, encompassing both resource and social-status-based factors. The concept of SEP has been found to be closely tied to that of human capital[261, p4)]. The components of SEP include standardised measures of parental educational attainment, occupational prestige and combined annual income. To represent family SEP, an unweighted average was calculated relative to the number of parents present in the home. Where there were two resident parents, the sum of the standardised component variables was divided by five, and where there were was only one resident parent, the sum was divided by three. The average score was then re-standardised to a mean of zero and a SD of 1, producing a final continuous measure of SEP[262].

The analysis considered the following additional student-level attributes: non-English speaking background, other medical conditions/disabilities, and child's health status. Non- English speaking background and medical conditions provide indicators of the current NAPLAN exemption policy[lxxx]. Other medical conditions/disabilities were defined by three binary variables resulting from the question 'Does your child have any medical conditions or disabilities lasting 6 months or longer?' These variables are defined as mutually exclusive variables: no language difficulties with one other medical condition, language difficulties plus one other medical condition, no language difficulties with two or more other medical conditions). The child's health status is an indicator of absence on the day of testing and is based on an ordered question: 'How is your child's current health?' (define: *excellent*, *very good*, *good*, *average*, and *below*). Categories are collapsed into *excellent*, *very good* and *average* health.

[lxxx] Students can obtain exemptions if they have a significant or complex disability or if they are from a non-English speaking background and arrived in Australia less than one year before the tests [173]

Appendix H: Approach to Multilevel Modelling

Approach to multilevel modelling

This appendix briefly outlines the multilevel modelling used to model the outcomes of interest. The multilevel modelling fitted is a two-level school-effects model; that is; there are data at two levels.

In this case, students sit within schools. The responses of interest, academic literacy, numeracy achievement and PSDQ scores are continuous variables. Expectations for education and NAPLAN attendance are categorical variables modelled as binary variables.

The model fitted allows a random intercept for schools and fixed effects for all other school and student-level characteristics:

$$y_{ij} = X\tau + Z\mu + \epsilon$$

where y_{it} is the academic literacy or numeracy scored for student i in school j,
$X\tau$ is the fixed effects (both school and individual level), $Z\mu$ is the random school effects and ϵ
is the between-student (within school) variation.

Model exploration

Model building[134]

1) Null model
2) Fixed effect individual (time and other covariates)
3) Fixed effect school (school academic achievement)
4) Random coefficients (Level 1 time, Level 2 individuals, Level 3 school)
5) Interactions
6) Residual diagnostics
7) REML vs. MLE.

The analysis starts by specifying a two-level variance components model to students' outcomes scores. This 'null' model includes only the intercept, school and individual random effects, time and a residual error term. Two approaches are considered to interpreting variance components in multilevel models: variance partition coefficients (VPCs) and intraclass correlation coefficients (ICC).

Using variance partition coefficients (VPC)[lxxxi], the school-level variance was calculated:

$$\mathrm{VPC_v} = \frac{\sigma_v^2}{\sigma_v^2 + \sigma_u^2 + \sigma_e^2 + \sigma_f^2} = \frac{0.126}{0.126 + 0.027 + 0.197 + 0.154} = 0.25$$

And the variance between students nested in schools over time as:

$$\mathrm{VPC_v} = \frac{\sigma_u^2 + \sigma_e^2}{\sigma_v^2 + \sigma_u^2 + \sigma_e^2 + \sigma_f^2} = \frac{0.027 + 0.197}{0.126 + 0.027 + 0.197 + 0.154} = 0.44$$

Of the variation in literacy scores, 25 per cent lies between schools, 44 per cent lies within schools between individuals over time, and the remaining 31 per cent lies within individuals. The VPC shows that there is some degree of clustering in the data. The null model supports the use of multilevel modelling, when compared with a linear model. LR test vs. linear model: $\mathrm{chi}^2(3) = 9635.19$ Prob > $\mathrm{chi}^2 = 0.0000$.

Using ICC, school ICC is calculated as the correlation between two students, i and j, within the same school.

$$\mathrm{p_v} = \mathrm{corr}(\mathrm{literacy_{ij,}}, \mathrm{literacy_{i'j,}}) = \frac{0.126}{0.126 + 0.027 + 0.197 + 0.154} = 0.25$$

The individual-level ICC is calculated as the correlation between two students, i and $\mathrm{i'}$, net of the school effects.

[lxxxi] In conditional models, VPCs are based on the residual, and therefore measure the proportion of outcome variation unexplained by predictor variables

$$p_v = \mathrm{corr}(\mathrm{literacy}_{ik,}\mathrm{literacy}_{i'k,}) = \frac{0.126 + 0.027 + 0.197}{0.126 + 0.027 + 0.197 + 0.154} = 0.69$$

The individual-level ICC does not coincide with individual VPC. The correlation between two students in different schools is assumed to be 0. Therefore, school-level literacy scores are slightly correlated, and individual level (net of school effects) is highly correlated.

This is repeated for the non-cognitive skills, PSDQ total score, parents' expectations, and NAPLAN attendance[lxxxii].

Using variance partition coefficients (VPC)lxxxiii the school-level variance is calculated:

$$\mathrm{VPC}_v = \frac{\sigma_v^2}{\sigma_v^2 + \sigma_u^2 + \sigma_e^2 + \sigma_f^2} = \frac{1.88}{1.88 + 0.22 + 16.31 + 7.54} = 0.07$$

And the variance between students nested in schools over time.

$$\mathrm{VPC}_v = \frac{\sigma_u^2 + \sigma_e^2}{\sigma_v^2 + \sigma_u^2 + \sigma_e^2 + \sigma_f^2} = \frac{0.22 + 16.31}{1.88 + 0.22 + 16.31 + 7.54} = 0.64$$

It can be observed that 7 per cent of the variation in literacy scores lies between schools, 64 per cent lies within schools between individuals over time, and 29 per cent lies within individuals. The VPC shows that there is some degree of clustering in the data. The null model supports the use of multilevel modelling, when compared with a linear model. LR test vs. linear model: $\mathrm{chi}^2(0) = 10662$. Prob > $\mathrm{chi}^2 = 0.0000$.

Using ICC, the school ICC is calculated as the correlation between two students, i and j,

---

[lxxxii] Methods for NAPLAN attendance and parents expectations for education not reported.

within the same school.

$$\mathrm{p_v} = \mathrm{corr}(\mathrm{PSDQ_{ij,}}\mathrm{PSDQ_{i'j,}}) = \frac{1.88}{1.88 + 0.22 + 16.31 + 7.54} = 0.08$$

The individual-level ICC is calculated as the correlation between two students, i and i', net of the school effects.

$$\mathrm{p_v} = \mathrm{corr}(\mathrm{PSDQ_{ij,}}\mathrm{PSDQ_{i'j,}}) = \frac{1.88 + 0.22 + 16.31}{1.88 + 0.22 + 16.31 + 7.54} = 0.71$$

The individual-level ICC does not coincide with individual VPC. The correlation between two students in different schools is assumed to be 0. Therefore, school-level PSDQ scores are slightly correlated, and individual level (net of school effects) is highly correlated.

In terms of parent's expectations for education (using XTMELOGIT), 31 per cent of the variation in literacy scores lies between schools, and 69 per cent lies within schools between individuals. The null model supports the use of multilevel modelling, when compared with a linear model. LR test vs. linear model: $chi^2(0) = 6073.49$ Probability > $chi^2 = 0.0000$.

Schools are then ranked by the magnitude of their predicted effects to test whether the random effects are normally distributed. The aim is to explore whether there are any structural features of the education system that need to be addressed. For example, Gemici et al[177].found significant differences in tertiary rankings by the type of school (government, independent, Catholic or co-educational vs. all-girls and all-boys schools). Additionally, the model needs to consider 'selection'. Do higher performing language students select into schools of higher academic achievement? In terms of literacy, the results show that the lowest scoring school has a literacy score of −0.67 and the highest scoring school has a literacy score of 1.28 (see Figure 14). Figure 15 shows that the random effects for literacy are largely normally distributed (plotted along the 45-degree line) with a small number of outliers from government schools. In terms of PSDQ, the lowest scoring school has a score of −1.66, and the highest scoring school has a score of 2.73. There is evidence of positive skewing. Figure 14 to Figure 17 show that the random effects for literacy are normally distributed (plotted along the 45-degree line) and are positively skewed for PSDQ scores.

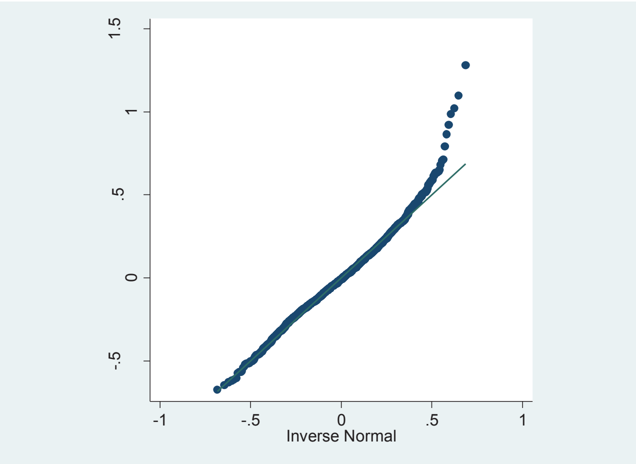


Figure 14: Ranking of literacy scores by individuals in schools

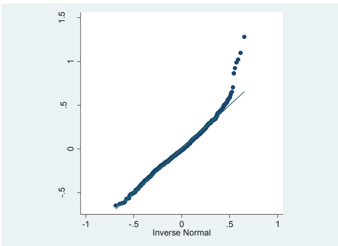
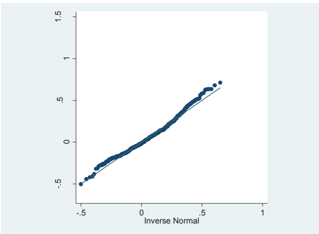
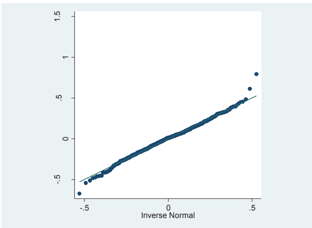
Government schools	Catholic schools	Independent schools
		

Figure 15: Ranking of literacy scores by individuals in schools (by school type)

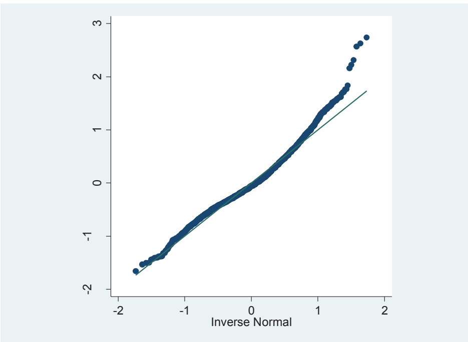


Figure 16: Ranking of PSDQ scores by individuals in schools

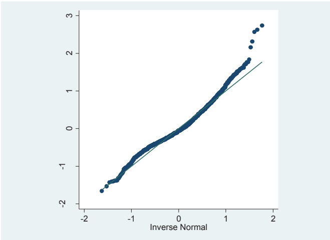
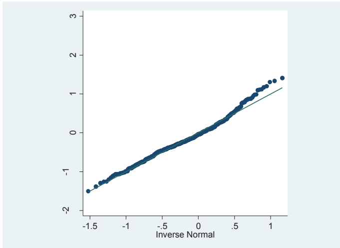
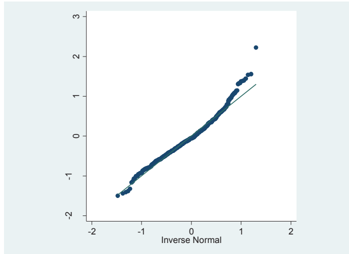
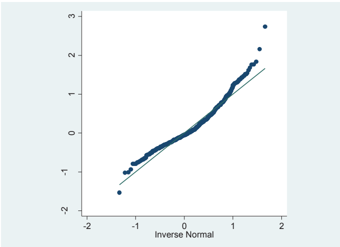
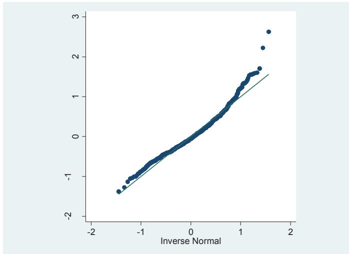
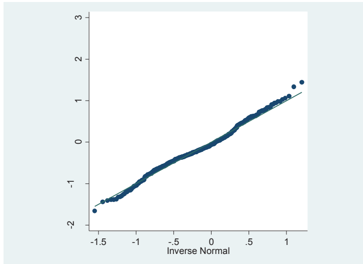
Government schools	Catholic schools	Independent schools
		
SEP 1	SEP 2	SEP5
		

Figure 17: Ranking of PSDQ scores by individuals in schools (by school type) and by Socioeconomic position (SEP)

Additionally, this study considers the impact of non-cognitive skills on the school-level variance of literacy and numeracy skills, and there is evidence that schools have the potential to foster these dispositions to support students in both academic achievements. Using variance partition coefficients (VPC)[lxxxiv], the school-level variance is calculated with these variables included in the null model and find that non-cognitive skills account for 1 per cent (0.25–0.24) of the overall school-level variance in literacy skills.

$$\mathrm{VPC_v} = \frac{\sigma_v^2}{\sigma_v^2 + \sigma_u^2 + \sigma_e^2 + \sigma_f^2} = \frac{0.098}{0.098 + 0.02 + 0.124 + 0.16} = 0.24$$

In terms of academic outcomes, the next question to be addressed relates to observed ethnic differences in academic progress that might be explained by other student characteristics. It is well known in the literature that low SES students have lower academic achievement and that these factors may be related to NESB and Indigenous status[144,153]. This is particularly important because these students are at higher risk of having language difficulties. This is addressed with the inclusion of fixed effects for NESB, Indigenous status and SES in the school academic achievement equation and in the use of propensity scores.

In terms of non-cognitive outcomes to account for the potential differences, fixed effects are included for SES, school type and school gender.

