

**CONSTRUCTION OF THE
AUSTRALIAN BUILT
ENVIRONMENT**

**OUTPUT AND EMPLOYMENT FOR 16
INDUSTRIES 2007-2019**

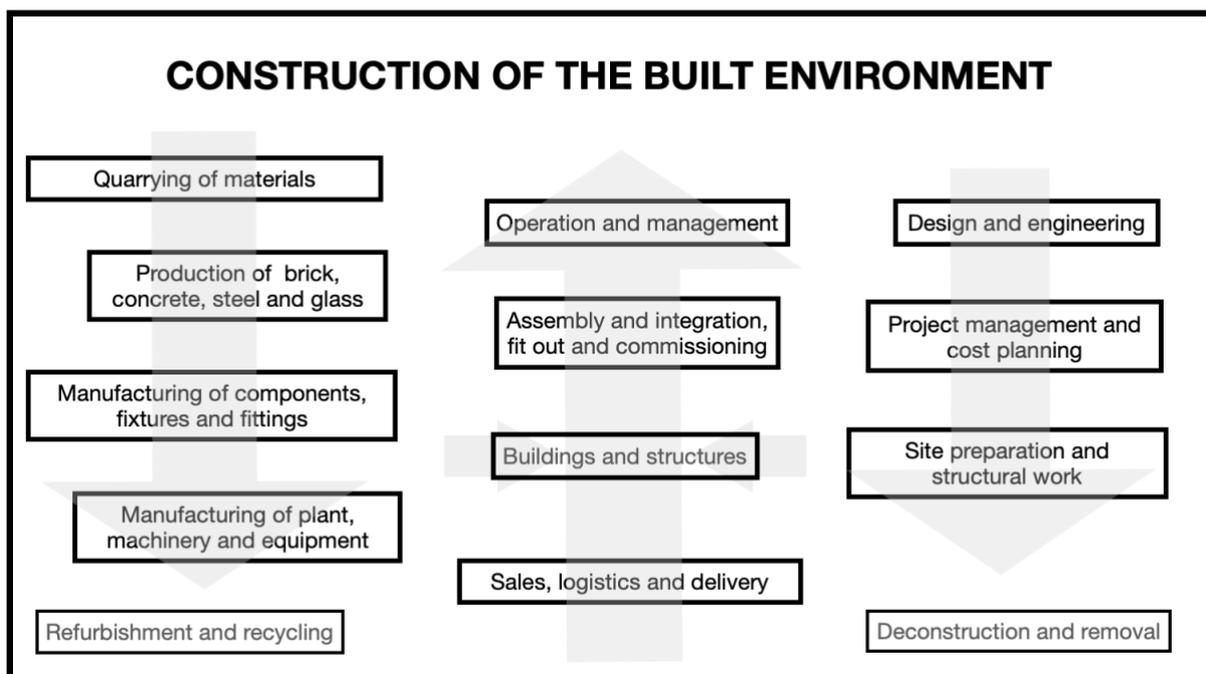
Construction Economics Research

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Figure 1. Many industries contribute to construction of the built environment



Introduction

The sixteen built environment industries included employed over 2 million people and produced \$270 billion in output in 2018-19. They contributed 14.2 percent to Australian GDP, within the long-run range between 14 and 15 percent of GDP since 2006-07. The share of total employment has fluctuated between 16.5 and 17.5 percent.

Table 1. Australian Built Environment Sector: Summary Statistics.

2018-19	Employment	IVA \$bn
Total Australian Built Environment Sector	2,126,000	270
Total Australia Employment and GDP	12,867,000	1,801
BES Percent of Australia total	16.5%	14.2%

Sources: ABS 8155, ABS 5206, ABS 6202.

This research combines data for industries included in *Australian Industry* (ABS 8155), that together form one of the largest and most important industrial sectors in the economy. It includes industries that have a direct physical relationship with buildings, structures, and the built environment. These industries collectively make up the Australian Built Environment Sector (BES).

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. The most recent issue is for 2018-19.

Table 1. Industries included in the Australian BES.

Supply industries	Demand industries	Maintenance industries
Non-metallic mining & quarrying	Residential property	Water, sewerage & drainage
Building construction	Non-residential property	Waste collection & disposal
Heavy and civil engineering	Real estate services	Building & industrial cleaning
Construction services		Building pest control services
Architectural services		Gardening services
Surveying & mapping services		
Engineering design & consulting		
Manufacturing industries		

An explanation of the background to this research and the methodology used is in *Measuring the Built Environment Sector*, available at constructioneconomicsresearch.com.

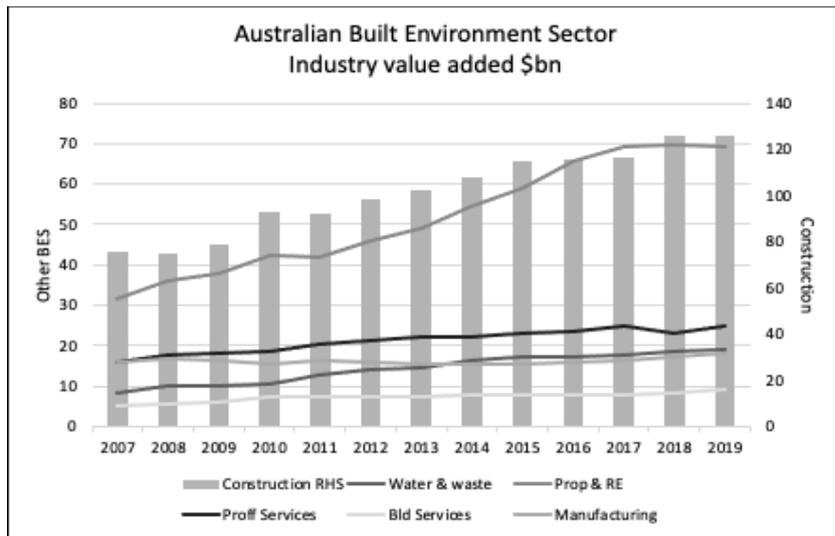
Australian BES Output

In an industrial sector like the BES changes in output, structure and dynamics will typically be slow and gradual. The Australian data confirms that is the case. Both output and employment have grown consistently since 2007. The general trend of an increasing share of services in output holds, with Professional, technical and scientific services and Property and real estate services both increasing their shares of BES output, by one percent and six percent respectively. The industry that has grown fastest is Property operators and real estate services, which doubled IVA between 2007 and 2016 and increased its share of total BES output from 20 to 26 percent (see Figures 2 and 3).

