ON THE MEASUREMENT AND CHARACTERISTICS OF CONSTRUCTION FIRMS IN THEORY AND PRACTICE

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Introduction

There is an old joke that an economist is someone who, finding something that works in practice, wonders if it will work in theory. The joke is so old its origins have been lost in time, and it relies on the stereotype of economics as abstract and theory driven. Like all stereotypes this is partially true, models using the basic tools of economics, like supply and demand or preferences and expectations, are based on theory and tested, mostly successfully, every day. However, while economic theory is comprehensive it is not complete. There are topics with unresolved theoretical issues in macroeconomics, such as monetary policy and productivity, and there are topics, such as firms, where theory is notable for its absence.

It has been said there is no theory of the firm. Archibald (1987, p. 357) thought "It is doubtful if there is yet general agreement among economists on the … 'theory of the firm'' and the purpose of the theory of the firm "is to investigate the behaviour of firms as it affects allocation and distribution" of resources. He then divided approaches to firms into 'optimizing' mathematical models and profit-seeking 'other' models, in particular Nelson and Winter's (1982) evolutionary theory of firms. He concluded that while there may not be *a* theory of the firm, there are many models that have been developed. Many of those models have been applied to construction firms by construction economists.

Machlup (1967) found a firm can be an organization, a decision-making system, a collection of assets and liabilities, a legal entity, or a form of business unit, and concluded these concepts are all different and useful. However, the 'theory of the firm' as reviewed by Machlup (1967) is a theory of how production and cost functions interact with demand in the market. Microeconomic theory takes firms as a production function, and the treatment of the firm as a production function shifted the meaning of 'firm' towards the optimizing model of a production process, avoiding questions of position, definition, internal structure and external boundaries. Those questions were addressed by

industry economists on a topic of shared interest: how economic activity is organized and studied (Schmalensee 1989). This is where topics such as imperfect competition and oligopolistic markets, auction theory, game theory, and buyer and supplier power are relevant, topics that cannot be discussed without reference to firms.

Industry economics is also concerned with the empirical problem of classifying firms and measuring industrial concentration. Firms are classified as belonging to specific industries on the basis of common characteristics in products, services, production processes and logistics (UN 2008). There are statistical and taxonomic issues with industry data, for example, a firm can have separate plants, or a factory might have a number of different production processes or products. Often the data cannot be disaggregated, is unrepresentative, or uncharacteristic of dynamic and evolving industry structures. In many cases data is not available or infrequent. There are major measurement problems in the treatment of quality changes in the inputs used and the capital intensity of factor usage. National statistical agencies do not use 'firm', but estimate the number and size of business units, enterprises, establishments and entrepreneurs, and the data is presented in different ways (Gruneberg 2019).

The precision of microeconomic models of optimizing firms is not possible in industry economics, partly because of the number of variables involved but mainly because of the lack of quality data. However, industry economics and microeconomic theory are both concerned with explaining why things happen: why are prices lower under one set of conditions than under another, why do some products succeed, why does a firm outsource some functions? Both view the type of market structure that links producers with suppliers and consumers as an important variable, but they differ in the scope of the variables they include (Carlton and Perloff 2005). Theory provides principles, which are the tools for defining problems, analysing issues and interpreting results. The analysis of firms, industries and markets requires the use of such tools, but the particular tools used depend on the theoretical framework chosen. Rodrik (2015) explains role of the models that economists use. There are many valid models, and the challenge is to know which is applicable to a specific problem or issue. This is the main point of his book: different models have different applications, there are no wrong models, only badly and inappropriately applied models. Rodrik thus regards contemporary economics as a collection of models, not as single grand theory (or a quest for one). The economist's craft lies in knowing which model is appropriate to the task at hand.

Construction firms present challenges on both sides of these theoretical and empirical issues, and the chapter is broadly divided into two main parts to reflect that. The chapter first surveys the data

on construction firms from Europe and the United States (US), which establishes the broad outline of an industry structure with many small firms and fewer large ones. This is followed by Australian data from five construction industry surveys done between 1986 and 2011, identifying trends and showing how changes in the number and type of firms have affected the structure of the industry, as the number of large firms significantly decreased. Based on the data presented there is a discussion on industry structure and concentration, which is the market share of the largest firms. More recent Australian data provides data by firm size based on employment, with micro firms less than 5, small firms 3-19, medium firms 20-199 and large firms more than 200 employees. Industry income and output shares by firm size and per employee are analysed.

The second half of the chapter discusses the theoretical issues, following developments in the treatment of firms in construction economics. Starting in the 1970s, there has been an evolving conception of both construction firms and the construction industry as the characteristics of the industry have been incorporated into economic models of firms and markets. The increasing sophistication of these models over the four decades to 2020 is detailed. The chapter also discusses the alternative approaches to firms found in relational contracting and the concept of hybrid firms. The important point these approaches raise is the boundaries of firms in a project-based industry with extensive subcontracting, an issue also addressed by transaction cost economics (TCE). The development of more complex models of firms since 2000 is then discussed, followed by the conclusion.

Construction is unusual as an industry, with a large number of small firms bidding for work in local and regional competitive markets, with little or no control over prices, coexisting with a small number of firms that, as main contractors and/or project managers, deliver large projects. Then there are the relatively few large national and international corporations in construction. Similar industry structures are found in retail, where there are a few large regional and sub-regional shopping malls and many widely distributed small shops, and health, with large hospitals, clinics and individual practices. In those industries supermarkets use their buying power to drive down costs, and hospitals are often monopsony buyers in their region. Neither retail nor health, however, are project-based industries. Construction is a geographically distributed industry that brings together many suppliers in many different locations, and is different from other project-based industries like shipbuilding or energy generation which bring together many suppliers at a few locations. In construction, from project to project temporary teams of clients, contractors, consultants and suppliers interact, bound by contracts between the legal entities that are the firms they represent. This is similar to a theatre or movie production, where a large number of different people and a

wide range of different skills are involved at different times during development, production and distribution, as the end credits demonstrate.

Firm Size and Distribution in Construction

The structure of an industry is the number of firms categorized by size, typically the number of employees. Firms are classified as small, medium or large, with the numbers used varying by country and industry, as the tables below show. Generally, small firms employ less than 20 people and have many working proprietors. Data on firms (often called enterprises in the statistics) is presented using the *International Standard Industrial Classification* (UN 2008). Section F in ISIC includes the complete construction of buildings (division 41), the complete construction of civil engineering works (division 42), and specialized construction activities or special trades, if carried out only as a part of the construction process (division 43). Also included is repair of buildings and engineering works. Although there are national variants on the Standard Industrial Classification (SIC) format there is also a great deal of commonality (for a detailed discussion of construction firms and the SIC see de Valence, 2019). Economic activities are subdivided in a four-level structure. Activities are first divided into 'sections', which are alphabetically coded. These sections divide productive activities into broad groupings such as 'Agriculture, forestry and fishing' (A), 'Manufacturing' (C) and 'Information and communication' (J). The classification is then organized into numerically coded categories, which are two-digit divisions, three-digit subdivisions or groups, and four-digit classes with the greatest level of detail. SIC codes therefore represent industries, and firms are classified (or often self-classify) to industries on the basis of common characteristics in products, services, production processes and logistics.

As the data in the tables below shows, construction statistics include a large number of small firms. These firms include many tradespeople (working proprietors) engaged in the alteration, repair and maintenance of the built environment as well as contractors and subcontractors for new builds. The broad base of small firms is a distinctive feature of the overall construction industry as national statistical agencies define it. There is a long tail of small firms, typically family-owned businesses in construction trades doing repair and maintenance work. Although this is a well-known feature of construction there is considerable variation across countries. The most recent data from Europe, the US, and Australia illustrates the point.