School academic achievement

The next step is to address the fixed effects at the school level. Two approaches were used to develop a school academic achievement variable. The first approach was adapted from Currie et al.[178], who developed a school academic achievement measure based on mean academic achievement scores at a school level[178]. In the LSAC, NAPLAN literacy and numeracy scores are available at the school level for Year 3, Year 5, Year 7 and Year 9. These are based on all students in the school who sit NAPLAN tests, and they correspond with Wave 3, Wave 4, Wave 5 and Wave 6 of the LSAC for a large proportion of children. A single continuous measure of school academic achievement is created defined as mean school score = {[mean (literacy Years 3, 5, 7, 9)] + [mean numeracy (Years 3, 5, 7, 9)]}/2. A low-, a median- and a high-achievement group are then established. High and low are defined as a score+ 25% and – 25% away from the mean respectively.

The second approach to the school academic achievement variable is derived using methods employed by Gemici et al. [177],who identified the school attributes that influence young people's transition to university over and above their individual background characteristics[177]. In this study, a single continuous measure of academic school academic achievement is created by combining the predicted academic achievement (net of individual background characteristics) and then estimating a school academic achievement mean based on all the students in the LSAC cohort from the same school[177].

Conceptually, a school's emphasis on academic success is most strongly reflected in its academic achievement over time. Gemici et al. [177] used predicted tertiary entrance rank and probabilities of university enrolment to create a school academic achievement measure for Year 12; however, our data is focused on a younger cohort—up to 15 years of age. For this cohort, academic achievement is a more appropriate outcome variable of interest.

Table 89 shows the multilevel results for the school and student-level predictors of literacy and numeracy, using the preferred school academic achievement measure. The effect of any given predictor is presented as a coefficient, which captures the increase or decrease in literacy or numeracy for each one-unit change in that predictor's unit of measurement.

Table 89: School and student-level predictors of literacy and numeracy

		Literacy		Numeracy	
School attribute	Categories	Coefficient	SE	Coefficient	SE
School location					
School sector	Government	Reference category		Reference category	
	Independent	−0.079	−0.037	−0.054	−0.039
	Catholic	−0.096	−0.028	−0.0825**	−0.030
School region	NSW	Reference category		Reference category	
	NSW Xmet large	0.041	−0.038	0.074+	−0.041
	NSW Xmet small	0.165	−0.113	0.287*	−0.119
	Vic. Met large	−0.010	−0.036	0.057	−0.040
	Vic. Met small	0.111	−0.169	0.199	−0.188
	Vic. Xmet large	0.047	−0.050	0.090	−0.055
	Vic. Xmet small	0.118	−0.092	0.197*	−0.100
	Qld Met	−0.010	−0.047	0.102*	−0.051
	Qld Xmet large	−0.002	−0.045	0.068	−0.049
	Qld Xmet small	−0.026	−0.088	0.183+	−0.094
	SA Met large	0.061	−0.051	0.000	−0.055
	SA Xmet large	0.069	−0.089	0.074	−0.097
	SA Xmet small	0.058	−0.178	0.197	−0.196
	WA Met large	−0.044	−0.047	−0.019	−0.051
	WA Met small	−0.008	−0.161	0.017	−0.167
	WA Xmet large	0.018	−0.074	0.133+	−0.080
	WA Xmet small	0.143	−0.102	0.268*	−0.111
	Tas. Met	0.064	−0.089	0.015	−0.095
	Tas. Xmet	−0.028	−0.076	−0.013	−0.082
	NT Met	−0.297**	−0.114	−0.130	−0.125
	NT Xmet large	0.004	−0.113	0.042	−0.121
	ACT	−0.074	−0.062	−0.051	−0.067
School demographics					
NAPLAN literacy	Continuous	0.281**	−0.041	−0.015	−0.045
NAPLAN numeracy	Continuous	−0.032	−0.038	0.325**	−0.042
Gender mix	Co-ed, Female, Male	Reference category		Reference category	
	Female	0.037	−0.059	−0.036	−0.060
	Male	−0.080	−0.054	−0.060	−0.055
LBOTE	Proportion	0.002	−0.061	0.091	−0.067
School SES	Continuous	0.000	0.000	0.000	0.000
Attendance	Continuous	0.008*	−0.003	0.008*	−0.004
Resources					
Class size	Number of students per FTE teaching staff	0.001	0.000	0.001	0.000
Income	$ per student	0.0000075 6+	0.000	0.000	0.000
Number of students/ FTE non-teaching staff	Number of non-teaching staff per student	0.00871+	−0.005	0.004	−0.006
Provide for student needs					
Teacher effectiveness	Quantile 1	reference category		reference category	
	Quantile 2	−0.016	−0.041	0.008	−0.050
	Quantile 3	0.124	−0.156	−0.258	−0.195
Academic achievement	Continuous	0.007	−0.010	0.010	−0.012

		Literacy		Numeracy	
School attribute	Categories	Coefficient	SE	Coefficient	SE
of school environment					
Academic orientation					
Approach to learning	Quantile 1	reference category		reference category	
	Quantile 2	0.200**	−0.019	0.155**	−0.022
	Quantile 3	0.334**	−0.021	0.258**	−0.024
Year 12 plans (parent)	Leave school before completion	reference category		reference category	
	Complete Year 12	0.278**	−0.054	0.215**	−0.065
	Complete trade or vocational training	0.294**	−0.054	0.226**	−0.064
	Go to university and complete a degree	0.583**	−0.054	0.530**	−0.064
	Obtain postgraduate qualifications at university	0.714**	−0.058	0.701**	−0.069
Year 12 plans (child at 15 years)	Leave school before completion	reference category		reference category	
	Complete Year 12	0.156+	−0.023	0.057*	−0.027
	Complete trade or vocational training	0.073	−0.025	0.083**	−0.029
	Go to university and complete a degree	0.498**	−0.027	0.135**	−0.031
	Obtain postgraduate qualifications at university	0.229**	−0.031	0.237**	−0.035
Student attribute					
Student demographics					
Male		−0.149**	−0.021	0.230**	−0.023
Indigenous Status		−0.372**	−0.061	−0.368**	−0.066
NESB		0.027	−0.036	0.057	−0.040
SEP	Quintile 1	reference category		reference category	
	Quintile 2	0.071**	−0.023	0.057*	−0.027
	Quintile 3	0.081**	−0.025	0.083**	−0.029
	Quintile 4	0.088**	−0.027	0.135**	−0.031
	Quintile 5	0.197**	−0.0306	0.237**	−0.0348
N		9592		9496	
LL		−9303		−10532	
AIC		18740		21199	
BIC		19220		21679	

Note. LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion.

Model building

The model building commenced by adding and comparing the school academic achievement variables: school academic achievement 1 and school academic achievement 2 (discussed above) to the null model. By using school academic achievement 1, the school-level variance dropped from 0.09 (null model) to 0.03 with residual variance being 0.277. Using school academic achievement 2, the school-level variance dropped from 0.09 to 0.01 with a residual variance of 0.28. The log-likelihood is −22049 for school academic achievement 1 and −21433 for school academic achievement 2. LR test = 2*(22049 − 21433)/3(df) = 410. The 5% point of a chi^2 distribution with 3df was 7.82 so the LR test rejects null hypothesis of no difference in model fit [263]. School academic achievement 2 is the favoured variable.

Next, this study considered school--level random slopes for time and school type and individual random slopes for individual SES (variable discussed above), language difficulties and non-English speaking background. Using LR tests the best model fit was established. The model specified includes random slopes for time at the school level and random slopes for time and SES at the individual level. The latter random slopes for time implied that variance in school literacy and numeracy achievement is a function of time and the former random slopes for time and SES implies that the variance in individual literacy and numeracy achievement is a function of time and SES. Goodness of fit tests were conducted to assess both approaches. Table 90 showed that the school-level variance drops from 25 per cent to 4 per cent using the first school academic achievement measure, compared to 0 per cent in the second school academic achievement measure. Using log-likelihood tests with 5 per cent significance the null hypothesis of no difference was rejected, between the first and second measures. The second school academic achievement measure provided the better model fit.

Table 90: Goodness of fit – school academic achievement approaches

	School-level variance	Individual variance	Residual	Log-likelihood	df	LR test
Null model	0.2 5	0.44	0.31	−16197	0	
School academic achievement 1[a]	0.04	0.59	0.35	−15579	3	$p < 0.05$
School academic achievement 2[b]	0.00	0.59	0.39	−15153	3	$p < 0.05$

Note. [a]Based on an approach used by Currie et al. (2000). [b]Based on an approach used by Gemici et al. [177]

Interactions

Last, interactions in the model are considered. As the emphasis of this analysis is on differential effects for students for language difficulties, the primary focus is on whether language impaired students benefit to a greater or lesser extent from attending schools of high academic achievement, when compared with their typical-language peers. Language difficulties are interacted with school academic achievement. In addition, it is evident that the effects of language on academic achievement vary over time and include an interaction of language difficulties and time. For completeness, three-way interaction is included, with language difficulties, time and school academic achievement.

Residual diagnostics

The assumption of constant variance for the residuals is assessed, and this study finds that the distribution of the conditional residuals is normal. No further transformation of the outcome variable is required. The residuals of the random effects (time, individual and school) are assessed. Using Q-Q plots, no evidence was seen of any extremely unusual random effects (results not displayed).

REML vs. MLE

The final specified model in the maximum likelihood (ML) estimation is compared to restricted maximum likelihood (REML). ML estimation causes covariance parameters to be biased, with smaller standard errors for the fixed effects in the model [264]. Using likelihood ratio (LR) tests we determine that the ML estimation is more efficient (results not displayed).

Propensity score weight

Selection bias arises from non-random selection; that is, reported effects may in fact be higher (or lower) than otherwise observed had an individual been randomly assigned to the 'treatment' group of interests. The use of propensity scores[180] provides a way to mitigate selection bias. This model serves as a mechanism for determining the probability of an individual having a language difficulty, based on relevant individual student characteristics.

The propensity score model determines the probability of an individual having a language difficulty. (Language difficulties status is defined as being > 1.25 SD away from the mean scores.) This probability is determined using a logistic regression model that includes a range of individual-level characteristics commonly associated with an individual's language status, such as child's gender, SES of the family, child's Indigenous status, whether the child is from a non-English speaking background, number of siblings in the family, child's IQ, mother's education, and the existence of other medical conditions. The propensity score model used in this paper is defined as:

$$\mathrm{logit}(y_i) = \alpha + X\tau + \epsilon$$

where y_i indicates whether the student is identified as having language difficulties, $X\tau$ is the fixed effects related to the individual's language status, and ϵ is the residual error term. Covariate adjustment methods are used, whereby the effect of treatment is included as a covariate in the second-stage model. The advantage of this method is that it involves a complete set of observations[181]. Using 'pscore' command in Stata 14, the balancing property of the score is assessed. Some imbalance between groups is expected. The analysis focuses on the balance of the covariates that are most important and ensures these are balanced. A child's medical condition is excluded from the final model to improve overall balance. This balancing effect is particularly strong in the background characteristics of the child. The probability is then converted to quintiles (1–5), and this becomes an independent variable in the equation. As a robustness check, the analysis also uses nearest-neighbour matching to establish a propensity weight. However, convergence of the XTMIXED could not be achieved and it is likely that this is due to the loss of observations, a feature of the matching approach[134].

Missing observations

The sample is subject to missing observations. The key variable that has the greatest proportion of missing observations is school identification. Some values of missing information can be imputed using additional questions available in the LSAC (discussed in Section 3.3). Table 88 shows that the reduced population is largely consistent with the overall LSAC population. The variables that were missing in greater than 5 per cent of the sample included approach to learning and the child's expectations for education at 15 years. The analysis explored whether there is an underlying mechanism that determines when an observation is missing for each of these variables. Using logistic regression models, there is evidence that those missing observations are correlated with each other (results not reported) and that they are not missing completely at random. Under this assumption, complete record analysis is not recommended[134]. Valid inferences can be obtained when observations are missing at random using inverse probability weighting, ad hoc methods or multiple imputations. Ad hoc methods were employed whereby missing observations represented an additional category in the equation for categorical variables or a separate missing dummy variable if the variable was continuous.

Multilevel weight

Individual-level weights only are provided in the LSAC dataset. Therefore, the options were to 1) assume schools are randomly selected into the sample or 2) estimate an appropriate school-level weight. The sampling strategy of the LSAC is to cluster by geographical area and then sample by postcode. Based on this sampling strategy, it was assumed that school-level weights were equal to 1. Individual-level weights were accounted for in the LSAC by using attrition weights. Due to convergence issues, the individual-level weights were assumed to be equal to 1.

Appendix I: Educational Quasi-Markets

The literature points to consequences of a changing educational landscape driven by market-oriented reforms that focus on school choice and competition[76,149,265]. This research shows that policymakers play a critical role in mitigating developmental gaps by aiming for equal access to high-achievement education—an underlying assumption of market theory. Although the government-school model remains the most dominant form of provision in Australia, increased government subsidies to independent schools has improved access for middle class families to non-government schools[76,265], and data from the National Schools Statistics Collection (NSSC) reveals that more parents are choosing non-government schooling options for the education of their children. Since 2001, the number of students in independent schools has increased 35 per cent, compared with 12 per cent growth in Catholic schools and 1.8 per cent in government schools[144]. Independent schools selectively admit pupils, based on academic ability, ability to pay or religious persuasion, regardless of where they live, and parental preference and school selection are the deciding factors.

The government-school model, which has historically been characterised as serving local communities only—with selection based on catchment areas rather than on ability—and as being universally non-selective, non-fee paying and government funded, has adopted some market-based principles. There is evidence of government schools in middle socioeconomic areas increasing academic capacity and size by attracting high-achievement students and through increased parental contributions[266]. These schools attract high-achievement students not only within the catchment but also from lower socioeconomic catchment areas, allowing opportunities for selectivity provided by high-demand places. This is described in the literature as the 'educational quasi-market'.

An increasing amount of international literature supports the educational 'quasi-market' discussed by Davies et al.[267].. For example, in Sweden, where similar education reforms were implemented in 2000, there is strong evidence of increasing segregation along lines of SES and immigrant status, partly determined by increased residential segregation but clearly fuelled by the 2000 reform. In this model, the effect of price is removed from the market equation because this is driven by government subsidisation, which ensures as all students have a right to free education. However, at the same time, competition is encouraged as a result of free choice on the part of 'customers'—that is, parents. Providers (i.e., schools) maximise their profits through reputation, which in turn drives demand for places and student numbers. Davies et al.[267] (1998) illustrate the quasi-market by an inverse U-shaped curve. Schools maximise profits by attracting students whose parents can pay high fees or who are 'attractive' in terms of their potential to boost average academic achievement. Optimal conditions are those where student numbers improve reputation and profit. Due to capacity constraints, beyond the optimum will cause decreasing reputation and profits.