Table 2. Output of the Australian Built Environment Sector

ABS 8155 ANZSIC Industry	Industry value added \$bn			
	2015-16	2016-17	2017-18	2018-19
09 Non-metallic mineral mining and quarrying	2.6	2.7	2.9	3.3
28 Water sewerage and drainage	13.2	13.1	14	13.9
29 Waste collection, treatment and disposal	4.2	4.5	5	5.3
30 Building construction	26.2	29.3	33.3	33.6
31 Heavy and civil engineering construction	21.2	18.6	20	19.8
32 Construction services	68.1	68.6	72.5	72.6
Total construction	115.5	116.6	125.8	126
6711 Residential property operators		11.1		
6712 Non-residential property operators		42.6		
6720 Real estate services		15.5		
67 Property operators and real estate services	65.6	69.2	69.8	69.2
6921 Architectural services	3.9			
6922 Surveying and mapping services	1.9			
6923 Engineering design and consulting services	17.9			
BES Professional, scientific and technical services	23.7	25	23.3	24.7
7311 Building and cleaning services		6		
7312 Building pest control services		0.7		
7313 Gardening services		1.4		
BES Building cleaning, pest control, other services	7.9	8.1	8.5	9.6
BES Manufacturing	16	16	17.2	18
Total BES IVA	248.8	255.2	266.5	269.5

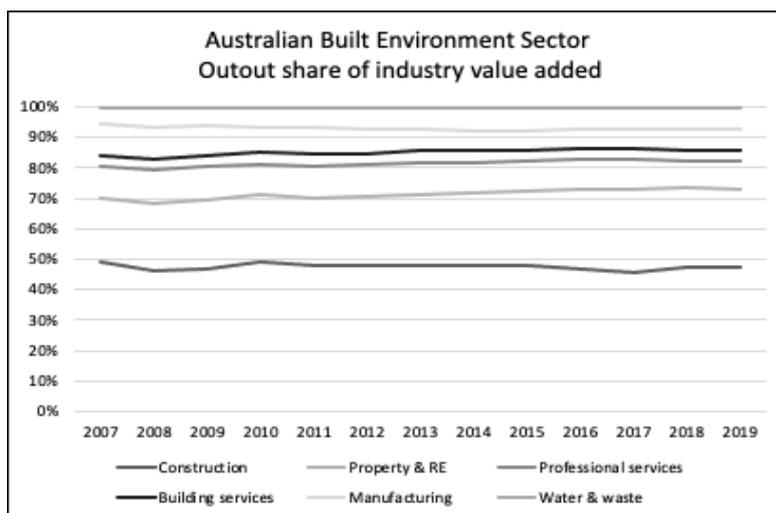
Figure 2. Output of Australian Built Environment Industries



Source: ABS 8155.

As found in the previous studies on the broad construction industry discussed above, total construction accounts for nearly half of the BES total. That share, however, has fallen from 53 percent of BES IVA to 47 percent between 2007 and 2019, at the same time Construction fell from 54 to 49 percent of total BES employment. Note the share of employment is one or two percent higher than the share of IVA, due to the labour-intensive nature of Construction Services.

Figure 3. Output Shares of Australian Built Environment Industries



Source: ABS 8155.

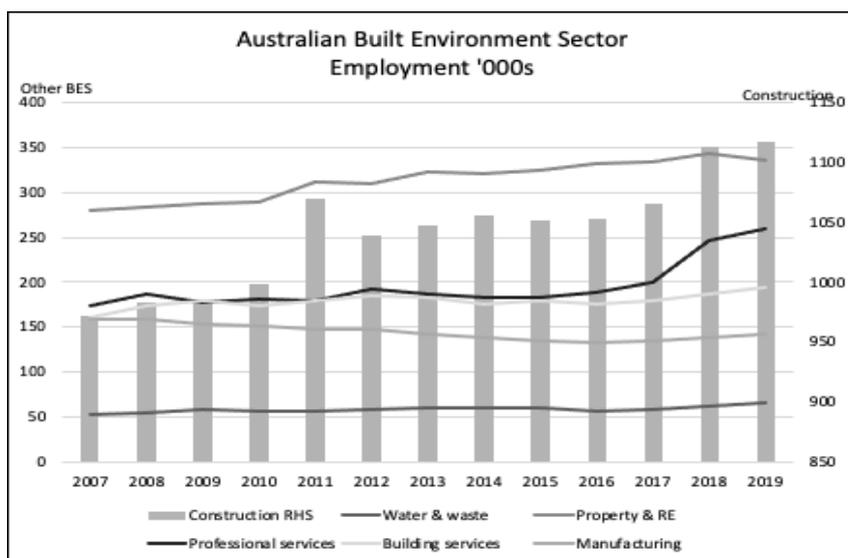
Because BES IVA is measured in current dollars, changes in its value reflect changes in both prices (paid for goods and services) and the quantity of output. To find changes in the quantity of output

and the real rate of growth, an implicit price deflator is used to adjust for the effect of price changes. Thus, changes in quantities are found by deflation, calculated by dividing the current-dollar value of GDP by an appropriate price index with the reference-year value set to 100. A price index is appropriate if its definition and coverage closely match those of the series being deflated. The ABS produces chain volume measures of industry gross value added, which are constant price estimates of industry output. Unfortunately, these are at the two digit SIC level and do not map closely to the sixteen BES industries.

Employment in the Australian BES

As a sector, the BES accounts for 16.5 percent of total employment in Australia. The total number of people employed in the BES has increased steadily but not dramatically, reaching 2,126,000 in 2018-19. Over that time, the significant changes in the composition of employment across the BES have been the rise in Professional, technical and scientific services from 10 to almost 12 percent, and the fall in manufacturing BES from 9 to under 7 percent, reflecting the fall in the manufacturing share in the overall economy. Employment in Professional, technical and scientific services increased from 189,000 to 259,000 between 2015-16 and 2018-19, both the largest and fastest increase across the BES. Table 4 shows percentage changes in people employed and annual growth rates of each industry.

Figure 4. Employment in Australian Built Environment Sector



Source: ABS 8155.

