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Preface

The 41st Annual Conference of the Australian and New Zealand Regional Science Association International (ANZRSAI) was held at the University of Southern Queensland, Toowoomba from 6 to 8 December, 2017, co-hosted with the Institute for Resilient Regions. A broad range of papers from academics, policy advisors and practitioners was presented to the conference. This publication contains the refereed proceedings of those contributed papers.

Participants who submitted their full paper by the due date were eligible to be considered for these refereed proceedings. There were thirteen papers submitted to a double blind refereeing process, all of which were accepted for presentation in this publication. One paper was subsequently withdrawn. As in previous conferences, I am very grateful to referees for their work within a short timeframe.

Three awards were presented at the conference dinner. The John Dickinson Memorial Award for best article in the *Australasian Journal of Regional Science* 2017 was awarded to Peter Fairbrother (RMIT University) for his article "When Politics Meets Economic Complexity: Doing Things Differently in the Gippsland Region, Australia" published in volume 23(3), pp. 400-420.

The ANZRSAI Award for Best Conference Paper 2017 was awarded to Robert J. Stimson, Michael Flanagan, William Mitchell, Tung-Kai Shyy and Scott Baum for their paper "Modelling Endogenous Employment Performance across Australia's Functional Economic Regions over the Decade 2001 to 2011". This paper is the first paper presented in these proceedings.

The ANZRSAI Award for Best Conference Paper by a Current or Recent Student 2017 was awarded to Omoniyi Alimi for his paper co-authored with David Maré, Jacques Poot and Les Oxley "How Does Immigration Impact on Metropolitan and Non-Metropolitan Income Distributions? Some New Zealand Findings". The committee highly commended two other entrants for this Award: Armand Djoumessi Mouafo, Shiu-Ling Chen and Stephen Cahoon for their paper "Innovation in Non-metropolitan Regions: A Review of the Literature"; and Zillur Rahman, Yogi Vidyattama, Delwar Akbar and John Rolfe for their paper "The Impact of Location Factors on Housing Price Variation in Melbourne: A Case Study of Western Melbourne Metropolitan Region".

I thank all the participants for their involvement in our 41st Annual Conference, particularly those who had travelled some distance from overseas to attend. The international community of regional science scholars is strengthened when people gather to share their research and expertise at conferences such as this.

Professor Paul Dalziel
Editor, 41st Annual ANZRSAI Conference Proceedings

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Modelling Endogenous Employment Performance across Australia's Functional Economic Regions over the Decade 2001 to 2011

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ABSTRACT

Patterns of spatial differentiation in endogenous regional employment performance across Australia's Functional Regions over the decade 2001 to 2011 are mapped and analysed. A range of spatial econometric models taking account of the spatial autocorrelation issue are used to investigate the factors which might explain that variation in performance, using the same approach as in previous studies of decadal inter-census periods. Implications for regional development policy are canvassed.

1. INTRODUCTION

Modelling regional economic performance has long been a concern of regional scientists. In recent times, there has been considerable emphasis on focusing on *endogenous growth* (see, for example, Stimson, Stough and Roberts, 2006; Johansson, Karlsson and Stough, 2001; Stimson, Stough and Nijkamp, 2011; Stimson and Stough with Salazar, 2009) providing a framework for measuring and modelling spatial variation in endogenous regional economic performance over time.

The modelling approach requires:

a) specification of a *dependent* variable that measures how change in economic performance over time (both growth and decline) might be attributable to factors and processes that are endogenous to the region; and

b) deciding on a set of *independent* variables that might provide explanation for the variation across regions in the incidence of that dependent variable, which is achieved using spatial econometric modelling.

That approach proposed by Stimson et al. (2009) has been adopted in several studies investigating the *endogenous* economic performance of regions across Australia over successive inter-census decadal periods (see Stimson, 2012; Stimson, Robson and Shyy, 2009a; 2009b; 2011; Stimson, Mitchell, Rohde and Shyy, 2011), and it is continued in this paper for the decade 2001-2011. It has also been used in the paper by Plummer, Tonts and Martinus (2014). Importantly, in the research undertaken by the authors reported here, *functional* regions

rather than *de jure* regions are used as the spatial base for the modelling as this has been shown to largely overcome the issue of spatial autocorrelation that is inherent in spatial econometric modelling based on using the latter as the spatial base for regional demarcation.