A report by the OECD in 2008[77] cautioned that school-choice policies need to be carefully implemented to ensure they do not exacerbate equity issues by increasing the segregation of some students in schools of low academic achievement. Indeed, the aim of equal access to schools of high academic achievement for children with disability has a significant way to go. This research points to the net effect of the 'school choice' model being what Lamb et al. [150,p53)] described as 'recurring systematic patterns of failure that can point to features of the education system that fail to work for certain groups of Australians' The challenge exists for Australia and other countries to develop universal policies that raise the standards for all students, create classrooms that serve all students in all communities, and support disadvantaged students and low-performing schools through improved educational opportunities[184].

Appendix J: Equation Specification

	School academic achievement		Academic achievement			Functioning				Strengths & difficulties	Educational expectations	
	School academic achievement	Probability of LD	Literacy	Numeracy	NAPLAN attendance	Physical function	Emotional function	Social function	School function	SDQ total score	Expect about education (P)	Expect about education (C)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
School level												
School type	X											
Location of school (region)	X											
School gender	X											
Class size	X											
Indigenous %												
LBOTE	X											
NAPLAN literacy	X										X	X
NAPLAN numeracy	X											
School ICSEA	X					X	X	X	X			
School-level Attendance	X				X							
Non-teaching staff												
Non-teaching staff/student	X											
School income/student	X											
School academic achievement			X	X	X	X	X	X	X	X	X	X
Individual level												
Gender	X	X				X	X	X	X	X		
Indigenous Status	X	X				X	X	X	X	X		
NESB		X										
SEP	X	X				X	X	X	X	X		
IQ	X	X				X	X	X	X	X		

	School academic achievement	Probability of LD	Literacy	Numeracy	NAPLAN attendance	Physical function	Emotion function	Social function	School function	SDQ total score	Expect about education (P)	Expect about education (C)
Language + other disability			X	X	X	X	X	X	X	X		
Other disability			X	X	X	X	X	X	X	X		
Health status					X	X	X	X	X	X		
Year 12 plans (child)	X											
PSDQ strengths and difficulties											X	
Approach to learning	X					X	X	X	X	X	X	
Literacy												
Numeracy												
Individual changes school academic achievement over time			X	X								
Family	Year 12 plans (parent)	X										
Number of siblings in family		X				X	X	X	X	X		
Mother's mental health						X	X	X	X	X		
If mother works						X	X	X	X	X		
Mother is a single parent						X	X	X	X	X		
Death in the family												
Illness of a relative						X	X	X	X	X		
Wave	X		X	X	X	X	X	X	X	X	X	X

Appendix K: Maternal Employment Participation in Australia – K Cohort

Table 91: Maternal employment participation in Australia (2004, 2006, 2008, 2010, 2012, 2014) – K cohort (OLS)

Maternal employment participation in Australia (2004, 2006, 2008, 2010, 2012, 2014) – K cohort (OLS)							
	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience	+ Education	All controls
LDnocond = 1	−0.410** (0.043)						
LDnocond = 20							
LD1_4–7 = 1		−0.169** (0.045)	−0.169** (0.0455)	−0.177** (0.0480)	−0.176** (0.0485)	−0.128** (0.049)	−0.110* (0.0501)
LD1_≥8 = 1		−0.144** (0.038)	−0.133** (0.0383)	−0.0591 (0.0419)	−0.054 (0.042)	−0.016 (0.043)	0.039 (0.043)
LD2_4–7 = 1		−0.170* (0.070)	−0.149* (0.0720)	−0.145+ (0.0777)	−0.142+ (0.078)	−0.099 (0.077)	−0.092 (0.079)
LD2_≥8 = 1		−0.639** (0.063)	−0.613** (0.063)	−0.606** (0.067)	−0.607** (0.067)	−0.505** (0.067)	−0.476** (0.068)
LD3_4–7 = 1		−0.717** (0.090)	−0.654** (0.091)	−0.615** (0.094)	−0.613** (0.095)	−0.484** (0.094)	−0.474** (0.096)
LD3_≥8 = 1		−0.742** (0.072)	−0.661** (0.073)	−0.611** (0.075)	−0.622** (0.076)	−0.521** (0.078)	−0.433** (0.079)
LDsev_timing = 20							
senslearn_condition = 1	−0.296** (0.059)	−0.181** (0.060)	−0.072 (0.062)	−0.020 (0.063)	−0.028 (0.064)	−0.057 (0.064)	−0.083 (0.064)
physmentalemot_condition = 1	−0.175** (0.063)	−0.151* (0.063)	−0.114+ (0.064)	−0.096 (0.069)	−0.095 (0.069)	−0.101 (0.068)	−0.089 (0.068)
other_condition = 1	−0.236** (0.049)	−0.231** (0.049)	−0.147** (0.0489)	−0.109* (0.0521)	−0.096+ (0.052)	−0.090+ (0.053)	−0.062 (0.054)
Mcarers_A			−0.402** (0.057)	−0.338** (0.060)	−0.346** (0.061)	−0.329** (0.061)	−0.120+ (0.064)
Mcarers_P			−0.737** (0.069)	−0.694** (0.071)	−0.708** (0.072)	−0.672** (0.073)	−0.548** (0.072)
14–15 - wave = 2	0.211** (0.037)	0.218** (0.037)	0.224** (0.037)	0.085* (0.039)	0.055 (0.040)	0.054 (0.041)	0.069+ (0.0410)
14–15 - wave = 3	0.386** (0.039)	0.402** (0.0385)	0.417** (0.0386)	0.167** (0.0443)	0.121** (0.0454)	0.114* (0.0457)	0.150** (0.0459)
14–15 - wave = 4	0.456** (0.039)	0.469** (0.0389)	0.493** (0.0391)	0.0819+ (0.0480)	0.0400 (0.0493)	0.0283 (0.0499)	−0.189** (0.0579)
14–15 - wave = 5	0.573** (0.040)	0.598** (0.0398)	0.635** (0.0399)	0.0671 (0.0536)	0.0454 (0.0551)	0.0224 (0.0556)	−0.171* (0.0826)
14–15 - wave = 6	0.600** (0.0403)	0.623** (0.0402)	0.663** (0.0405)	−0.0537 (0.0600)	−0.0384 (0.0619)	−0.0734 (0.0625)	−0.291**(0.0872)
14–15 - m - K–6 depression scale				0.235** (0.0206)	0.239** (0.0207)	0.249** (0.0208)	0.212** (0.0214)

Maternal employment participation in Australia (2004, 2006, 2008, 2010, 2012, 2014) – K cohort (OLS)							
	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience	+ Education	All controls
14–15 - no. siblings of study child in household = 1				0.0931* (0.0441)	0.0559 (0.0448)	0.0305 (0.0449)	0.0238 (0.0455)
14–15 - no. siblings of study child in household = 2				−0.151** (0.0463)	−0.198** (0.0472)	−0.191** (0.0474)	−0.185** (0.0478)
14–15 - age of youngest child in household				0.0937** (0.00498)	0.0995** (0.00550)	0.101** (0.00559)	0.0916** (0.00581)
1 biological parent and 1 non-biological parent				0.00642 (0.0562)	0.00783 (0.0578)	0.0410 (0.0585)	0.0392 (0.0594)
1 biological parent no P2				−0.179** (0.0378)	−0.163** (0.0382)	−0.128** (0.0390)	−0.0619 (0.0517)
m@14–15 - age					0.167 (0.124)	0.0925 (0.128)	0.160 (0.134)
m@14–15 - ageXm@14–15 - age					−0.00202 (0.00315)	−0.000395 (0.00325)	−0.00175 (0.00341)
m@14–15 - ageXm@14–15 - ageXm@14–15 - age					−0.00000265 (0.0000263)	−0.0000143 (0.0000271)	−0.00000570 (0.0000285)
MYr12						0.401** (0.0450)	0.390** (0.0453)
Mpostgraddummy = 1						0.223** (0.0448)	0.239** (0.0460)
Mpostgraddummy = 2						0.367** (0.0468)	0.384** (0.0476)
Mtradedummy = 1						0.437** (0.0393)	0.418** (0.0399)
Mtradedummy = 2						0.0289 (0.0426)	0.0463 (0.0433)
NESB							−0.387** (0.0380)
5 quantiles of [other_inc] = 2							0.00381 (0.0481)
5 quantiles of [other_inc] = 3							0.0522 (0.0492)
5 quantiles of [other_inc] = 4							0.0262 (0.0495)
5 quantiles of [other_inc] = 5							−0.366**(0.0497)
Mdis_pen							−1.116** (0.177)
14–15 - m/f receiver of pps							0.0299**(0.00293)
n_otherwelf = 1							0.136+ (0.0767)
n_otherwelf = 2							−0.413** (0.0909)
Constant	0.273** (0.0267)	0.318** (0.0271)	0.323** (0.0272)	−1.028** (0.107)	−4.238** (1.607)	−3.610* (1.652)	−4.343* (1.736)

Maternal employment participation in Australia (2004, 2006, 2008, 2010, 2012, 2014) – K cohort (OLS)							
	No controls (+ time)	LD severity	+ Carer Allowance and Care Payment	+ Family background	+ Experience	+ Education	All controls
N	18828	18828	18828	17878	17878	17878	17852
LL	−10864	−10722	−10610	−9128	−9072	−8844	−8486
AIC	21749	21476	21256	18348	18242	17797	17098
BIC	21836	21601	21397	18706	18624	18218	17589

Note. Robust standard errors in parentheses. LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion.
+ significant at 10%. * significant at 5%. ** significant at 1%.

Table 92: Maternal employment participation in Australia (2004, 2006, 2008, 2010, 2012, 2014) – K cohort (Heckman)

Maternal employment participation in Australia (2004, 2006, 2008, 2010, 2012, 2014) – K cohort (Heckman)							
	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience	+ Education	All controls
LDnocond = 1	−0.284** (0.046)						
LDnocond = 20							
LD1_4–7 = 1		−0.035 (0.048)	−0.031 (0.048)	−0.041 (0.049)	−0.047 (0.049)	−0.164** (0.052)	−0.029 (0.408)
LD1_≥8 = 1		−0.095* (0.040)	−0.079* (0.040)	−0.010 (0.042)	−0.015 (0.043)	−0.018 (0.043)	0.037 (0.044)
LD2_4–7 = 1		−0.004 (0.075)	0.029 (0.077)	0.010 (0.078)	0.017 (0.079)	−0.139+ (0.080)	−0.008 (0.426)
LD2_≥8 = 1		−0.496** (0.067)	−0.459** (0.066)	−0.425** (0.067)	−0.430** (0.067)	−0.555** (0.071)	−0.387 (0.453)
LD3_4–7 = 1		−0.561** (0.095)	−0.493** (0.097)	−0.418** (0.094)	−0.413** (0.095)	−0.527** (0.097)	−0.396 (0.402)
LD3_≥8 = 1		−0.560** (0.077)	−0.461** (0.077)	−0.420** (0.077)	−0.435** (0.077)	−0.557** (0.081)	−0.357 (0.387)
LDsev_timing = 20							
senslearn_condition = 1	−0.294** (0.062)	−0.209** (0.063)	−0.089 (0.064)	−0.054 (0.064)	−0.063 (0.064)	−0.048 (0.064)	−0.095 (0.087)
physmentalemot_condition = 1	−0.128* (0.065)	−0.113+ (0.065)	−0.073 (0.066)	−0.104 (0.069)	−0.107 (0.069)	−0.099 (0.068)	−0.098 (0.082)
other_condition = 1	−0.205** (0.052)	−0.210** (0.052)	−0.112* (0.052)	−0.066 (0.053)	−0.059 (0.053)	−0.096+ (0.053)	−0.033 (0.156)
Mcarers_A			−0.486** (0.058)	−0.435** (0.061)	−0.438** (0.061)	−0.295** (0.063)	−0.187 (0.343)
Mcarers_P			−0.757** (0.071)	−0.711** (0.071)	−0.722** (0.072)	−0.664** (0.073)	−0.579** (0.171)
wage fit	1.080** (0.066)	0.945** (0.068)	0.990** (0.068)	1.072** (0.078)	1.083** (0.0810)	−0.396+ (0.205)	0.907 (4.529)
14–15 - wave = 2	0.150** (0.039)	0.163** (0.039)	0.171** (0.0390)	0.0437 (0.0401)	0.0263 (0.0406)	0.0544 (0.0411)	0.0491 (0.108)
14–15 - wave = 3	0.416** (0.0408)	0.425** (0.0407)	0.443** (0.0408)	0.200** (0.0447)	0.180** (0.0458)	0.0820+ (0.0476)	0.209 (0.297)
14–15 - wave = 4	0.422** (0.0401)	0.436** (0.0400)	0.464** (0.0403)	0.0810+ (0.0482)	0.0716 (0.0496)	0.00579 (0.0504)	−0.125 (0.322)
14–15 - wave = 5	0.529** (0.0413)	0.553** (0.0411)	0.594** (0.0413)	0.0553 (0.0537)	0.0699 (0.0553)	0.000603 (0.0562)	−0.0885 (0.416)
14–15 - wave = 6	0.579** (0.0420)	0.602** (0.0418)	0.646** (0.0422)	−0.0571 (0.0602)	−0.00508 (0.0622)	−0.0981 (0.0631)	−0.204 (0.446)
14–15 - m - K–6 depression scale				0.177** (0.0210)	0.182** (0.0212)	0.271** (0.0237)	0.169 (0.215)
14–15 - no. siblings of study child in household = 1				0.0659 (0.0442)	0.0350 (0.0449)	0.0249 (0.0450)	0.0238 (0.0455)
14–15 - no. siblings of study child in household = 2				−0.164** (0.0465)	−0.200** (0.0473)	−0.196** (0.0476)	−0.185** (0.0478)
14–15 - age of youngest child in household				0.0898** (0.00499)	0.101** (0.00555)	0.101** (0.00560)	0.0916** (0.00581)

Maternal employment participation in Australia (2004, 2006, 2008, 2010, 2012, 2014) – K cohort (Heckman)							
	No controls (+ time)	LD severity	+ Carer Allowance and Carer Payment	+ Family background	+ Experience	+ Education	All controls
1 biological parent and 1 non-biological parent				0.0181 (0.0568)	−0.00452 (0.0582)	0.0578 (0.0592)	−0.00344 (0.222)
1 biological parent no P2				−0.361** (0.0397)	−0.359** (0.0407)	−0.0485 (0.0573)	−0.248 (0.935)
m@14–15 - age					0.155 (0.127)	0.0590 (0.128)	0.164 (0.112)
m@14–15 - ageXm@14–15 - age					−0.00236 (0.00323)	0.000611 (0.00326)	−0.00220+ (0.00116)
m@14–15 - ageXm@14–15 - ageXm@14–15 - age					0.00000370 (0.0000269)	−0.0000235 (0.0000272)	
MYr12						0.480** (0.0618)	0.208 (0.908)
Mpostgraddummy = 1						0.286** (0.0549)	0.109 (0.649)
Mpostgraddummy = 2						0.450** (0.0642)	0.206 (0.888)
Mtradedummy = 1						0.466** (0.0420)	0.355 (0.315)
Mtradedummy = 2						−0.00533 (0.0464)	0.123 (0.385)
NESB							−0.319 (0.343)
5 quantiles of [other_inc] = 2							0.0373 (0.172)
5 quantiles of [other_inc] = 3							0.105 (0.266)
5 quantiles of [other_inc] = 4							0.0111 (0.0910)
5 quantiles of [other_inc] = 5							−0.442 (0.383)
Mdis_pen							−1.333 (1.105)
14–15 - m/f receiver of pps							0.0267 (0.0167)
n_otherwelf = 1							0.120 (0.113)
n_otherwelf = 2							−0.521 (0.544)
Constant	−3.306** (0.222)	−2.835** (0.230)	−2.981** (0.232)	−4.353** (0.270)	−7.067** (1.653)	−2.103 (1.770)	−6.901 (11.10)
N	17852	17852	17852	17852	17852	17852	17852
LL	−9824	−9748	−9629	−8992	−8943	−8823	−8485
AIC	19672	19531	19296	18078	17987	17757	17097
BIC	19765	19663	19444	18444	18376	18185	17588

Note. LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion.