Table 3. Employment in the Australian Built Environment Sector

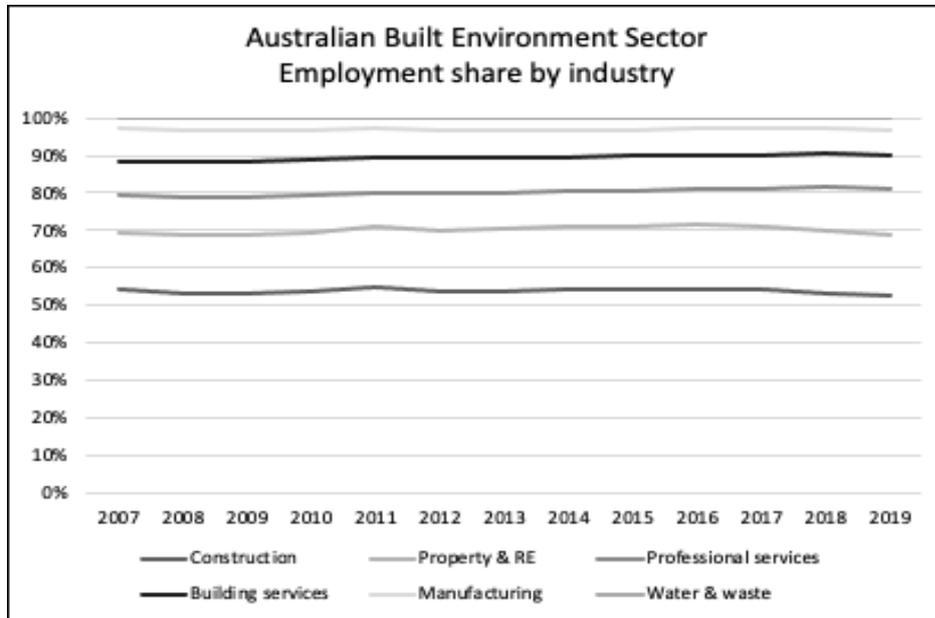
ABS 8155 ANZSIC Industry	Employment '000s			
	2015-16	2016-17	2017-18	2018-19
09 Non-metallic mineral mining and quarrying	12	12	13	13
28 Water sewerage and drainage	27	27	28	29
29 Waste collection, treatment and disposal	29	31	34	36
30 Building construction	208	212	224	225
31 Heavy and civil engineering construction	122	110	119	115
32 Construction services	723	748	771	777
Total construction	1,053	1,070	1,115	1,117
6711 Residential property operators		50		
6712 Non-residential property operators		146		
6720 Real estate services		137		
67 Property operators and real estate services	331	334	343	336
6921 Architectural services	40			
6922 Surveying and mapping services	16			
6923 Engineering design and consulting services	133			
BES Professional, scientific and technical services	189	199	247	259
7311 Building and cleaning services		150		
7312 Building pest control services		10		
7313 Gardening services		21		
BES Building cleaning, pest control, other services	175	179	186	194
BES Manufacturing	133	134	138	142
Total BES Employment	1,949	1,986	2,101	2,126

Although the industry shares in total employment look stable, the growth in employment in Professional services is notable, which increased from 9.6 percent to over 12 percent of BES employment between 2007 and 2019. After Construction the Property operators and real estate services industry is the largest employer, followed by Professional services.

The industry shares of BES output and employment have in fact changed over time, as shown in Table 4. The decline of manufacturing and decreasing share of Construction has seen the Property and real estate services industry increase its share of IVA from 16 to 26 percent, and share of employment from 15 to 21 percent between 2007 and 2019. The Water and waste and Property and

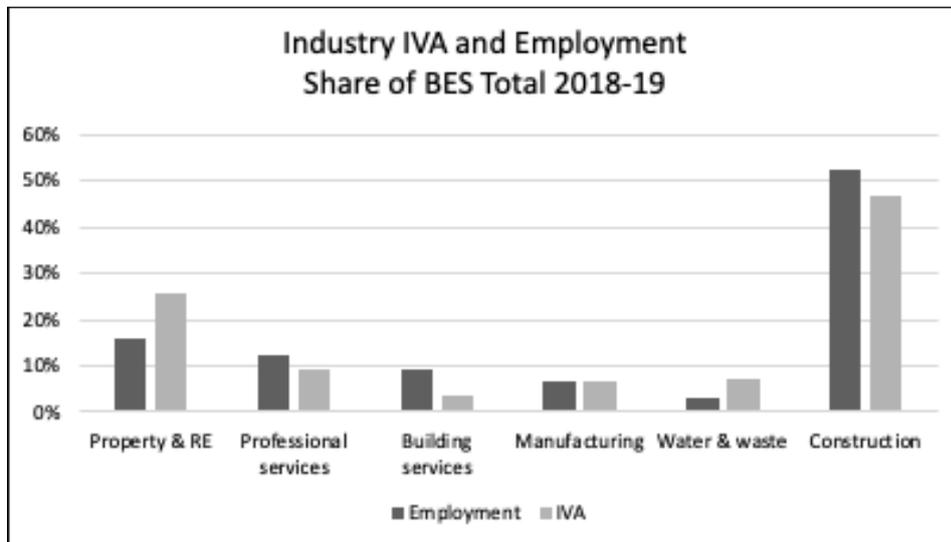
real estate services industries have positive differences between the shares of IVA and employment, reflecting their higher capital requirements and investment in buildings, structures, plant and equipment.

Figure 5. Employment Shares in Australian Built Environment Sector



Source: ABS 8155.

Figure 6. BES Industry shares of output and employment



Source: ABS 8155.

Table 4. Output and employment industry shares of BES total 2007 and 2019

		Property & RE	Professional services	Building services	Manufacturing	Water & waste	Construction
Employment	2007	15.4%	9.6%	8.9%	8.8%	2.9%	53.7%
	2019	15.8%	12.2%	9.1%	6.7%	3.1%	52.5%
IVA	2007	20.47%	10.20%	3.46%	10.33%	5.49%	48.69%
	2019	25.61%	9.15%	3.63%	6.66%	7.22%	46.63%

Industry Comparisons

Across the sixteen industries included in the Australian BES there are significant differences between them in their growth rates of employment and output. Since 2007 employment in Professional services has grown an average of 3.8 percent a year, twice as much as other industries, and since 2014 by over 8 percent a year. Because IVA is in current dollars and not adjusted for price changes, unlike the national accounts data for example, growth rates are in nominal values and appear high. Water and waste and Property and real estate have both increased by over 9 percent a year.

