DOES SIZE COUNT DOWN UNDER? AUSTRALIAN SCHOOL PERFORMANCE, SCHOOL SIZE AND PUBLIC POLICY

Abstract

In principle, education research might be expected to yield evidence on the determinants of success that could then be used to inform public policy. However, if key determinants are missing from empirical specifications, then public policy decisions may well be made in a vacuum. Moreover, if empirical work is informed by disparate conceptual approaches, then public policies may be formulated, which ultimately work at cross-purposes. We examine the issue of school size from both the economic and the ecological perspective. Our regressions on a seven year panel of Australian data suggest that there is a trade-off to be made between efficiency on the one hand, and the desire to lift academic standards on the other. Failure to consider the question of school size from both economic and ecological perspectives means that an important public policy lever has largely gone unrecognised in the Antipodes. We conclude our essay with a consideration of the public policy implications arising from our work.

There is general consensus amongst scholars and the wider public that education plays an essential role in modern societies and this shared appreciation of the importance of education has resulted in a high level of investment in systems of schooling. Economists point to the important role that education plays in the accumulation of human capital, which is a critical component for economic growth. Indeed, some economists have asserted that the health of a nation's education system is akin to an early warning device for the future health of the nation's economy (Hanushek 2006). Sociologists, on the other hand, often point to the critical role that education plays in transmitting social capital (Teese 2005). To monitor the effectiveness of educational institutions, many jurisdictions conduct or participate in regular testing for key domains of learning (for instance, the Programme for International Student Assessment (PISA) conducted by the Organisation for Economic Co-operation and Development (Abalde 2014)). Jurisdiction-wide standardised testing and reporting of student and school academic achievement are often controversial and criticised by teachers, in particular, but they do 'tend to capture what parents and voters in a school district ultimately care about' (Andrews et al. 2002).

In principle, it should be possible to employ this data on school performance (both economic and academic) in empirical research to identify the determinants of school success, and thus point the way to efficacious public policy. However, in practise, problems with the data, empirical models and disparate conceptual approaches of scholars has largely thwarted evidence-informed public policy (Marks 2015).

The issue of optimal school size is a good illustration of the problems that are encountered by those wishing to formulate evidence-informed public policy. In many jurisdictions, school-level data are not available, which means that analysts either neglect the issue of size entirely or are forced to work at a level for which data can be obtained (often the district level) (Andrews et al. 2002; Marks 2014). Other times, the model specification has been unsatisfactory – for instance, some of the extant empirical work fails to allow for likely parabolic associations and is therefore incapable of accurately

reflecting the theoretical expectations regarding the association between size and performance (both economic and academic (e.g., Leithwood and Jantzi 2009). Indeed, much of the actual policies implemented have been formed and executed in an evidence vacuum and have, not unsurprisingly, proven largely ineffective (Hanushek 2003). Even when data availability and model specification have been appropriate, very disparate conceptual approaches to the question of optimal school size have produced quite contrary evidence.

The two main approaches employed by scholars to investigate the optimal size of schools are economic and ecological perspectives. The economic approach is generally concerned with the association between school size and unit cost and is pursued for the purpose of arriving at the most technically efficient (defined as the optimal conversion of inputs into outputs) size of education institutions (Lee and Loeb 2000). The evidence arising from studies of this type has led to a policy preference for relatively large schools capable of capturing economies of scale in production process (economies of scale refer to an economic concept whereby the average total costs of producing some goods is expected to initially decrease in response to expanded output) (Crosnoe et al. 2004). The ecological perspective, on the other hand, focusses on how the size of schools affect the number and types of interactions between students, teachers and communities (Lee et al. 2001). The conclusion of this stream of research has generally been that smaller educational institutions are less bureaucratic, foster more and a better quality of interactions and hence tend to be conducive to improved education outcomes (Lee and Loeb 2000; Leithwood and Jantzi 2009). Rarely have scholarly studies employed both approaches and hence attempted to discover whether there is a school size (or indeed a range of school sizes) that might strike a balance between minimising economic inputs while maximising academic achievement outputs (Crosnoe et al. 2004). Demonstrating how the two disparate approaches yield quite different recommendations for optimal size, and hence public policy prescriptions, is the principal aim of this paper.

It is easy to see how failure to examine simultaneously the question of school size from both economic and ecological perspectives can easily result in multiple public policies working at cross-

purposes. The risk of this sort of undesirable outcome occurring would seem to be further magnified where different tiers of government are involved in formulating and implementing public policy. For instance, one can imagine how federal governments might implement public policy aimed at increasing educational standards in order to improve the nation's economic welfare but be thwarted in their objective by state governments, which may avoid spending on new schools in order to alleviate their own budgetary pressures. Indeed, if the respective public policymakers are not even aware that school size might be a determinant of performance (both economic and academic) – because there is a vacuum of empirical evidence relating to the association – then it may not even be apparent to stakeholders that the tiers of government are working at cross purposes. As we will detail later, this is essentially the set of circumstances in play in Australia, which is the context for our empirical work that follows.