Table 93: Maternal employment participation in Australia (2004, 2006, 2008, 2010, 2012, 2014) – K cohort (Dynamic RE)

Maternal employment participation in Australia (2004, 2006, 2008, 2010, 2012, 2014) – K cohort (Dynamic RE)								
	LD	LD severity	Carer Allowance and Carer Payment	Family background	+ Experience	All controls	All controls + MUNDLAK	All controls + MUNDLAK + d_lag
LDnocond = 1	−0.209** (0.0501)							
LDnocond = 20	−0.873 (0.598)							
LD1_4–7 = 1		−0.265* (0.110)	−0.254* (0.109)	−0.219* (0.106)	−0.215* (0.106)	−0.113 (0.104)	−0.010 (0.124)	−0.019 (0.093)
LD1_≥8 = 1		−0.308** (0.0912)	−0.288** (0.0904)	−0.167+ (0.0887)	−0.150+ (0.0883)	−0.064 (0.086)	0.114 (0.104)	0.110 (0.080)
LD2_4–7 = 1		−0.402* (0.173)	−0.372* (0.172)	−0.312+ (0.167)	−0.295+ (0.166)	−0.158 (0.161)	0.120 (0.208)	0.067 (0.156)
LD2_≥8 = 1		−0.662** (0.155)	−0.616** (0.154)	−0.616** (0.151)	−0.599** (0.150)	−0.421** (0.148)	−0.199 (0.192)	−0.008 (0.146)
LD3_4–7 = 1		−1.213** (0.179)	−1.162** (0.177)	−0.912** (0.175)	−0.865** (0.174)	−0.658** (0.170)	−0.193 (0.307)	0.090 (0.240)
LD3_≥8 = 1		−1.216** (0.134)	−1.130** (0.133)	−0.971** (0.133)	−0.926** (0.133)	−0.671** (0.130)	−0.178 (0.279)	0.099 (0.221)
LDsev_timing = 20		−1.046+ (0.592)	−0.765 (0.588)	−0.464 (0.582)	−0.301 (0.583)	−0.242 (0.582)	7.990 (7.982)	8.835 (6.366)
senslearn_condition = 1	−0.155* (0.069)	−0.085 (0.069)	−0.051 (0.069)	−0.058 (0.073)	−0.054 (0.073)	−0.071 (0.073)	−0.072 (0.077)	−0.099 (0.083)
physmentalemot_condition = 1	−0.050 (0.075)	−0.032 (0.075)	−0.005 (0.075)	−0.026 (0.079)	−0.028 (0.079)	−0.032 (0.079)	−0.008 (0.081)	0.036 (0.085)
other_condition = 1	−0.123* (0.057)	−0.105+ (0.057)	−0.073 (0.057)	−0.084 (0.061)	−0.071 (0.061)	−0.056 (0.061)	0.003 (0.064)	0.061 (0.078)
Mcarers_A			−0.486** (0.079)	−0.393** (0.083)	−0.406** (0.083)	−0.380** (0.082)	−0.127 (0.097)	0.047 (0.106)
Mcarers_P			−0.811** (0.095)	−0.772** (0.098)	−0.779** (0.098)	−0.761** (0.098)	−0.467** (0.114)	−0.313** (0.120)
14–15 - wave = 2	0.403** (0.0362)	0.406** (0.0362)	0.406** (0.0362)	0.181** (0.0408)	0.121** (0.0417)	0.128** (0.0417)	0.224** (0.0617)	
14–15 - wave = 3	0.779** (0.0386)	0.784** (0.0386)	0.791** (0.0386)	0.372** (0.0493)	0.269** (0.0520)	0.265** (0.0518)	0.432** (0.101)	0.130* (0.0566)
14–15 - wave = 4	0.906** (0.0400)	0.909** (0.0400)	0.927** (0.0401)	0.257** (0.0575)	0.133* (0.0620)	0.127* (0.0617)	0.257+ (0.144)	−0.0982 (0.0924)
14–15 - wave = 5	1.099** (0.0422)	1.104** (0.0422)	1.131** (0.0424)	0.188** (0.0693)	0.074 (0.075)	0.057 (0.075)	0.287 (0.195)	−0.0894 (0.139)

Maternal employment participation in Australia (2004, 2006, 2008, 2010, 2012, 2014) – K cohort (Dynamic RE)								
	LD	LD severity	Carer Allowance and Carer Payment	Family background	+ Experience	All controls	All controls + MUNDLAK	All controls + MUNDLAK + d_lag
14–15 - wave = 6	1.173** (0.0447)	1.177** (0.0447)	1.209** (0.0450)	0.0419 (0.0814)	−0.028 (0.089)	−0.048 (0.088)	0.251 (0.237)	−0.141 (0.176)
14–15 - m -K–6 depression scale				0.293** (0.0270)	0.296** (0.0270)	0.294** (0.0268)	0.185** (0.0317)	0.187** (0.0348)
14–15 - no. siblings of study child in household = 1				0.0977 (0.0718)	0.0259 (0.0720)	0.0162 (0.0712)	0.230** (0.0843)	0.165+ (0.0849)
14–15 - no. siblings of study child in household = 2				−0.187* (0.0784)	−0.293** (0.0790)	−0.263** (0.0779)	0.216+ (0.119)	0.170 (0.135)
14–15 - age of youngest child in household				0.149** (0.00777)	0.155** (0.00817)	0.157** (0.00812)	0.156** (0.0102)	0.109** (0.0112)
1 biological parent and 1 non-biological parent				−0.180* (0.0820)	−0.179* (0.0828)	−0.131 (0.0822)	−0.0556 (0.0948)	−0.0724 (0.0921)
1 biological parent no P2				−0.273**(0.0553)	−0.251**(0.0556)	−0.187**(0.0554)	−0.142+ (0.0851)	−0.0773 (0.0968)
m@14–15 - age					−0.119 (0.135)	−0.205 (0.134)	−0.234+ (0.135)	0.0226 (0.157)
m@14–15 - ageXm@14–15 - age					0.00663+ (0.00346)	0.00834* (0.00344)	0.00802* (0.00347)	0.00168 (0.00396)
m@14–15 - ageXm@14–15 - ageXm@14–15 - age					−0.0000837** (0.0000291)	−0.0000958** (0.0000290)	−0.0000930** (0.0000292)	−0.0000362 (0.0000326)
MYr12						0.593** (0.0821)	0.487** (0.0791)	0.282** (0.0650)
Mpostgraddummy = 1						0.490** (0.0858)	0.375** (0.0832)	0.129+ (0.0681)
Mpostgraddummy = 2						0.769** (0.0859)	0.628** (0.0833)	0.377** (0.0689)
Mtradedummy = 1						0.567** (0.0670)	0.536** (0.0649)	0.295** (0.0545)
Mtradedummy = 2						0.216** (0.0735)	0.199** (0.0712)	0.107+ (0.0606)
NESB							−0.549** (0.0732)	−0.263** (0.0547)
5 quantiles of [other_inc] = 2							−0.0495 (0.0547)	−0.0543 (0.0581)
5 quantiles of [other_inc] = 3							−0.121* (0.0596)	−0.143* (0.0647)
5 quantiles of [other_inc] = 4							−0.101 (0.0654)	−0.188** (0.0724)
5 quantiles of [other_inc] = 5							−0.529** (0.0724)	−0.613** (0.0817)
Mdis_pen							−0.417* (0.200)	−0.241 (0.208)
14–15 - m/f receiver of pps							0.0118**(0.00327)	0.00911**(0.00323)
n_otherwelf = 1							0.126 (0.0838)	0.130 (0.0801)
n_otherwelf = 2							−0.373** (0.101)	−0.295** (0.0992)
LDnocondbar							−0.397 (0.398)	−0.443 (0.317)

Maternal employment participation in Australia (2004, 2006, 2008, 2010, 2012, 2014) – K cohort (Dynamic RE)								
	LD	LD severity	Carer Allowance and Carer Payment	Family background	+ Experience	All controls	All controls + MUNDLAK	All controls + MUNDLAK + d_lag
senslearn_conditionbar							0.315 (0.202)	0.206 (0.161)
physmentalemot_conditionbar							0.00641 (0.228)	0.180 (0.180)
other_conditionbar							−0.427* (0.185)	−0.413** (0.145)
Mdis_penbar							−2.369** (0.448)	−1.384** (0.363)
singleparentbar							0.0935** (0.0101)	0.0580** (0.00824)
prelbar							−0.0452 (0.0646)	0.0321 (0.0625)
n_otherwelfbar							−0.795** (0.193)	−0.427** (0.154)
MAgebar							0.0365 (0.0230)	0.00685 (0.0218)
mdepressionbar							0.189** (0.0591)	0.0858+ (0.0511)
nsibbar							−0.310** (0.0712)	−0.0685 (0.0733)
ayngchbar							−0.0295+(0.0159)	−0.0102 (0.0150)
Mcarers_Abar							0.338+ (0.200)	0.0988 (0.169)
Mcarers_Pbar							−0.371 (0.238)	−0.278 (0.197)
other_incquintbar							−0.138** (0.0340)	−0.0265 (0.0298)
dlag								0.881** (0.0430)
d0								0.753** (0.0526)
lambda								
Constant	0.441** (0.0358)	0.566** (0.0393)	0.579** (0.0391)	−1.287** (0.153)	−1.555 (1.726)	−0.964 (1.717)	−0.717 (1.758)	−3.800+ (2.076)
N	24370	24370	24370	22691	22691	22691	22652	18705
LL	−10780	−10717	−10671	−9480	−9427	−9284	−8942	−6287
sigma_u	1.547	1.525	1.508	1.412	1.399	1.348	1.233	0.648
rho	0.705	0.699	0.695	0.666	0.662	0.645	0.603	0.296
AIC	21585	21469	21383	19057	18956	18680	18044	12736
BIC	21690	21615	21545	19442	19365	19130	18686	13371

Note. LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion.

Appendix L: Data- Chapter 5

Final sample for analysis- Chapter 5

From the original sample of approximately 10,000 children, 7 per cent were excluded because the primary carer was not the biological mother (where it was difficult to justify a fixed effects model), and 3 per cent were excluded because the mother was aged 60 years or over (because these were unlikely to be the biological mother). A further 1 per cent had observations in only one wave; 0.04% had an outlier wage, leaving 25,486 observations in the B cohort and 24,375 in the K cohort, respectively, for participation equations. A further 15 per cent were self-employed or ‘other’, leaving 21,652 and 20,490 in the wage rate and hours equations. In the B cohort, 13,268 were employees and 12,206 had a wage rate reported. In the K cohort, 14,236 were an employee, and 13,054 had a wage rate reported. This resulted in 4,768 children in the B cohort and 4,586 children in the K cohort (Table 94).

Table 94: Final sample for analysis

Sample for analysis	B	K
Mothers	26,566	29,898
Only biological children with female carer being mother	26,471	25,559
Mother is not over 60 as unlikely to be biological mother	25,977	24,909
Drop if only have one wave of information	25,650	24,439
Not an outlying wage	25,486	24,375
Is not self-employed or other	21,652	20,490
Total observations	*25,486*	*24,375*
Is an employee	13,268	14,236
Has wage rate reported	12,206	13,054
Total individuals	*4,768*	*4,586*

Mother’s employment

Mothers were defined as employed (or working) if they answered *yes* to any of the questions (full-time employment, part-time employment, employed but on maternity leave). Mothers were defined as not working if they answered *yes* to any of the questions (unemployed and looking for work, not in the labour force).

Working mothers were also asked whether they worked for an employer, worked in their own business or were not in the labour force. Those who worked in their own business or other employment were excluded from the wage and hours' equations because those mothers who were self-employed tended to have extreme values, either very low or high work hours that resulted in very high wage rates.