Eurostat compiles data from the 27 members of the European Union (EU) and publishes an annual *Construction of Buildings Statistics*. The most recent (Eurostat 2020) has firm size data for 2017 for employment, value added and 'apparent labour productivity' (their term for value added per employee), for the EU total (shown in table 1). Eurostat micro firms have less than 10, small firms 10-49, medium firms 50-249 and large firms more than 250 employees.

> The enterprise size structure of the construction of buildings sector is dominated by micro enterprises (employing fewer than 10 persons). Almost 95 % of all enterprises were categorized as micro enterprises, they employed 46.2 % of the persons employed in the EU-27's construction of buildings sector in 2017 and accounted for 36.2 % of its value added. While the 400 large enterprises (employing 250 or more persons) contributed 10.7 % of the employment, they generated 18.4 % of total value added, and thereby recorded the apparent labour productivity of EUR 69.9 thousand per person employed. (Eurostat 2020: 6)

Eurostat also provides this data for each of the individual countries, table 2, which shows significant regional variation:

> Micro and small enterprises collectively employed three quarters of the construction of buildings persons in 2017 for EU total and more than half in nearly all of the EU Member States, the exceptions were Denmark, France and Austria. The share of the persons employed in large enterprises was less than one quarter in most Member States, the exceptions being France, Austria and Sweden. In value added terms, the contribution of large enterprises reached 55.2 % in France, but was less than 10.0 % in Bulgaria, Ireland, Spain, Italy, Cyprus, Portugal, Romania and Slovakia. (Eurostat 2020: 7)

Table 1

Key size class indicators, Construction of buildings (NACE Division 41), EU-27, 2017

	Number of enterprises (thousands)	Number of persons employed (thousands)	Value added (EUR million)	Apparent labour productivity (EUR thousand per head)
All enterprises	799.8	2 894.2	117 614.3	40.6
All SMEs	799.4	2 584.7	95 982.2	37.1
Micro	753.1	1 337.0	42 600.5	31.9
Small	41.4	794.5	31 842.3	40.1
Medium-sized	4.9	453.2	21 539.4	47.5
Large	0.4	309.5	21 632.1	69.9

Note: For confidentiality issues rounded or calculated figures have been used. The sum of all categories does not equal the total of all enterprises due to estimated values with lower reliability.

Source: Eurostat (online data code: sbs_sc_sca_r2)

eurostat

Source: Eurostat 2020

Table 2

Number of persons employed by enterprise size class, Construction of buildings (NACE Division 41), EU-27, 2017

	Total (thousands)	SMEs	Micro	Small	Medium-sized	Large
				(% of total)		
EU - 27	2 894.2	89.3	46.2	27.5	15.7	10.7
EU - 28	3 342.9	87.4	45.3	26.7	15.4	12.6
Belgium	83.6	90.5	50.7	19.7	20.1	9.5
Bulgaria	62.2	95.9	20.3	40.0	35.6	4.1
Czechia	89.7	92.8	43.5	31.8	17.4	7.2
Denmark	26.1	75.4	18.0	28.2	29.2	24.6
Germany	301.7	88.2	21.3	43.1	23.8	11.8
Estonia	17.3	56.3	56.3	:	:	:
Ireland	36.3	93.0	56.7	25.7	10.6	7.0
Greece	31.7	85.1	61.7	23.3	:	:
Spain	490.6	97.8	68.6	22.5	6.7	2.2
France	208.7	51.5	23.3	16.5	11.7	48.5
Croatia	37.9	91.8	37.5	33.0	21.3	8.2
Italy	300.5	98.1	64.0	25.9	8.2	1.9
Cyprus	11.4	100.0	43.1	28.7	28.2	0.0
Latvia	23.3	96.2	32.3	39.0	24.9	3.8
Lithuania	41.7	92.4	24.3	41.3	26.8	7.6
Luxembourg	12.9	53.5	13.6	:	39.9	17.7
Hungary	62.3	84.1	48.3	35.7	:	:
Malta	3.5	66.7	35.4	:	31.4	:
Netherlands	139.4	90.4	55.6	17.7	17.0	9.6
Austria	67.6	72.2	14.1	28.6	29.5	27.8
Poland	286.7	91.4	57.7	18.3	15.4	8.6
Portugal	147.1	95.5	50.7	31.1	13.7	4.5
Romania	172.4	94.1	33.4	36.6	24.1	5.9
Slovenia	13.8	77.0	41.6	35.4	:	:
Slovakia	35.6	96.1	59.9	23.7	12.5	3.9
Finland	77.0	84.9	38.8	32.3	13.8	15.1
Sweden	113.2	74.4	31.1	25.9	17.5	25.6
United Kingdom	448.6	75.1	39.2	21.9	14.1	24.9
Iceland	7.1	91.1	44.3	28.9	18.0	8.9
Norway	87.1	85.7	36.0	33.6	16.0	14.3
Switzerland	83.8	76.7	11.6	23.2	42.0	23.3

(:) not available
Source: Eurostat (online data code: sbs_sc_con_r2)

eurostat

Source: Eurostat 2020

In the US the Census Bureau collects data on industries and enterprises, the latest being 2012. The website has this notice: “Due to limited resources and competing priorities of critical programs within the Census Bureau, the Enterprise Statistics Program has been suspended.” Reflecting the scale of the American economy, the size range of firms is much greater than the EU and the largest firms much larger, as in Table 3. Again, over 95 percent of US firms are small, in this case with less than 100 employees, and have on average five or six employees. However, there were 212 firms with 1,000 or more employees that had a total 630,000 employees, of which nearly 160,000 were employed by the nine largest firms.

Table 3. US Construction 2012

Enterprise employment size	Number of enterprises	Sales or revenue $1,000,000	Annual payroll $1,000,000	Number of paid employees
All enterprises	581,601	1,349,346	260,606	5,006,131

Less than 100 employees	576,272	812,924	154,461	3,336,286
100 - 499 employees	4,788	226,818	46,899	817,823
500 - 999 employees	na	82,320	14,787	222,481
1,000 - 2,499 employees	141	79,475	14,968	211,141
2,500 - 4,999 employees	45	62,749	10,516	145,875
5,000 - 9,999 employees	17	38,072	7,497	113,133
10,000 employees or more	9	46,988	11,476	159,392

Source: US Census Bureau 2012, table 2; na is not available due to sampling issues.

Australian Construction Industry Surveys

There have been five Construction Industry Surveys (CIS) by the Australian Bureau of Statistics (ABS), the most recent for 2011-12. All five surveys found the construction industry is overwhelmingly made up of small firms which contribute most of the industry's output and account for almost all of the number of enterprises. Table 4 shows the breakup between contractors in *Building and Engineering* and the subcontractors in *Construction services* (which were called trades in the earlier surveys). The 2002-03 survey used different categories of businesses (not establishments) in residential, non-residential and non-building, and trade services and is not comparable with the other surveys. In 2002-03 there were 339,982 businesses of which 269,228 were trade services and 70,753 were residential, non-residential and non-building businesses

Table 4. Construction, number of firms by industry subdivision '000.

	1984-85	1988-89	1996-97	2011-12
Building construction	24.5	19.6	33.1	31.3
Engineering construction	3.4	3.9	3.1	5.7
Construction services	77	74.5	158	173

Source: ABS Construction Industry Survey. Australian Bureau of Statistics, Cat. No. 8772.0. 1996-97, 1988-89 and 1984-85 Private Sector Construction Establishments: Number operating during the year. 2011-12 Number of establishments at end June.