The modelling reported in this paper employs a framework in which:

a) the spatial base is 134 *Functional Economic Regions* (FERs) across both the capital city metropolitan regions and the non-metropolitan regions of Australia that have been derived by the authors (and reported in Stimson, Mitchell, Flanagan, Baum and Shyy, 2016);

b) the *dependent variable*, measuring endogenous regional employment performance, is the regional (or differential) component derived from a shift-share analysis of employment change over the decade 2001-2011; and

c) the *independent (explanatory) variables* that potentially might explain variation in the dependent variable, are a set of 27 measures derived from census data that relate to factors and processes that regional scientists have been suggesting might influence endogenous regional performance, plus five locational variables.

The paper is structured as follows. The next section briefly reviews past approaches to research investigating regional economic performance in Australia. That is followed by an outline of the data and methodology used in the analysis. Next, the spatial patterns of endogenous regional performance - the dependent variable - over the decade 2001-2011 are mapped and described. The bulk of the paper then presents the results of the spatial econometric modelling performed to identify those factors that might explain the variations in endogenous regional employment performance across Australia's FERs. Finally, there is a brief discussion of the policy implications of the model findings.

2. OVERVIEW OF APPROACHES TO RESEARCH INTO REGIONAL PERFORMANCE IN AUSTRALIA

Since the 1970s Australia has undergone as series of significant structural economic transitions, and the impacts of those shifts have not been homogeneous over space, and there is considerable variation in the economic performance of regions across Australia, both within the major large metropolitan cities and beyond, into regional Australia.

Stimson (2012) has provided a detailed review of research investigating regional economic performance in Australia, most of which has been based on using *de jure* regions - such as Local Government Areas or Statistical Local Areas (SLAs), or aggregations of them - as the spatial unit of analysis, and not on using *functional* regions.

The nature of those economic and social 'divides', as they were emerging in the decade or so up to the late 1990s, were discussed in the book by O'Connor, Stimson and Daly (2001) on Australia's changing economic geography. Divides have also been identified in other studies (such as Baum, Stimson, O'Connor, Mullins and Davis, 1999; Baum, O'Connor and Stimson, 2006). Spatial mismatches were shown to be evident in regional shares of population and population change and in shares of investment in economic activity.

The O'Connor, et al. (2001) study raised a series of challenging implications for people-based and for place-based policy responses in addressing those spatial disparities, especially the infrastructure needs of those segments and places in the space economy that are significant contributors to national wealth and competitiveness to enhance their performance.

Stimson (2012: p. 162) pointed out that:

> … Understanding the dynamics underlying the spatial differences that exist in the economic development and performance of Australia's regions is a complex task.

Regional research studies conducted over the last two to three decades had identified a range of factors influencing patterns of regional development and performance for specific periods of time. But:

> … the specific conclusions reached and the relationships identified are not necessarily consistent because of the different focus of the studies and their different methodologies, variations in the spatial units of analysis used, and the different time periods that are analysed (p. 162).

Stimson pointed out that many studies have investigated:

> … regional differentials in, and inter-relationships between, regional population size and growth, employment changes, structural shifts in industry employment, income levels, resource endowments, and the locational characteristics of regions (p. 162),

along with aspects of human capital. Among other things, they had shown that a region's industry structure, its occupation mix, and its human capital structure are affected not only by the size of the region's economy and its resource endowments, but also by its level of remoteness in the context of the nation's settlement system.