To investigate the disparate public policy recommendations arising from economic and ecological approaches respectively, we first outline the theoretical foundations for why school size might matter. Thereafter we describe the system of secondary public schooling in Australia and the National Assessment Program in Literacy and Numeracy that forms the context for our empirical work. We also outline the panel regression strategy that we employ to determine optimal school size for urban public schools from both economic and ecological perspectives. Following this, we present the results from our various empirical estimations and outline the range of optimal school sizes suggested by each of the conceptual lenses. We conclude with an investigation of the public policy levers that might be used to optimise school size.

Why Size Matters

Student population size has particular salience for urban schools, because this is where population pressures are most keenly felt (Lee and Loeb 2000) and also where public policy architects have greatest flexibility to introduce interventions such as school consolidations (due to relatively small distances between existing education campuses). Moreover, it is important to carefully define the level of schooling that one is focussed on investigating because the effects of size are likely to be

different for primary and secondary schools, respectively. In the discussion that follows we concentrate on the implications of size for secondary schools because these institutions are more likely to be affected by matters such as breadth of curriculum, teacher specialisation and the like that are detailed in the extant literature. Public (government) schools are the focus for our study given that public policymakers have greater leverage in this portion of the sector for significant reforms in connection with optimising school size (such as school consolidation which is mostly not an option for private education providers given the relatively less dense footprint of their campuses). We first review the theoretical foundation for the economic approach (which deals with the question of how school size is related to per student expenditure) to urban public secondary school size, before turning to the literature on the ecological approach (which looks at the association between school size and educational achievement).

Economic Approach (School Size and Per Student Expenditure)

There is a large literature that examines the economics of education production in a general sense – how inputs are related to outputs, and the sort of incentives that might be introduced to improve performance (such as merit based pay, privatisation of some education functions, and fostering choice for parents) (Hanushek 2003). However, the literature regarding the association between school size and unit cost is much narrower and focussed on American studies (Abalde 2014). In a thorough survey of the literature since 1990, Leithwood and Jantzi (2009, p. 480) report mixed evidence from five studies where 'two of these studies report results favouring large schools, two favouring small schools and one favouring mid-size schools'. In an earlier review of the literature, Andrews et al., (2002) surveyed ten studies of which eight presented evidence consistent with economies of scale (and one presented evidence suggesting constant returns to scale). The relative scarcity of economies of scale studies in education is due to problems of data availability (often only district enrolment data is available; Leithwood and Jantzi, 2009). Moreover, a good proportion of the extant studies have been criticised for perceived specification problems – principally the failure to include a squared term for school size required to identify the turning point for 'U-shaped' functions (Andrews et al., 2002). In sum, the existing literature is not conclusive given the narrow context of studies and perceived

specification problems and hence it is fair to say that a consensus does not exist in the literature regarding the association between school size and efficiency.

In the language of neo-classical economics, the term 'economies of scale' refers to the situation whereby average total costs are expected to reduce as output expands for some functions. It is important to be mindful that economies of scale – when they do indeed exist – are finite, and eventually all savings will be exhausted after which time unit costs will no longer reduce as output continues to expand. Indeed if output is expanded beyond the relatively long domain of constant returns to scale, then diseconomies may emerge (that is, average total costs will start to increase as production expands) Figure 1).

[PLEASE INSERT FIGURE 1 HERE]

Education seems particularly well suited to scale based economies, given that the size of support and management staff need not necessarily increase in direct proportion to the number of students attending a school. For instance, most schools will have a single Department Head (for instance, a Head of Mathematics) irrespective of the number of students attending. In similar vein, a single Principal generally leads management of schools, although the number of Deputy-Principals may alter slightly between schools of very disparate size. Moreover, scale can provide opportunities for some staff to specialise (for instance, support staff may specialise in providing clerical assistance) and this may allow for a relatively higher level of output per staff input. Thus, for those operating from the economic perspective, a 'big is beautiful' mantra tends to prevail (that is, big is cheaper per student; Andrews et al. 2002). However, it must be remembered that not all goods and services are associated with economies of scale and it is therefore important to empirically test the putative association between size and expenditure per student before pursuing policies aimed at yielding pecuniary savings.

It is also important to remain cognisant of the potential for inefficiency to creep in at very high levels of production. Diseconomies occur principally because of a reduction in organisational transparency. For instance, in very large schools, poorly performing staff may not be quite as visible as they are in smaller campuses and management interventions thus less effective (if they occur at all). It is also more difficult to co-ordinate staff in large schools and this difficulty may result in extra administrative burdens, which might translate into additional costs for management and support staff. The likely existence of diseconomies of scale is both the reason why cost functions are predicted to follow a 'U-shape' and the reason why size increasing interventions such as consolidation should not be pursued in the absence of robust evidence.