How the size of firms is measured in the CIS has changed twice. The three surveys in 1996-97, 1988-89, and 1984-85 divided firms into three sizes: employ less than 5, employ 5-19, and employ 20 or more. The 2011-12 survey divided firms into small 0-19, medium 20-199 and large with over 200 employees. The 2002-03 survey divided firms by income and the data cannot be compared to the other surveys however, although income was used to classify firms, the 2002-03 survey produced a similar result. The ABS found "The construction industry was characterised by a large number of very small businesses. During 2002–03, 64.7% (219,926) of construction businesses earned income less than $100,000 and a further 25.3% (86,035) earned income between $100,000 to less than $500,000." (ABS 8772, 2002-03, p. 7). Using the different metric of income it was found 90% of firms were small or very small. Here the 1996-97 survey and the 2001-12 survey data is presented. The breakup of firms by size is in table 5.

Table 5. Construction firm size and number of operating businesses.

Survey	Firm size		
1996-97	Employment less than 5	Employment 5 to 19	Employment 20 or more
No. of firms	182, 000	11,100	1,200
2011-12	Small 0-19	Medium 20-199	Large 200+
No. of firms	204,929	4,648	186

Source: ABS 1996-97 and 2011-12. *Construction Industry Survey.* Australian Bureau of Statistics, Cat. No. 8772.0.

In the 1996-97 survey businesses with less than five employees accounted for 94% of all businesses and over two-thirds of all employees. Less than 1% of businesses employed 20 or more. Businesses with less than five employees accounted for slightly less than half the total income and expenses, whereas businesses with employment of 20 or more accounted for almost one-third of these. The data for 1996-97 is in table 6 converted to percentages, showing the importance of the 0.62% of large firms. Their 13.6% of employees earned 32.3% of salaries and wages, generated over 28% of income and nearly 25% of gross output.

Table 6. Percent of total construction by Firm Size 1996-97

Selected indicators	Employment less than 5	Employment 5 to 19	Employment 20+
Operating businesses	93.67	5.71	0.62
Employment	68.62	17.74	13.63
Wages and salaries	39.39	28.24	32.38
Total income	48.13	23.55	28.32

Operating profit before tax	74.42	11.28	14.30
Industry gross product	53.50	22.14	24.36

Source: ABS 1996-97. *Construction Industry Survey.* Australian Bureau of Statistics, Cat. No. 8772.0.

The survey in 2011-12 classified firms by the number of employees into small 0-19, medium 20-199 and large with over 200. The same data for the 2011-12 survey is in table 7. The changes between 1996 and 2012 are revealing. The total number of firms has increased marginally from 195,000 to 210,000, but the share of small firms has increased from 94% to 98% as the number of medium and large firms fell from 12,300 to less than 5,000. There was a trend with the number of medium sized firms decreasing to less than half, while slightly increasing their share of industry employment.

In 2011-12 less than 0.1% of firms were large, employing 18.6 % of the workforce, paying 32% of wages and salaries and generating 27% of industry income and 25% of output. These figures are remarkably similar to the 1996-97 CIS numbers, however, the 186 large firms in 2011-12 had almost the same share of employment, income and output that 1,200 firms had in 1996-97. This was a significant increase in industry concentration. In the 1996 survey the 1,200 firms employing 20 or more had a total of 66,000 employees and accounted for 13.6% of employment and 24.4% of industry output. In 2012 there were 186 firms employing 200 or more with 177,000 employees, accounting for 18.6% of employment and 25.5% of IVA. These long-run lchanges in industry structure can only be the result of a long wave of mergers and acquisitions reducing the number of firms while increasing concentration and reducing competition, and should be of particular interest to major clients and regulators.

Table 7. Percent of total construction by Firm Size 2011-12

	Small 0-19 persons	Medium 20-199 persons	Large 200 or more persons
Businesses	97.7	2.2	0.1
Employment	62.1	19.3	18.6
Wages and salaries	37.9	26.3	35.8
Income	49.0	23.6	27.3
Operating profit before tax	74.0	17.4	8.6
Industry value added	51.6	22.9	25.5

Source: ABS 2011-12. *Construction Industry Survey.* Australian Bureau of Statistics, Cat. No. 8772.0.

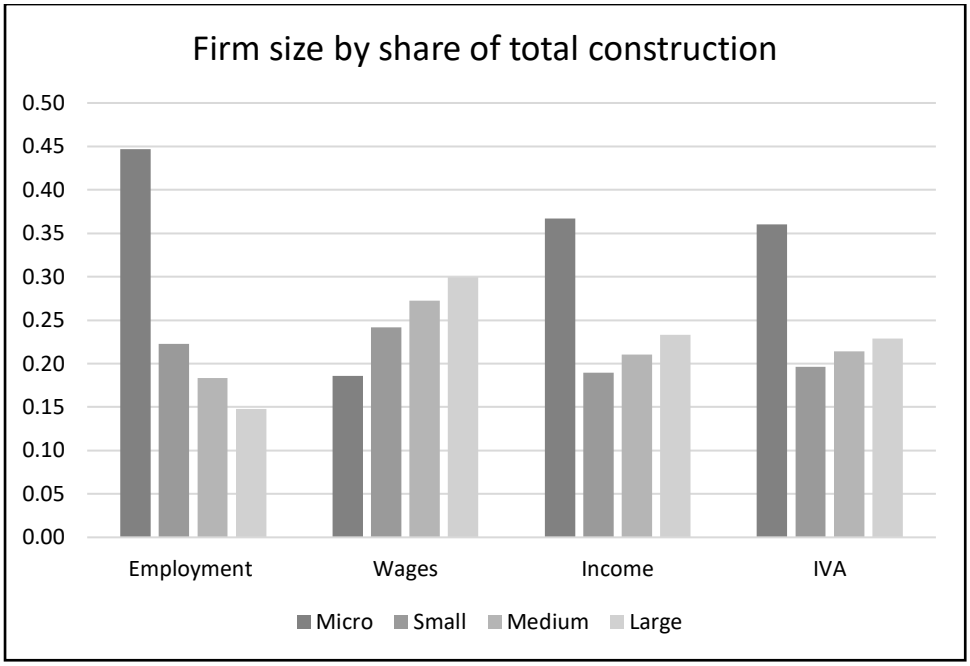
Australian Industry Data

This data is provided in the Australian Bureau of Statistics annual publication *Australian Industry* (ABS 8155), produced annually using a combination of directly collected data from the annual Economic Activity Survey conducted by the ABS, and Business Activity Statement data provided by businesses to the Australian Taxation Office. The data includes all operating business entities and government owned or controlled Public Non-Financial Corporations. *Australian Industry* excludes the finance industry and public sector, but includes non-profits in industries like health and education and government businesses providing water, sewerage and drainage services. The selected industries included account for around two-thirds of GDP. Excluded are ANZSIC Subdivisions 62 Finance, 63 Insurance and superannuation funds, 64 Auxiliary finance and insurance services, 75 Public administration, and 76 Defence. The most recent issue is for 2018-19.

The analysis is based on industry value added (IVA) and industry employment. IVA is the estimate of an industry's output and its contribution to gross domestic product (GDP), and is broadly the difference between the industry's total income and total expenses. IVA is given in current dollars in *Australian Industry.* The data is presented at varying levels for industry divisions, subdivisions and classes, but unfortunately does not include the number of firms. Micro firms have less than 5 employees, small firms 3-19, medium firms 20-199 and large firms more than 200 employees.

Figure 1 shows the shares of the indicators used in the comparison of the CIS, with similar results. Large firms have 15% of employment, 30% of wages and salaries and 23% of output, not too dissimilar to the CIS data. Medium firms have 18% of employment, 27% of wages and salaries and 21% of output, again not too dissimilar to the CIS data. Micro and small firms account for approximately 65% of employment but only 55% of output, thus explaining the problem of the long-run low growth rate of productivity in construction (de Valence and Abbott 2015). Figure 2 shows large firms have twice the level of output per employee, measured as IVA per employee, and medium firms nearly 50% more. This is an imperfect but useful proxy for productivity. There is no significant difference between micro and small firms, but large firms have twice the added value per employee of micro and small firms. Medium size firms are in the middle.

