EMPLOYMENT CHANGE IN MINING AND MANUFACTURING IN AUSTRALIA, 2010/11 – 2015/16: DISSECTING THE SUBNATIONAL PATTERNS AND CONCENTRATIONS

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ABSTRACT: This paper recognises Krugman's (1991) core-periphery model and analyses the reallocation of employment across the Australian metro and non-metro regions over the period 2010/11-2015/16. The differences were interpreted using shift-share analysis and industry-specific location quotients, and patterns of change and concentrations for mining and manufacturing are highlighted, given the significance of these industries during this period. The industry-specific location quotients suggest that there was a shift in relative concentrations of mining and manufacturing industries in non-metropolitan regions. The shift-share results are consistent and suggest that regional specialisation and regional competitiveness are characteristic of employment change in metro regions. In non-metropolitan regions, employment moved in line with the national effect. The causal factors that explain these employment disparities are the subject of on-going research.

KEY WORDS: Regional employment; shift-share analysis; location quotient; mining; manufacturing; Australia

1. INTRODUCTION

Traditional trade theorists have ignored the spatial economy by considering neither trade within countries nor the locations of production (Baldwin, 1992). In response, Krugman (1991) developed the *core-periphery model*, a model of agglomeration that incorporates regional specialisation in the industry systems of cities. Krugman (1991) introduced the Krugman Index to measure the degree to which industry structures

differ between regions. The index takes a value between 0 (for regions with the same industrial structure relative to a benchmark region) and 2 (for regions with an industrial structure that has nothing in common compared to a benchmark region). Industry localisation by region generates knowledge spillovers, labour market pooling and efficient supply chains. Empirical research on regional specialisation of employment has not been limited to the core-periphery model, but also includes other metrics, such as the coefficient of regional specialisation (CRS) and the coefficient of absolute regional specialisation (CARS). Nevertheless, the core-periphery model generated strong interest in empirical work on regional variations in industrial specialisation (Robson, 2009).

In Australia, several empirical studies have explored changes in regional employment and regional specialisation. For instance, Dixon and Freebairn (2009) concluded that regional specialisation decreased due to de-specialisation in manufacturing following substantial tariff reductions over the period 1985-2006. In contrast, Beer and Clower (2009) asserted that deregulation contributed to the growth of some regional cities during 1996-2001. Hicks *et al*. (2014) examined employment specialisation from 2001 to 2006, and observed only weak evidence that employment specialisation occurred, and when it did, regions had a greater level of employment specialisation relative to metropolitan areas.

Two significant changes in the Australian industrial structure subsequent to the above studies have been the mining cycle and the automotive decline from 2010/11 to 2015/16. Australia's mining sector had performed well since the 2000s, and at its peak, between 2011 and 2012, represented approximately 8 per cent of GDP. This prompted the Reserve Bank of Australia (RBA) to assert "This 'mining boom' represents one of the largest shocks to hit the Australian economy in generations" (Downes *et al*., 2014, p.1). The rapid growth in the mining sector generated a positive impact on regional areas by promoting labour demand, investments, intermediate inputs, taxes, royalties and other services. In parallel, the mining boom inflated the Australian dollar by around 40 per cent, thus harming other industries exposed to trade, such as manufacturing and agriculture (Tulip, 2014). After the mining decline, by early 2016, it represented approximately only 4 per cent of GDP (RBA, 2016). With the mining decline, vast changes were expected in regional industry choice and employment.

The period 2010/11-2015/16 also signified a remarkable decline in the automotive industry. Whilst the assistance to the automotive industry introduced in 2008/09 continued into 2010/11, the Productivity

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Commission determined in 2014/15 that ongoing assistance to the industry should be abolished by 2018/19. All Australian-based automotive manufacturers (i.e. Holden, Ford and Toyota) then announced they would cease production in Australia by the end of 2017.

This paper examines the regional employment shifts in capital cities and the 'rest-of-state' regions during 2010/11 and 2015/16, highlighting the mining and manufacturing industries that were significant during this period. Shift-share analysis was used to dissect the change in employment into (i) a national effect, (ii) an industry mix effect and (iii) a competitive effect. The national effect explains how much of the regional industry's growth moves with the overall growth of the national economy, the industry mix effect shows the changes in employment across various industry sectors (regional specialisation), and the competitive effect identifies the changes in employment due to regional competitive advantage (regional competitiveness) (Bailey and Berkeley, 2014; Biderman *et al*., 2016; Wixe and Andersson, 2016). The industry-specific location quotients (LQs) were estimated to measure how the relative concentrations of regional employment shifted (Cruz and Teixeira, 2014; Duvivier *et al*., 2017; Mason *et al*., 2017; Morrissey, 2016). The location quotients offer the static picture of the economy at any given point in time (Kiser, 1992), and the shift-share analysis provides the dynamic picture of changes in an economy over time.

We chose the capital cities and the 'rest-of-state' regions for our analysis for several reasons. First, tracking variations in the industry structure is vital for the state governments because a shift in the regional concentrations of industries may necessitate revisiting state industry policies and changing state assistance programmes. For instance, the suite of policies for the automotive industry included state government-provided subsidies in the form of tax concessions or exemptions, and the provision of land for factory development and employee housing (Beer, 2018). Second, a transformation in the industrial structure requires improved labour mobility, institutions and programmes to teach the necessary skills to participate in new industries, and the identification and facilitation of new markets. Most of these policies fall under the state government jurisdiction. Third, state governments also provide transport, communication, power and other infrastructure to attract and retain industries at specific states / regions and connect them with supply chains and commodity markets; thus, the necessary changes are only possible with an understanding of the regional shifts in the industry shares. In summary,

the patterns will be more visible at a micro-geography level; however, the scale of geography used in this study is policy-relevant as industry policies are developed and implemented at the state level or above.