Wage rate

The mother's wage rate was calculated as mother's gross annual income/52 weeks/weekly work hours. The wage rate is not normally distributed and is log transformed for the analysis. The LSAC presents mother's income as one measure of gross wages plus other income, including welfare benefits. To control for income that is unrelated to active participation in the labour force, three additional variables were considered (number of sources of other income, number of other welfare benefits, and other income). The number of other sources of income included profit/losses, shares in a partnership, property income, dividends/interest, government payments and child support, defined as 0, 1 and 2 or more. To calculate other income, mother's income was subtracted from the continuous household income variable. Household income was calculated from parents' reported pre-tax weekly income from all sources (wages/salary, profit/losses, shares in a partnership, property income, dividends/interest, government payments, and child support). Total gross household income was defined as the sum of the weekly income reported by mothers and their partners, plus any other household members that earned income. Total individual annual income was then calculated by multiplying the pre-tax weekly amount by 52 weeks. The household income variable was then inflated to 2014 dollars, using the wage rate of the Australian Consumer Price Index and scaled by the international square root approach[257] in order to account for household size. Missing observations were imputed by constructing missing values based on individual means across available panels. Complete record analysis was used if the individual had a missing wage in all waves. This is discussed in detail in Chapter 3. Households with negative gross income and households in the lowest decile of income where there is a discrepancy between income and SES (i.e., income ≤ 5% & SEP ≥ 95%) were excluded (household) as these households tend to have access to resources that allow them to maintain a higher standard of living than implied by their incomes alone [268].

Welfare benefits included Disability Support Pension, Parenting Payment Single, Youth Allowance, Family Tax Benefit A and B, Rent Assistance, Health Care Card, Child Care Benefit and Austudy, but excluded Carer Allowance and Carer Payment[lxxxv]. This was defined as 0, 1 and 2 or more. A dummy variable for mother's Disability Support Pension and Parenting Payment Single was considered separately because there is a high correlation between Carer Payment and these welfare benefits[68].

Mother's human capital was determined by the level of skill, defined by five dummy variables (mothers who did not complete Year 12 but have a trade qualification, mothers who completed Year 12 with a trade qualification, mothers who completed Year 12 without a trade qualification, mothers with a bachelor's degree and mothers with a post-graduate degree), mother's work experience; approximated by mother's age and mother's age squared.

Labour-market shocks due to childbirth were accounted for using two variables (number of siblings, age of the youngest child). Non-biological siblings were excluded, and the variable was categorised as 0, 1 and 3 or more siblings.

Additionally, the mother's LFP was considered in the B cohort equation as an approximation for pre-birth labour force attachment. These include five dummy variables to indicate pre-birth income (mother's salary before tax $1,500 or more per week, mother's salary before tax $700–$1,499 per week, mother's salary before tax $250–$699 per week, mother's salary before tax < $250 per week, mother's salary before tax unknown) three dummy variables indicating type of employment (mother is in permanent position, mother is in casual employment, mother is in fixed-term employment) and one variable indicating mother's pre-birth usual work hours per week.

Regional differences in average earnings were accounted for by a set of 22 dummy variables (state, metropolitan, large and small regional centres).

Socioeconomic differences in earnings were captured by the variable SEP. SEP is defined as a composite measure developed for the LSAC, encompassing both resource-based factors and factors based on social status. Resource-based factors include income, wealth and educational attainments, while factors based on social status include the prestige and status associated with different occupations. The concept is tied closely to human capital[178].

Carers' benefits

Carers are entitled to two government benefits, known as Carer Allowance (Mcarers_A) and Carer Payment (Mcarers_P). Carers are entitled to Mcarers_P if they cannot support themselves through paid employment due to their caring responsibility, subject to means and asset testing. Mcarers_A is a supplementary payment, paid to carers who provide daily care in a private home to a person with disability. Eligibility is based on the severity of the condition, and they are not taxable or income tested. As at 2017, the rate of Carer Allowance was $118.20 per fortnight[244] and Carer Payment was $601.50 per fortnight[245].

Healthcare need factors other than disability were also considered. Psychological distress is measured in the LSAC using the Kessler 6 (K6) scale, which comprises six items and has been widely used and validated in many epidemiological studies (e.g., Furukawa et al. 2003)[269], scaled from 1 to 5. Additionally, English as a second language (NESB) and age (Wave) were considered in the analysis. Missing observations are labelled *20* throughout the analysis.

Table 95: Variable definitions

Variable	Measurement	Label
Mother works	Dummy variable1 = Yes, 0 = No	WORK
Mother's hours of work	Average weekly hours of work (log transformed)	LNHOURS
Mother's income	Annual disposable mothers income	
Mother's wage rate	Mother's income/52 weeks/ hours of work (log transformed)	LNWAGERATE
Language definitions		
Language difficulties only	Dummy variable1 = Yes, 0 = No	LDnocond = 1
Missing language	Dummy variable1 = Yes, 0 = No	LDnocond = 20
Language by persistence and timing of identification		
LD1_0–3 years	Identified at one time only, between 0–3 years of age.	LD1_0–3 = 1
LD1_4–7 years	Identified at one time only, between 4–7 years of age	LD1_4–7 = 1
LD1_≥8 years	Identified at one time only, at 8 years or older	LD1_≥8 = 1
LD2_0–3 years	Identified twice, the first time between 0–3 years of age	LD2_0–3 = 1
LD2_4–7 years	Identified twice, the first time between 4–7 years of age	LD2_4–7 = 1
LD2_≥8 years	Identified twice, the first time at 8 years or older	LD2_≥8 = 1
LD3_0–3 years	Identified three or more times, the first time between 0–3 years of age	LD3_0–3 = 1
LD3_4–7 years	Identified three or more times, the first time between 4–7 years of age	LD3_4–7 = 1
LD3_≥8 years	Identified three or more times, the first time at 8 years or older	LD3_≥8 = 1
Other impairment definitions		
Sensory/learning		senslearn_condition = 1
Missing		senslearn_condition = 20
Physical/emotional/behavioural		physmentalemot_condition = 1
Missing		physmentalemot_condition = 20
Other		other_condition = 1
Missing		other_condition = 20
Mother's age		MAge
Mother's age squared		MAge2
Mother speaks another language at home	Dummy variable 1 = Yes, 0 = No	NESB
Mother completed Year 12	Dummy variable 1 = Yes, 0 = No	MYr12
Mother did not complete Year 12 and completed trade qualification	Dummy variable 1 = Yes, 0 = No	Mtradedummy = 1
Mother completed Year 12 and completed trade qualification	Dummy variable 1 = Yes, 0 = No	Mtradedummy = 2
Mother has bachelor's degree	Dummy variable 1 = Yes, 0 = No	Mpostgraddummy = 1
Mother has postgraduate degree	Dummy variable 1 = Yes, 0 = No	Mpostgraddummy = 2
Mother has partner who is biological parent	Dummy variable 1 = Yes, 0 = No	2 non-biological parents
Mother is single parent	Dummy variable 1 = Yes, 0 = No	1 biological parent no P2
Mother has partner other than child's biological parent	Dummy variable 1 = Yes, 0 = No	1 biol parent and 1 non-biol parent
Household income	Dummy variable 1 = Yes, 0 = No	other_inc
Mother receives Carer Allowance	Dummy variable 1 = Yes, 0 = No	Mcarers_A
Mother receives Carer Payment	Dummy variable 1 = Yes, 0 = No	Mcarers_P
Variable	Measurement	Label

Variable	Measurement	Label
Mother receives Parenting Payment Single	Dummy variable 1 = Yes, 0 = No	10–11 - m/f receiver of pps
Mother receives Disability Support Pension	Dummy variable 1 = Yes, 0 = No	Mdis_pen
Mother receives one other welfare payment	Dummy variable 1 = Yes, 0 = No	n_otherwelf = 1
Mother receives two or more other welfare payments	Dummy variable 1 = Yes, 0 = No	n_otherwelf = 2
Mother receives one other income sources (other than wages)	Dummy variable 1 = Yes, 0 = No	n_otherinc = 1
Mother receives two or more other income sources (other than wages)	Dummy variable 1 = Yes, 0 = No	n_otherinc = 2
Mother's pre-birth human capital (B cohort only)		
Mother is in permanent position	Dummy variable 1 = Yes, 0 = No	Permanent employee
Mother is in casual employments	Dummy variable 1 = Yes, 0 = No	Casual employee
Mother is in fixed-term employment	Dummy variable 1 = Yes, 0 = No	Fixed-term employee
Mother's usual work hours per week	Average weekly hours of work	10–19 hours per week
		20–29 hours per week
		30–34 hours per week
		35–39 hours per week
		40–49 hours per week
		50 or more hours per week
Mother's salary before tax $1,500 or more per week	Dummy variable 1 = Yes, 0 = No	$1 500–$1 999 per week
Mother's salary before tax $700–$1,499 per week	Dummy variable 1 = Yes, 0 = No	$1 000–$1 499 per week
Mother's salary before tax $250–$699 per week	Dummy variable 1 = Yes, 0 = No	$700–$999 per week
Mother's salary before tax < $250 per week	Dummy variable 1 = Yes, 0 = No	$500–$699 per week
Mother's salary before unknown	Dummy variable 1 = Yes, 0 = No	Unknown salary
Socioeconomic position	Standardised score	sep
Number of biological siblings the child has		nsib = 1
	Only child	
	1 biological sibling	nsib = 2
	2 or more siblings	nsib = 3
Age of the youngest child in household		ayngch
Wave	Wave 1 (child aged 0–1 yrs [B] 4–5 yrs [K])	Wave 1
	Wave 2 (child aged 2–3 yrs [B] 6–7 yrs [K])	Wave 2
	Wave 3 (child aged 4–5 yrs [B] 8–9 yrs [K])	Wave 3
	Wave 4 (child aged 6–7 yrs [B] 10–11 yrs [K])	Wave 4
	Wave 5 (child aged 8–9 yrs [B] 12–13 yrs [K])	Wave 5
	Wave 6 (child aged 10–11 yrs [B] 14–15 yrs [K])	Wave 6

Interpretation of Heckman selection model

The first model is a choice model – are you in the group or not? For example, are you in the labour market (and have a wage) or not? The second stage then examines the effects of the independent variables on the outcome (wages, for example). Each stage has a residual or error term for each observation. To test for bias, the relationship between the residuals for the two stages (Stage 1 and Stage 2) is examined. If the unobservables in the selection model are correlated with the unobservables in the Stage 2 model, there are biased estimates without correction (or in an OLS model). This is basically saying that unobservables in the selection (or choice) of entering the labour market are also affecting the Stage 2 model. The results of Eq. 5.4.2.1 showed that *rho* is positive, which indicates that the unobservables or error terms are positively correlated with one another. Therefore, in the wage model, if ability is an unobservable and it is positively related to working (Stage 1) and positively related to wages (Stage 2), *rho* will be positive. A positive selection (or positive *rho*) indicates that those who select into waged employment would earn higher wages than a random sample from the population of women with a comparable set of characteristics. However, this value depends on whether or not there is a statistically significant effect of selection, or whether the chi-square value for *rho* is statistically significant. If it is not, there no effects of selection (those who select into the wage sample do not have higher wages relative to those with average characteristics drawn at random from the population).

Appendix M: Subgroup Analysis (NESB, Siblings, Household structure)

Table 96: Subgroup analysis of non-English speaking backgrounds

	Work	LN_Wage	Work hours	Work	LN_WAGE	Work hours
		NESB =1			NESB=0	
LDsev_timing=1	-0.101 (0.099)	0.016 (0.036)	-3.303* (1.621)	-0.154 (0.094)	0.059 (0.037)	-1.381 (0.964)
LDsev_timing=2	-0.052 (0.113)	-0.001 (0.042)	-1.345 (1.825)	-0.102 (0.108)	0.029 (0.044)	-0.471 (1.083)
LDsev_timing=3	-0.427* (0.181)	-0.044 (0.063)	-6.275* (2.668)	-0.510** (0.172)	0.0556(0.066)	-3.573* (1.811)
LDsev_timing=4	-0.257 (0.195)	-0.021 (0.071)	-1.650 (2.757)	-0.337+ (0.186)	0.020 (0.076)	-1.745 (1.942)
LDsev_timing=5	-0.514+ (0.310)	-0.020(0.108)	-6.377 (4.219)	-0.590* (0.295)	0.146 (0.114)	-5.755+ (3.209)
LDsev_timing=6	-0.495 (0.325)	-0.015 (0.116)	-10.70* (4.741)	-0.618* (0.309)	0.165 (0.123)	-6.883* (3.232)
senslearn_condition=1	-0.029 (0.106)	0.036 (0.0397)	5.731** (1.830)	-0.037 (0.099)	0.095* (0.041)	-1.341* (0.626)
physmentalemot_condition=1	-0.156 (0.099)	0.054 (0.037)	-1.430 (1.640)	-0.187* (0.094)	0.085* (0.038)	-0.921 (0.597)
other_condition=1	0.008 (0.096)	-0.029 (0.033)	-0.836 (1.615)	-0.026 (0.090)	-0.044 (0.034)	-0.719 (0.570)
Mcarers_A	-0.009 (0.083)	0.027 (0.036)	-0.0810(1.458)	-0.020 (0.078)	0.020 (0.037)	0.831 (0.589)
Mcarers_P	-0.373** (0.106)	-0.009 (0.053)	-1.214 (1.572)	-0.382** (0.102)	0.064 (0.054)	-2.049** (0.759)
N	13990	12039	1740	15968	14318	14507
rho	0.285	0.335	0.324	0.265	0.325	0.369

NESB= non- English speaking background

Table 97: Subgroup analysis of household structure

	Work	Work hours	Work	Work hours	Work	Work hours
	2 biological parents		1 biological parent and 1 non-biological		Single mother	
LDsev_timing=1	-0.116 (0.091)	-1.485+ (0.901)	-0.117 (0.103)	-9.034** (3.072)	-0.142 (0.102)	0.397 (1.628)
LDsev_timing=2	-0.060 (0.103)	-0.093 (1.023)	-0.086 (0.118)	-1.600 (3.229)	-0.103 (0.117)	-1.046 (1.768)
LDsev_timing=3	-0.442** (0.166)	-3.075+ (1.668)	-0.480* (0.188)	-10.25+ (5.300)	-0.498** (0.187)	-2.721 (2.982)
LDsev_timing=4	-0.297+ (0.179)	0.092 (1.783)	-0.243 (0.203)	-9.117 (5.810)	-0.291 (0.201)	0.157 (3.144)
LDsev_timing=5	-0.533+ (0.284)	-4.111 (2.846)	-0.503 (0.322)	-17.11+ (9.497)	-0.587+ (0.320)	-3.449 (5.195)
LDsev_timing=6	-0.576+ (0.298)	-5.810+ (2.980)	-0.452 (0.338)	-25.23* (10.06)	-0.531 (0.335)	-6.289 (5.471)
senslearn_condition=1	-0.056 (0.099)	-0.568 (0.672)	-0.022 (0.106)	1.569 (2.522)	-0.042 (0.106)	-1.481 (1.537)
physmentalemot_condition=1	-0.209* (0.093)	-0.750 (0.617)	-0.138 (0.100)	-0.085 (2.747)	-0.166+ (0.100)	-2.095 (1.593)
other_condition=1	-0.023 (0.090)	-0.671 (0.613)	0.035 (0.097)	-1.538 (2.222)	0.015 (0.096)	-1.968 (1.414)
Mcarers_A	0.0005 (0.077)	1.646** (0.626)	-0.007 (0.084)	0.985 (2.477)	-0.059 (0.085)	-1.640 (1.303)
Mcarers_P	-0.379** (0.100)	-0.369 (0.800)	-0.402** (0.109)	-0.861 (2.548)	-0.380** (0.108)	-6.130** (1.612)
N	16006	13997	13795	582	13875	1668
rho	0.236	0.398	0.309	0.339	0.305	0.201