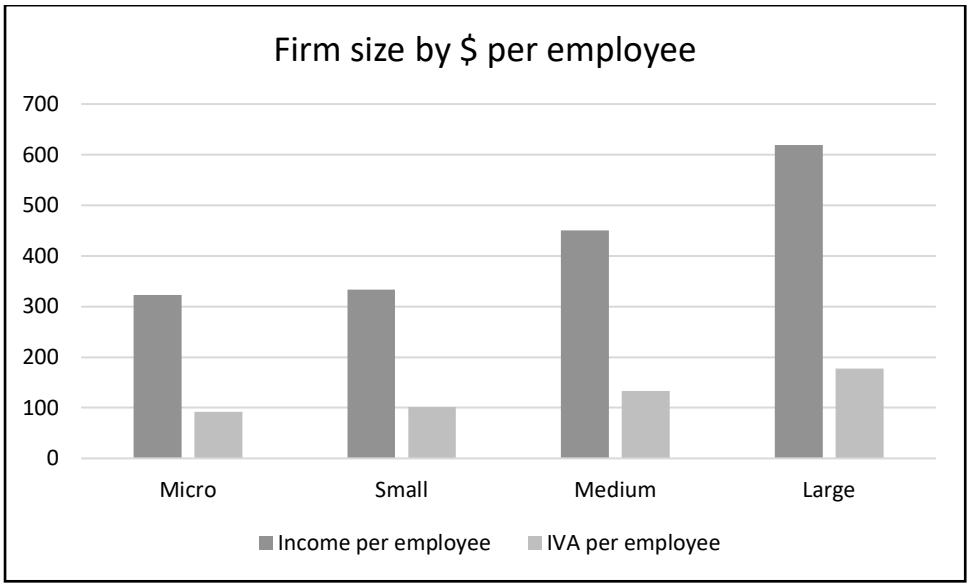
Figure 1. Construction firms 2018-19



Source: ABS 2020. *Australian Industry 2018-19.* Australian Bureau of Statistics, Cat. No. 8155.0.

Firms leverage the capital on their balance sheet to maximise revenue and profits. For firms in construction markets annual revenue is the aggregated income from current work, or contracts won but not completed. Construction firms and contracts range widely in duration, size and value, but the amount of work a firm can take on must be related to the capital a firm has available. This relationship between firm size and the annual value of contracts or projects undertaken is based on the assumption that construction firms seek to maximize revenue but are constrained by their working capital. In construction the contract packages reflect the complexity of work, so there is a wide range of contract sizes. Construction contracts can, therefore, be arranged based on contract size and complexity. This is a well-known and widely agreed characteristic of the industry, with the relationship first investigated in the 1980s when Flanagan and Norman (1982) found competing contractors' bids were affected by the type of project and by the value range. Small bidders considered both contract type and size, and large bidders were more successful when bidding for large contracts. Contract size and complexity were also important for Hillebrandt (1985), who argued the wide range of contract sizes in the construction market is the major determinant of the number of firms able to undertake the work. Male (1991) had a 'project-based vertical market defined by project size and complexity', where going up the vertical market left fewer companies able to undertake particular types of project.

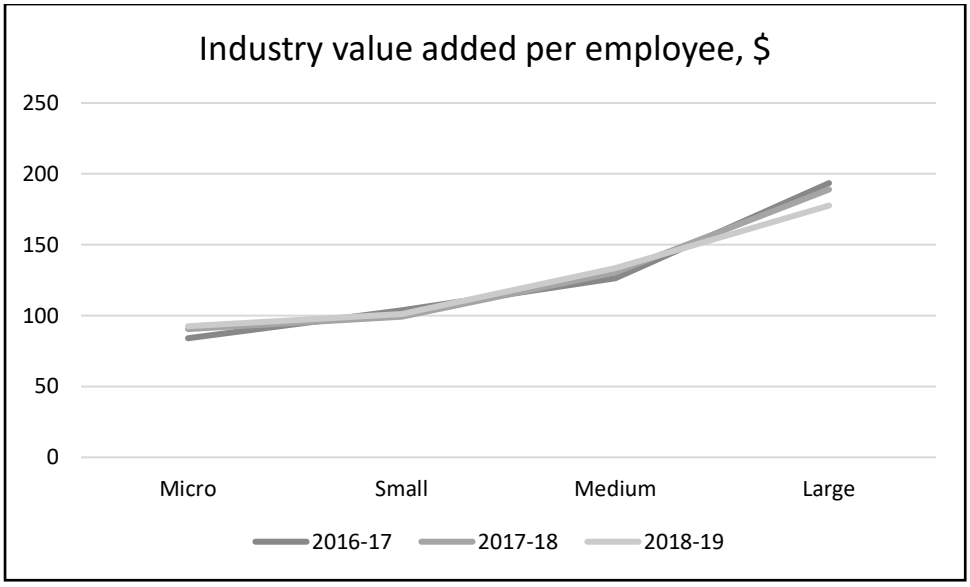
Figure 2. Income and industry value added per employee



Source: ABS 2020. *Australian Industry 2018-19.* Australian Bureau of Statistics, Cat. No. 8155.0.

Construction has a large number of small firms bidding for work in competitive markets with little or no control over prices. There is a smaller number of firms that can deliver large projects in a given region, and there are a few dozen multinational corporations in construction. Construction economics has a wide range of views on the types of markets these firms operate in and their competitive behaviour (reviewed in de Valence 2011). There is, however, universal agreement that construction is an industry of projects, and firms operate in markets for projects of many different types. Skitmore (1991) found bidders for construction contracts should not be considered as homogeneous or standardized, Drew and Skitmore (1992) concluded consistently bidding for specific types of construction work is a successful strategy, and Drew and Skitmore (1997) found that differences in competitiveness are greater for different contract sizes than for different types of contract. Larger firms have more depth, more resources, and more technical and financial capacity therefore, as Low and Lau concluded (2019:31) “The construction industry can also be structured by size of contract and degree of complexity. Large construction firms usually undertake large contracts with a high degree of complexity.”

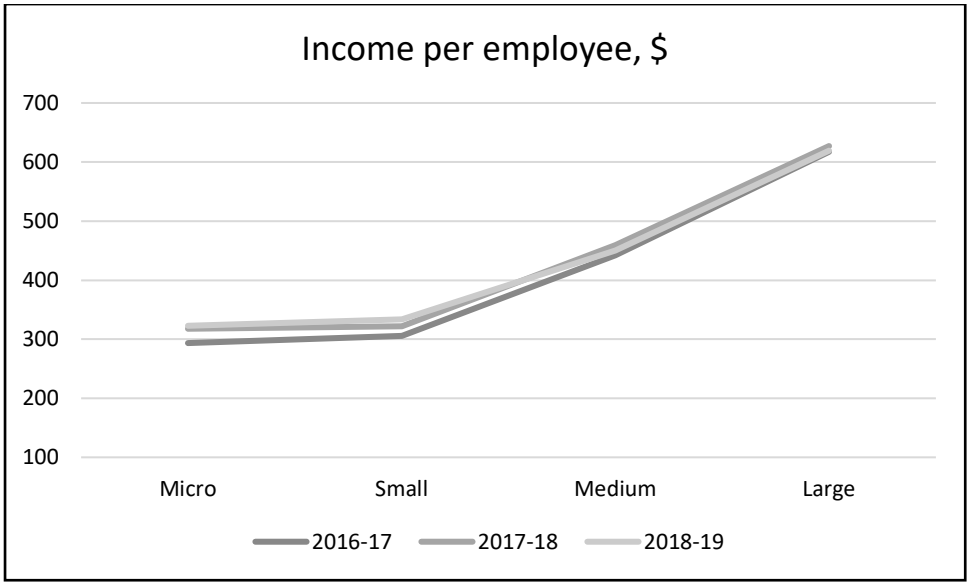
Figure 3. Firm size and industry value added per employee



Source: ABS 2020. *Australian Industry 2018-19.* Australian Bureau of Statistics, Cat. No. 8155.0.