It is important at the outset to emphasise that shift-share analysis was used here as a standardisation technique to dissect regional employment growth into components. Shift share analysis indexes a regional economy against a reference economy, typically the national economy (Kiser, 1992), and is a measure of the relative shares of the gains or losses of an industry compared with a growth norm. A growth norm is the average growth of a group of comparable regions. For instance, the gains and losses in employment for the sectors of a regional economy are compared with those of the national economy. This is in contrast to the controversial use of this approach for causal explanation of industrial growth changes and growth forecasting (Arcelus, 1984). The questions that shift-share analysis answers in this article are: Is our mix of local industries a rapid or slow growth mix compared to the total mix of Australian industries? Are regions getting an increasing or a decreasing share of each industry?

The paper is structured as follows: section 2 discusses the recent trends in Australia's industrial composition, including the changes in employment in mining and manufacturing industries during the period 2010/11-2015/16. Section 3 describes the methodology and data. The detailed results are presented in Section 4 and are discussed in Section 5. Section 6 concludes the paper with a summary of key findings and policy reflections.

2. RECENT INDUSTRY-SPECIFIC EMPLOYMENT TRENDS AND REGIONAL GROWTH PATTERNS

The industry value added (IVA) estimates showed a strong boom and bust cycle in the mining sector during 2009‑2016 (Figure 1). The boom triggered new growth in demand for services and new investments in the mining and service sectors—see Corden (2012) and Tyers and Walker (2016). Since 2013, mining and carbon taxes constrained the production capabilities of mining companies and the status of China's economy also led to decreasing revenues. Furthermore, the manufacturing industry showed a gradual decline from 2011/12‑2013/14 and stagnation afterwards. The historically high value of the Australian dollar and the country's relatively expensive labour put the automotive industry under competitive pressure from cheaper imports, creating a detrimental effect on the export competitiveness of Australian firms. These factors hindered efforts to address scale issues through the expansion of production for

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export, ultimately resulting in diseconomies of scale in the automotive industry. The other two largest industries, 'Construction' and 'Professional, scientific and technical services', were steady, with increasing value contributions to GDP (Figure 1).
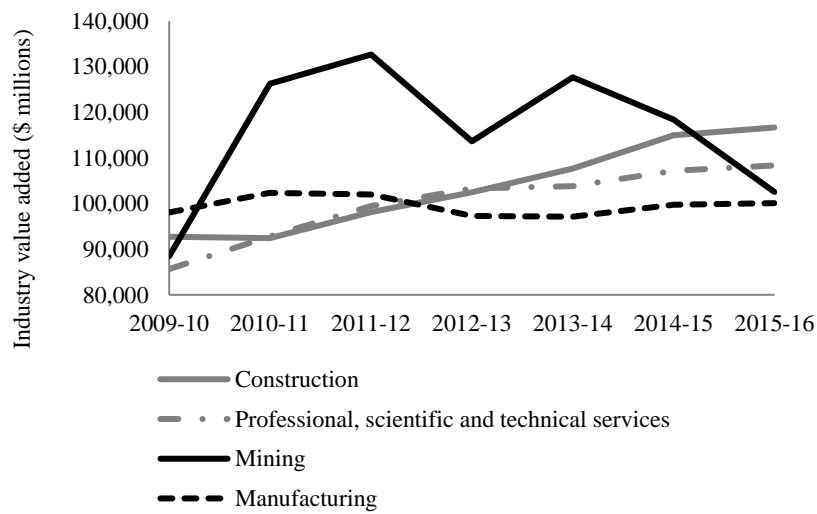
Figure 1. Industry Value Added to GDP, 2009/10‑2015/16. Source: ABS cat. no. 8155.0 - Australian Industry.

Figure 2 shows the economic performance of regions from 2010/11 to 2015/16, measured by real gross income. As a measure of real purchasing power of income generated by production within a region, real gross income is calculated by adjusting the chain volume measure of gross state product (GSP) for changes in the terms of trade. The largest decreases were recorded for Western Australia and Queensland. Notably, the pattern of real gross income of Western Australia during this period is synonymous (albeit with low-intensity) with that of the mining IVA shown in Figure 1. The real gross income of South Australia was also sluggish from 2011; by contrast, New South Wales and Victoria recorded steady growth in their respective economies.
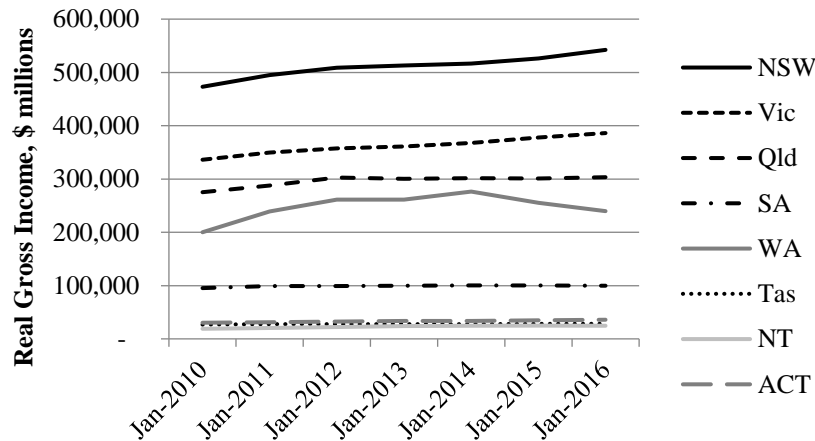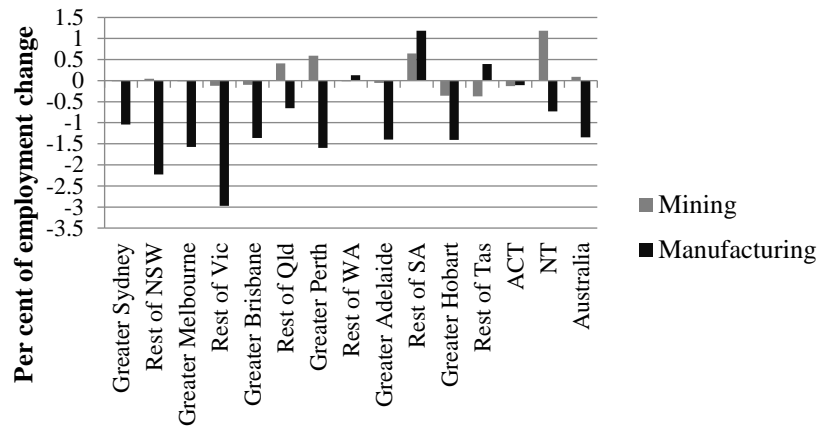
Figure 2. Real Gross Income: Chain Volume Measures, Australian
States, 2010–2016. Source: Australian National Accounts: State Accounts, Cat. No. 5220.0.
Notes: Region abbreviations: NSW – New South Wales; Vic – Victoria; Qld – Queensland; WA –
Western Australia; SA – South Australia; Tas – Tasmania; ACT – Australian Capital Territory; NT –
Northern Territory.