Some examples of such regional research include the following:

- work by the Commonwealth Government's Bureau of Transport and Regional Economics (2004a; 2004b) has modelled relationships between regional shifts in industry structure diversification/specialisation, structural change in employment, unemployment, human capital, and the size of regional economies;
- research by Trendle and Shorney (2003) investigated the relationship between regional industry diversity and unemployment in the State of Queensland;
- studies by Bradley and Gans (1998) and Hogan, Berry and Thorpe (1999) focused on analysing increasing regional industrial diversity;
- a study by Garnaut, Connell, Lindsay and Rodriguez (2001) investigated regional influences on employment and population growth;
- studies by Harrison (1997) and Garnett and Lewis (2000) focused on relationships between regional education participation rates and qualifications, migration, and labour markets;
- a study by the National Centre for Social and Economic Modelling (Lloyd, Harding and Hellwig, 2000) investigated the 'hollowing out' of income across regions; and
- a study by Plummer, et al. (2014) investigated uneven development and local competitiveness across Western Australia's regional cities.

However, as Stimson (2012) has noted, relatively few studies have:

> …incorporated an explicit focus on the nature of occupational structure, occupational status, and education qualifications and skills, all of which are important components in the consideration of human capital differentials in regional development and performance (p. 162).

Much of the published research on regional performance has tended to focus on modelling variation in aggregate employment change or the incidence of unemployment, and on the level of income. And some of the research on differentials in regional performance has been restricted to measuring and modelling an aspect of patterns of economic performance within Australia's capital city metropolitan regions or within a specific city, while other research has been focused specifically on the nation's non-metropolitan regions.

A variety of methodologies have been used to investigate aspects of regional economic performance in Australia, but predominately the preferred approach has been to use a multiple regression model, most typically an Ordinary Least Squares (OLS) model, and sometimes also a backward step-wise regression model.

Modelling approaches other than straight regression analysis also have been used in research investigating regional performance in Australia. Examples include the following:

- using a binomial logit model in a cross-sectional study investigating the relationship between education, skills and qualifications and the economic performance of the five mainland States of Australia (Lawson and Dwyer, 2002);
- using Principal Components Analysis (PCA) to model regional variations in human capital (Stimson, Baum, Mangan, van Gellecum, Shyy and Yigitcanlar, 2004);
- developing typologies of community opportunity and vulnerability and using Multi-Discriminant Analysis (MDA) to describe the characteristics of the categories in those typologies, as in the study by Baum, Stimson, O'Connor, Mullins and Davis (1999) and Baum, O'Connor and Stimson (2006);
- developing typologies to produce functional classifications of regional cities and towns across Australia and showing how those have evolved over time (Beer, 1999; Beer and Maude, 1995); and
- using Shift-Share Analysis and the national shift component of employment change by industry sector to shed light on the proposition that an explanation of differences in regional employment growth was that some strongly performing regions are more specialized in rapidly growing industry sectors - like mining - across the Australian Bureau of Statistics Labour Market Regions over the period 1996-2001 (Bureau of Transport and Regional Economics, 2004a; 2004b).

To take account of the spatial autocorrelation problem that is inherent in using aggregated spatial data, especially where it is based on *de jure* regions, it is important for modelling to use a *spatial dependence test*, along with a *multicollinearity test*, and to employ a *Spatial Error Model (SEM)* and a *Spatial Autoregressive (SAR) Model*, which was the approach used by Stimson et al. (2011) in their study of variations in endogenous regional employment performance of FERs over the decade 1996-2006, and it is the approach used in this paper.

There have also been attempts to forecast the growth of regions into the future (Adams, 2002; Beer, 2002) looking at the effects of:

(i) national shifts in employment on regional growth;
(ii) initial industry structure on regional growth;
(iii) industrial diversity; and
(iv) the level of education, skills and qualifications.

It is only during the last decade that regional research in Australia has specifically focused on measuring and modelling *endogenous* regional performance, initiated by Stimson, Robson and Shyy (2004; 2005; 2006), and used also by Plummer, at al. (2014).

It is worth noting that, while traditionally it has been common for economists to theorize about regional convergence occurring over time in phenomena such as income, it is very clear from the empirical research investigating regional economic performance across Australia that, rather than regional convergence occurring, there appears to be divergence with a considerable degree of unevenness of performance being the rule across regions.

3. DATA AND METHODOLOGY

The analysis of *endogenous regional employment performance* across Australia over the decade 2001-2011 reported in this paper follows the methodology used by Stimson et al. (2011) in the previous analysis for the decade 1996-2006.