Table 98: Subgroup analysis of the number of siblings

	Work	Work hours	Work	Work hours	Work	Work hours
	Only child		1 sibling		2 of more siblings	
LDsev_timing=1	-0.112 (0.102)	-0.524 (2.053)	-0.163+ (0.097)	-2.247* (1.115)	-0.092 (0.095)	-0.197 (1.152)
LDsev_timing=2	-0.079 (0.116)	-1.947 (2.162)	-0.118 (0.111)	-1.760 (1.289)	-0.036 (0.109)	1.387 (1.305)
LDsev_timing=3	-0.468* (0.186)	-3.609 (4.037)	-0.513** (0.177)	-4.753* (2.250)	-0.415* (0.174)	-1.171 (2.080)
LDsev_timing=4	-0.235 (0.200)	-2.441 (4.079)	-0.349+ (0.191)	-0.839 (2.286)	-0.239 (0.189)	1.705 (2.253)
LDsev_timing=5	-0.529+ (0.319)	-5.750 (6.448)	-0.605* (0.302)	-5.402 (3.652)	-0.463 (0.299)	-1.335 (3.564)
LDsev_timing=6	-0.481 (0.335)	-10.92+ (6.622)	-0.623* (0.317)	-5.350 (3.741)	-0.442 (0.313)	-1.524 (3.820)
senslearn_condition=1	-0.056 (0.107)	5.190* (2.353)	-0.0148 (0.103)	-1.961 (1.209)	-0.042 (0.102)	-0.184 (0.854)
physmentalemot_condition=1	-0.172+ (0.0998)	0.863 (1.957)	-0.175+ (0.097)	-1.140 (1.075)	-0.174+ (0.096)	-0.678 (0.812)
other_condition=1	0.0344 (0.0967)	-2.256 (1.894)	-0.014(0.093)	-0.072 (1.024)	0.005 (0.092)	-1.682* (0.791)
Mcarers_A	-0.029 (0.085)	-3.311+ (1.930)	-0.036 (0.082)	1.776+ (0.941)	0.010 (0.079)	1.033 (0.711)
Mcarers_P	-0.416** (0.110)	-2.342 (2.664)	-0.403** (0.105)	-2.919** (1.110)	-0.350** (0.102)	-1.163 (0.902)
N	13965	1962	14850	7839	14861	6446
rho	0.300	0.288	0.275	0.350	0.264	0.396

Appendix N: Threshold Analysis – Chapter 6

The threshold analysis included:

1) increasing the prevalence of language difficulties to 17 per cent (up from 7 per cent). The literature suggests that the prevalence of language difficulties may be up to 17 per cent and possibly higher among children from disadvantaged backgrounds.
2) testing the 95% CI of the extrapolation rate from literacy and numeracy to LFP. The extrapolated estimates were based on a study by Mu et al.[270] using literacy and numeracy measures from the ABS 'PIAAC survey in 2011–12. This analysis was not able to not consider the impact on school intervention programs, such as vocational education and training. The literature suggests that these types of programs may be effective in mediating the long-term LFP penalties of low literacy. This may reduce estimates of any LFP penalty.

The model was most sensitive to the prevalence of language difficulties. The analysis showed that a prevalence rate of 17 per cent for language difficulties increased the cost to society to $3.308 billion per year. This represented an increase of 240 per cent. Assuming the lower estimate of the extrapolation rate reduced the per capita costs to $3,520 per child per year or $1.101 billion in societal cost.

Table 99: Threshold analysis

	Threshold	Base case	Threshold	Estimate	95% CI		Estimate	95% CI	
	Base case			$4,353	$5,653	$2,470	$1,362,268,570	$1,768,764,594	$772,807,615
1	Prevalence of language difficulties	0.07	0.17		N/A		$3,308,366,527	$1,768,764,594	$772,807,615
2	Extrapolate rate (lower 95% CI)	0.04	0.015	$3,520	$4,591	$1,986	$1,101,424,801	$1,436,624,195	$621,309,018
3	Extrapolate rate (upper 95% CI)		0.067	$5,249	$6,882	$2,896	$1,642,359,373	$2,153,341,116	$906,141,789

Note: CI = confidence interval.

Appendix 0: (DRAFT unpublished publication) used for extrapolation

Mu C, Reeve R, Cronin P. Association of literacy and numeracy with adult health and socioeconomic outcomes. Submitted to Health Economics (papers)[86]

Key words: Literacy and numeracy skills; employment; health; social capital; simultaneous equation model

Abstract

Literacy and numeracy are cognitive skills which are core components of human capital. Understanding the effect of literacy and numeracy skills on individual outcomes in adulthood can help identify long term benefits of interventions to improve these skills. Utilising a national survey in Australia, we examine the links between literacy and numeracy skills and adult health and socioeconomic outcomes including employment status and social capital (measured by volunteering and level of trust). To account for the potential endogeneity of literacy and numeracy skills and educational attainment, we develop a simultaneous equation model consisting of outcome variables, literacy and numeracy skills, and education. The results show that literacy and numeracy skills exert a positive influence on education, health, the probability of being employed, the probability of participating in volunteer work and having high level of trust.

[86] References are in unformatted version

1. Introduction and background

Literacy and numeracy are important skills necessary for individual socioeconomic wellbeing and for the development of a productive and cohesive society. Literacy and numeracy are cognitive skills which are core components of human capital and support development of other forms of human capital including health. Human capital influences education, labour force outcomes and social inclusion. In turn, education can influence healthy behavior which improves health, which is itself both an input to and component of human capital [236]}. Thus, there is an endogenous relationship between literacy and numeracy and adult health and socioeconomic outcomes.

According to Heckman, investment in early childhood education and development will build the skills necessary for future success in health and life [38]. The short term costs of interventions in childhood are offset by long term gains including better health outcomes, reduced need for social services, reduced crime and increased productivity [38]. Previous research by Cronin, Reeve and Goodall [271] has shown that disadvantaged Australian children are more likely to have poor literacy and numeracy skills. Following Heckman's equation, if literacy and numeracy can be improved by interventions in childhood then the cost of such interventions should be weighed against the long term benefits accrued in adulthood. A better understanding of the links between literacy and numeracy skills and individual outcomes in adulthood can help to identify long term benefits of interventions to improve literacy and numeracy skills.

There is a substantial literature on the effect of education as a proxy for human capital on health and labour force outcomes. However, the Organisation for Economic Co-operation and Development (OECD) has shown it to be a poor proxy because people with the same level of education show varying skills [252]. A few studies directly estimate the impact of cognitive skills on health, employment, and earnings by using literacy and numeracy measures. These studies have demonstrated a positive association between literacy and numeracy and health and labour market outcomes, including wages and employment [234,236,240,272-274].

The focus of existing studies investigating the relationships between literacy and numeracy skills and socioeconomic outcomes is on labour force outcomes and associated productivity growth. Whilst the most recent literature in this area recognizes the complexity of the relationship between human capital skills and labour force outcomes, this has not been considered in their econometric modelling. Furthermore, the role of literacy and numeracy in developing social capital has been neglected in adult literacy and numeracy policy and practice [275]; this neglect is of reflective the focus on labour force outcomes in the economic literature.

In this study, we model individual outcomes in adulthood associated with literacy and numeracy. We utilise the rich confidentialised unit record file (CURF) data compiled by the Australian Bureau of Statistics (ABS) from the Australian national survey Programme for the International Assessment of Adult Competencies (PIAAC) in 2011-12. Our study aims to expand on the current literature by applying structural equations modelling to estimate the complex relationships between the variables to reduce the possible bias present in existing studies. Specifically, we develop a simultaneous equation model (SEM) consisting of outcome variables (adult health and socio-economic status), literacy and numeracy skills, and education, to account for the potential endogeneity of literacy and numeracy skills and educational attainment. Additionally, we fill a gap in the literature by providing evidence on the role of literacy and numeracy in developing social capital.

The results show that literacy and numeracy skills exert a positive influence on education, health, the probability of being employed, the propensity for participating in voluntary work, and forging a high level of trust. There is evidence of gender heterogeneity in these effects.

Data and methodology

Data

We use basic CURF data from the PIAAC survey (2011–12) conducted by ABS on behalf of the OECD. The survey was conducted throughout Australia from October 2011 to March 2012 and collected information on skills and competencies for people aged 15 to 74 years including in the domains of literacy and numeracy. In addition to literacy and numeracy measures, the survey data include a range of indicators of socioeconomic wellbeing. There are 8,600 respondents and the final sample size is 6,108 after dropping observations with missing values.[87]

Variables

To more fully reflect the potential benefits of interventions that improve literacy and numeracy skills, we consider the impact of literacy and numeracy skills on a range of outcomes including employment, health status, and the development of social capital. Employment status is described by labour force states with three categories: not participating in the labour force, unemployed, and employed. The first two categories are further combined into one due to the small sample size in the unemployed group.[88] Health status is measured by a binary indicator variable with a value of 1 if the if the survey participant reported 'good',' very good', or' excellent health'

It has been established that social capital can facilitate co-operation, exchange and innovation in a society; therefore, it is relevant to investigate whether high literacy and numeracy skills promote the development of social capital. In this study, an individual's social capital is measured by whether the respondent worked for a charity or volunteer organization in the last 12 months and self-reported levels of trust. Levels of trust are related to a survey question asking the respondent whether they agree that 'there are only a few people that you can trust completely' (on a scale of 1 to 5 from strongly agree to strongly disagree). We derived a binary indicator variable from the responses to this question with a value of 1 for 'disagree' or 'strongly disagree', representing the presence of a high level of trust.[89]

Our key explanatory variables are literacy and numeracy skills. Respondents were given various tasks to assess their literacy and numeracy skills, generating ten plausible values (scores) on a scale ranging from 0 to 500 that measure their literacy and numeracy skills. There is a strong and positive correlation between literacy and numeracy skills, which induces collinearity issues;[90] therefore, one standardised variable of the average of literacy and numeracy test scores was created to account for both skills. As this variable is a measure of both literacy and numeracy, the effects of these two skills on the outcome variables cannot be identified separately.

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[87] There are no substantial differences between the original sample and our analysis sample in the distributions of variables used in the estimation. The results are available upon request.
[88] There are 185 unemployed individuals (3%) in the sample.
[89] 0 for answers of 'strongly agree', 'agree', and 'neither agree or disagree'.
[90] The correlation coefficient between literacy and numeracy scores for all observations is 0.92.

Two categories were used for the highest educational attainment: (1) school only, up to Year 12, and (2) tertiary education, including certificate, diploma, and bachelor degree or higher. Additionally, age, gender, marital status (living with a partner or not), country of birth (Australia, other English-speaking countries, and others), age of youngest children (no children, 0-14 years, 15-24 years, and 25 years or above) were also included. The variable names and definitions used in this paper are summarised in Table 1 along with their mean and standard deviation (for continuous variables).

[Insert Table 1]

Empirical method and specification

The employment status of an individual i is modelled by

$$employ_i^* = \alpha_0 + \alpha_1 X_i + \alpha_2 health_i + \alpha_3 skillscore_i + \alpha_4 edu_i + \epsilon_i^1 \quad (1)$$

$$employ_i = \begin{cases} 1 & if\ employ_i^* \geq 0 \\ 0 & otherwise \end{cases} \quad (2)$$

The health determination equation is specified as

$$health_i^* = \beta_0 + \beta_1 X_i + \beta_2 skillscore_i + \beta_3 edu_i + \epsilon_i^2 \quad (3)$$

$$health_i = \begin{cases} 1 & if\ health_i^* \geq 0 \\ 0 & otherwise \end{cases} \quad (4)$$

where $employ_i^*$ and $health_i^*$ can be treated as an index of an unobserved propensity for being employed and having good health, separately. $employ_i$ denotes the observed employment decision of an individual i, taking the value of 1 if an individual is employed and a value of 0 if unemployed or not in the labour force. X_i is a vector of personal characteristics. $skillscore_i$ is the standardized value of the average of the literacy and numeracy skill scores. $health_i$ is an indicator variable, with 1 for self-reporting good health and 0 for poor health. edu_i is an indicator variable, with 1 for having high education and 0 for low education. ϵ_i^1 and ϵ_i^2 are error terms, which are assumed to follow the normal distribution.

The two outcome variables of social capital (participation in voluntary work and level of trust) are modelled separately by

$$S_{i\_j}^* = \theta_{0\_j} + \theta_{1\_j} X_i + \theta_{2\_j} skillscore_i + \theta_{3\_j} edu_i + \epsilon_{i\_j}^3, \quad j = 1, 2 \quad (5)$$

$$S_{i\_j} = \begin{cases} 1 & if\ S_{i\_j}^* \geq 0 \\ 0 & otherwise \end{cases} \quad (6)$$

where $S_{i\_j}^*$ denotes the propensity of participating in voluntary work ($j = 1$) or having a high level of trust ($j = 2$). S_{i_j} with $j = \{1, 2\}$ is the observed choice for voluntary work participation and exhibition of a high level of trust, respectively.