Diverse regional economic growth patterns are indicative of shifting
industry-specific employment in Australian cities and regions. Figure 3
shows the contributions of mining and manufacturing industries to the
employment change in regions between 2010/11 and 2015/16. Despite the
marked decline in the mining industry at the national level by 2015/16, the
core mining-resourced regions Rest of Qld, Greater Perth, Rest of SA, and
NT added more employment from 2010/11 to 2015/16. According to
Connolly and Orsmond (2011), the same states recorded the highest shares
of mining within the respective state outputs (Western Australia – 27%,
Northern Territory – 21%, Queensland – 10% and South Australia – 4%).
The states with a large mining resource base were thus more resilient to
industry shocks. By contrast, the manufacturing sector declined in most of
the regions during this period. Regions that had had a dominant automotive
presence (e.g. Rest of Vic and Greater Melbourne) contributed to the
greatest declines (Figure 3). Against that general trend, Rest of SA and
Rest of Tas reported gains in manufacturing employment.

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Figure 3. Regional Employment Change in Mining and Manufacturing,
2010/11−2015/16. Source: ABS (2017b). Notes: The classification of regions in Figure 3 (and
the analysis that follows) is slightly different from that used in Figure 2 due to different data sources.
Region abbreviations: NSW – New South Wales; Vic – Victoria; Qld – Queensland; WA – Western
Australia; SA – South Australia; Tas – Tasmania; ACT – Australian Capital Territory; NT – Northern
Territory.

3. METHODOLOGY

Deconstructing Employment Growth

There are several Australian scholarly articles (Plummer *et al*., 2014;
Robson, 2011; Stimson, 2011; Stimson *et al*., 2018) and research reports
(Bureau of Transport and Regional Economics (BTRE), 2004a, 2004b)
using shift-share analysis to capture the regional shift component as a
measure of competitive advantage in their assessments of regional industry
employment performance. For instance, the recent work by Stimson *et al*.
(2018) used the regional (differential) component of employment obtained
from a shift-share analysis as the dependent variable in their analysis. The
study concluded that the regional shift itself shows some spatial
dependence and divergence (not convergence), and unevenness of shifts
being the rule across regions during 2001-2011. The findings of Robson
(2011) indicated that most of the negative regional shift effect in Sydney
and positive regional shift effect in Brisbane over the period were
attributable to the manufacturing industry. Bureau of Transport and

Regional Economics (BTRE) (2004a) found that some strongly performing regions were more specialised in rapidly growing industry sectors such as mining during 1996-2001.

Shift-share analysis was used here to dissect the employment variation at the regional scale to illustrate differences in the patterns of employment growth from 2010/11 to 2015/16. Shift-share analysis measures the degree to which some structural characteristics (i.e., industrial structure) account for differences (i.e., rates of growth) between categories of an overall population (i.e., regions) (Fothergill and Gudgin, 1979). In doing so, it disaggregates regional employment change in an industry to identify the components of that change. This particularly involves emphasising the part of regional growth or decline in an industry that is region-specific. The regional shift component is intended to provide a measure of the relative performance of the region in a particular industry. A positive shift is then associated with the comparative locational advantage of the region for that industry and vice versa (Stevens and Moore, 1980). We followed Arcelus's (1984) use of national employment as the point of reference for the estimation of change in regional growth but not the use of shift-share analysis as a tool for causal explanation of industrial/productivity growth (see section 1).

Shift-share analysis divides the employment variation between two periods into components that can be linked to national circumstances (national effect), regional emphasis on fast-growing sectors (industry mix effect) and regional competitiveness (competitive effect). The methodology implemented by Franklin (2014) to estimate the three effects was preferred, due to incorporation of the extensions proposed by Arcelus (1984), providing further specifics of employment change. Using this technique, the industry-level employment variation in regions over a period was compared against a benchmark region: the nation.

The method dissected the variation of employment between two periods into three effects:

$$\Delta E_i^r = N_i^r + M_i^r + C_i^r \tag{1}$$

The national effect (N_i^r) captures the growth of industry i's employment in region r that would have been expected if it grew at the same rate as the nation. The industry mix effect (M_i^r) isolates the employment change in industry i that is attributable to region r's specialisation in industries that are growing at a faster rate at the national level. The competitive effect

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(C_i^r) measures the contribution of specific characteristics of region r to overall employment change.