3.1 Spatial Units

The spatial unit of analysis used are *Functional Economic Regions* (FERs) that have been compiled by the authors as reported by Stimson, Mitchell, Flanagan, Baum and Shyy (2016) using the Intramax procedure developed by Masser and Brown (1975). The building blocks for the FERs are the Australian Bureau of Statistics' Statistical Areas Level 2 (SA2s). It uses the 2011 census journey-to-work data to analyse commuting patterns with FERs being demarcated to maximise within-region coincidence between where people live and where they work. The advantage of using FERs is that they tend to overcome, or at least minimise, the *spatial autocorrelation* problem encountered in the use of *de jure* regions (such as Local Government Areas), as has been demonstrated in the Stimson et al. (2011) paper.

It is worth noting that the method used to demarcate the FERs was *not* constrained by restricting them to be fall within State and Territory borders, as is the case with the Australian Bureau of Statistics Labour Market Regions. That means some FERs cross over the state border between New South Wales and Victoria, along the eastern part of the border between New South Wales and Queensland, and along some of the border between Victoria and South Australia.

Within and around the capital city metropolitan city regions there are multiple FERs: 10 across the Sydney-Newcastle-Wollongong conurbation; seven across the Melbourne-Geelong region; six across the Brisbane-South East Queensland region that extends north to the Sunshine Coast and south to the Gold Coast; four across the greater Perth region; but only two across the greater Adelaide region. That reflects the emergence over time of a multi-centre spatial structure for Australia's big cities and the regionalisation of metropolitan labour markets.

Beyond the metropolitan city regions, the FERs tend to become much larger as the degree of remoteness and sparsity of settlement (and thus remoteness) increases, and they are often elongated in shape along the main roads, which is not surprising.

3.2 Model Variables

Following the framework proposed by Stimson et al. (2009), the modelling approach here uses as the *dependent variable* a surrogate measure of endogenous regional employment performance over time, which is measured as the differential (or regional) component derived from a Shift-Share Analysis of regional employment change over the decade 2001-2011, standardised by the size of the regional labour force at the beginning of the period.

The *independent (or explanatory) variables* used to investigate potential factors that might explain the variation in regional performance on the dependent variable is the same set of 32 variables used in the previous studies cited above, 27 of which are derived from census data, and five of which are explicit locational variables (see Table 1).

3.3 Modelling Approaches

As was done in the Stimson et al. (2011) analysis for the decade 1996-2006, a range of models are applied to investigate those potential causes of the spatial variation in endogenous regional employment performance over the decade 2001-2011:

- First, an *OLS full model* was run without allowing for spatial effects. *Spatial dependence tests* were then run, including the *Lagrange Multiplier (LM) tests*, and the *Moran's I test*

was run on residuals (see Anselin, Bera, Florax and Yoon, 1996); Anselin, 1998). A *multicollinearity test* was also run.

Table 1: The Variables Used to Model Change in Endogenous Regional Employment Change over the Decade 2001-2011 across Australia's Functional Economic Regions

Dependent Variable

REG_SHIFT: Regional Shift component of a Shift-Share Analysis of Employment change (2001 to 2011)/Labour Force (2001)/1000