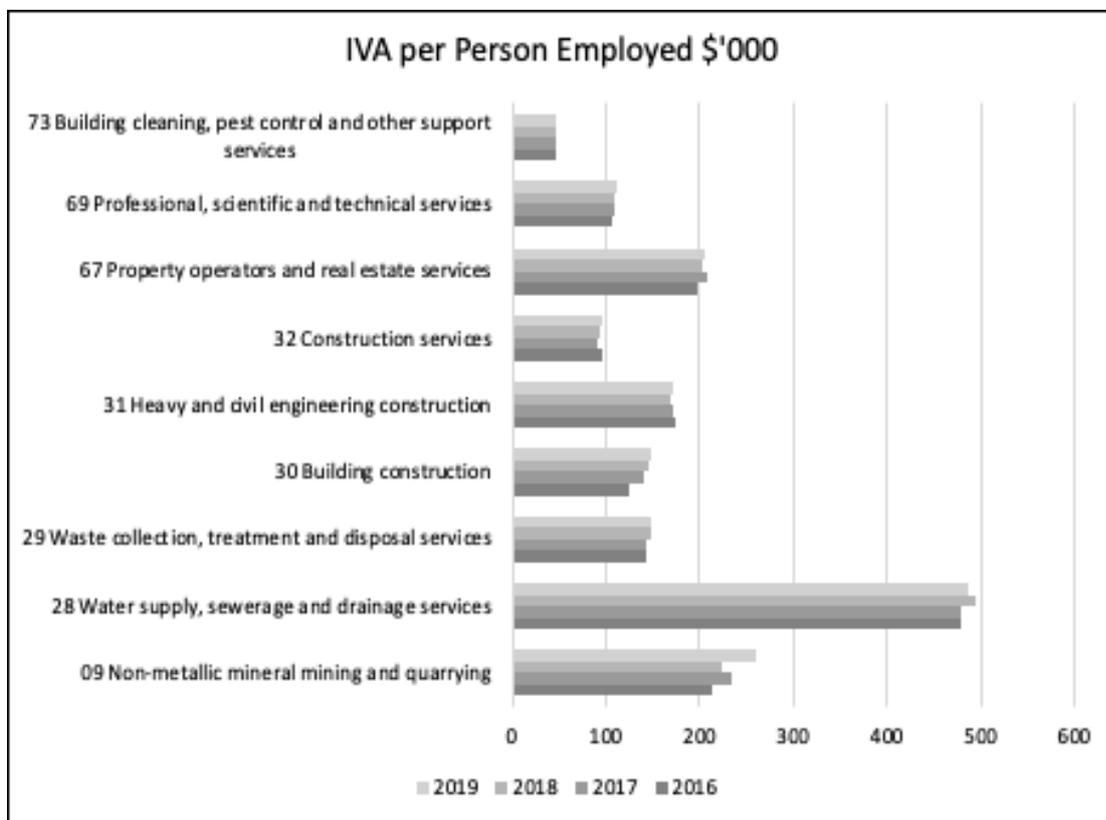
Table 5. Average annual growth rates 2006-07 to 2018-19 and 2014-15 to 2018-19, percent

Industry	Employment 2006-07 to 2018-19	5 year avg 2014-15 to 2018-19	IVA 2006-07 to 2018-19	5 year avg 2014-15 to 2018-19
Water and waste	1.7	1.7	9.7	3.6
Construction	1.1	1.2	5.2	3.4
Property and real estate	1.6	0.9	9.1	5.4
Professional services	3.8	8.2	4.3	2.1
Building services	1.6	2.0	5.3	3.6
Manufacturing	-0.8	0.4	1	3.5
Total BES	1.3	1.8	5.7	3.8

The BES IVA and employment data gives the contribution of the individual industries and the structure of the BES, as shown above. This data can be also be used to reveal other characteristics of these industries and to make comparisons between them, starting with IVA per person employed. Broadly, the stability of IVA per person employed across the BES implies both employment and output have increased at about the same rate, and there is little evidence of substitution of capital for labour through increasing mechanization and automation (Chan 2019).

IVA per person employed reflects the capital structure of an industry, which is the investment required for physical capital like machinery and buildings and intellectual capital like patents and processes. The higher the capital requirements, or capital intensity, of an industry the higher the level of IVA per person employed is expected to be because workers with more capital are more productive. Both excavators and shovels require one operator but the former sifts more soil. That effect is seen across the BES, where services like cleaning and construction trades have the lowest level of IVA per person employed, but also have lower capital requirements than the higher IVA per person employed industries of Water and waste, Property and real estate, Professional services, Engineering and Mining. These industries in Figure 7 are also the high gross fixed capital formation (GFCF) industries in Figures 8 and 9.

Figure 7. Output per person employed. Nine industries.



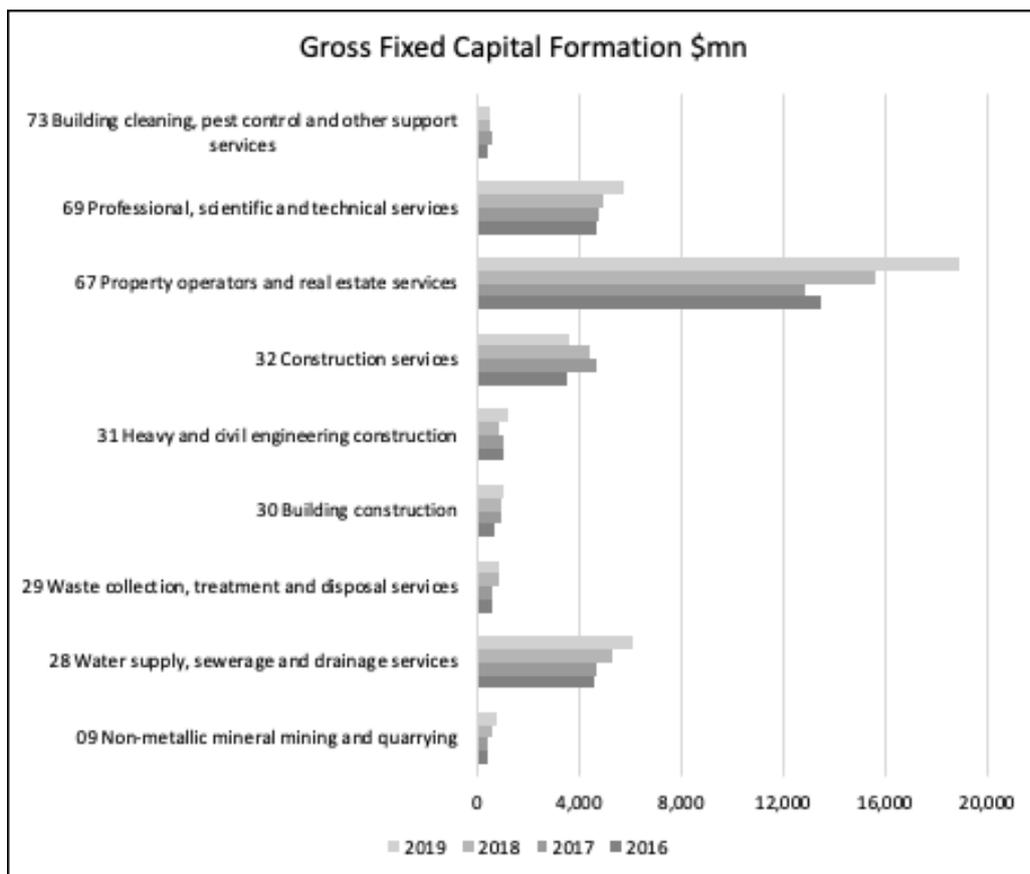
Source: ABS 8155.