The relationship between firm size and IVA per employee is not surprising, large firms are typically better managed than small firms (Bloom and van Reenen 2010). Management was identified by Hillebrandt and Cannon (1990) as the most important determinant of the capacity and capability of construction firms, because managerial skills give a contractor greater flexibility. How firms utilise their capabilities differentiates them within a diverse, location-based production system. It is widely recognised there are differences between industries in the way that production is organized and new technology adopted, adapted and applied (Nelson and Winter 1982), but differences within industries generally get less attention (Andrews *et al.* 2015). Important differences are the individual characteristics of firms such as their size, the effects of competitive dynamics, and how the adoption of new technology by one company in an industry influences the adoption of technology by other companies in that industry (Dosi 1982). For building and construction this is significant, not only because of the number of small and medium size firms, but because of the size and reach of the major firms.

Figure 4. Firm size and income per employee



Source: ABS 2020. *Australian Industry 2018-19.* Australian Bureau of Statistics, Cat. No. 8155.0.

The relationship between firm size and contract value is a fundamental reality in construction, and is also the foundation of the relationship between projects and firms. A firm is a legal entity and the typical reporting period is one year. A firm's income is the cumulative cash flow of their portfolio of projects over a year. The focus on projects and construction management in construction research can miss the role of firms as the ongoing participants in the industry.

Industry Structure and Concentration

The physical characteristics of location and projects mean construction is organized into local and regional markets around supply and availability of the resources needed to deliver projects for local clients. Cooke (1996: 138) describes the industry as "dominated by a large number of small firms" and "geographically fragmented", and Male (2003: 135) thought the level of fragmentation was a direct result of the sophistication and complexity of technology used in commercial buildings, the vagaries and variability of demand and the consequent increasing trend towards specialisation, subcontracting and self-employment. These characteristics were addressed in the earliest research on the organization of construction. Stinchcombe (1959) contrasted bureaucratic and craft systems of work administration: manufacturing has mass production with economies of scale through

standardization of tasks, but construction uses standardized products and parts. In craft production work administration and control is given to workers and foremen, but they do not make decisions on product type, design and price, which are made by others, variously referred to as administrators, bureaucrats, clients and employers. Stinchcombe argued bureaucratic administration requires long production runs and predictable work-flow, while uncertainty and variability in work-flow will make subcontracting and the craft system more efficient.

Viewing the construction industry as predominantly made up of small firms supports the view of the industry as fragmented with the characteristics of perfect competition (e.g. Runeson 2000). There are parts of the industry that fit the perfect competition model, the small and medium size contractors that rely on low-bid tendering to get work and labour based subcontractors, such as formworkers, steel fixers, bricklayers and concreters. There are few significant barriers to entry to the construction industry for small firms, and such barriers will continue to be low while the industry maintains current practices based on a large number of small, specialised subcontractors. These firms compete on the basis of price, so labour-intensive subcontractors and small contractors can be assumed to operate under perfect competition. There are, however, a limited number of contractors capable of managing large projects, and the barriers to entry at this level in the form of prequalification are significant, based on track record, financial capacity and technical capability (de Valence 2007). The data, which emphasises the number of firms, is deceptive:

> Because of the very large number of small firms, the entire industry is often characterized as unconcentrated. That description is too broad, however, because not all construction companies do overlapping work and some segments are much less fragmented than others. For example, a limited number of general contractors are capable of managing the very large projects, whereas there are a great many small subcontractors. Competition among large general contractors and among specialty firms seems to be oligopolistic, while rivalry among small contractors who do basic labour tends to be closer to perfect competition …. when relevant markets are defined, as opposed to considering the whole industry, competition is often limited because many firms are specialized or cannot compete on large projects … limited competition and substantial entry barriers can facilitate many different types of anticompetitive conduct, including unilateral and horizontal varieties. In addition, procurement procedures for construction projects are often conducive to collusion. (OECD 2008: 9).

Construction is an industry where there is evidence of concentration (McCloughan 2004), and significant barriers to entry exist due to prequalification systems and capability requirements used by clients to select contractors for major projects (Ezulike 1997). Oligopolistic competition focuses on competition through product differentiation, or in the case of building and construction through specialisation in particular types of projects (e.g. bridges, high-rise), forms of procurement (e.g. design and build, negotiated work), finance and PFI type projects, or relationships with clients (such as alliancing or partnering), or by region. Suppliers of glass facades, lifts and building automation systems are also oligopolistic because there are few manufacturers of these products. Between these two market structures there are some firms in the industry that are in monopolistic competition. These are medium size contractors that have specialised and differentiated their products and services, or have developed ongoing relationships with clients and thus get negotiated work (de Valence 2003).

Ofori (1990) recognised there are many heterogenous small firms in the construction industry, and discusses (and provides data for) Singapore, the US, Canada and Western Europe. He concludes "whereas the construction industry has a pyramid structure, the distribution of its workload takes the form of an inverted pyramid. In other words, the industry is relatively concentrated. The small firms are generally uncommitted, transient, undercapitalised, have poor access to credit, operate within limited geographical areas, and seldom apply modern management tools" (Ofori 1990: 77). Langford and Male argued "the construction industry is first, comprised of geographically dispersed and overlapping project-based market structures and second, is hierarchically structured in terms of company size. Fragmentation is high at the smaller end of the industrial structure, for example in repair and maintenance work, whilst for new-build work fragmentation decreases according to project characteristics, including those with an international dimension. Entry and exit barriers to the industry are many but exist often in a subtle form." (Langford and Male 2001: 26).

The construction industry has its own organizational and institutional features. For Bresnen and Marshall (2001) the industry is a mature, project-based industry with complex professional and organizational contractual and working relationships. The industry is geographically distributed, causing significant horizontal and vertical differentiation within construction firms, with potential for uncoupling between project activities and organizational strategies. Dubois and Gadde (2002) describe a decentralised, project-based structure as a loosely coupled system, where temporary project teams come and go, combining members from a broad range of firms and industries as required. Moreover, the context is one of wider networks containing many small and medium size firms in localized subcontracting markets (Gruneberg and Ive 2000).

Although Bresnen (1990) discusses a range of organizational and institutional relationships where external contracting is common, he sees large contractors delivering major projects as the core of the construction industry's system of production at the end of the twentieth century. By this stage the production system had a clear outline, and a clear structure, for bringing together the products, suppliers and materials needed for building and engineering projects, and had stabilised around particular forms of procuring, financing and managing those projects. Construction materials like cement, concrete and glass, and components like building management systems, interior walls, plumbing fixtures, glass facades, lifts and elevators are all oligopolistic industries in a mature supply chain (Syverson 2008).

The construction industry of today is the outcome of a long development path over the twentieth century. It has a production system that has been developing since the introduction of steam engines over 200 years ago, followed by successive developments in iron, glass, steel and concrete technologies. Many of the industry's global leaders are well-established, Bechtel for example is over 100 years old, and other firms like Hochtief, Skanska, and AECOM can trace their origin stories back over a similar period. Shimizu is over 200 years old. From an industry life-cycle perspective (Hughes 1989), the modern industry is in the late stage of competition and consolidation, where successful firms survive and thrive, and gain both market share and market power over time (Syverson 2019). Consolidation of an industry leads to concentration in a few firms.

A stylized representation of construction industry firms by market type is in table 8, showing how concentrated markets can be the outcome of either firm size or specialization. Figure 5 relates market type to contract size. As a firm gets larger it takes on bigger projects and compete with fewer other firms. How construction economists sought to reconcile theoretical and conceptual models of construction firms with the messy reality of the construction industry is discussed in the next section.