Independent Variables

Derived from census data
SPEC_01: Specialisation Index for 2001 (Herfindahl-Hirschman Index)
SPEC_CH: Change in Specialisation Index from 2001 to 2011 (Herfindahl-Hirschman Index)
SCI: Structural Change Index (2001 to 2011)
SCI_CH: Change in the Structural Change Index (from 2001-2006 to 2006-2011)
L_INC_01: Median Individual Income – 2001 Annual (Log) (real)
L_INC_CH: Change in Median Individual Income – 2001 to 2011 Annual (Log) (real)
UNEMP_01: Unemployment rate in 2001
UNEMP_CH: Change in Unemployment rate from 2001 to 2011
L_POP_01: Log of population (2001)
L_POP_CH: Change in Log of population (2001 to 2011)
LQ_MAN_01: Location Quotient for the Manufacturing Industry in 2001
LQ_INF_01: Location Quotient for the Information media & telecommunications Industry in 2001
LQ_FIN_01: Location Quotient for the Financial & insurance services Industry in 2001
LQ_PRO_01: Location Quotient for the Professional, scientific & technical services Industry in 2001
LQ_MAN_CH: Change in the Location Quotient for the Manufacturing Industry, 2001 to 2011
LQ_INF_CH: Change in the Location Quotient for the Information media & telecommunications Industry, 2001 to 2011
LQ_FIN_CH: Change in the Location Quotient for the Financial & insurance services Industry, 2001 to 2011
LQ_PRO_CH: Change in the Location Quotient for the Professional, scientific & technical services Industry, 2001 to 2011
POSTGRAD_01: Proportion of labour force with a Postgraduate Degree or higher in 2001
BACHELOR_01: Proportion of labour force with a Bachelor Degree or higher in 2001
TECHQUALS_01: Proportion of labour force with technical qualifications in 2001
POSTGRAD_CH: Change in the Proportion of labour force with a postgraduate degree or higher, from 2001 to 2011
BACHELOR_CH: Change in the Proportion of labour force with a bachelor degree or higher, from 2001 to 2011
TECHQUALS_CH: Change in the Proportion of labour force with technical qualifications, from 2001 to 2011
SYMBA_01: Proportion of Symbolic Analysts (Managers + Professionals) in Employment in 2001
SYMBA_CH: Change in the proportion of Symbolic Analysts (Managers + Professionals) in Employment from 2001 to 2011
VOLUNTEER_11: Proportion of Volunteers in Working Age Population (15–64) in 2011

Locational Variables
A_COAST: Border is adjacent to coastline (No = 0; Yes = 1)
P_METRO: Border is adjacent to metropolitan statistical division (No = 0; Yes = 1)
D_URBAN: Classified as Urban under Australian Classification of Local Governments system (1 = Yes, 0 = No)
D_REMOTE: Classified as Remote under Australian Classification of Local Governments system (1 = Yes, 0 = No)
W_METRO: Border is within metropolitan statistical division (No = 0; Yes = 1)