According to Arcelus (1984), the competitive effect comprises two components: overall employment increase at the region level and the actual competitive portion that would be the effect of regional level industries growing at a faster rate compared with national level industries:

$$C_i^r = R_i^r + RM_i^r \tag{2}$$

where R_i^r is a regional effect measuring growth due to overall employment growth at the regional level, and RM_i^r is a regional industry mix effect measuring growth in employment in an industry due to industry growth rates at both the national and regional levels.

A further extension suggested by Arcelus (1984) subdivides each effect in equation (1) into two sub-effects. The 'expected' component represents the increase in employment that would have been generated if the region and nation had a similar employment composition. The 'regional specialisation' component represents the change attributable to the region's deviation from the nation.

The estimation of a regional industry's 'homothetic employment' (HE_i^r) is required to accomplish this subdivision, and this represents region r's hypothetical employment in industry i if both the region's and the nation's employment structure (i.e., sectoral composition) are the same. The homothetic employment is calculated as follows:

$$HE_i^r = E^r * \frac{E_i^n}{E^n} \tag{3}$$

where E^r is the total regional employment, E_i^n is the industry i's national employment, and E^n is the national aggregate employment—all representing the first period.

Then, the shift-share components are represented as follows:

$$N_i^r = HE_i^r * E^n + (E_i^r - HE_i^r) * e^n \tag{4}$$

$$M_i^r = HE_i^r * (E_i^n - E^n) + (E_i^r - HE_i^r) * (E_i^n - E^n) \tag{5}$$

$$C_i^r = HE_i^r * (E_i^r - E_i^n) + (E_i^r - HE_i^r) * (E_i^r - E_i^n) \tag{6}$$

where E_i^r is region r's employment in industry i in 2010/11, e^n is the national employment growth rate between 2010/11 and 2015/16, and all other notations are as previously defined. Notably, in each equation, the first part is the 'expected' portion and the second part is the 'regional specialisation' portion for each effect (as mentioned previously).

The R_i^r and RM_i^r components within C_i^r [equation (2)] are calculated as follows:

$$R_i^r = HE_i^r * (e^r - e^n) + (E_i^r - HE_i^r) * (e^r - e^n) \tag{7}$$

$$RM_i^r = HE_i^r * [(e_i^r - e^r) - (e_i^n - e^n)] + (E_i^r - HE_i^r) * [(e_i^r - e^r) - (e_i^n - e^n)] \tag{8}$$

where e^r is the regional employment growth rate between 2010/11 and 2015/16, e_i^r is region r's employment growth rate in industry i between 2010/11 and 2015/16, e_i^n is the national growth rate in industry i's employment between 2010/11 and 2015/16, and all other notations are as previously defined.

Tracking the Industry Concentrations of Regions

To evaluate the industry concentrations of regions, the location quotients (LQs) for the mining and manufacturing industries in 2010/11 and 2015/16 (i.e. pre- and post-economic transformations) were estimated. According to the economic base theory, an industry with higher production multipliers than other industries indicates that expansion of its production is more beneficial to the economy in terms of inducing productive activities (Morrissey, 2016). Based on economic base theory, LQs compare the concentration of employment in a particular industry in a region with its national share to provide information on the relative specialisation of a region in a given industry.

The location quotient for industry i in region r was calculated as follows, using the same notations as above:

$$LQ_i^r = \frac{\left(\frac{E_i^r}{E^r}\right)}{\left(\frac{E_i^n}{E^n}\right)} \tag{9}$$

An LQ greater than 1 indicates that a region has proportionately more people employed in a specific industry sector compared with the national

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figure. A higher location quotient thus indicates a particular region has a specialisation in a specific industry.

4. DATA

The dataset was sourced from the Australian Labour Force Survey (LFS), available from the Australian Bureau of Statistics (ABS). The LFS covers the period from Q4 1984 to Q1 2017 (reported in February, May, August and November each year), and includes employed persons classified by industry division (ANZSIC) in each Greater Capital City and Rest of State region (ABS, 2017b). Given the focus of this paper on recent employment changes, particularly those associated with the mining cycle and the manufacturing decline, only data from 2010/11 to 2015/16 were analysed. To eliminate the impact of short-term shocks on the analysis, employment numbers for each reporting year were calculated as an average across the relevant four quarters. For instance, employment in the mining industry in the period 2010/11 was the average of employment in this sector in Q3 and Q4 of 2010 and Q1 and Q2 of 2011. The regions covered were all the state capital cities, namely Greater Sydney, Greater Melbourne, Greater Brisbane, Greater Perth, Greater Adelaide and Greater Hobart, and other regions, including the Australian Capital Territory, the Northern Territory, Rest of New South Wales, Rest of Victoria, Rest of Queensland, Rest of Western Australia, Rest of South Australia and Rest of Tasmania. Figure 4 shows the locations of these regions within Australia.
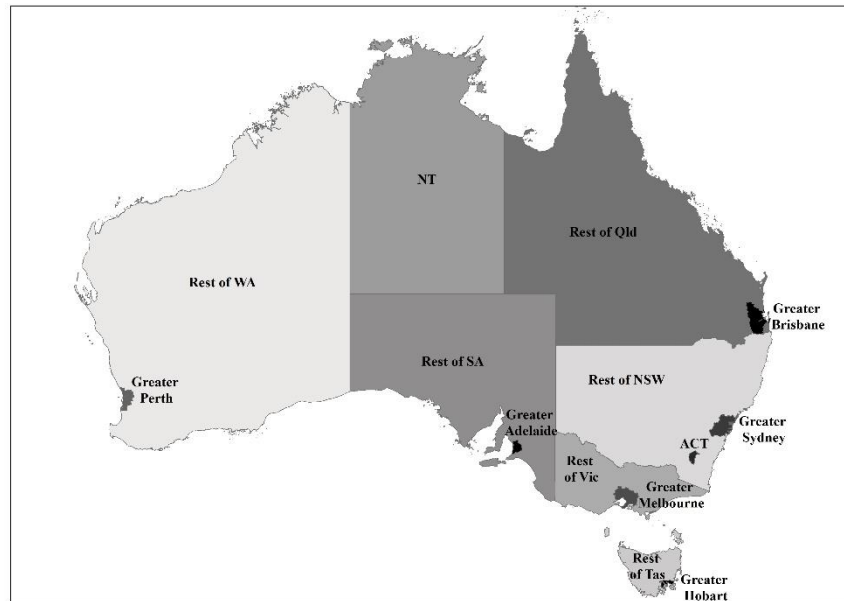
Figure 4. Capital Cities and Regions of Australia. Source: Based on ABS 2011 digital boundaries, the ABS digital boundaries for Greater Capital City Statistical Areas and States have been combined to produce the relevant geographies for the LFS data. Note: Greater city areas are metropolitan capital cities of states. Region abbreviations: NSW – New South Wales; Vic – Victoria; Qld – Queensland; WA – Western Australia; SA – South Australia; Tas – Tasmania; ACT – Australian Capital Territory; NT – Northern Territory.