Ecological Approach (School Size and Student Achievement)

Sociologists are keen to draw a distinction between the economic concepts of production and what actually goes on inside schools. Education is a social endeavour that takes place between persons interacting in a defined community – not mere outputs proxied by student numbers (Teese 2005; Oxley 1997). As communities grow larger, interactions become less frequent, more formal and a bureaucracy emerges (Lee et al. 2001). In larger organisations, it is not always possible to discern clearly the actions of each person, and the effect that a person's actions might have on others (Messner 1952).

Discipline is more difficult in larger schools – for example, anyone who has ever had to stand on playground duty as a teacher is well aware that to follow-through on playground incidents it is essential to know the offending student's names, which can be a near impossible task in a campus of a few thousand students. Collaboration and sharing about student welfare is also more difficult in large schools (staff are often assigned to subject-specific staffrooms which might be at opposite ends of the campus and it is not at all unusual for staff not to know one another by name, let alone know which students they teach in common). Indeed, the evidence suggests that collaborative responsibility for discipline and learning may be substantially stronger in small schools (Lee and Loeb 2000). The reason for the higher incidence of collective responsibility in small schools is probably also derived,

in part, from the fact that there is a higher probability of encountering any particular student in class or the playground, thus suggesting that each staff member might have a vested interest in helping to improve behaviour and academic performance outcomes. Research also points to a greater sense of connectedness, a more positive relationship with teachers and a greater likelihood of participation in extra-curricular activities in smaller schools (Crosnoe et al. 2004), as well as higher retention rates and levels of student engagement (Leithwood and Jantzi 2009). Otherwise stated, for most sociologists the predominate mantra is that 'small is intimate and small is effective' (that is, small schools create a better learning environment and hence higher average achievement; Andrews et al. 2002).

However, there are undoubtedly problems that small schools face. For example, in small schools students are often pigeon-holed as a result of their behaviour or academic performance in earlier years – or even as a result of the behaviour and performance of siblings that have preceded them (Leithwood and Jantzi 2009). It is also the case that there is less opportunity for teacher specialisation in small schools and this may become particularly problematic in the later years of secondary school when the curriculum both broadens and becomes more sophisticated (Lee and Loeb, 2000). Indeed, in small schools, size may act as a constraint against streaming students (according to ability) and even result in the occurrence of composite classes wherein more than one year level of student receives instruction from a single teacher during a single lesson[1] (Abalde 2014). Because size may have negative impacts on school performance, as well as positive influence, it is reasonable to posit that empirical evidence from the ecological perspective might tend to follow an inverted 'U-shape' curve. The extant evidence on school size and educational achievement is even more mixed than the evidence relating to the economic approach and hence suggests little consensus on the matter of how school size is associated with educational achievement. In a recent survey of the literature, Leithwood and Jantzi (2009) reviewed eighteen studies and found that only six studies provided evidence of an

[1] It is acknowledged that the practice of streaming students by ability is still somewhat controversial and that it might be the case that streaming sometimes reduces academic performance. In addition, we acknowledge that less specialisation in curriculum could also result in less stratification of the student population, which may in fact improve average performance (Lee et al. 2001).

inverted ‘U-shaped’ association (while five studies suggested that as school size increased so did achievement, and eight studies suggested the opposite). Once again, a major criticism of existing work relates to perceived specification problems – in particular the failure to allow for non-linear associations (Leithwood and Jantzi, 2009).

[PLEASE INSERT FIGURE 2 HERE]

A Heuristic Model for Economic and Ecological Perspectives

The basic model used for both economic and ecological investigations into school size controls for both student and school characteristics so that *ceteris paribus* conclusions may be derived from empirical results. The education process function starts with a group of students who have varying levels of socio-educational advantage (income and educational attainment of parents, indigeneity, gender, past performance in education, language spoken at home) (Teese 2000; Marks 2015). Because persons tend to sort themselves according to taste for local government goods and services, socio-educational advantage is generally concentrated geographically, which suggests that averages at the level of individual schools will often prove adequate (Fischel 2006). The next component of the function is the suite of school characteristics – staff-student ratios for teaching and support staff as well as some measure of the quality of staff inputs. School size (which tends to vary only slightly with time) is the variable of principal interest for our present work and we have therefore captured it as a separate input in our heuristic, despite that fact that it is indeed a school characteristic. Figure 3 summarises the basic model employed in the work of scholars operating from ecological or economic perspectives (see, for example, Lee and Loeb 2000; Andrews et al. 2002).