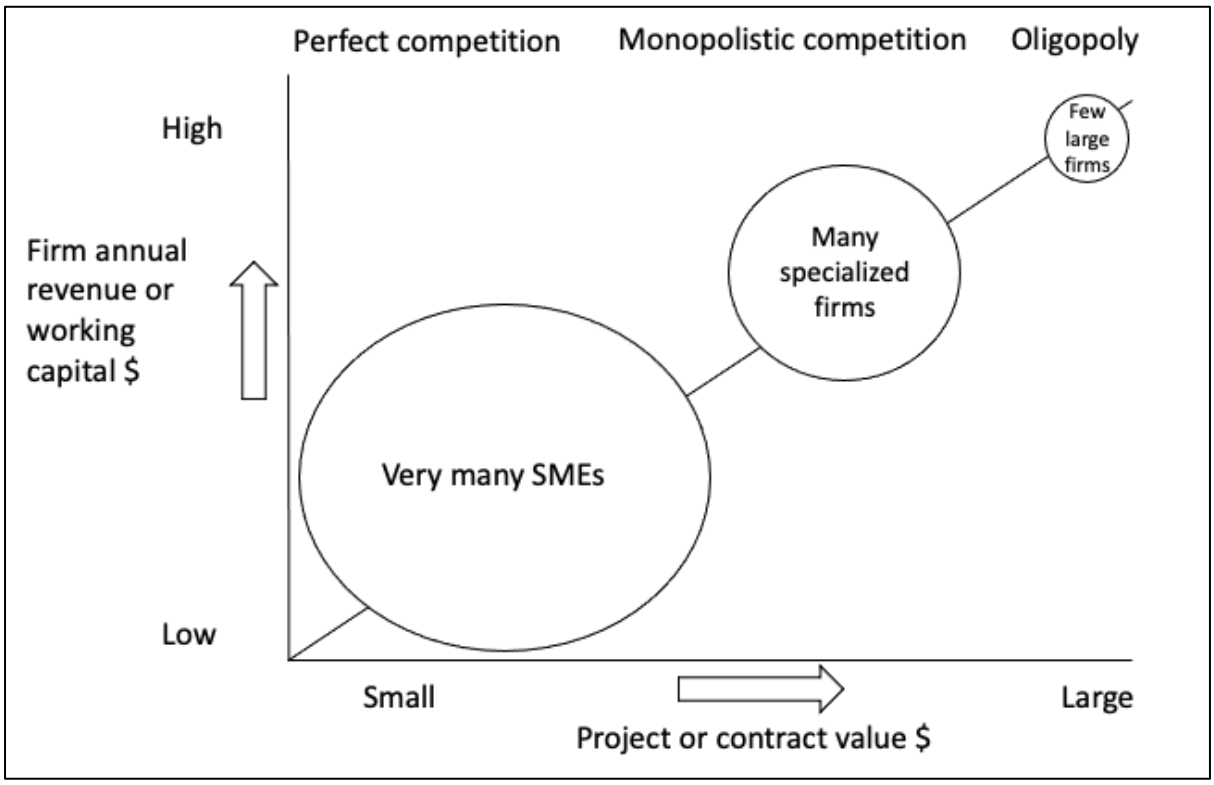
Table 8. Construction Firms by Market Type

Construction	Perfect Competition	Monopolistic competition	Oligopoly
Subcontractors	Labour based subcontracting	Mechanical services (HVAC), demolition	Lifts, building automation

Contractors	Many small and medium contractors	Some medium sized contractors	Large head contractors

Source: de Valence 2011

Figure 5. Large firms deliver bigger projects and compete with fewer other firms.



Development of Conceptual Models of Construction Firms

In an economics textbook the model of a firm is sparse and lacks detail. Firms are optimisers of scarce resources constrained by technological capacity. Based on cost and demand functions a firm maximizes profit as a 'black box' that mysteriously but efficiently turns inputs into outputs as its contribution to total industry output. In introductory texts this neoclassical model is presented graphically as the set of choices a firm faces to minimize marginal cost and maximize profit based on marginal revenue. Firms here are price takers, they are small relative to the market, they do not have market power, and their products are homogeneous (i.e. the same).

Hillebrandt (1974) used this model of a firm in chapters on costs, demand and markets. However, Hillebrandt ranged widely, with alternative views on the objectives of the firm (growth, revenue, managers' incentives), costs for project-based firms, revenue curves and mark-ups, product differentiation, and the effects of different types of markets included. That discussion incorporated the characteristics of construction, based on Hillebrandt's familiarity with the British industry, and led to two key conclusions. The first was perfect competition due to ease of entry. Even with a limited, selected number of tenderers there is 'effective competition', with the same outcome as perfect competition. The short discussion of imperfect competition (pp. 136-38) is conventional and construction is not mentioned. The second conclusion was that marginal analysis is appropriate for project-based firms. This model of the firm can also be found in Briscoe (1988) and Runeson (2000) - they, like Hillebrandt, attempted to reconcile neoclassical economics with construction industry characteristics.

At the end of the 1980s three books taking radically different approaches to the industry and the firm appeared. Ball (1988) gives a Marxist analysis of British construction, focusing on social relations and the contracting system, and claims "One theoretical avenue which seems of little use in studying the industry is to apply neoclassical economic theories of the firm" (1988: 19). The dual role given to firms as producers (of buildings) and merchants (purchasing inputs) foreshadowed the trade credit/cash farming literature, with Ball arguing the merchanting role predominates at the expense of wages and productivity.

By contrast, Bon's *Building as an Economic Process* (1989) applied Austrian economics to construction. This branch of economics, a polar opposite to Marxism, is relevant to construction because it emphasises capital and the capital stock, the pivotal role of investment in capital formation, the explicit role of the time taken for investment decisions to be fulfilled, the cyclic nature of economic and building activity, and the possibility of production plans or projects failing. Firms here are vehicles for investment, preparing plans and sourcing the capital required, and the building process is a series of decisions on the use of capital. The book strongly linked construction (supply) to the property market (demand) through capital flows and the need for ongoing repair and maintenance, and Bon suggested this relationship should be the basis of a research agenda in construction economics (CE). However, much of that research is now in the atheoretical area of life-cycle costs, and Bon's book remains the only use of Austrian economics in CE.

Hillebrandt and Cannon (1989) argue in their book that it is "inherently difficult to relate the economic structure, behaviour and performance of contracting firms to theoretical models" (1989:

6). Their alternative is managerial economics (on firm decision-making) and management theory (on business strategy, organization theory and human resources), explored in seven of the eight other contributions to the book. This illustrates the large grey area between construction management and construction economics, where topics like these are of mutual interest and cannot be considered from an economic viewpoint without reference to industry custom and practice.

Thus, at the end of the 1980s, there were four distinctly different concepts of construction firms, supported by detailed analysis of the industry in Britain, where these researchers worked. These were: Neoclassical firms in competitive contracting markets; Marxist firms acting as producers and merchants; Austrian firms circulating capital between construction and property; and Managerial firms organized for construction.

Alternatives to Firms

Coase (1937: 388-90) argued that the firm is an organisation, rather than just a production function. He separated the market from the firm with the 'price mechanism' on one hand and its 'supersession' on the other. For Coase, the alternative to the firm was the coordination of self-employed individual producers by the market, each being his or her 'own master'. In construction and other project-based industries the coordination of individual producers is known as subcontracting and is the responsibility of the main contractor and their project manager.

However, subcontractors are often not engaged in a single transaction, as in the market-based trades of instant exchange and settlement envisaged in economics textbooks. Richardson (1972) identified relationships between firms as important, Hughes (1983) saw production as an organized network of firms, and Goldberg (1980) and Dore (1983) argued the relationship between a large corporation and its subcontractors is typically more durable and intensive than a market relationship. The idea of 'relational contracting' had firms develop long-term ties with subcontractors, often with mutual understanding and trust that are not typical of markets. Instead of using the market, the firm will rely on a trusted supplier, especially when their relationship involves shared knowledge and learning (see Gill 2010 for these issues in a major construction project).