5. PATTERNS OF REGIONAL EMPLOYMENT CHANGE AND THE SHIFTING INDUSTRIAL CONCENTRATIONS

As discussed in section 2, Australian industries saw significant structural changes from 2010/11 to 2015/16, particularly the changing contributions of mining and manufacturing industries to the economy and related employment changes. Shift-share analysis was used to break down these industry contributions and growth tendencies in the economy at national and regional levels (see section 3). The findings reported in this section discuss the patterns of industry-specific employment change in Australian regions.

The analysis began by examining the 'homothetic employment' in 2010/11, that is, the employment a region would have in each industry if its distribution was the same as the nation's. This analysis can indicate the input made to each effect from a region's specialisation in specific industries, namely industry-level deviations from the national norm. As

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discussed in section 2, the mining and manufacturing industries underwent substantial changes over the study period. A cross-comparison of regional differences between homothetic and actual employment for mining and manufacturing industries reveals the regions specialising in these industries (Figure 5).
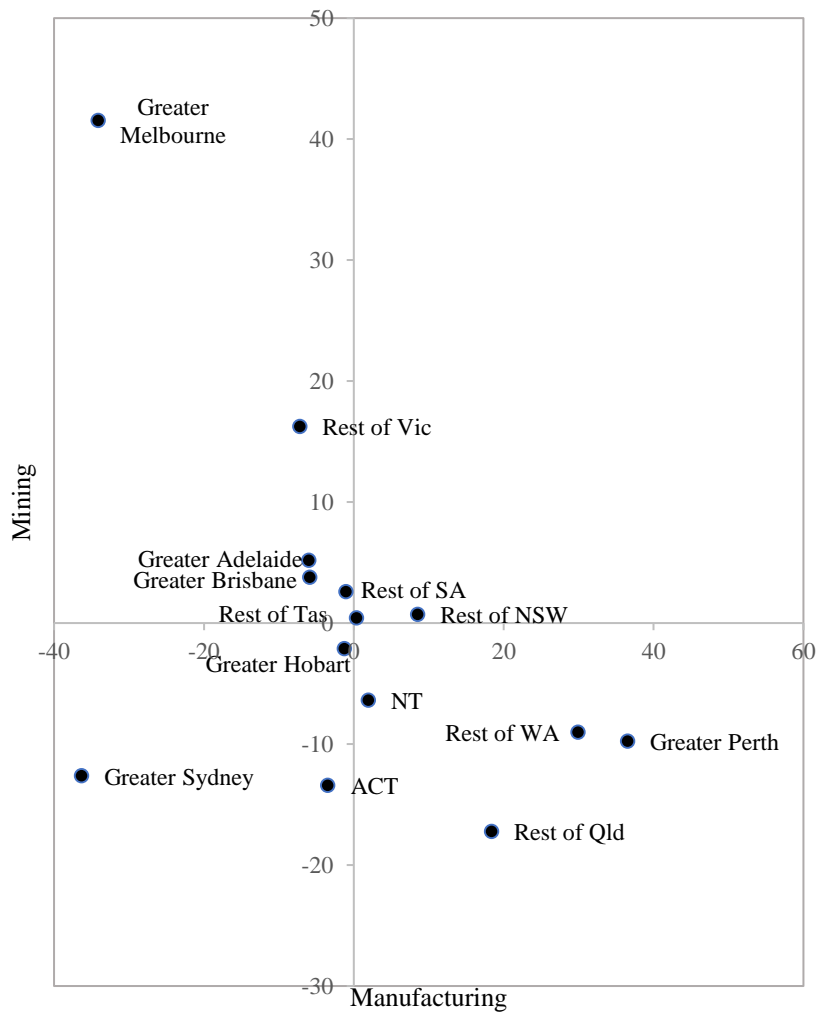
Figure 5. Cross-Comparison of Regional Differences Between Homothetic and Actual Employment ('000), Mining and Manufacturing, 2010/11. Source: the Authors.

The mining and manufacturing sectors showed two clear patterns across regions: an over-representation of manufacturing and an under-representation of mining (Greater Melbourne, Rest of Vic, Greater Adelaide, Greater Brisbane and Rest of SA) and an over-representation of mining and an under-representation of manufacturing (Rest of Qld, Greater Perth, Rest of WA and Northern Territory). The former pattern was associated with the active automotive industry, particularly in Victoria and South Australia, whereas the latter is related to the dominant share of mining in Queensland and WA. Rest of NSW and Rest of Tas had a slightly higher share of mining and manufacturing than they would if their employment distribution had been the same as the nation as a whole. Greater Sydney and the ACT were notable as regions with an under-representation of both industries. The homothetic employment thus highlights the regions that were specialising in the mining and manufacturing sectors across the nation in 2010/11.