[PLEASE INSERT FIGURE 3 HERE]

If economies of scale do exist for education production then we would expect a 'U-shaped' curve for functions plotting the average total cost per student against the number of students in a school. That is, costs might be expected to initially decrease, as economies of scale are captured, but later increase as diseconomies of scale emerge. The turning point of an expenditure function (estimated by employing calculus to find the school population at which the first derivative – or the slope of the curve – equals zero and the second derivative is positive) would thus represent the optimal scale for urban secondary schools with respect to maximising efficiency. By way of contrast, the literature suggests that the association between school size and academic performance might follow an inverted 'U-shape' curve – performance may initially increase as size allows for specialisation and other benefits, but then turn downwards once the point is reached at which interactions become more formal and less frequent. The turning point for an ecological function (school population at which the first derivative is zero and the second derivative is negative) would thus represent the optimal scale for academic performance (as captured by test instruments). If these two respective turning points coincide at similar numbers of students, then it will lead to a simple prescription for optimising the size of schools with respect to both economic and ecological perspectives. However, this level of serendipity is probably far more than what researchers and public policy architects could reasonably expect. In all likelihood, there will be a gap between the optimal sizes indicated by the two perspectives. School sizes located between the two optimal sizes will represent the best compromise between efficiency and academic performance – the degree to which individual school sizes are closer to one turning point than another might be interpreted with respect to the relative importance given by policymakers to the competing policy objectives. Figure 4 illustrates how public policy architects might reconcile the empirical findings from the two approaches.

[PLEASE INSERT FIGURE 4 HERE]

We now briefly outline the context for our analyses and the empirical strategy, which we employ.

Context and Empirical Strategy

We noted earlier that it is critical for public policymaking to be informed by robust empirical evidence that is capable of identifying key determinants associated with both the economic and ecological approaches to education performance. There is a veritable dearth of empirical evidence to inform decision making in the context of Australia – there is not a single study that attempts to demonstrate the disparities yielded by different approaches to optimal school size. Indeed, despite the fact that school size is one of the variables included in standard datasets that can be obtained under a deed of licence through the Australian Curriculum, Assessment and Reporting Authority (ACARA) it is often neglected in statistical modelling. Moreover, when school size has been employed, explanatory variable models have tended to eschew a quadratic term (school size squared) which prevents detection of 'U-shaped' and inverted 'U-shaped' curves predicted by theory (see, for instance, Miller and Voon 2012). This neglect of the importance of school size for modelling aspects of school performance largely reflects a neglect of the concept in public policymaking – by and large the prominent and robust debates about education in Australia have focussed on school funding, despite the 'broad evidence from the experience in the US and the rest of the world [which] suggests that this is an *in*effective way to improve quality' (emphasis added; Hanushek 2003, F66). Moreover, it should also be noted that the neglect of school size as an explanatory variable in Australian empirical modelling is consistent with much of the extant scholarly work from abroad (see Andrews et al. 2002; Leithwood and Jantzi 2009). Without robust empirical evidence, it is quite possible that public policy will ultimately prove ineffective or even counterproductive – especially in a context of heightened complexity arising from different tiers of government being involved with funding and implementing of education programs.

Australia is a federation of six states and two territories which are severally and constitutionally responsible for the funding and operation of public schools. Only around 59% of secondary school students (Years 7 to 12) in Australia are educated in public institutions – the remainder attend private schools which are mostly run by faith-based providers funded through a mixture of often substantial

tuition fees and support from the federal government (Australian Bureau of Statistics (ABS) 2018). Public schools, by contrast, receive around 87% of their funding from state and territory governments, and approximately 12% from the federal government in addition to the small quantum raised from non-compulsory tuition fees. Total operating expenditure related to the schooling of around 950,000 students attending public secondary schools in aggregate for the 2015/16 financial year was $17.7 billion.

Throughout the last decade the Australian federal government has been actively engaged in policy aimed at improving academic achievement by the nation's school students (including *inter alia*, federal school funding reform, curriculum reviews and an 'education revolution' (the catch phrase of the public policy sales pitch as articulated by the former federal government – see below)). The motivation for engagement by the federal government came in response to poor results in international exams (such as PISA), as well as a need to build human capital for economic welfare (see, Hunjan and Blumer 2016). In 2008, the ACARA was established and the National Assessment Program for Literacy and Numeracy (NAPLAN) was introduced, which is a national examination for all Year 3, 5, 7, and 9 students conducted annually. NAPLAN test scores are set on a common scale ranging from 0 to 1,000 and have been designed expressly for comparing academic performance between different schools across time (Ngheim et al. 2015). The introduction of NAPLAN was closely followed by the introduction of the MySchool website in 2010 designed to assist parents to investigate the performance in NAPLAN, funding and school demographics of both public and private institutions. The idea of the website was to reduce information asymmetries and to provide parents with a sounder basis for making choices about where to educate their children. In the same year, the Education Minister initiated a review into funding arrangements for both public and private schools, which became commonly referred to as the Gonski report, after its Chair, David Gonski. The report recommended an increase to government funding of 'about $5 billion or around 15% of all government's recurrent [school] funding' per annum, with the federal government to 'bear around 30% of the increase' (Gonski 2011, xviii). Increases to federal funding for education were passed just prior to the 2013 federal election and the matter of continued commitment to implementation of the