As a combination of output and employment IVA per person employed looks like a measure of productivity, but while it is indicative that is not the case. Output is not adjusted for price changes and employment is not given in hours worked in *Australian Industry*, therefore the usefulness of IVA per person employed as a proxy for productivity per person is limited. Although these appear to be similar to the output and input data needed to calculate productivity, indexes of output and input

are used for productivity analysis (ABS 2002). Nevertheless, the small changes seen in Figure 7 reflect the lack of productivity growth many studies have found in construction and related industries (see de Valence and Abbott 2015 for a review).

IVA per employee highlights differences in the capital requirements of industries. Capital expenditure by firms is their purchases of buildings, structures, software and machinery, known as gross fixed capital formation (GFCF). 'Gross' means the expenditure is measured without deducting the consumption of fixed capital through wear and tear caused by its use in production. GFCF has two types of assets, material and intellectual, the latter includes mineral exploration; computer software and databases; and entertainment, literary and artistic originals. In the long run, investment in GFCF determines industry growth rates and their level of labour productivity.

Figure 8. BES GFCF. Nine industries.



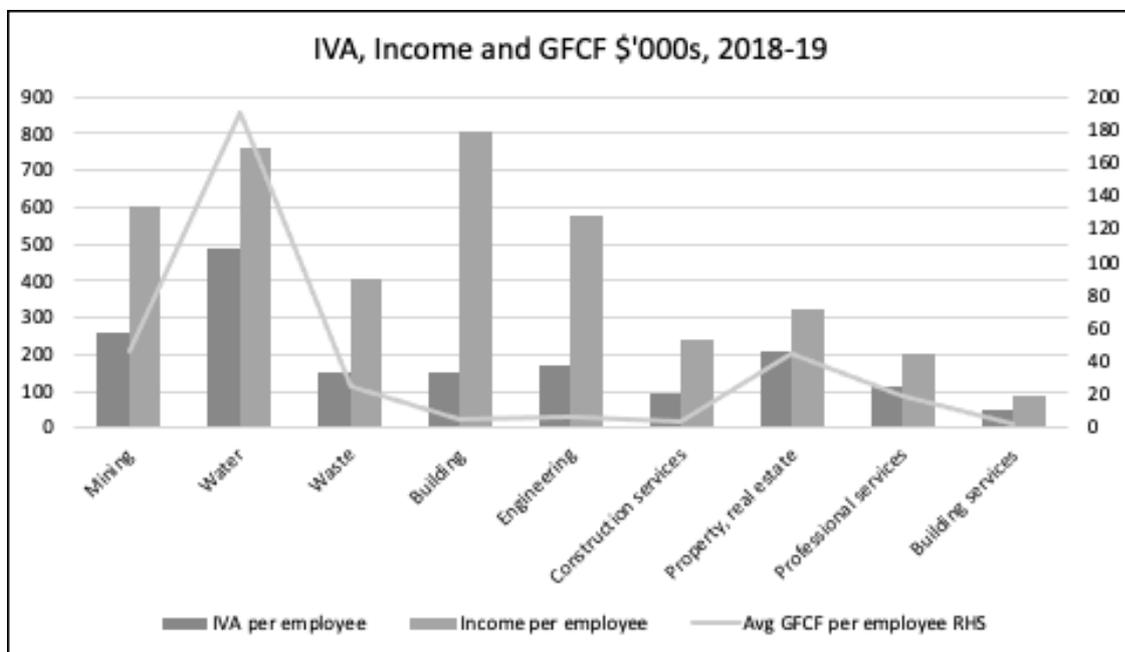
Source: ABS 8155.

Over time, annual GFCF becomes the capital stock of an industry, the quantity of assets used in production, and industries range from labour intensive to capital intensive. Capital intensity is typically measured as the ratio of fixed capital to labour, or of assets to revenue in a company's

accounts. Industries that are capital intensive like cement, water and sewerage, and real estate require large amounts of capital, and therefore high levels of GFCF. In the absence of capital stock data at this level, GFCF is an alternative measure of capital intensity across the BES. However, annual GFCF figures are highly variable, so here a four year average is used. In Figure 9, when this average GFCF per employee between 2015-16 and 2018-19 is compared to IVA per employee there is a close match, industries with high IVA per employee also have high expenditure on GFCF per employee. Water, sewerage and drainage, Property and real estate, and Professional and technical services are the industries with relatively high levels of GFCF.

The three Construction industries all have a low level of GFCF, which typically lease or rent large machinery and equipment. Many Construction services are labour intensive and average GFCF per employee is low because it is spread over many employees. Also, when the value of IVA per employee is compared to income per employee, the Building and Engineering industries convert relatively low shares of their revenue into value added, reflecting a contracting business model based on managing cash flow. At the other extreme, Water and waste and Property and real estate convert around 65 percent of income per employee into IVA.

Figure 9. Industry comparison of IVA, income and GFCF per person employed



Source: ABS 8155.