There are also 'hybrid' concepts such as the 'quasifirm' as developed by Eccles (1981) as a response to Stinchcombe (1959), who considered cases in the construction industry where "relations between

the general contractor and his subcontractors are stable and continuous over fairly long periods of time and only infrequently established through competitive bidding. This type of 'quasi-integration' results in what I call the 'quasifirm'." (Eccles 1981: 339-40). He argued this 'stable and continuous' contracting relationship is not just a form of relational exchange along the lines of Richardson, Goldberg and Dore above, subcontracting is an `interface' between the market and the firm. Both relational exchange or quasifirms can be used to describe aspects of subcontracting, Eccles applied it to construction, and Cheung (1983) also used building work as one of his three examples of transactions. Lai (2000) analysed whether a construction project is a market or hierarchy in some detail, in the context of subcontracting as the interaction of firms in a market. His view is that this interaction is largely contractual, following Masten (1991) who forcefully argued for the importance of the firm as a legal entity.

A contract defines the boundary of a firm because it creates a legal person with unambiguous identity. Hodgson (2002: 26) concludes "A firm is defined as an integrated and durable organisation involving two or more people, acting openly or tacitly as a 'legal person', capable of owning assets, set up for the purpose of producing goods or services". He then asks "why do so many economists evade the obvious, everyday, legally grounded, definition of the firm?" and argues that it is because economists frame the analysis of the firm and the market in universal, ahistorical and relatively de-institutionalised terms. If the boundaries of the firm are indistinct, alternatives like 'internal markets' within firms, the 'quasifirm', 'hybrid firms' and firms as 'quasi-markets' are possible. However, as Lai (2000) and Hodgson (2002) argue, there is no good reason to abandon the formal, legal conception of firms because of relational contracting, networking, subcontracting or other developments. Firms can act strategically, and thus will sometimes form coalitions, and some relationships will be more durable than others.

Ive and Gruneberg argued that subcontractor markets exist in a separate and distinct way from contractor markets: "… firms engaged in each stage of the process of production of the built environment … compete directly (actually or potentially) with one another, and thus constitute an industry. The firms of other stages in the process stand not as competitors but as suppliers or buyers from that industry". (Ive and Gruneberg 2000: 7-8). Repeated interaction does not a relationship make. In de Valence (2015) this argument was extended, suggesting a market is created by the main contractor as they go through the subcontracting process. The paper introduced the idea that procurement of subcontractors for a project creates an identifiable, though temporary, market for goods and services. Such a market has distinctive characteristics that make it different from other markets, because subcontractors are a hierarchically organised network of autonomous producers.

This is a short-lived market characterized by an imbalance in bargaining power between subcontractors bidding for work and contractors acting as auctioneers, to the potential detriment of both subcontractors and clients.

Development of New Models of Firms

Issues with the model of firms with perfect information, constant returns to scale, and no market power created a broad research agenda in economics. Two topics in that agenda crossed over and were applied to construction firms in the 1990s. The first was on the boundaries of the firm and transaction cost economics (TCE) based on the work of Coase (1937) and Williamson (1975), who described firms as a 'nexus of contracts' and claimed "Any issue that arises as or can be reformulated as a contracting issue can be examined to advantage in transaction cost economizing terms" (Williamson 2000: 599). First applied to construction by Winch (1989), TCE offered a mechanism to analyse construction procurement methods (Ive and Chang 2007), conflicts of interests among contracting parties (Li *et al*. 2013), hidden costs associated with pre- and post-contract work (Walker and Wing 1999), and uncertainty and risk (Chang 2013).

TCE became an active research stream (reviewed by Aziz 2021). Firms minimize transaction costs by choosing either internal production or external supply, the make-buy decision investigated by Murray and Kulakov (2019) for international construction firms. This added another explanation for subcontracting to the flexibility and minimizing fixed costs explanation already established by Stinchcombe (1959), where specialization by subcontractors results in lower cost of supply under specific contract conditions. The extension of TCE to construction introduced issues like the hold-up problem on required investment (Winch 2006), incentives and contracts (Ive and Chang 2007), and reframed information asymmetry between participants as a principal-agent problem (Cerić 2014).

In their book on construction firms Gruneberg and Ive (2000) included a chapter on TCE. They also added to the Hillebrandt and Cannon (1989) managerial model of the firm different types of markets, industry capacity, productivity, decision-making under uncertainty and models of pricing, cost and investment. Construction firms were differentiated by specialization, size and growth rates. Firms manage portfolios of projects in markets that have barriers to entry and can become concentrated. This is a considerably more complex model of construction firms. Their Prologue concludes "The aim of this book is to give a clear understanding of some of the economic issues directly confronting construction firms in their operations and provide the economic basis for

planning and decision making." (2000: xvii). However, while they follow Hillebrandt and Cannon (1989) on management decisions, they also include discussion on capital circuits and the social structure of accumulation, which builds on Ball (1988).

By including a range of firm-specific and industry-specific factors in pricing decisions, and the subsequent profit margin, Gruneberg and Ive (2000) focused on how average costs at the firm level are marked up, constrained by factors such as union power, sales and promotion activities, the degree of concentration in the market, the level of overheads to be covered and the prices of competing products. Another important distinction introduced by Gruneberg and Ive is the difference in pricing behaviour between large construction firms and small firms, which they describe as near-firms or micro-firms. The large firms are oligopolistic, an important point, but small firms operate under conditions that closely resemble those of perfect competition and are "constrained by a chronic shortage of operating financial capital" (Gruneberg and Ive 2000: 225).

Research on firms and industry trends became more focused as topics like small and medium enterprises (SMEs) in construction, innovation, and megaprojects became active research streams in the 2000s. That research broadly showed industry trends such as use of BIM, integrated design and manufacture, and framework procurement agreements are driven by the largest firms, and that separation between local, national and international firms and markets was growing ever wider as globalization gathered momentum in the new millennium (Runeson and de Valence 2009). Over the 1990s there had been increased interest in international contracting and contractors (e.g. Ive 1990, Low 1991, Crosthwaite 1998). Alliances in international construction became a focus of research: Badger and Mulligan (1995) and Bing *et al*. (1999) addressed why alliances are formed, types and benefits of international alliances, trends in global construction and risks in international markets. Kangari and Sillars (1997) looked at Japanese construction alliances. Norwood and Mansfield (1999) studied construction companies in international joint ventures in the Asian market. Ofori (2003) recognised an "international construction system" where firms chose markets based on firm and national competitive advantages. Firm advantages include name and size, national advantages are related to distance to the market and historical, social and economic relationships. Brockman (2009) differentiated international, multinational and global markets and firms, with international firms competing outside their domestic market. Over these years the perspective on the industry shifted from a fragmented system of production to one where a significant proportion of the value of work done is coordinated by the small number of large firms that deliver large projects.

That new view of the industry underpinned Gruneberg and Francis' *The Economics of Construction* (2019), which provided 'a game theory account of the behaviour of firms', the second crossover from economics. In the 1990s game theory became the dominant approach in industry economics (see Tirole 1988, Carlton and Perloff 2005). They discuss aspects of firms' business models, financing, contractual disputes and power relations at greater length than Hillebrandt, building on the research on construction firms done over the previous three decades. There is also the use of case studies of the collapse of UK contractor Carillion in 2018, Grenfell Tower, construction for the London Olympics and manufactured housing. These illustrate how the business environment a construction firm faces has become significantly more complex over the decades. Hillebrandt's turnover and profit maximizing firm in the 1970s has evolved into one primarily concerned with growth and survival in the 2020s. While that may be a matter of degree, it is not insignificant. Gruneberg and Francis argue contracting markets compete profits down to the point where firms cannot invest in productivity improvements. According to Hillebrandt prices, costs and profits for a project were determined by a conventional marginal analysis, producing an equilibrium result. In Gruneberg and Francis the last two chapters point to an emerging field of research on the economics of construction projects, combining project financial and feasibility studies with procurement strategies. Construction firms operate in an industry Gruneberg and Francis describe as "a highly fragmented project-based industry, with very low profit margins and a high risk of failure for the many firms operating in a very complex supply chain".