new funding arrangements was a major policy issue throughout the election campaign (Drew and Fahey 2018). Indeed the 'education funding wars', as they have become known in the media, continue to the present day and have played an important role in the toppling of two incumbent Prime Ministers. The main issue in contention is the relative funding provided to government and non-government schools by the federal government, when considered with respect to student need (Karp 2018). Curiously, the issue of school size has been largely ignored in the Australian debates on education – as has the need for robust empirical evidence to guide public policy initiatives (Drew and Fahey 2018).

To investigate whether school size is salient to improving education outcomes for urban public secondary schools we conducted two separate empirical estimations consonant with the economic and ecological approaches of scholarly inquiry, respectively. For our economic investigations, we regressed operating expenditure per student against a range of controls relating to student characteristics, school characteristics and school size. For our ecologically motivated investigations, we regressed a composite index of average school performance in the Year 9 NAPLAN exams against controls for student characteristics, school characteristics and school size (Year 7 NAPLAN results were not used because exams occur in May, just a few months after students are first enrolled in secondary schools in Australia). Student characteristics were measured by the ACARA index of community socio-educational advantage (ICSEA), which is a continuous metric of educational advantage derived from data on parent education and occupation reported at the time of student enrolment. ICSEA has long been recognised as a predictor of student success and is thus an essential control (Teese, 2000). We also controlled for the proportion of indigenous students, proportion of students from a non-English speaking background, and proportion of female students. Indigenous students face both cultural and language barriers to education in Australia, non-English speaking students will clearly be challenged in the literacy domain and could also have difficulty understanding the prose that accompanies numeracy testing, and the relatively higher performance of females in literacy and relative lower performance in numeracy is well attested to by the literature (Marks, 2014) These student characteristics are not only consistent with the scholarly literature from Australia but

also reflect the limits of data availability from ACARA. It is important to note that the ACARA deed of licence comes with strict conditions including a prohibition on any one academic having simultaneous access to both student-level data and school-level data. School characteristics were measured by student-teacher ratio, student-support staff ratio, whether the school was a combined primary-secondary campus (a type of urban public secondary school), consonant with the extant Australian literature and data availability (Marks 2015; Miller and Voon 2012). Education unions have long argued that both class size (proxied by student-teacher ratios) and teacher aide support (proxied by the student-support staff ratio) are determinants of achievement and this position also has some scholarly support (Miller and Voon, 2014). For the economic investigation, we included an index of NAPLAN achievement as a variable to control for school quality. For the ecological investigation we included the operating expenditure per student as a school characteristic variable, which is mainly influenced by teacher salaries, which are negotiated on a state-wide basis and vary according to the level of tertiary qualification and the number of years of teaching experience, and can thus be considered as a crude proxy for teacher quality (teacher qualification and years of experience data is not publicly available in Australia through ACARA deed of licence data).

Mixed effects estimations were made and are reported in the next section of this paper. Alternative panel regression techniques are not appropriate for the structure of education data, which explains why mixed effects models are ubiquitous in education research. For instance, fixed effects is not appropriate given that our school population data is very close to time invariant (and would thus lead to imprecise estimates due to a disregard of the variance between schools even if the key coefficients were reported at all), while random effects regression[2] imputes all of the intercepts into the composite error term (Wooldridge, 2010). Mixed effects modelling, by contrast, allows for both fixed effects (intercepts and slopes for the population as a whole) and random effects (intercepts and slopes that can vary for the higher hierarchy – in our case the jurisdiction) and thus offers the best of both worlds

[2] We did, in fact, also run random effects models as part of our thorough robustness tests and found similar results, which can be obtained from the authors.

to analysts. For the mixed-effects modelling, we employed random intercepts for the seven[3] states and territories (which is consistent with the fact that the states and territories independently operate their public school systems) and random slopes for ICSEA (which is consistent with the fact that there is a relatively large variation in educational attainment and employment in the various states of Australia). We experimented with a number of specifications which all yielded similar results (this included a specification controlling for Year 7 NAPLAN achievement, which could be considered a crude proxy for the academic abilities of students enrolling in secondary schools[4]). Likelihood-ratio tests were also conducted and confirmed that modelling with random slopes resulted in a significantly better fit, which attests to the importance of employing a mixed-effects regression model.