Literary and numeracy skills and educational attainment in Equations (1), (3), and (5) are not exogenously determined. The endogeneity derives from two sources. First, it may result from omitted variables. The literary and numeracy skills and educational attainment in the employment, health status, and social capital equations are likely to be correlated with the error terms that capture individuals' unobserved talents, motivation, and preferences. Second, the endogeneity may be the result of reverse causality in the sense that employment and health status could influence how much education or training an individual undertake, in the practice. For example, individuals who are healthier or who are employed and possess higher income may be more likely to have more human capital investment, resulting in higher literacy and numeracy skills and higher educational levels. The two possible cases of endogeneity would bias the estimates upwards.[91]

In order to correct for the endogeneity of the two variables, we model the literary and numeracy skills and education equations, (7) and (9), and estimate them simultaneously with the equations for outcome variables, i.e. employment equation, (1), health status equation, (3), and social capital equation, (5).[92]

$$edu_i^* = \gamma_0 + \gamma_1 X_i + \gamma_2 Z_{1i} + \epsilon_i^4 \qquad (7)$$

$$edu_i = \begin{cases} 1 & if\ edu_i^* \geq 0 \\ 0 & otherwise \end{cases} \qquad (8)$$

$$skillscore_i = \phi_0 + \phi_1 X_i + \phi_2 Z_{2i} + \epsilon_i^5 \quad (9)$$

Identification of the above SEM is achieved by imposing exclusion restrictions in the equations for edu_i and $skillscore_i$, respectively. Specifically, following the literature, we include level of highest educational qualification of mother or female guardian and level of highest educational qualification of father or male guardian in Z_{1i} in equation (7). These terms provide us with an exclusion restriction, instrumenting edu_i. The underlying assumption is that while parental educational attainment may has a positive effect on the children's educational level, it is unlikely to directly affect the health status and labour market outcomes of their children. Z_{2i}, in equation (9), includes the number of books had in household when the respondent was 16 as an exclusion restriction for the variable measuring the literacy and numeracy skills. These excluded restrictions are expected to influence the formation of an individual's literacy and numeracy skills, but they do not affect the health and socio-economic status directly. lists the variables of the SEM used in each equation.

Additionally, the unobservable factors, such as individuals' talents, motivation, and preferences, are set as a latent variable and are incorporated in all sub-equations in the simultaneous equation system, thus allowing a correlation between the unobserved parts of these equations. The SEM is estimated by maximum likelihood (ML) estimation using Stata.

Results

[91] We estimate the employment equation with literacy and numeracy skills as an explanatory variable (i.e. the reduced-form equation), the marginal effect of literacy and numeracy skill is 0.077, suggesting that that one standard division increase in literacy and numeracy skill score is associated with an increased probability of employment of 7.7 percentage points. When we estimate the employment equation jointly with the equation for literacy and numeracy skills, the marginal effect becomes 0.053. Similarly, the marginal effects of education for employment are 0.136 and 0.127 for these two model specifications, separately. This affirms that the failure to control for the endogeneity of literary and numeracy skills and educational attainment would have an upward bias on the results.

[92] The error terms in the simultaneous equation system are assumed to follow a multivariate normal distribution.

Tables 2, 3, and 4 present the estimation results for employment and health status, level of trust, and volunteer work participation, separately. Of particular interest are the coefficients of literacy and numeracy skills variables in these equations. From Table 2, we can see that better literacy and numeracy skills are associated with a higher probability of being employed, relative to that of not employed. In addition, higher literacy and numeracy skills are also correlated with a higher propensity of having good health status. Educational attainment and good health status have a positive and significant impact on the propensity of being employed. Individuals who have a lower probability of being employed are those who have dependent children age 0-14, who are aged 55 and above, who are females, and who are single. For the health determination equation, people who are married and younger are more likely to have better health status.

The results presented in Tables 3 and 4 suggest that higher literacy and numeracy skills and education levels are associated with a higher probability of participation in voluntary work and a higher probability of having high level of trust. Females, individuals who were born in Australia, and who are aged 55 and above have a higher probability of voluntary work participation and having a high level of trust. Having children gives rise to a higher likelihood of voluntary work participation.

[Insert Table 2]

[Insert Table 3]

[Insert Table 4]

Literacy and numeracy skills and educational attainment equations serve as the 'first stage' equations. The variables excluded from the second stage equations, number of books in household at age 16 in the literacy and numeracy skills equation and parents' level of education in the education equation, are highly significant, showing the validity of our instruments. Their estimated coefficients imply that having more books at home in childhood lead to higher literacy and numeracy skills. The level of parental education impacts positively on their children's education.

The literacy and numeracy skills and other socio-demographic factors may have a different effect on these outcome variables by gender; the simultaneous equation models are estimated for men and women separately as a subsample analysis. Table 5 lists the marginal effects of literacy and numeracy and education for men and women. One standard deviation increase in literacy and numeracy skill score is associated with an increased probability of employment of 4.0 and 4.3 percentage points for men and women, respectively. Marginal effects for educational attainment on being employed are positive, but larger for men (9.8 percentage points) than for women (8.8 percentage points). Higher education attainment leads to better health status only for males but not for females. Literacy and numeracy skills contribute more to high level of trust for males than that for females. Another interesting finding is that the effect of children on employment varies by gender. The presence of young dependent children (less than age 14) reduces the job participation of females but not of males. Males with children aged 15-24 are more likely to participate in the labour force while no such trend is revealed for females.[93]

[Insert Table 5]

In addition, we re-define the health status and educational attainment as variables with 3 categories and utilise the ordered probit model as an alternative model specification. Consistent results are found. We also introduce a two-way relationship between literacy and numeracy skills and education levels; the results show a positive and significant association

[93] Results for subsample analysis are available upon request.

between them, suggesting that literacy and numeracy can be enhanced through formal education and higher literacy and numeracy skills facilitate higher educational attainment.

Conclusion

Literacy and numeracy skills are shown to exert a positive influence on education, health, the probability of being employed, the probability of participating in voluntary work and having high level of trust. After controlling for education, the effect of literacy and numeracy skills on health and socioeconomic outcomes is still statistically significant, suggesting that literacy and numeracy skills have an indirect effect through formal education on individual outcomes in adulthood and also influence them directly. The results can inform an economic model which can be used to estimate the costs and benefits of interventions to improve adult literacy and numeracy and associated outcomes.

Literacy and numeracy can be acquired in many channels, including during early childhood, through formal education, and through informal means (in day-to-day activities at home or on-the-job training). A direction of future research is to consider the relative importance of these pathways.

Table 1 Definitions of variables and descriptive statistics

Variable	Description	Mean	SD.
Dependent variable			
Employed	=1 if employed; =0 not in the labour force or unemployed	0.722	
Good health	=1 if self-reported 'good', 'very good' or 'excellent' health; =0 if self-reported 'poor' or 'fair' health	0.845	
Tertiary education	=1 if obtained certificate, diploma, or bachelor degree or above; =0 if Year 12 or below	0.585	
Volunteer work participation	=1 if work for a charity or volunteer organization in the last 12 months; =0 otherwise	0.431	
High level of trust	=1 if have a high level of trust; =0 otherwise	0.249	
Independent variable			
Literacy and numeracy skill	The standardised value of the average of literacy and numeracy test scores	0.000	(1.000)
Age			
Age 15-24	=1 if age is between 15 and 24; =0 otherwise	0.111	
Age 25-34	=1 if age is between 25 and 34; =0 otherwise	0.166	
Age 35-44	=1 if age is between 35 and 44; =0 otherwise	0.205	
Age 45-54	=1 if age is between 45 and 54; =0 otherwise	0.184	
Age 55-64	=1 if age is between 55 and 64; =0 otherwise	0.193	
Age 65 and above	=1 if age is between 65 and above; =0 otherwise	0.141	
Male	=1 male; =0 female	0.468	
Country of birth			
Australia	=1 if born in Australia	0.728	
English speaking	=1 if born in main English speaking country (not Australia)	0.120	
Others (base group)	=1 if born in non-English speaking country	0.152	
Married	=1 if living with spouse or partner	0.575	
Age of the youngest children			
No children (base group)	=1 if no children	0.379	
0-14 years	=1 if the age of the youngest children is between 0-14 years	0.250	
15-24 years	=1 if the age of the youngest children is between 15-24 years	0.116	
25 years or above	=1 if the age of the youngest children is 25 years or above	0.256	
English mainly spoken at home	=1 if English is the main language spoken at home; =0 otherwise	0.926	
Level of highest educational qualification of mother or female guardian			
Primary or lower secondary education	=1 if primary or lower secondary education	0.645	
Upper secondary education	=1 if upper secondary education	0.174	
Tertiary education	=1 if short-cycle tertiary education or bachelor degree or above	0.182	
Level of highest educational qualification of father or male guardian			
Primary or lower secondary education	=1 if primary or lower secondary education	0.575	
Upper secondary education	=1 if upper secondary education	0.222	
Tertiary education	=1 if short-cycle tertiary education or bachelor degree or above	0.202	

Number of books in childhood (at age 16)		
10 books or less	=1 if had 10 books or less in household at age 16; =0 otherwise	0.123
11-25 books	=1 if had 11-25 books in household at age 16; =0 otherwise	0.128
26-100 books	=1 if had 26-100 books in household at age 16; =0 otherwise	0.339
101-200 books	=1 if had 101-200 books in household at age 16; =0 otherwise	0.188
201-500 books	=1 if had 201-500 books in household at age 16; =0 otherwise	0.142
More than 500 books	=1 if had more than 500 books in household at age 16; =0 otherwise	0.079

Note: Standard deviations for continuous variables are shown in bracket

Table 2: Estimation results for employment and health status regressions

	Employed		Good health		Literacy and numeracy skills		High education	
Variables	(1)		(2)		(3)		(4)	
Literacy and numeracy skills	0.166***	(0.055)	0.303***	(0.064)				
Tertiary education	0.335**	(0.154)	0.353**	(0.172)				
Good health	0.646***	(0.061)						
Age categories (base is age15-24)								
Age 25-34	0.216**	(0.104)	-0.455***	(0.122)	0.215***	(0.042)	1.480***	(0.098)
Age 35-44	0.321***	(0.105)	-0.591***	(0.122)	0.212***	(0.045)	1.389***	(0.103)
Age 45-54	0.240**	(0.095)	-0.708***	(0.111)	0.078*	(0.046)	1.164***	(0.105)
Age 55-64	-0.420***	(0.094)	-0.738***	(0.111)	-0.018	(0.050)	1.085***	(0.114)
Age 65 and above	-1.556***	(0.100)	-0.668***	(0.111)	-0.335***	(0.056)	0.772***	(0.127)
Male	0.369***	(0.040)	-0.069	(0.042)	0.144***	(0.021)	0.016	(0.048)
Country of birth (base is in other countries)								
Born in Australia	0.008	(0.068)	-0.002	(0.070)	0.241***	(0.036)	-0.382***	(0.086)
Born in other main English speaking countries	-0.025	(0.085)	0.029	(0.089)	0.351***	(0.046)	-0.272**	(0.106)
Married	0.202***	(0.049)	0.147***	(0.050)	0.194***	(0.024)	0.321***	(0.054)
The age of the youngest children (base is no children)								
Youngest children age 0-14	-0.459***	(0.065)	0.084	(0.068)	-0.110***	(0.033)	-0.190**	(0.076)
Youngest children age 15-24	0.131	(0.083)	0.073	(0.082)	-0.183***	(0.042)	-0.110	(0.095)
Youngest children age 25+	-0.069	(0.081)	0.020	(0.084)	-0.214***	(0.043)	-0.333***	(0.095)
English mainly spoken at home	0.137	(0.095)	0.029	(0.099)	0.445***	(0.049)	0.080	(0.117)
Number of books had in household at age 16 (base is 10 or less books)								
11-15 books					0.375***	(0.041)		
26-100 books					0.477***	(0.035)		
101-200 books					0.674***	(0.039)		
201-500 books					0.869***	(0.041)		
More than 500 books					0.947***	(0.048)		
Highest educational attainment of mother or female guardian (base is primary or lower secondary education)								
Upper secondary education							0.254***	(0.070)
Tertiary education							0.441***	(0.078)
Highest educational attainment of father or male guardian (base is primary or lower secondary education)								
Upper secondary education							0.233***	(0.062)
Tertiary education							0.560***	(0.075)
Constant	-0.193*	(0.106)	1.300***	(0.109)	-1.174***	(0.057)	-0.815***	(0.127)
Number of observations	6108							

`Table 3 Estimation results for level of trust regressions

	High level of trust		Good health		Literacy and numeracy skills		High education	
Variables	(1)		(2)		(3)		(4)	
Literacy and numeracy skills	0.644***	(0.120)	0.315***	(0.061)				
Tertiary education	1.081***	(0.274)	0.387**	(0.162)				
Good health	0.100	(0.177)						
Age categories (base is age15-24)								
Age 25-34	-0.426***	(0.151)	-0.468***	(0.119)	0.215***	(0.042)	1.478***	(0.098)
Age 35-44	-0.405***	(0.149)	-0.606***	(0.120)	0.212***	(0.045)	1.387***	(0.103)
Age 45-54	-0.114	(0.120)	-0.717***	(0.110)	0.078*	(0.046)	1.162***	(0.105)
Age 55-64	0.041	(0.118)	-0.746***	(0.110)	-0.019	(0.050)	1.077***	(0.114)
Age 65 and above	0.323**	(0.130)	-0.669***	(0.112)	-0.336***	(0.056)	0.764***	(0.127)
Male	-0.243***	(0.056)	-0.071*	(0.043)	0.143***	(0.021)	0.015	(0.048)
Country of birth (base is in other countries)								
Born in Australia	0.256***	(0.091)	-0.001	(0.070)	0.241***	(0.036)	-0.373***	(0.086)
Born in other main English speaking countries	0.149	(0.103)	0.030	(0.090)	0.352***	(0.046)	-0.269**	(0.106)
Married	-0.103*	(0.062)	0.143***	(0.050)	0.194***	(0.024)	0.324***	(0.054)
The age of the youngest children (base is no children)								
Youngest children age 0-14	0.051	(0.076)	0.087	(0.068)	-0.110***	(0.033)	-0.190**	(0.076)
Youngest children age 15-24	0.055	(0.096)	0.075	(0.082)	-0.184***	(0.042)	-0.105	(0.095)
Youngest children age 25+	0.145	(0.106)	0.025	(0.083)	-0.215***	(0.043)	-0.331***	(0.095)
English mainly spoken at home	-0.133	(0.126)	0.026	(0.098)	0.445***	(0.049)	0.077	(0.116)
Number of books had in household at age 16 (base is 10 or less books)								
11-15 books					0.375***	(0.041)		
26-100 books					0.478***	(0.034)		
101-200 books					0.672***	(0.038)		
201-500 books					0.873***	(0.041)		
More than 500 books					0.937***	(0.048)		
Highest educational attainment of mother or female guardian (base is primary or lower secondary education)								
Upper secondary education							0.212***	(0.069)
Tertiary education							0.430***	(0.077)
Highest educational attainment of father or male guardian (base is primary or lower secondary education)								
Upper secondary education							0.259***	(0.060)
Tertiary education							0.581***	(0.073)
Constant	-1.513***	(0.235)	1.296***	(0.110)	-1.174***	(0.057)	-0.820***	(0.127)
Number of observations	6108							

