Employment supported by final demand for construction services

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Office of Economic and Statistical Research
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1 Introduction

The purpose of this paper is to provide a technical overview of a methodology to calculate employment supported by final demand for construction services. While this paper provides a method for estimating the contribution that final demand for construction services makes toward aggregate Queensland employment, it would not be suitable for use in economic impact analysis or in cost benefit analysis.

Deriving model based estimates of the employment supported by final demand for construction services does not necessarily require complex economic modelling. Estimates can be calculated using simple industry-wide (average) employment to output ratios. For example, using the simple employment to output ratio provided in this paper it can be stated that each $1 million of government gross fixed capital formation\(^1\) would likely, on average, support approximately 6.70 full time equivalent (FTE) jobs across the Queensland economy in 2011-12.

While this employment estimate is derived from the latest Queensland input-output (I-O) table (referenced to 1996-97), the methodology for deriving the estimate addresses the long time period between the I-O table’s reference year and the year for which the employment estimate is required.

The derivation of such an estimate requires three key steps:

1. A ratio of average employment supported per $1 million of a specific final demand item is calculated using the latest Queensland I-O table;
2. The employment ratio is extrapolated to bring the estimate forward to the current year, adjusting for price changes since the I-O reference year; and
3. Adjustments are also made to allow for trends in productivity that have occurred in the period since the I-O reference year.

Each step in the derivation process is discussed in turn below.

2 Derivation of an estimate of employment supported by final demand for construction services

2.1 Input-Output Data

A ratio of average employment supported per $1 million of final demand for construction services can be calculated using an I-O table. I-O tables are large data sets that provide detailed information on the structure of industries and the inter-relationships between industries, commodities, final users and suppliers of factor inputs (labour, capital and land) in the economy\(^2\).

I-O tables are constructed from a combination of mechanical methodologies and detailed survey data. As the data collection and preparation process for the I-O accounts is necessarily labour and computationally intensive, I-O tables are often published sometime after the reference year. While the Australian Bureau of Statistics (ABS) produces only national I-O tables, I-O tables for state economies can also be developed\(^3\).

In making use of I-O data, an analyst faces the dilemma of choosing between more recent data and data specific to the region of interest. While the most recent I-O data available in Australia

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\(^1\) Gross fixed capital formation is the value of acquisitions of new and existing produced assets, other than inventories, less the value of disposals of new or existing produced assets, other than inventories.

\(^2\) More information on I-O tables can be found in ABS 5216.0, *Australian National Accounts: Concepts, Sources and Methods*, Chapter 9.

\(^3\) Queensland is the only state to have produced and publicly released an official state level input-output table.
have a reference year of 2006-07, at the time of writing, the most recent Queensland-specific I-O data are for 1996-97.

When attempting to analyse Queensland industries in an I-O framework, a key disadvantage of using Australian I-O data is not necessarily that Queensland industries have significantly different production methods than in the rest of Australia, but that the import-intensity at a state level is likely to be significantly greater than would be found in a national table. In light of this, it is likely that using an employment ratio derived from a national I-O table would significantly overstate the employment associated with an element of final demand in Queensland. Therefore, despite the fact that the Australian table has much more recent data, the Queensland I-O table referenced to 1996-97 is a more suitable data source.

The methodology used to calculate an employment ratio from the Queensland I-O table is provided below

### 2.2 Deriving an employment estimate from an Input-Output table

#### 2.2.1 Structure of an Input-Output table

The I-O table is a system of accounts which shows, in value terms, the supply and disposal of goods and services within the economy in a particular year. Figure 1 provides a diagrammatic representation of the Queensland I-O table from 1996-97.

Along the row of an I-O table is the sales of products to other industries for further processing (intermediate usage) or to the various categories of final demand. The columns of the table show the inputs used in an industry’s production, whether they be intermediate inputs or primary inputs such as labour and capital. The table is balanced such that total inputs into each industry is equal to total outputs from each industry.

As can be seen in Figure 1, quadrant 1 or the intermediate quadrant of the table, incorporating the matrix of industry rows and columns, shows all intermediate (non-final use) transactions. These transactions provide a representation of the interdependence or economic linkages between producing industries or sectors.