Economic role of the Australian BES

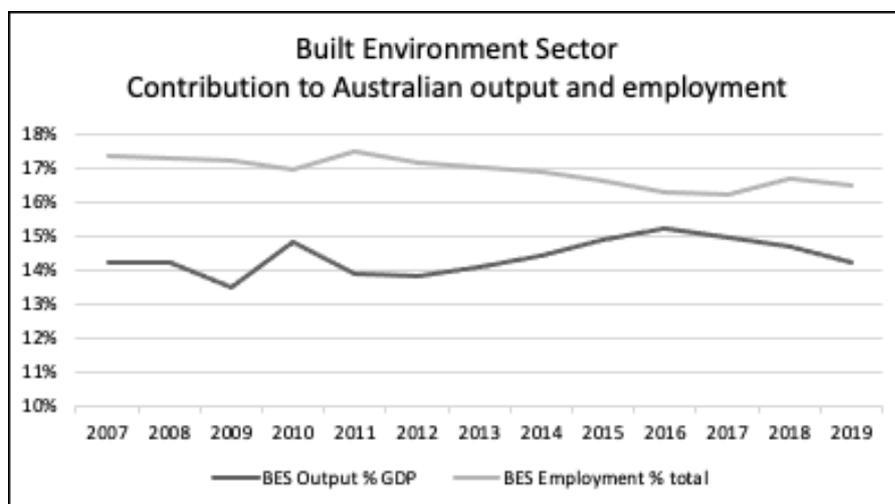
Taking a broad view of an industrial sector provides perspective on its role and significance in economic and technological development. The IVA of the sixteen built environment industries contributed 14.2 percent to Australian GDP in 2018-19, within their long-run range between 14 and 15 percent of GDP since 2006-07. The BES share of total employment fluctuated between 16.5 and 17.5 percent of total employment, reaching a high in 2011 after a major fiscal stimulus during a period of exceptionally high mining investment expenditure.

Table 6. Australian Built Environment Sector: Summary Statistics.

2018-19	Employment	IVA \$bn
Total Australian Built Environment Sector	2,126,000	270
Total Australia Employment and GDP	12,867,000	1,801
BES Percent of Australia total	16.5%	14.2%

Sources: ABS 8155, ABS 5206, ABS 6202.

Figure 10. Economic Role of the Australian Built Environment Sector.



Sources: ABS 8155, ABS 5206, ABS 6202.

Construction has strong demand-pull linkages from other industries but relatively weak supply-push linkages, which means the contribution to total output through the industry's domestic supply chain has an important macroeconomic role. The scale and continuity of the BES contribution to output and employment is a significant component in macroeconomic stability, directly through household incomes and indirectly through aggregate demand. Recognising this, policies to increase building and construction work are a common response to slowdowns in growth during the contraction phase of

the business cycle, and increased infrastructure spending is seen as an effective policy to support demand in the short run while developing assets for the future. The Australian experience managing the global financial crisis after 2007 and the end of the mining boom in 2014 are given below as examples of the importance of the BES to macroeconomic policy.

Fiscal Policy and the Global Financial Crisis

The economic stimulus used by governments during the global financial crisis that started in 2007 followed the Keynesian macroeconomic fiscal policy framework of increased government expenditure. The Australian Government's response to the crisis included a major school building program and a home insulation scheme, as well as large and small infrastructure projects. As the following Figures show, the counter-cyclical timing and impact of the Rudd Government's fiscal stimulus and building program is an example of the effectiveness of policies that engage the entire BES network of firms and organizations.

Separating the BES from the other industries in the ABS data shows the increase in Commonwealth Government spending in 2009-10 on schools, buildings and infrastructure flowed through to the wider economy over the following years. The big increase in spending was concentrated on building work in the 2009-10 and 2010-11 budgets, in Figure 11. With the increase in public building there was a very large increase in the IVA of the built environment industries. The BES IVA increased by 12 percent over 2009-10, at a time when nominal GDP growth was under 2 percent, in Figure 12.

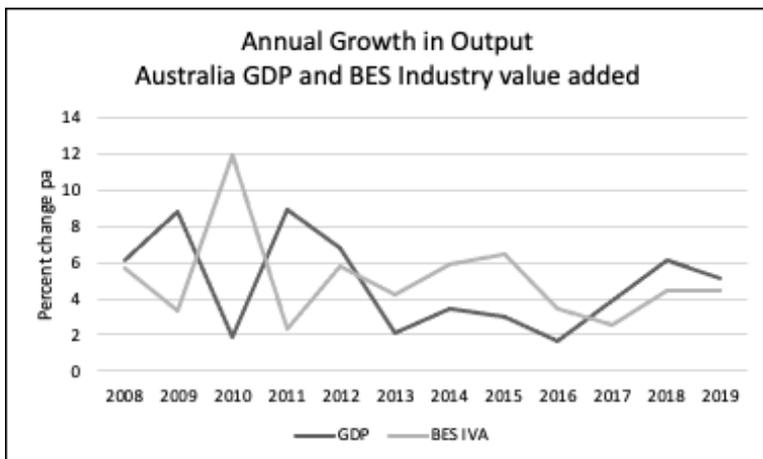
Australia was the only G20 country to avoid a recession during the global financial crisis, and one reason was the increase in Commonwealth construction expenditure, with a fiscal stimulus of five percent of GDP during the crisis. After starting to increase in 2008-09, in 2009-10 Public sector building work done more than doubled to over 1.5 percent of GDP. Australian Government net debt had previously peaked in 1996 at 18 percent of GDP, then fell to zero by 2006, and was back to 12.5 percent of GDP in 2013-14 after the GFC and years of large budget deficits.

Figure 11. Government expenditure on building



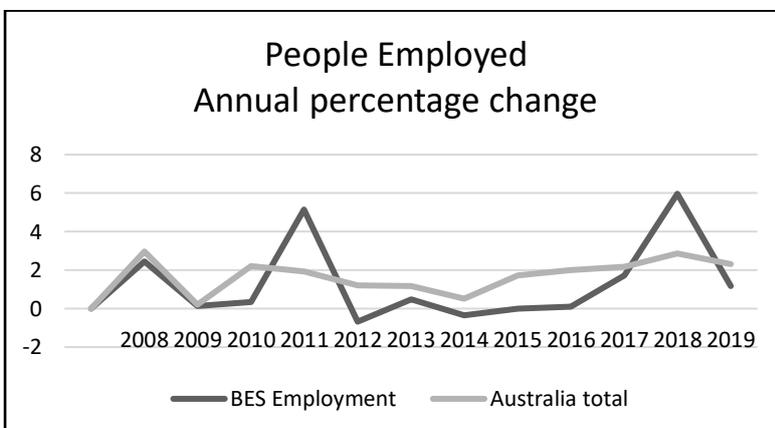
Source: ABS 8752.