Table 4: Estimation results for volunteer work participation regressions

Variables	Volunteer work participation (1)		Good health (2)		Literacy and numeracy skills (3)		High education (4)	
Literacy and numeracy skills	0.812***	(0.166)	0.261***	(0.054)				
Tertiary education	1.522***	(0.374)	0.234	(0.149)				
Good health	0.111	(0.218)						
Age categories (base is age 15-24)								
Age 25-34	-1.145***	(0.252)	-0.400***	(0.112)	0.215***	(0.042)	1.490***	(0.098)
Age 35-44	-0.691***	(0.194)	-0.539***	(0.112)	0.212***	(0.045)	1.386***	(0.103)
Age 45-54	-0.608***	(0.170)	-0.669***	(0.102)	0.078*	(0.046)	1.164***	(0.105)
Age 55-64	-0.201	(0.138)	-0.707***	(0.104)	-0.019	(0.050)	1.083***	(0.113)
Age 65 and above	0.331**	(0.149)	-0.662***	(0.109)	-0.336***	(0.056)	0.772***	(0.127)
Male	-0.281***	(0.069)	-0.063	(0.042)	0.144***	(0.021)	0.019	(0.048)
Country of birth (base is in other countries)								
Born in Australia	0.370***	(0.108)	-0.005	(0.069)	0.242***	(0.036)	-0.383***	(0.086)
Born in other main English speaking countries	0.017	(0.113)	0.037	(0.088)	0.352***	(0.046)	-0.272**	(0.106)
Married	-0.136*	(0.073)	0.164***	(0.049)	0.195***	(0.024)	0.322***	(0.053)
The age of the youngest children (base is no children)								
Youngest children age 0-14	0.461***	(0.114)	0.070	(0.066)	-0.110***	(0.033)	-0.182**	(0.075)
Youngest children age 15-24	0.241**	(0.116)	0.058	(0.080)	-0.183***	(0.042)	-0.109	(0.095)
Youngest children age 25+	0.352***	(0.133)	-0.005	(0.081)	-0.214***	(0.043)	-0.327***	(0.094)
English mainly spoken at home	-0.169	(0.137)	0.053	(0.096)	0.445***	(0.049)	0.066	(0.117)
Number of books had in household at age 16 (base is 10 or less books)								
11-15 books					0.362***	(0.040)		
26-100 books					0.468***	(0.034)		
101-200 books					0.665***	(0.038)		
201-500 books					0.866***	(0.041)		
More than 500 books					0.942***	(0.048)		
Highest educational attainment of mother or female guardian (base is primary or lower secondary education)								
Upper secondary education							0.231***	(0.067)
Tertiary education							0.455***	(0.075)
Highest educational attainment of father or male guardian (base is primary or lower secondary education)								
Upper secondary education							0.229***	(0.059)
Tertiary education							0.558***	(0.072)
Constant	-1.046***	(0.295)	1.306***	(0.110)	-1.168***	(0.057)	-0.806***	(0.127)
Number of observations	6108							

Table 5: Marginal effects of literacy and numeracy and education

	Literacy and numeracy skills (standardised score)			Tertiary education		
Outcome variables	All	Male	Female	All	Male	Female
(1) Employed	0.041***	0.040**	0.043**	0.085**	0.098*	0.088*
	(0.013)	(0.018)	(0.018)	(0.040)	(0.059)	(0.053)
Good Health	0.067***	0.076***	0.050***	0.080**	0.127**	0.029
	(0.012)	(0.017)	(0.017)	(0.038)	(0.065)	(0.048)
(2) High level of trust	0.161***	0.207***	0.126***	0.264***	0.062***	0.174***
	(0.018)	(0.032)	(0.020)	(0.045)	(0.019)	(0.053)
(3) Volunteer work participation	0.205***	0.195***	0.213***	0.433***	0.442***	0.438***
	(0.016)	(0.023)	(0.022)	(0.065)	(0.101)	(0.085)

Table A 1: Variables used in sub-equation of the simultaneous equations model

	Equation					
	Employment	Health status	Volunteer work	Level of trust	Education	Literacy and numeracy skill
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)
Literacy and numeracy skill	X	X	X	X		
Education	X	X	X	X		
Health status	X		X	X		
Age	X	X	X	X	X	X
Male	X	X	X	X	X	X
Country of birth	X	X	X	X	X	X
Married	X	X	X	X	X	X
Age of the youngest children	X	X	X	X	X	X
English mainly spoken at home	X	X	X	X	X	X
Level of highest educational qualification of mother or female guardian					X	
Level of highest educational qualification of father or male guardian					X	
Number of books in household at 16						X

Appendix P: Robustness check – Conditioning on mean WAI scores

Examiner 2 identifies that the biggest challenge in the thesis is whether the estimated costs can be directly attributed to language disorders. The examiner proposes a robustness test which conditions on a mean IQ score (WAI) in the relevant analysis to test how these estimates may differ to the estimates in the thesis. The basis for this assumption is to further control for the impact of low cognitive ability in the estimate of costs. The base case analysis considered IQ by excluding observations in the lowest 10% of the sample. This assumption adds another step by explicitly considering IQ in each of the equations and then calculating marginal effects, conditional on the mean IQ of the sample. Table 100 considers this assumption in the health utilisation analysis in Chapter 3. Table 101, Table 102 and Figure 20 considers this assumption in the education chapter in Chapter 5. Overall the sensitivity analysis showed that the conditional estimates were highly consistent with the base case in each chapter. On this basis, the sensitivity analysis supports the conclusions made throughout the thesis that these costs can be reasonably be attributed to DLD.

Table 100: Chapter 3: Health care expenditure (and OOP) and children's language difficulties (2004, 2006, 2008, 2010, 2012, 2014) – K cohort ($)

Base case (Table 22, Table 23)

	Health care expenditure				OOP			
	Base case		Conditional on mean WAI (Z-score)		Base case		Conditional on mean WAI (Z-score)	
	FE							
	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
Language difficulty								
0	$1,927	[1926.7,1926.7]	$1,926	[1926.2,1926.2]	$397	[396.5,396.5]	$396	[396.3,396.3]
1	$2,166	[2166.2,2166.2]	$2,166	[2165.7,2165.7]	$456	[456.1,456.1]	$456	[455.9,455.9]
Number of observations	18142		18142		18142		18142	

+ p<0.10, * p<0.05, **p<0.01

Table 101: Chapter 4: Mean literacy scores (at 6 to 7 years and 14 to 15 years) by language difficulty status (Base case Table 38)

	Low achievement school		Median achievement school		High achievement school	
	Z score	95% CI	Z score	95% CI	Z score	95% CI
Panel A			Mean Literacy Scores 6/7 years			
Language						
Typical language	-0.162**	[-0.223,-0.101]	0.003	[-0.0322,0.0376]	0.0983**	[0.0517,0.145]
LD1_4–7	-0.127	[-0.326,0.0724]	-0.030	[-0.165,0.105]	-0.128	[-0.334,0.0781]
LD1_≥8	-0.388**	[-0.492,-0.283]	-0.307**	[-0.406,-0.209]	-0.220*	[-0.397,-0.0439]
LD2_4–7	-0.416**	[-0.719,-0.113]	-0.283*	[-0.503,-0.0634]	-0.408+	[-0.830,0.0148]
LD2_≥8	-0.607**	[-0.763,-0.451]	-0.408**	[-0.557,-0.258]	-0.235	[-0.644,0.174]
LD3_4–7	-0.677**	[-0.956,-0.397]	-0.647**	[-0.959,-0.336]	-0.246	[-1.247,0.756]
LD3_≥8	-0.593**	[-0.750,-0.437]	-0.588**	[-0.764,-0.412]	-0.636*	[-1.183,-0.0882]
Panel B			Mean Literacy Scores 14/15 years			
Language						
Typical language	-0.308**	[-0.391,-0.226]	0.155**	[0.107,0.204]	0.598**	[0.537,0.658]
LD1_4–7	-0.525**	[-0.804,-0.247]	0.065	[-0.125,0.254]	0.377**	[0.0964,0.658]
LD1_≥8	-0.912**	[-1.064,-0.760]	-0.560**	[-0.686,-0.435]	-0.160	[-0.386,0.0667]
LD2_4–7	-0.836**	[-1.287,-0.385]	-0.189	[-0.499,0.120]	0.096	[-0.640,0.832]
LD2_≥8	-1.242**	[-1.479,-1.005]	-0.933**	[-1.137,-0.729]	0.067	[-0.416,0.550]
LD3_4–7	-1.769**	[-2.198,-1.340]	-0.861**	[-1.275,-0.447]	-0.416	[-1.295,0.463]
LD3_≥8	-1.494**	[-1.764,-1.225]	-1.244**	[-1.560,-0.927]	-0.373	[-1.114,0.369]

"+ p<0.10, * p<0.05, ** p<0.01" 95% CI= 95% confidence interval. Model controls for language, time, school achievement, change in schools, IQ and propensity score

Table 102: Chapter 4: Gains in literacy between 6 to 7 years and 14 to 15 years (Z-Scores) Base case (Table 40)

	Low achievement school		Median achievement school		High achievement school	
	Z score	95% CI	Z score	95% CI	Z score	95% CI
Gains in Literacy Scores from 6/7 years to 14/15yrs						
Language						
Typical language	-0.146**	[-0.241,-0.0520]	0.153**	[0.0987,0.207]	0.499**	[0.432,0.567]
LD1_4–7	-0.398*	[-0.711,-0.0855]	0.10	[-0.116,0.306]	0.505**	[0.189,0.821]
LD1_≥8	-0.524**	[-0.692,-0.355]	-0.253**	[-0.400,-0.106]	0.061	[-0.208,0.329]
LD2_4–7	-0.420	[-0.933,0.0924]	0.09	[-0.260,0.447]	0.50	[-0.282,1.289]
LD2_≥8	-0.635**	[-0.905,-0.365]	-0.525**	[-0.755,-0.295]	0.302	[-0.270,0.875]
LD3_4–7	-1.092**	[-1.578,-0.607]	-0.21	[-0.709,0.281]	-0.170	[-1.345,1.005]
LD3_≥8	-0.901**	[-1.197,-0.605]	-0.655**	[-1.001,-0.310]	0.263	[-0.594,1.120]

* p<0.05, ** p<0.01, *** p<0.001 95% CI= 95% confidence interval. Model controls for language, time, school achievement, change in schools, IQ and propensity score

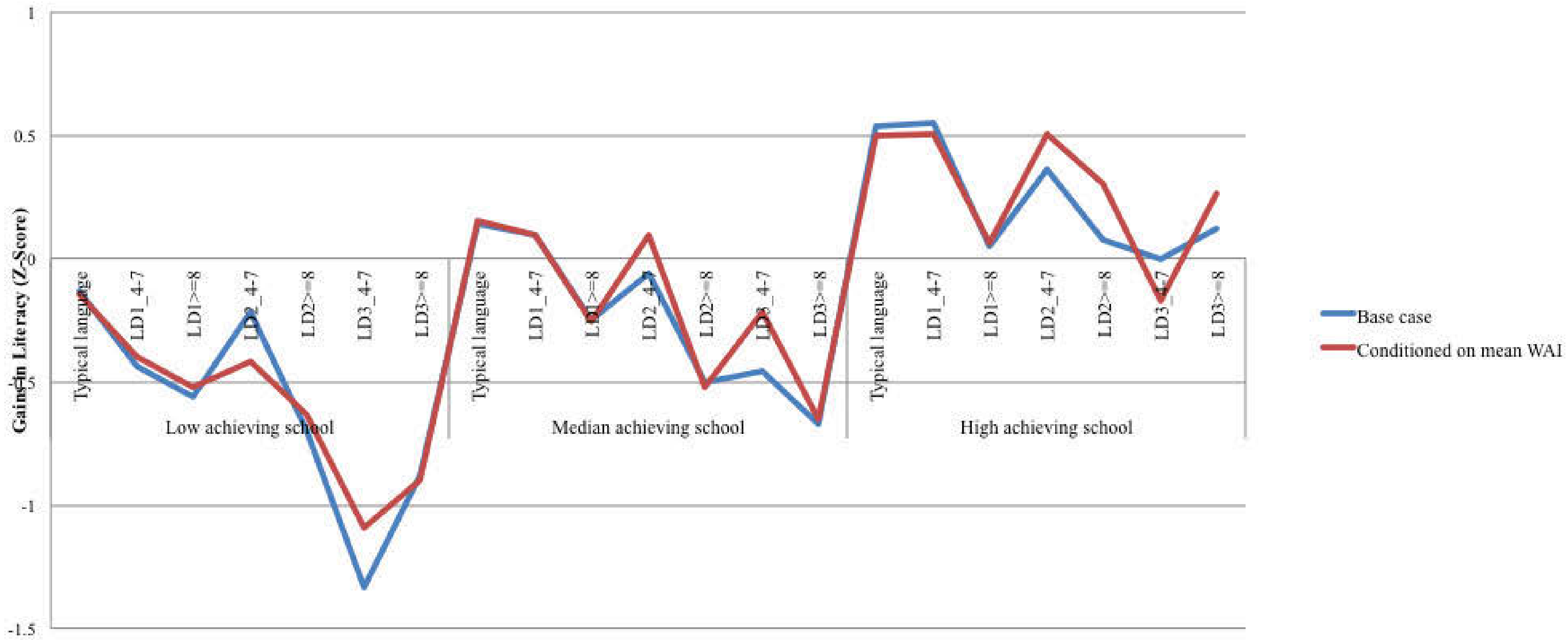

Figure 18: Comparison of literacy gains (6 to 7 years to 14 to 15 years) – Base case vs. conditional on mean WAI

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