Quadrant 2, or the final demand quadrant, records sales of industry output to final demand, that is, the end use of goods and services. The Queensland I-O table shows sales of products to seven final demand categories including household and government consumption, exports and private and public gross fixed capital formation. As such, final demand for construction services is captured in this quadrant.

Quadrant 3, or the primary quadrant, shows payments to the factors of production, such as compensation of employees and gross operating surplus and mixed income, as well as taxes and imported inputs. Quadrant 4 records primary inputs associated with final demand (mainly taxes).

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4 The Direct Allocation Queensland I-O table is used when calculating an employment ratio. An explanation of the difference between the direct allocation and indirect allocation I-O tables can be found in Office of the Government Statistician, “Queensland Input-Output Tables 1996-97.”

5 While the Queensland I-O table has 107 industries, the diagram depicts only five key sectors for brevity.
2.2.2 Deriving an employment to final demand ratio

Using the interlinkages in the I-O table, the contribution any element of final demand makes to total employment can be derived. If derived appropriately, the estimate captures both the direct and indirect employment associated with final demand expenditure, while maintaining the condition that the sum of employment from all final demand components is equal to total employment in the economy.

The method for estimating the direct and indirect employment associated with an element of final demand from an I-O table follows a relatively straightforward mathematical procedure. This is described in detail in ABS 5246.0.

Dividing an estimate of employment by the expenditure on final demand provides a ratio of employment to final demand. This represents the average employment supported by each dollar of final demand expenditure in the reference year of the I-O table.

For example, since government gross fixed capital formation relating to construction is an element of final demand in the I-O table (see previous description) the ratio of employment to final demand expenditure can be used to approximate the contribution the government’s construction expenditure makes to total employment in a given year.

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6 Since employment ratios are estimated from economy-wide data, employment estimates should be considered to be average employment associated with the relevant expenditure component. The contribution to employment made by individual capital projects may vary significantly from the average.
Using the methodology above, the Queensland I-O table suggests that, in 1996-97, each $1 million of government investment expenditure on construction directly and indirectly supported, on average, approximately 13.94 FTE jobs. This estimate includes both the employment directly supported by government construction expenditure as well as employment supported in those industries supplying goods and services to the construction industry. For example, if government final demand supports activity and employment in the construction industry, it will also support some employment in the cement industry since cement is an input into construction.

2.2.3 Scope
The estimate described above has been derived for government gross fixed capital formation relating only to expenditure on residential, non-residential and engineering construction. As such, the estimate should be applied only to expenditure on residential, non-residential and engineering construction and cannot be applied to, for example, land purchases.

While it is theoretically possible to calculate an employment to final demand ratio for any element of construction expenditure, it is not always practical to calculate an employment to final demand ratio for some elements such as plant and equipment. The reason for this is that the majority of plant and equipment are imported from interstate or overseas and so do not directly generate significant employment activity in Queensland.\(^7\)

2.3 I-O estimate adjusted for prices
Any method of estimating Queensland employment related to final demand for construction services based on Queensland I-O data will need to deal with the long time period between the table reference year and the current year. The long lag times mean that the cost of a unit of construction in the current year will be significantly different from that which was occurring in the table’s reference year. Failing to adjust for these price changes would significantly overstate the employment estimate.

A price-adjustment methodology can be developed to inflate prices through to 2009-10 using the 1996-97 Queensland I-O table and ABS data from the National Accounts.\(^8\) Having used historical data to derive estimates for 2009-10, the remaining task is to bridge the time gap between the latest data and 2011-12.

Given the volatility of demand in the construction industry, projecting construction prices forward over the period 2010-11 and 2011-12 is not straightforward. Estimates from ABS 5206.0 indicate that Queensland construction prices increased over the first two quarters of 2010-11 by 1.4 per cent. These estimates formed the basis of the increase projected for 2010-11.

For 2011-12, construction prices are projected using long run average price changes. Construction prices have, on average, increased by 4.0 per cent per annum over the period 1996-97 to 2009-10, and if the estimated increase in prices in 2010-11 is taken into account, the appropriate projection for construction prices in 2011-12 is 3.8 per cent.