From the fragmented perfectly competitive industry of the 1970s, by 2020 the model of firms in the construction industry is a hierarchical supply chain managed by main contractors and project managers, reflected in the system of tiered suppliers, from oligopolistic tier 1 contractors down through layers of monopolistic competition where firms compete among themselves, to a deep layer of small firms in perfectly competitive markets. The industry maintains key elements of hierarchical governance through contracts between tiers of subcontractors and suppliers, optimizing supply chains through standardization of parts and products. Some firms act variously as contractors, subcontractors, designers or consultants, depending on circumstance. As this shows, there is no clear boundary where discussion of firms crosses over to discussion of an industry, reflecting the grey areas in the relationship between microeconomics and industry economics.

How an industry organizes production fundamentally determines the number and nature of firms. Topics like construction innovation and productivity are industry characteristics that cannot be sensibly discussed without reference to the number and size of firms and the structure of the industry. What the idea of a fragmented industry of mainly small firms misses is the importance of

the large firms in the industry. From an industry life-cycle perspective (Hughes 1989), the industry is in the late stages of competition and consolidation, where successful firms survive and thrive, and gain both market share and market power over time (Syverson 2019).

Conclusion

The chapter started with data on firm size and industry structure from the EU and US, showing the general pattern of many small firms and few large ones. Australian data provided more detail, tracking firm numbers through five surveys showed a significant decrease in the number of large firms while their share of industry income was more or less unchanged. This reveals the increasing concentration of the industry between 1996 and 2012. The relationship between firm size and contract value is a fundamental reality in construction, and is also the foundation of the relationship between projects and firms. Some aspects of that were explored using industry data from the Australian Bureau of Statistics, showing a clear relationship between firm size and income. Large firms also have twice the level of IVA per employee compared to small and micro firms.

The number, fragmentation and diversity of construction firms makes generalizing about their financing, management, behaviour and strategy challenging. To deal with this, researchers investigating aspects of construction often divide the industry into categories such as Tier 1, 2, or 3 firms, subcontractors or consultants, or into market segments like residential building or engineering construction. Alternatively, firms can be assumed to be homogeneous in character as contractors in a project-based industry, while differing in scale and size. Both these approaches have strengths and weaknesses, as the theoretical debates about the nature of construction firms demonstrate. The chapter also finds classifying construction firms by size instead of industry sectors resolves some of the issues raised in relation to the structure and conduct of the construction industry, in a way that division into sectors based on the type of project does not.

This chapter argues firms are economic agents, whose behaviour is determined by the type of market they compete in. The relationship between firm size and the value of contracts or projects undertaken is used to determine the number of competitors and market type the firm competes in, based on the assumption that construction firms seek to maximize revenue but are constrained by their working capital. The characteristics of large firms in an oligopolistic market, the characteristics of a medium size construction firm in monopolistic competition with similar firms, and of a small firm in a perfectly competitive market are identified. The chapter presents a stylized view of firms

and places them in the context of contracting markets for projects. Data supporting the empirical relationship between firm size, revenue and value added is presented and analysed.

As this chapter shows, there is no clear boundary where discussion of firms crosses over to discussion of an industry, reflecting the grey areas in the relationship between microeconomics and industry economics. How an industry organizes production fundamentally determines the number and nature of firms. Topics like construction pricing, innovation and productivity are industry characteristics that cannot be sensibly discussed without reference to the number and size of firms and the structure of the industry. What the idea of a fragmented industry misses is the importance of large firms in an industry where they typically might be less than 1% of the number of firms. Construction statistics include a large number of small firms, typically family-owned subcontractors in the trades or engaged in the alteration, repair and maintenance of the built environment. The broad base of small firms is a distinctive feature of the overall construction industry as national statistical agencies define it. There is a long tail of small firms, a few large ones, and even fewer international contractors. However, as Edgerton (2007) notes, old technologies survive long after innovations that were claimed to replace them arrived, such as the telegraph, fax machine and vinyl records with telephones, email and CDs respectively. Stone, brick and wood have been widely used materials for millennia, and industrialized materials like corrugated iron, glass and concrete are ubiquitous. Because a large part of construction work is maintaining and repairing the existing stock of buildings and structures, current skills, technologies and materials will continue to be used by these small firms and there will be continuing demand for their services.

The fact that the construction industry of today is the outcome of a long development path is an important characteristic of the industry. A small group of international contractors have become incumbents in global markets for large projects. Many local and regional markets also have incumbents that are large relative to their subcontractors. For construction this is significant, because these major firms have the management and financial resources required to invest in new products and processes, and, in particular, technological capability, that small firms do not. The issue may be the ability of firms to capture knowledge externalities, adopt new techniques, and adapt to the impact of both emerging technologies and new entrants (Brynjolfsson *et al*. 2019.).

Bridging the divide between the empirical data available on firms and theoretical models of firms is difficult. Microeconomic models of firms optimizing along a production function are theoretically strong and work well, other models are less precise. Brochner (2011: 20) argued “current theories of industrial organization should be fruitful” when applied by construction economists. These are the

models of firms industry economics employs to explain their characteristics and operation, the structure of supplier and client markets, the forms of competition and cooperation between firms, and the effects of economies of scale and scope on industries. Each individual industry has a distribution in the number and size of firms that is specific to that industry, determined by its particular system of production, so a generalized production function may not explain the characteristics and operation of those firms. This becomes a more significant issue if firms are not in a perfectly competitive market, as assumed by microeconomic theory, such as concentrated and oligopolistic markets.

Crossing the divide between data on construction firms and theoretical models of those firms took several decades. The first model was Hillebrandt (1974), which was firmly based on microeconomic theory and applied the production function method to construction firms, applying a standard economic model that proved to be very durable, and appeared to be suitable to an industry made up of small firms in perfectly competitive markets. However, the data that revealed the fragmentation of the construction industry also showed the existence of a relatively small number of large firms. To explain their characteristics required other models from outside microeconomic theory. As discussed above, by the end of the 1980s managerial, Marxist and Austrian models of construction firms had been developed, and the concepts of quasi-firms and hybrids had been proposed. Then in the 1990s, TCE was applied to construction and the key theoretical issue of the boundaries of firms in contracting markets. It became increasingly apparent research on important industry topics cannot be done without addressing the issue of the role of large firms: examples are small firms and supply chains, international contractors and megaprojects, auctions and procurement, and innovation and productivity. Through investigating the empirical and theoretical issues these topics raise, a better understanding of the nature of these complex interactions can be found.

An optimizing firm is a theoretical mathematical constructs, often described as a ‘black box’ of some unknown set of resources, routines and knowledge inside a firm required for production. Ideally, such a firm is a profit maximizer (setting output) competing in efficient markets (setting prices), and from that perspective how the firm maximizes profit is not that important. Reality is more complex. Many firms go bust or get taken over, successful firms grow but with limits, industries have life cycles of decades and products life cycles of much less. Patterns of demand and supply ebb and flow over time, as the economy goes through short-run business cycles and long-run structural change. Most firms have finite lives, but some survive and thrive. How and why that is the case has been the subject of extensive research in industry economics in general and in construction economics in

particular. There may not be much theory, but there is no shortage of topics and issues to investigate.

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