Industry-Level Shift-Share Results

Shift-share analysis dissected the aggregate variation in each region's employment in an industry over a period, expressed as a deviation from the national average, into its component parts. To that end, it utilised the homothetic employment and the difference between actual and homothetic employment to estimate the portion of employment variation that would have accrued to the region for each effect if its employment structure had been the same as the nation's ('expected effects'), and the increase in employment it realised by specialising in specific industries, compared with the nation ('regional specialisation').

Table 1 presents the results of the shift-share analysis for mining and manufacturing industries, using the regions with the highest initial employment in 2010/11 in mining (Greater Perth and Rest of Qld) and manufacturing (Greater Melbourne and Greater Sydney). In the analysis, each effect comprises the expected and specialisation components, and the competitive effect contains regional and regional industry mix effects (see section 3 for details).

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Table 1. Industry-Level Shift-Share Results, 2010/11‑2015/16.

			Mining		Manufacturing	
			Greater Perth	Rest of Qld	Greater Melbourne	Greater Sydney
Shift-share component						
National effect		Expected	1 204	1 431	12 926	13 894
		Specialisation	2 521	1 266	2 865	-871
		Total	**3 725**	**2 697**	15 791	13 023
Industry mix effect		Expected	933	1 108	-30,946	-33 265
		Specialisation	1 952	981	-6 860	2 085
		Total	2 885	2 089	**-37 806**	**-31 180**
Competitive effect (Regional effect + Regional industry mix effect)	Regional effect	Expected	-1 204	-1 431	-12 926	-13 894
		Specialisation	-2 521	-1 266	-2 865	871
		Total	-3 725	-2 697	**-15 791**	**-13 023**
	Regional industry mix effect	Expected	3 036	2 234	16 745	24 970
		Specialisation	6 354	1 977	3 712	-1 565
		Total	**9 390**	**4 211**	20 456	23 405
Total employment change			**12 275**	**6 300**	**-17 350**	**-7 775**

Source: the Authors

   Total national effect was positive for each industry in each region because national effect measures the potential growth that can be ascribed to national employment growth. The specialisation component within the national effect was either positive or negative, depending on whether the region's proportion of employment in a specific industry was greater or less than the same proportion at the national level. The expected and specialisation elements could be positive or negative for the industry mix effect, the regional effect and the regional industry mix effect, depending on the employment composition in the region and the nation.

   During the period 2010/11‑2015/16, the mining industry's employment in Greater Perth increased substantially (Table 1). This employment growth can be explained by Greater Perth's specialisation in mining growing at a faster rate at the regional level (regional industry mix effect), and the national growth of employment in general (national effect). Notably, Rest of Qld presented the same effects in terms of employment change in mining, an indication the respective regional industrial structures and national growth trends boosted employment in that industry. The

significant regional industry mix effect confirms that both regions had a competitive advantage in mining. Additionally, both the 'expected' and 'specialisation' components had the same direction (i.e., either positive or negative) as the total for each effect, an indication that the deviation of a region's employment structure from the nation and a region's unique specialisations compounded to generate a certain total effect.

According to Table 1, the decline in employment between 2010/11 and 2015/16 in the manufacturing industry in Greater Melbourne is mostly explained by that region's specialisation in industries declining at the national level (industry mix effect). The manufacturing decline was also partly due to the decreasing overall employment in that region (regional effect). Yet again, Greater Sydney's decline in manufacturing employment was also associated with the industry mix effect and regional effect. Comparing the 'expected' and 'specialisation' components for each effect, any positive (negative) effect of the deviation of the industry structure of Greater Melbourne from the nation was accompanied by a positive (negative) effect from regional specialisations in that region. For Greater Sydney, the 'expected' and 'specialisation' components had the opposite effects on total employment.

Region-Level Shift-Share Results

The national effect was also positive for each region because the nation as a whole gained employment during the period covered in the study (Table 2). Furthermore, national employment growth in certain industries increased employment in Greater Sydney and Greater Perth (notably mining-related employment), due to their specialisation in those industries. However, some regions, particularly Rest of Vic and Rest of NSW, experienced a decrease in employment due to specialisation in industries deteriorating at national level.

Generally, the regions that experienced greater employment growth tended to have positive competitive effects, and the regions with less growth, or a decline (e.g., as seen in Greater Hobart), had negative competitive effects. A positive competitive effect indicates that regional industries are outperforming their national level counterparts. Based on this indicator, the competitiveness of Greater Sydney, Greater Melbourne and Greater Perth seemed to be associated with an increase in employment from 2010/11‑2015/16. Notably, a majority of metropolitan city regions (i.e. Greater Sydney, Greater Melbourne, Greater Perth, and Greater Brisbane) experienced regional industry mix effect, that is, their employment growth

was primarily attributable to the faster industry growth at the specific-region level compared with the national level.

Table 2. Shift-Share Results, Regions of Australia, 2010/11–2015/16.

	National effect	Industry mix effect	Competitive effect		Regional industry mix effect	Total employment change
			Competitive effect (Regional effect + Regional industry mix effect)	Regional effect		
Greater Sydney	159,140	9,720	58,090	-159,140	217,230	226,950
Greater Melbourne	148,050	-153	32,753	-148,050	180,803	180,650
Greater Brisbane	76,283	1,919	-777	-76,283	75,506	77,425
Greater Adelaide	43,421	1,539	-42,685	-43,421	736	2,275
Greater Perth	66,009	5,774	34,568	-66,009	100,576	106,350
Greater Hobart	7,229	828	-8,132	-7,229	-903	-75
Rest of NSW	81,638	-5,380	-7,408	-81,638	74,230	68,850
Rest of Vic	44,614	-9,168	-15,047	-44,614	29,568	20,400
Rest of Qld	78,415	-1,406	-33,533	-78,415	44,881	43,475
Rest of SA	11,937	-3,765	-6,197	-11,937	5,740	1,975
Rest of WA	18,197	-2,453	5,481	-18,197	23,678	21,225
Rest of Tas	9,185	-1,287	-6,348	-9,185	2,837	1,550
Northern Territory	8,329	974	3,047	-8,329	11,376	12,350
Australian Capital Territory	14,270	2,883	-13,819	-14,270	450	3,333

Source: the Authors.