As an example, estimates for employment supported per $1 million of government gross fixed capital formation relating to construction, adjusted simply for price movements, are provided in Table 1.

\(^7\) In the case of plant and equipment imported from interstate or overseas, there may be some minor employment impacts in Queensland where they are sourced through a Queensland wholesaler but due to difficulties in measuring these impacts it is recommended that they be excluded.

\(^8\) At the time of writing, the last full year of data available was for 2009-10. Data from the first half of 2010-11 were also available.
### Table 1: Employment ratios for government gross fixed capital formation, adjusted only for price movements

<table>
<thead>
<tr>
<th>Year</th>
<th>Employment per $1 million expenditure</th>
<th>13 year historical average of construction price movements</th>
<th>Projected construction prices movements</th>
<th>Projected employment per $1 million expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FTE jobs %</td>
<td>%</td>
<td>%</td>
<td>FTE jobs</td>
</tr>
<tr>
<td>1996-97</td>
<td>13.94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009-10</td>
<td>8.42</td>
<td>4.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010-11 (p)</td>
<td>1.4</td>
<td>8.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011-12 (p)</td>
<td>3.8</td>
<td>8.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: ABS 5206.0, ABS 8755.0 and OESR.

(p) projection

As shown in Table 1, when historical construction price movements are factored in, FTE employment per $1 million of government gross fixed capital formation relating to construction is adjusted from 13.94 in 1996-97 to 8.42 in 2009-10. After applying projected price movements, the employment ratio adjusts to 8.00 in 2011-12.

### 2.4 Adjusting for productivity

In addition to making adjustments for price changes between 1996-97 and 2011-12, the employment ratio should be adjusted for observed and projected labour productivity changes during the period. As an improvement in labour productivity implies that industry uses less labour per unit of output, estimates of the employment ratio need to be adjusted accordingly.

From observing movements in real construction output and employment, an estimate of average annual productivity growth from 1996-97 to 2009-10 (the last full year for which ABS data are available) can be derived. Any changes in construction industry labour productivity can then be applied to the direct construction employment component of the employment to final demand ratio.

Average annual productivity growth (measured by output per full time equivalent (FTE) job) is calculated by applying a compound growth formula over the years 1996-97 to 2009-10. As the term implies 'output per FTE job' is estimated by dividing the total output in the construction industry by FTE employment.

Output in the Queensland construction industry can be estimated using data produced by the ABS. The ABS currently undertakes a quarterly Building Activity Survey and a quarterly Engineering Construction Survey. The Building Activity Survey collects statistics on new buildings and alterations and additions to existing buildings. Construction activity not defined as building (e.g. construction of roads, bridges, railways and earthworks, etc.) is covered by the Engineering Construction Survey. Estimates from both these surveys provide a near complete quarterly picture of building and construction in Queensland. These data are published in ABS 8752.0 and ABS 8762.0.

One difficulty in measuring construction output is determining the level of private alterations and additions to dwellings. To overcome this difficulty, data are extracted from the ABS Australian National Accounts, National Income, Expenditure and Product (ABS 5206.0) as the ABS makes an adjustment for the under coverage of alterations and additions data reported in the Building Activity Survey. As the ABS National Accounts do not split public investment by type of asset the data for public dwelling construction, non-dwelling construction and engineering construction were extracted from the Building Activity and Engineering Construction Surveys. These data allow the
estimation of a measure of output of the construction industry in Queensland on an annual basis up to 2009-10.

In addition to the above methodology for measuring output, a measure of employment in the construction industry is required. The ABS monthly Labour Force Survey collects data on employment by industry by state in the mid month of each quarter. Data on part-time and full-time persons employed in the construction industry in Queensland are published in ABS 6291.0.55.003.

From the observed movements in real construction output and employment, the growth in labour productivity of the construction industry is estimated to be 0.9 per cent per annum over the period 1996-97 to 2009-10.