Results

The results from our two separate empirical estimations are summarised in Table 2, where Model 1 is an estimate based on the economic perspective and Model 2 is the estimated base on the ecological perspective. From the economic perspective (Table 2, Model 1) the results of our seven year panel of Australian urban public secondary school data suggests that the optimal school size is around 1,410 students, at the one percent level of statistical significance. That is, when school size is close to 1,410 enrolments the cost per student is, on average, minimised. By way of contrast, the ecological perspective (Table 2, Model 2), based on the same seven year panel of data, suggests that that the optimal school size is much lower, around 1,064 students, at the one percent level of statistical significance. That is, when school size is close to 1,064 students then average achievement in the NAPLAN examinations tends to be maximised.

Clearly, the two different approaches to the question of optimal school size yield two very different results. To make this point more explicit we plotted the curves for each function on a single axis in

[3] South Australian data is excluded from our analysis because, unlike the other states, children do not commence secondary school until year 8.
[4] The results from this alternate specification can be obtained from the authors. In consideration of the important principle of parsimony and the likelihood of introducing multicollinearity we elected to report the results in Table 2 exclusive of a year 7 lagged variable.

Figure 5. As can be seen, a public policymaker informed by the economic perspective would be aiming to introduce policies to shift school size towards the magic figure of 1,400 but doing so would likely yield lower than desired NAPLAN achievement. In similar vein, a public policymaker informed by the ecological perspective would be aiming to introduce policies to shift school size downwards (relative to the economic perspective) to levels of around 1,060 but doing so would result in lower technical efficiency (and hence a higher per student cost) than might be desired. There is a relatively large gap between the two optimal school sizes informed by the two disparate perspectives. This means that the choice of which perspective to give most weight to is likely to have weighty implications for performance (economic or academic).

[PLEASE INSERT FIGURE 5 HERE]

For coherent public policy, it would seem to be important to have, at least, compatible objectives. As we noted earlier, state governments in Australia are under budgetary pressure and their public policy prescriptions are most likely to accord with economic perspectives. By way of contrast, the federal government is desirous to lift performance of Australian school students for national economic welfare objectives and its public policy prescriptions are most likely to accord with ecological perspectives (Drew and Fahey 2018). So not only do we have two different perspectives providing for two disparate recommendations for optimal school size, but at the same time we also have two different tiers of governments which are likely to be pursuing two different policy objectives. Moreover, because the association between school size and performance (both economic and academic) has largely been neglected in the empirical literature and public policy debates in Australia most of the public policymaking has been conducted in an evidence vacuum akin to that deplored by Hanushek (2006).

The pragmatic and fully informed public policymaker will probably be aware of the fact that the area bounded by the two curves and respective turning points identifies a zone of policy compromise on the question of optimal school size for public secondary education institutions. That is, if both

objectives (cost per student and average education achievement) are felt to have merit then rational public policymakers will attempt to engineer policy that results in school size lying somewhere between the two turning points. If relatively more weight is given to academic achievement then sizes closer to 1,060 students will be the aim; if concerned more with cost control then sizes closer to 1,400 will be the aim. How close rational public policymakers attempt to go towards one or the other of the turning points should tell us about the importance given to the trade-offs (with respect to marginal rates of substitution in terms of willingness to accept marginal declines in expected student achievement or unit cost). What is certain, however, is that a close conformity to both cost control *and* academic achievement goals is not possible given the disparate optimal size estimates for urban public secondary schools produced by our two separate models informed by the two theoretical perspectives. A public policy compromise seems quite unavoidable.

In 2016, around 40% of urban government secondary schools in our sample were over the optimal size as predicted by our ecological perspective model. Moreover, about 14% of urban government secondary schools were larger than the optimal size as predicted by the economic perspective model. This means that around 26% of urban secondary schools are in our zone of policy compromise and that 74% of schools fall outside of either objective. As a result, there seems to be significant scope for public policymakers in Australia to improve education performance in cognisance of our robust empirical estimations. Moreover, the need to act decisively on the matter of school size is brought into stark relief by population growth projections of 74-79% and 65-77% for Australia's two major cities (Sydney and Melbourne, respectively) over the coming three decades (Infrastructure Australia 2018).

As an aside, the statistically significant results for ICSEA score are notable and broadly consistent with the extant literature. Higher ICSEA scores are associated with statistically significant higher per student costs and higher NAPLAN performance. This is of little comfort to the public policymaker because relative socio-educational advantage is something that is resistant to manipulation in the short run. However, school size *is* something that can be relatively easily manipulated by public policy architects, and we now turn our attention to explicating the most efficacious methods for doing so.