The specific effects for each region indicate that a region's increase in employment is explained by a combination of effects. The national effect is associated with employment growth across regions but a key contributor to employment growth in Rest of NSW, Rest of Vic, Rest of Qld, Rest of SA and Rest of Tas. This result suggests employment growth in a number of 'rest of city' regions moved closely with national employment growth.
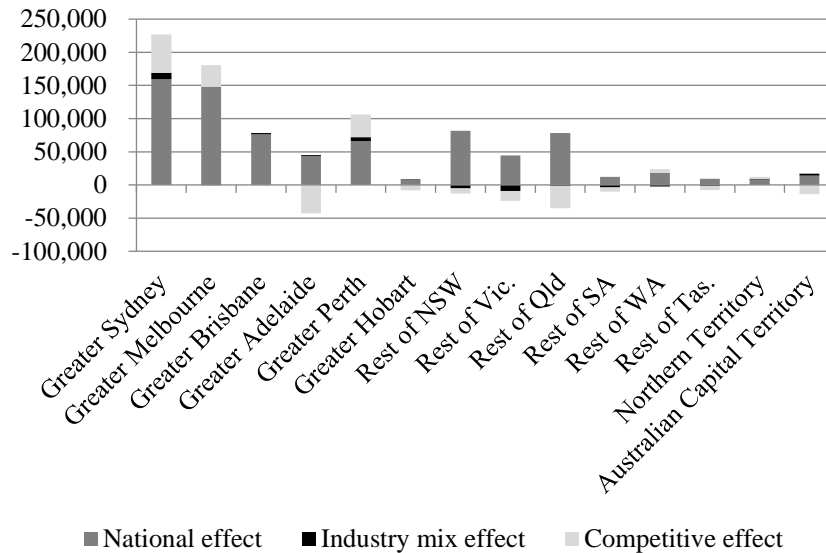
Figure 6. Shift-Share Component Contributions to Employment Change, Regions of Australia, 2010/11‑2015/16. Source: the Authors.

Yet, metropolitan city regions in Australia showed a mix of effects. First, the competitive effect was strongly related to the employment growth in Greater Sydney, Greater Melbourne and Greater Perth. Specifically, these regions were observed to have more people employed in the industries that were growing at a faster rate than the nation (Figure 6). Notably, however, the same competitive effect was linked to a decline in employment in other regions (e.g. Greater Adelaide, Rest of Qld and Rest of Vic). Second, the measure of regional specialisation (i.e., industry mix) showed a sizeable positive effect on employment in Greater Sydney, Greater Perth and the ACT. The same regional specialisation showed a negative effect on employment in Rest of Vic, Rest of NSW and Rest of SA. These results collectively highlight the significant patterns of regional competitiveness and specialisation in metro regions and an important national effect in non-metro regions.

The Shifting Industrial Concentrations

The estimated LQs illustrate that the intensity of relative concentrations of regional mining and manufacturing industries fluctuated between

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2010/11 and 2015/16 (Table 3); however, regions with a specialisation in either mining or manufacturing generally remained specialised in those industries during the period. As such, Rest of WA, Greater Perth, Rest of Qld, Northern Territory and Rest of NSW specialised in mining, while Rest of Vic, Greater Melbourne, Rest of SA, Greater Adelaide, Greater Brisbane and Rest of Tas specialised in manufacturing during the period. A notable feature of regions that specialised in mining was the higher intensity of concentration: seven-fold (Rest of WA) and three-fold (Greater Perth) deviations from the national share of employment in mining.

Table 3. Location Quotients for Mining and Manufacturing Industries, 2010/11 and 2015/16.

Region	Mining		Manufacturing	
	2010/11	2015/16	2010/11	2015/16
Greater Sydney	0.14	0.12	0.94	0.97
Greater Melbourne	0.13	0.11	**1.22**	**1.23**
Greater Brisbane	0.71	0.62	**1.04**	**1.04**
Greater Adelaide	0.48	0.43	**1.09**	**1.10**
Greater Perth	**3.09**	**3.26**	0.88	0.83
Greater Hobart	0.31	0.12	0.77	0.72
Rest of NSW	**1.39**	**1.35**	**1.01**	0.89
Rest of Vic	0.39	0.31	**1.29**	**1.12**
Rest of Qld	**1.88**	**2.01**	0.83	0.89
Rest of SA	0.66	0.97	**1.17**	**1.55**
Rest of WA	**7.20**	**6.87**	0.61	0.74
Rest of Tas	**1.15**	0.90	**1.04**	**1.28**
Northern Territory	**1.86**	**2.40**	0.40	0.37
Australian Capital Territory	0.08	0.00	0.26	0.29

Source: the Authors.

As an exception to this general trend, the employment share in certain regions with borderline specialisations in both mining and manufacturing in 2010/11 was by 2015/16 below the national share; thus, by 2015/16, Rest of Tas and Rest of NSW no longer specialised in mining and

manufacturing, respectively. Overall, the mining cycle and the decline of the manufacturing industry were associated with shifts in relative concentrations of mining and manufacturing employment, particularly in non-metropolitan regions.