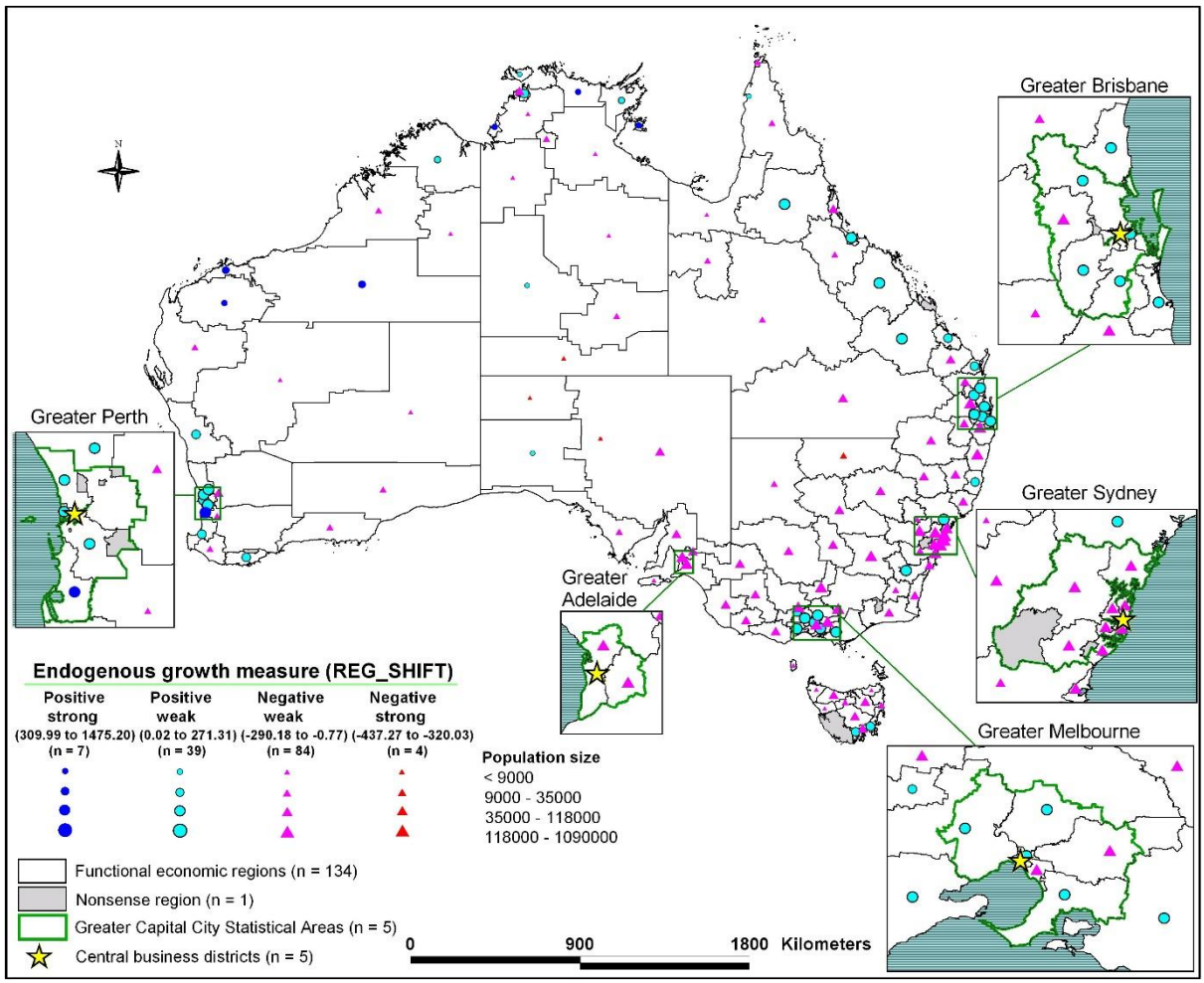
Source: The authors.

- Second, a *backward step-wise regression* (based on AIC) was run to derive an OLS specific model. Again, spatial dependence tests and a multicollinearity test were run.
- Third, using the same variables, a *Spatial Error Model (SEM)* was run, which includes a lagged spatial error term.
- Finally, for completeness and for comparison, a *Spatial Autoregressive (SAR) Model* was run on the same variables, which includes a lagged dependent variable.

4. Spatial Patterns of Endogenous Regional Employment Performance

It is important to understand the economic context of the decade 2001-2011 in Australia. The decade began just after the 2000 Sydney Olympics. The long-boom years of economic growth that had begun following the recession of the early 1990s continued until later in the first decade of the new millennium. Not surprisingly, then, one would expect there to be marked variations in the direction and the magnitude of endogenous regional employment performance over the decade 2001-2011 across Australia's FERs, and that is the case as clearly shown in Figure 1.

Figure 1: Map of Positive and Negative Scores on the Endogenous Regional Employment Performance (REG_SHIFT) Dependent Variable Measure, 2001-2011



Source: The authors.

When the world was impacted by the sharp downturn of the Global Financial Crisis (GFC), fortunately it had a relatively low aggregate impact on Australia. But it did have significant variable regional impacts. The decade was also characterised by the resources boom led by high commodity prices and an escalation in mining investments, output and exports, which was to create circumstances for what has been described as a 'two-speed economy'.

Overall, across the 134 FERs that remained in the analysis after eliminating those in some of the very remote and barely inhabited areas in the vast continent of Australia, over the decade 2001-2011 only 46 FERs (or 34%) recorded a *positive* score on the endogenous regional employment performance measure, with only seven of those FERs having a *strong positive* performance. Thus, the big majority of the FERs (88 or 66%) recorded *negative* scores on the endogenous regional employment performance variable, with four of them having a *strong negative* performance.

Table 2 lists the FERs that were the top 25 positive performers and those that were the bottom negative performing FERs on the endogenous regional employment performance measure for the decade 2001-2011.