Over and above the direct construction impact, the I-O methodology includes indirect purchases by the construction industry from other industries in Queensland. For this indirect component, it is more appropriate to apply a Queensland economy-wide estimate of average annual labour productivity growth from 1996-97 to 2009-10, which is estimated to be 1.8 per cent per annum9.

A weighted average of the direct and indirect productivity growth observed between 1996-97 and 2009-10 (1.2 per cent per annum) has been used to project the employment ratio to 2011-12.

Table 2 is constructed using the same price extrapolation methodology as used in Table 1 and, in addition, the estimates are now adjusted for productivity improvements in the construction industry for the direct component and economy wide for the indirect component of the ratio.

To continue the example used above, estimates for employment supported per $1 million of government gross fixed capital formation adjusted for productivity growth are shown in Table 2. As shown in the table, when productivity movements are accounted for, FTE employment per $1 million of government gross fixed capital expenditure is estimated to be 6.70 in 2011-12.

Table 2: Employment ratios, adjusted for both price and labour productivity changes

<table>
<thead>
<tr>
<th></th>
<th>Employment per $1 million output</th>
<th>Projected construction prices movements</th>
<th>Projected labour productivity movements*</th>
<th>Projected employment per $1 million output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FTE jobs</td>
<td>%</td>
<td>%</td>
<td>FTE jobs</td>
</tr>
<tr>
<td>1996-97</td>
<td>13.94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009-10</td>
<td>7.21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010-11 (p)</td>
<td>1.4</td>
<td>1.2</td>
<td></td>
<td>7.03</td>
</tr>
<tr>
<td>2011-12 (p)</td>
<td>3.8</td>
<td>1.2</td>
<td></td>
<td>6.70</td>
</tr>
</tbody>
</table>

Source: ABS 5206.0, ABS 8755.0 and OESR.
(p) projection
* Weighted sum of construction industry direct component and economy wide productivity indirect component.

9 OESR estimate.
3 Interpreting the estimate

In interpreting the estimate of employment to final demand derived using the methodology described above, a number of considerations and caveats must be taken into account. In relation to the example used above, the estimate for employment supported per $1 million of government gross fixed capital formation relating to construction must be interpreted with the following caveats in mind:

1. Employment estimated from the employment to final demand ratio illustrates the contribution that government gross fixed capital expenditure relating to construction makes toward aggregate Queensland employment in a given year. Alternatively, it is an estimate of the number of jobs that are supported by final demand for construction services. A contribution measure does not include what might be described as induced consumption effects, such as the effects of the income spent in retail and housing industries by workers employed on construction projects, since inclusion of these effects would create an aggregate employment estimate that exceeds total employment in the given year.

2. The estimate of the employment to final demand ratio is not suitable for use in economic impact analysis or in cost benefit analysis.

3. The extent to which government construction expenditure generates additional employment depends significantly on business cycles. For example, in a recession the degree to which public expenditures would crowd out private construction activity would be moderate. Conversely, when the economy is strong and capacity constrains exist, it is likely that increasing public expenditures would simply result in a transfer of labour from private construction projects, with no aggregate increase in overall employment levels in the economy.

4. Employment effects for construction in Queensland are estimated from economy-wide data and so should be considered to be the average employment effects for construction projects. Individual construction projects may vary significantly from this average.

5. The FTE employment ratio of 6.70 jobs per $1 million relates only government gross fixed capital formation relating to construction services in 2011-12. To determine the employment associated with future demand, further adjustments to the employment ratio would be required.

6. The employment estimate only applies to government gross fixed capital expenditure on residential, non-residential and engineering construction. That is, land purchases, capitalised software development and plant and equipment are excluded from any calculation of employment.

When reporting employment:

- The employment impact estimated using the methodology outlined above should be expressed as the average number of FTE jobs supported by $1 million of final demand for construction services, rather than jobs generated; and

- For construction expenditure over multiple years, employment estimates should be either calculated for each year and stated separately, or stated as an average over the number of years. It is not appropriate to sum employment estimates over multiple years. For example, if it was estimated that final demand for construction services supported 6,700 jobs in each year for two years, the employment impact should be stated as “6,700 FTE jobs supported for two years” as opposed to “13,400 FTE jobs supported”.