6. DISCUSSION

As reported in section 5, a number of regions showed negative industry mix effects, that is, a loss of employment because they specialised in nationally declining industries (e.g. manufacturing). In addition, Greater Hobart showed a negative regional industry mix effect as a result of employment decline attributable to the decline of specific industries at the region level. These results may reflect historical oversights in federal and state government policies regarding the type of industries to be assisted in specific regions.

Prior to the tariff and non-tariff reforms of 2006, the automotive industry received widespread support from the government. Eventually, Australia had four foreign-owned assemblers and approximately 200 firms supplying components, with factories mainly in Victoria and Adelaide. However, the competitiveness waned with the removal of tariffs and non-tariff barriers, affecting regional specialisation and employment. Removal of tariffs tends to incentivise specialisation where comparative advantages exist, and our findings indicate that one region specialising in mining and another in manufacturing lost their *specialisation status* between 2010/11 and 2015/16. It is suggested that perhaps some of the industries that specialised in mining and manufacturing in the first place did so in part due to the assistance they received from the tariffs. This evidence is consistent with (Krugman, 2009), who suggested that the elimination of trade barriers creates a tendency for greater specialisation in regions where comparative advantages exist (Dixon and Freebairn, 2009). Thus, the specialisation potential of regions with comparative advantages should be facilitated. Hicks *et al*. (2014) suggest a greater level of *absolute specialisation* in regions would be required to achieve a greater effect on reducing regional unemployment.

Traditionally, industries based on natural endowments help explain the differences across states and territories; notably, the manner in which states and territories develop acquired endowments to absorb new industries may differ, because the accumulation of acquired endowments may depend on the level of human and physical capital, and human capital varies amongst states and territories. For instance, the ABS (2017a) revealed that a higher

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percentage of people had a bachelor's degree or higher qualification in Australia's capital cities (30%) compared with regional areas (16%), and 7 per cent in capital cities and 3 per cent outside capital cities had postgraduate qualifications. The gap in physical capital between cities and regional areas also varied, reflected in the higher stock of physical capital per worker in cities. Disparities such as the land-locked nature, sea access, transport networks and employment densities that produce production externalities may also explain the differences across states and territories to some extent.

Regional differences in employment may also reflect different regulatory frameworks. Various regulations in states and territories, such as payroll taxes, wage setting, dispute resolution processes, environmental laws and other bureaucratic and legislative requirements, are important determinants of firm location and employment creation. Overall, the regional/city governments' role in nurturing the type of industries in which that specific regions specialise is paramount in facilitating growth.

The growth of the mining sector may have far reaching consequences for other industries and non-mining regions, due to spillovers in the form of labour demand, investments, intermediate inputs, equity holders, tax payments and royalties. Resource-rich states such as Western Australia, Queensland and the Northern Territory, representing approximately 60 per cent of mining resources in the country, reflected far better economic indicators (e.g., state output and population growth) during the resource boom relative to other states (Connolly and Orsmond, 2011). However, despite higher concentrations of mining resources in those states, the distribution of mining income is more dispersed across the nation, an indication that mining decline may affect the industries across the nation. This contrasts with the *Dutch disease hypothesis*, which argues that the mining boom could be detrimental to other sectors (especially manufacturing) by raising non-tradable wages and domestic exchange rates. If mining declines, there may be a restructuring of industries because of emerging new comparative advantages and vast changes in industry choice, regional employment and overall economic growth may be expected. Any assistance package should thus consider these cross-industry spillovers.

7. CONCLUSIONS

Australian industrial structure experienced significant changes between 2010/11 and 2015/16, including the mining cycle and the decline of the automotive industry. This paper examined these key industry dynamics and associated employment patterns for Australian regions by combining shift-share analysis and location quotient (LQ) analysis.

The *homothetic employment* estimates confirmed that Greater Melbourne, Rest of Vic, Greater Adelaide, Greater Brisbane and Rest of SA specialised in manufacturing, a factor that is associated with a decrease in employment in Greater Melbourne during the mining decline. The manufacturing decline was also associated with the decreasing overall employment in this region (regional effect). The homothetic employment estimates also confirmed Rest of Qld, Greater Perth, Rest of WA and Northern Territory specialised in mining. As highlighted by shift-share analysis, this specialisation attributed to the growth of employment in Greater Perth and Rest of Qld. The national growth of employment in general (national effect) also contributed to employment growth in mining.

Regional specialisation was generally associated with positive employment outcomes in metro regions but not in non-metro regions. The regional shift-share analysis revealed that competitiveness was key to potential employment growth in most metro areas (e.g. Greater Sydney, Greater Perth and Greater Melbourne), suggesting that faster industry growth at the specific region level and unique regional characteristics in those areas increased employment. In contrast, non-metropolitan areas showed negative effects on employment from non-competitiveness. In summary, significant positive effects from regional specialisation and competitiveness were observed in Australia's metro regions, strongly indicating the resilience of metro regions to national industry shifts. In contrast, a notable national effect was apparent for the 'rest of city' regions. Economic events—mining cycle and the decline of the automotive industry—were observed to be related to regional employment in different ways.

LQs revealed that most regions with a higher concentration of mining or manufacturing remained 'specialised' in those industries over the study period. However, there was a shift in the relative concentrations of mining and manufacturing industries in non-metropolitan regions; some non-metropolitan regions reporting a marginally higher share of employment in an industry, compared with the nation in 2010/11, lost their specialisation status (i.e. Rest of Tas in mining and Rest of NSW in

manufacturing). Both shift-share and LQ analyses provided consistent results and suggest mining and manufacturing employment in non-metro areas was affected the most by the mining cycle and manufacturing decline.

At least two directions for future research are in order. First, the potential role of the causal factors in explaining these employment disparities is the subject of on-going research. Second, though the scale of geography used in this analysis is policy-relevant as industry policies are developed / implemented at the state level or above, a future micro-geography level analysis can demonstrate the patterns of change at a more fine-grained level.

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