Public Policy Recommendations and Conclusion

If robust empirical analysis of the type that we conducted earlier suggests optimal school size that is at odds to the size of extant urban public secondary school campuses, then responsive and rational public policymakers will attempt to change campus size. In the case of schools that are too small the main policy lever is school consolidation. Many states in Australia have been quietly going about school consolidations for years with very little united public opposition (see, for instance, NSW Teachers Federation 2018), which stands in stark contrast to the media and political attention engendered by local government amalgamations for instance (see Grant and Drew, 2017). The reason for this surprising political success of putatively unpopular public policy is that, in general, state governments have followed a heresthetic that involves executing one isolated amalgamation at a time (Drew and Fahey, 2018). By taking on the task one bite at a time – rather than in a single mass amalgamation programme – media, community and political attention is diffused rather than concentrated. Indeed, while there have been some stories in local media, more prominent state-wide outlets have, for the most part, largely neglected the matter (a notable exception is Tomazin 2009). This demonstrates that the clever public policymaker (in Rikerian terms) can indeed increase school size in response to empirical evidence, without incurring significant political damage.

For schools that are too large the obvious public policy lever is to build more schools. However, the capital costs of doing so might be prohibitive. Indeed, if motivated by the economic perspective, it may not be a rational decision in some cases to incur significant capital costs in pursuit of lower

operating expenditures depending on the cost benefit calculus. Moreover, in a lot of urban areas, lack of undeveloped land presents as an imposing problem. Some state governments have responded to the shortage of land by constructing high-rise schools but this has attracted strong expressions of public concern (see, for example, McNab 2017).

An alternative to building new schools might be found in the 'schools within schools' literature (see, Barker and Gump 1964; Lee et al. 2001). The idea here is to break large schools into subunits 'where all students and most teachers are members of only one subunit' (Lee et al 2001, p. 365). If executed comprehensively – by setting aside quarantined classrooms, and recess area spaces for certain year level cohorts and ensuring that teaching resources are (as far as possible) dedicated to specific year levels and housed in year level staffrooms (rather than subject specific staffrooms, to foster closer collaboration) – then schools within schools will capture many of the desirable attributes of smaller campuses. However, often the implementation stands in stark contrast to the ideal. For instance the middle school movement that first appeared in Queensland Australia, in the early 2000s, was poorly implemented – teachers remained in their subject discipline staffrooms, teachers were inadequately trained, classrooms were scattered throughout the schools, and recess areas were quarantined in name only – and not surprisingly failed to produce the desired outcomes (the lead author was part of an implementation team and tutored tertiary students in a university pilot programme; see also, Main 2012). Cynical observers would draw attention to the fact that the middle school programme in Queensland also involved moving year 7 students from primary schools (where numbers were high and space limited) to high schools (where vacant classrooms were often the norm as a result of the flight to private education at the secondary school level). Moreover, the middle school programme was associated with the introduction of middle school education degrees that provided a supply of teachers that was important to relieve pressure on science, mathematics and information technology teachers, in particular, who were in short supply. Therefore, it is not entirely certain that the major motivation for the middle school programme in Queensland (and other states of Australia) was to improve education outcomes. What is indisputable is that a rushed implementation programme, with insufficient resourcing left many practitioners and scholars unsatisfied (see, for example, Prosser

2008). If programmes such as the middle school initiative were carefully re-introduced with an unambiguous motivation to improve school outcomes and resourced appropriately then doing so would essentially halve student numbers in the subunits and thus might achieve optimal school size at relatively low expense.

In conclusion, this work has achieved its principal objective by demonstrating that disparate public policy recommendations arise from different theoretical (and hence empirical) approaches (economic and ecological respectively) to the question of optimal school size. Otherwise stated, the aims of the economic approach (minimising cost per student) and ecological approach (maximising education achievement) seem to be irreconcilable. Moreover, we have discussed in some detail the public policy implications that follow from our results. Future research should look at replicating this study in different school jurisdictions and at different levels of schooling (for example, urban public primary schools). Consideration should also be given to investigating empirical methodologies that might reconcile the two approaches and thus provide further guidance in the zone of policy compromise that we identify in our paper. In this latter regard, a three stage least squares methodology might prove helpful and we certainly commend the quest to empirically reconcile the different empirical approaches to our peers. In sum, we have shown that school size most definitely does count down under and we encourage public policymakers to take cognisance of same (when attempting to optimise performance), and our scholarly peers to investigate whether size also counts elsewhere.

References

Andrews, M., Duncombe, W. and J. Yinger. (2002). Revisiting Economies of Size in American Education: Are We Any Closer to Consensus? *Economics of Education Review* 21, 245-262.

Abalde, M. (2014), "School Size Policies: A Literature Review", *OECD Education Working Papers*, No. 106, OECD Publishing, Paris, https://doi.org/10.1787/5jxt472ddkjl-en.