Table 2: The bottom 25 negative performing FERs and the top 25 positive performing FERS on the endogenous regional employment performance variable for the decade 2001-2011

Top 25 *negative* performing FERs (name given)	State/Territory, type of region	REG_SHIFT score
1. Petermann - Simpson	NT: Remote	-437.2739166
2. APY Lands	SA: Remote indigenous lands, north west	-367.6052307
3. Bourke - Walgett	NSW: Inland far west, remote	-359.6419387
4. Coober Pedy	SA: Inland, remote	-320.0340477
5. Renmark - Loxton	SA: Inland, irrigation area	-290.1754182
6. Victoria River	NT: Remote, indigenous	-287.7707821
7. Dorset	TAS: Coastal, rural, north east	-281.1617911
8. King Island	TAS: Island, rural remote	-265.9318968
9. Swan Hill - Deniliquin - Wentworth	NSW-VIC: Inland irrigation area	-263.4774996
10. Snowy Mountains	NSW: Inland south, rural	-248.6266220
11. Griffith - Narrandera	NSW: Inland, irrigation area	-244.0103606
12. Manjimup - Bridgetown	WA: Coastal, rural, south west	-243.3089350
13. Longreach and surrounds	QLD: Inland far west, pastoral	-217.2412607
14. Carnarvon - Exmouth	WA: NW remote mining	-214.1387132
15. Moree - Inverell - Goondiwindi	NSW- QLD: Inland north, rural	-213.3415212
16. Charters Towers - Ayr	QLD: Coastal and inland north	-204.8155484
17. Brookton - Narrogin - Katanning	WA: Inland, rural	-202.4857934
18. Parkes - Cobar	NSW: Inland western plains, rural	-196.4080787
19. Cape York Peninsula	QLD: Far North Cape, remote	-195.2428712
20. Ingham - Innisfail	QLD: Coastal north, rural	-194.9280890
21. York - Dalwallinu - Merredin	WA: Inland, rural	-193.7412466
22. Carpentaria	QLD: Coastal, far north, remote	-192.9291385
23. Tennant Creek - Barkly	NT: Inland remote	-189.3799572
24. Northern Darwin suburbs	NT: Metropolitan suburban	-187.5386101
25. Mildura and surrounds	VIC-NSW: Inland, irrigation area	-185.2242600

Top 25 *positive* performing FERs (name given)	State/Territory, type of region	REG_SHIFT score
1. Ashburton	WA: North west, remote mining	1475.2003860
2. Thamarrurr	NT: Indigenous area, remote	991.9831003
3. Port Hedland - Newman - East Pilbara	WA: North west, remote mining	751.6731816
4. Karratha - Roebourne	WA: North west, remote mining	708.2806127
5. Rockingham - Mandurah	WA: Metropolitan outer suburban, south	443.3334812
6. Anindilyakwa	NT: Indigenous land council area, remote	439.2604002
7. West Arnhem	NT: Remote, indigenous	309.9875564
8. Darwin City - Inner suburbs	NT: Metropolitan inner	271.3055835
9. Western	SA: Inland, remote	253.3676169
10. Weipa	QLD: Coastal, far north, remote	243.8628282
11. Mackay - Whitsunday	QLD: Coastal, regional city and rural	232.8954608
12. Gladstone and surrounds	QLD: Coastal, north	218.6443992
13. Sunshine Coast	QLD: Metropolitan outer suburban northern	197.4943849
14. Palmerston - Litchfield	NT: Inland, remote	183.0851687
15. Melbourne West - North West - Bacchus Marsh	VIC: Metropolitan outer suburban, north and west	162.6978148
16. Gold Coast - Tweed	QLD-NSW: Metropolitan outer suburban, south	158.5154890
17. Bunbury - Margaret River	WA: South west coastal, regional city and wine area	142.9204609
18. Ipswich - Springfield	QLD: Metropolitan outer suburban, west	138.8049684
19. Hervey Bay - Maryborough	QLD: Coastal, regional city and rural	136.4600045
20. Midland - Mundaring - Gingin	WA: Inland rural	134.8232042
21. Brisbane North - Moreton Bay Region	QLD: Metropolitan suburban, north	128.5096330
22. Mornington Peninsula - Dandenong - Pakenham	VIC: Metropolitan outer suburban, southeast	98.1366192
23. North Perth - Joondalup	WA: Metropolitan outer suburban, north	98.0774790
24. Greater Townsville	QLD: Coastal regional city	91.2981568
25. Fremantle - South Eastern Perth	WA: Metropolitan suburban, south	90.9848153

Source: The authors.