Figure 12. Annual percentage change in output



Sources: ABS 8155, ABS 5206

Figure 13. Annual percentage change in people employed

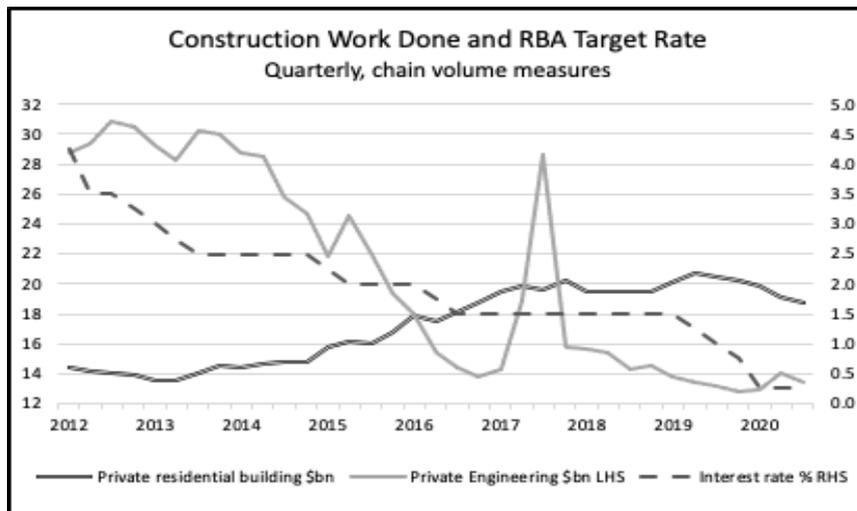


Sources: ABS 8155, 6202.

Monetary Policy and the Transition

Rebalancing the economy after the mining boom ended in 2014 was another major macroeconomic challenge. To support aggregate demand the Reserve Bank of Australia lowered interest rates and encouraged banks to lend for mortgages and property development, see Figure 14. During the subsequent residential boom in apartment building from 2013-18, the BES supported output across the economy as the mining boom ended and engineering construction and business investment fell from 18 percent of GDP to 8 percent. Over that period residential building rose from around 120,000 to over 200,000 commencements a year, due to an increase in high density apartment developments. In 2017-18 BES employment growth peaked around 6 percent, at the top of the residential cycle.

Figure 14. Private Sector Construction and Interest Rates



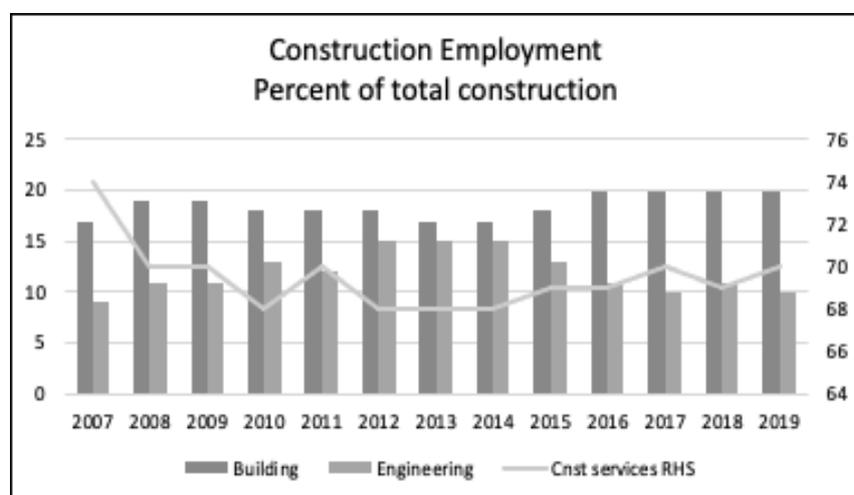
Sources: ABS 8752, 8762, Reserve Bank of Australia.

Australia's mining boom started in the early 2000s, and between 2006-07 and 2013-14 Engineering construction more than doubled its share of Construction IVA, increasing from 12 to 24 percent. Over that period the share of Construction services fell from 67 to 55 percent of total Construction IVA, while Building was around 20 percent. By 2016-17 Engineering had fallen to 16 percent of Construction IVA, Building had increased to 25 percent, and Construction services were 59 percent. The shift from Engineering to Building meant BES IVA was growing around twice as much as GDP between 2003 and 2017, and the strong backward linkages between industries meant the effect on the economy was stronger compared to the mining boom because of the large amounts of imported plant, machinery and equipment included in the Engineering work statistics (included are oil and gas platforms for example).

The BES clearly has a significant role in the economy, as the examples of the effects on BES output and employment of fiscal policy in the global financial crisis and monetary policy in the transition after the mining boom show. In the first case, a very large increase in 2009-10 on Public sector building work saw an increase in BES IVA of 12 percent and employment of 6 percent. In the second case, after 2013 as engineering construction work fell from the highs of the mining boom, interest rates were lowered and the increase in residential building work supported the economy during a difficult macroeconomic transition.

Within Construction, internal dynamics saw significant changes as the IVA shares of the three component industries rose and fell with changes in the composition of Construction output: Construction services between 67 and 53 percent; Building between 20 and 27 percent; and Engineering between 12 and 24 percent of Construction IVA. While those fluctuations in output were occurring there was a shift in employment away from Construction services as Engineering increased, which was reversed after 2014 as Building work increased and Engineering fell.