Baker, B. and W. Duncombe. (2004). Balancing District Needs and Student Needs: The Role of Economies of Scale Adjustments and Pupil Need Weights in School Finance Formulas. *Journal of Education Finance* 29(3), 195-221.

Barker, R. and R. Gump (1964). *Big School, Small School: High School Size and Student Behaviour*. Stanford University Press: Standford.

Crosnoe, R., Johnson, M., and G. Elder. (2004). School Size and the Interpersonal Side of Education: An Examination of Race/Ethnicity and Organizational Context. *Social Science Quarterly* 85(5), 1259 -1274.

Drew, J. and G. Fahey. (2018). Framing Unpopular Policies and Creating Policy Winners - the Role of Heresthetics. *Policy & Politics*. doi.org/10.1332/030557318X15241518778612

Fischel, W. (2006). *The Tiebout Model at Fifty*. Lincoln Institute of Land Policy Press: Cambridge.

Gonski, D. (2011). *Review of Funding for Schooling: Final Report*. Canberra: Australian Government.

Hanushek, E. (2003). The Failure of Input-Based Schooling Policies. *The Economic Journal* 113, F64-F98.

Hanushek, E. (2006). Our School Performance Matters. *The Journal of Education* 185(3), 1-6.

Hunjan, R. and C. Blumer. (2016). Australian Schools are in 'Absolute Decline' Globally, Says PISA Report. *ABC*, 7 December 2016.

Infrastructure Australia (2018). Future Cities: Planning for our growing population, *Reform Series,* Sydney, Australia.

Karp, P. (2018). Will Scott Morrison's $4.6bn Package End the School Funding Wars? *The Guardian*, 21 September 2018.

Lee, V. and S. Loeb. (2000). School Size in Chicago Elementary Schools: Effects on Teachers' Attitudes and Student Achievement. *American Educational Research Journal* 37(1), 3-31.

Lee, V., Ready, D., and D. Johnson. (2001). The Difficulty of Identifying Rare Samples to Study: The Case of High Schools Divided Into Schools-Within-Schools. *Education Evaluation and Policy Analysis* 23(4), 365-379.

Leithwood, K., and D. Jantzi. (2009). A Review of Empirical Evidence about School Size Effects: A Policy Perspective. *Review of Educational Research* 79(1), 464-490.

McNab, H. Department of Education's Flagship High Rise School Plans Panned by City of Sydney. *Daily Telegraph*, 18 October, 2017.

Main, K. (2012). Effective Middle School Teacher Teams: A Ternary Model of Interdependency Rather than a Catch Phrase. *Teachers and Teaching* 18(1), 75-88.

Marks, G. (2015a). The Size, Stability and Consistency of School Effects: Evidence from Victoria. *School Effectiveness and School Improvement* 26(3), 397- 414.

Marks, G. (2014) Demographic and Socioeconomic Inequalities in Student Achievement Over School Career. *Australian Journal of Education* 58(3), 223-247.

Marks, G. (2015b) School Sector Differences in Student Achievement in Australian Primary and Secondary Schools: A Longitudinal Analysis. *Journal of Social Choice* 9(2), 219-238.

Messner, Johannes. 1952. *Social ethics. Natural law in the modern world*. Translated by J. J. Doherty. St Louis: B Herder Book Co.

Miller, P. and D. Voon (2012) Government Versus Non-Government Schools: A Nation-wide Assessment Using Australian NAPLAN Data. *Australian Economic Papers* 51(3), 147–166.

Miller, P. and D. Voon. (2014). School Outcomes in New South Wales and Queensland: A Regression Discontinuity Approach. *Education Economics* 22(5), 427-448.

New South Wales Teachers Federation (2018). Recess, Closure and Amalgamations of Schools. www.nswtf.org.au accessed 8th November 2018.

Nghiem, H., H. Nguyen, R. Khanam and L. Connelly (2015). Does School Type Affect Cognitive and Non-Cognitive Development in Children? Evidence from Australian Primary Schools. *Labour Economics* 33, 55-65.

Oxley, D. (1997). Theory and Practice of School Communities. *Educational Administration Quarterly* 33, 624-643.

Prosser, B. (2008). Unfinished But Not Yet Exhausted: A Review of Australian Middle Schooling. *Australian Journal of Education*, 52(2): 151-167.

Teese, R. (2000) *Academic Success & Social Power*. Melbourne: Melbourne University Press.

Teese, R. (2005). For Which Young People Do Schools Work Well and Why? In *"No Time to Lose: The Wellbeing of Australia's Children"*. Richardson, S. and Prior, M. (eds). Carlton: Melbourne University Press.

Tomazin, F. (2009). Our Disappearing Schools. *The Sydney Morning Herald*, 6th July 2009.

Wooldridge, J. (2010). *Econometric Analysis of Cross section and Panel Data*. MIT Press: Cambridge.