Figure 15. Industry shares of Construction employment



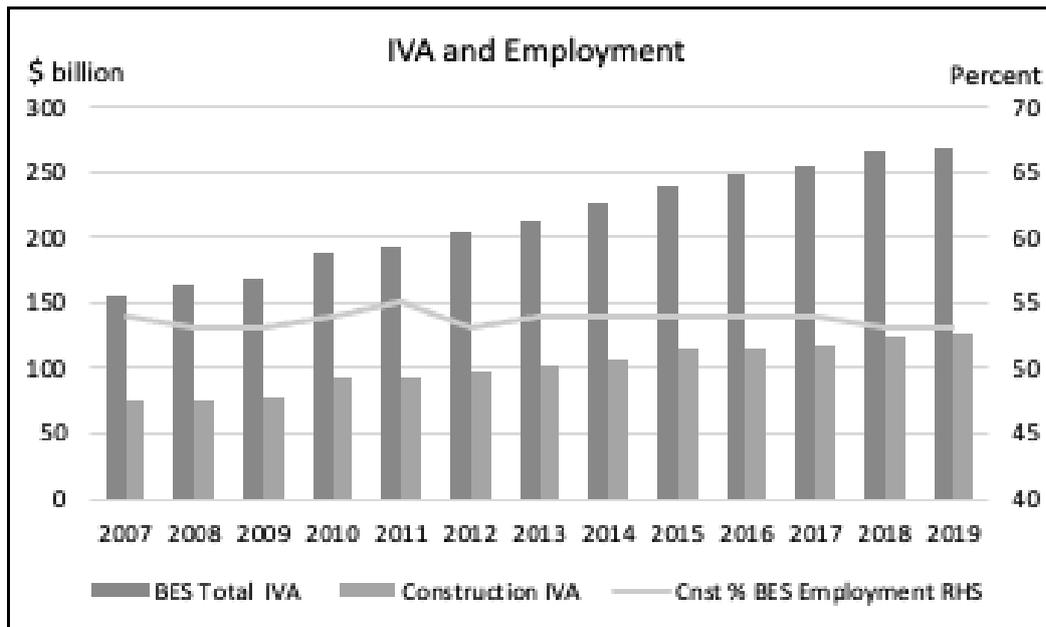
Source: ABS 8155.

Why Measure the BES?

Construction includes three of the 16 industries involved in the production of the built environment. On-site work links suppliers of materials, machinery and equipment, products and components, and all other inputs required to deliver the buildings and structures that make up the built environment.

Consultants provide design, engineering, cost planning and project management services. Once produced, buildings and structures then need to be managed and maintained over their life cycle, work done by another group of related industries. The built environment also needs infrastructure and services like water and waste disposal, provided by yet more industries. As Figure 16 shows, Construction only accounts for around half of the total output and employment of the BES.

Figure 16. BES and Construction IVA and employment



Source: ABS 8155.

A dense network of many different firms and participants such as this is often called an industrial or economic network or sector, because it is too diverse and distributed to be a cluster in the conventional geographic sense. There is no specific definition of an industrial sector, as it is a broad collection of firms with one or more common characteristics, like 'manufacturing' or 'the business sector', though firms in these sectors come from many different industries. This is also the case with the diverse collection of industries involved in constructing and maintaining the built environment.

In a time of rapid urbanisation and great social and environmental challenges, infrastructure, the built environment and city policies have become central issues in public policy. The quality of the built environment the BES delivers is a major determinant of the quality of life. Further, in a fundamental sense, how cities function depends on how well the BES can deliver the projects required, and cities are at the centre of the modern economy. There are many issues affecting the built environment, many of which are wicked problems of great complexity that range widely across

industries, institutions and regulatory systems. How measuring the BES helps is by providing an overview of a value chain, from suppliers to end users, and offering a view, or views, of pathways to future policy goals. It does this by allowing possibilities for deeper integration between participants across the sector.

Taking a sector approach to the built environment allows for a wider perspective on industrial development, which is important when work is project-based. Economies grow by upgrading the products they produce and export, but the technology, capital, institutions, and skills needed to make newer products are more easily adapted from related products with common labour and capital requirements. This network of relatedness between products means industries move through their product space by developing goods and services close to those they currently produce, based on their ability to adapt with new products and services. Under these conditions, the set of options available to a narrow SIC industry are strongly influenced by its position in the product space of the wider sector it contributes to. With digital twins and the wide range of new production technologies currently emerging, such as 3D printing of concrete, automated machinery and buildings made with new materials like engineered wood, the BES is a laboratory for the fourth industrial revolution. Because it is not possible to know now which of these technologies will work at scale, a role of policy as facilitator can be through providing opportunities for new methods of production, organisation and management to be tested and trialled on demonstration projects throughout the industries that contribute to the construction and maintenance of the built environment. Other important parts of the economy such as tourism and defence are described as industrial sectors, although firms in these sectors come from many different industries there is a framework for policies to support industry development and capabilities and maintain a pipeline of projects.

Conclusion

There are sixteen industries with data available from the annual ABS publication *Australian Industry* that can be classified as contributing to the construction, management and maintenance of the built environment. The collective significance of these industries is obscured by their diversity, ranging from architecture to waste disposal, and their geographic distribution. A method to measure the contribution of built environment industries to output and employment using SIC codes has developed by construction economists has been applied to Australia using the data from *Australian Industry*.

Between 2007 and 2019 the Australian BES accounted for 14-15 percent of GDP and 16-17 percent of total employment. It has a significant role in the economy, with examples given of the effects on BES output and employment of fiscal policy in the global financial crisis and monetary policy in the transition after the mining boom. In 2009-10 expenditure on Public sector building work led to an increase in BES IVA of 12 percent and employment of 6 percent. In 2013-14, as engineering construction work fell from the highs of the mining boom, interest rates were lowered and increasing residential building work supported the economy during a difficult macroeconomic transition over the next three years.

The three industries that make up total Construction are the largest component of the BES, but their share has fallen gradually from 49 to 47 percent of total BES IVA. Construction employment, however, has remained at 53 percent of total BES employment. Within Construction the internal dynamics saw significant changes as shares of the three component industries rose and fell with changes in the composition of Construction output. Adapting to these shifts in demand and changes in the type of work, industries across the BES have demonstrated the characteristic flexibility and responsiveness of project-based production.

There has also been a long-run trend in the BES reflecting the increasing share of services in the wider economy. Within BES total output this can be seen in the increased share of Property and real estate services in IVA from 20 percent to 26 percent between 2007 and 2019. BES employment shares of the total have been relatively stable except for Professional services, which had the biggest increase in employment, of 20 percent, and fastest growth, of 8 percent a year in the 5 years to 2019. Since 2007 the share of Manufacturing in BES IVA and employment has fallen from 10 percent to 7 percent, although the nominal value of IVA produced by Manufacturing related industries has had a small increase.

In the same way Manufacturing is not itself an industry, but a collection of industries that make up an industrial sector of the economy where firms have similarities in products and processes, industries that contribute to the construction and maintenance of the built environment can also be collected and their contribution to output and employment measured. The economic role of the BES is important and better data can contribute to economic policy decisions that, through the BES and its dense network of linkages between industries, significantly affect macroeconomic outcomes.