Some distinctive characteristics are evident from the pattern across Australia of *positive* and *negative* performance of FERs on the endogenous regional employment performance variable over the decade 2001-2011, and these are discussed below.

4.1 Positive Endogenous Regional Employment Performance

The *positive performing* FERs are located across much of the capital city metropolitan regions, including Melbourne, Brisbane and Perth, across the ACT, and in Darwin and Hobart. But this was *not* the case for Adelaide, and *nor* was it for Sydney.

Positive performance was also spread across much of the nation's inland wheat-sheep belt, and it occurred in some areas of coastal NSW, Queensland, eastern Victoria, and Western Australia. Positive performance is also found in some of the mining regions and in some of the indigenous settlement regions of Western Australia, Queensland and the Northern Territory. The existence of *positive* endogenous regional employment performance for some of the FERs that are indigenous settlements is surprising, but probably explained by the concerted public policy efforts of governments to create indigenous employment, which is in fact an exogenous factor but is picked-up by default in the measure of the REG_SHIFT dependent variable.

4.2 Negative Endogenous Regional Employment Performance

The *negative performing* FERs are located widely across regional Australia beyond the capital cities and especially across the nation's vast remote areas. That includes farming and grazing regions of western Victoria, South Australia, parts of central and western Queensland, and in Western Australia. Those regions largely form Australia's extensive wheat-sheep belt. Some of the *negative* performing FERs are also found in parts of coastal New South Wales, Queensland, Victoria, South Australia and Western Australia. Most of the FERs in Tasmania also had *negative* performance.

Within the capital city metropolitan regions, *negative* performance on the endogenous regional employment performance dependent variable was also present across all of Adelaide, across all of Sydney, in eastern Melbourne, and in the north-west of Brisbane.

5. THE MODELLING AND RESULTS

As indicated earlier, several approaches were used to model the role the *independent* variables might play in explaining the variation in the dependent variable across the FERs. These models and their results are discussed below.

5.1 The Ordinary Least Squares Full Model

First the *OLS regression full model* was run without allowing for spatial effects (see Table 3). The R^2 is quite high (0.9414). Only nine of the independent variables are significant in explaining the variation in the scores on FERs on the dependent variable, six having a *positive* and three having a *negative* influence on endogenous regional employment performance.

The *positive* effects are variables relating to:

- industry diversification/specialization at the beginning of the decade and the decade 2001-2011;
- the region's structural change index at the start of the decade;
- population change over the decade;
- the level of unemployment at the beginning of the decade;
- change in the incidence of information jobs; and
- the measure of remoteness.

The *negative* effects are from the variables relating to:

- the initial level of income; and
- change in the incidence both of people with bachelor qualifications and of people with technical qualifications.

It is noteworthy that some variables have a different direction (positive/negative) to model outcomes in the Stimson et al. (2011) paper analysing the decade 1996-2006.

The Anselin Lagrange Multiplier (LM) tests - both the original and the robust tests - were used to test for spatial dependence, both error and lag (Table 4). In addition, the Moran's *I* test on residuals was run (Table 5). The full model shows no evidence of spatial dependence (lag or error) according to the LM tests or Moran's *I* on residuals.

A test for multicollinearity using variance inflation factors (VIF) was run (Table 6). Obviously, some of these are very high.

Table 3: Full OLS Model Results

Coefficient	Estimate	Std. Error	*t* value	*p* value
(Intercept)	510.084	412.418	1.237	0.219025
Spec_01	542.682	249.199	2.178	0.031756 *
Spec_ch	725.606	372.764	1.947	0.054366.
Sci	799.754	192.563	4.153	6.87e-05 ***
Sci_ch	67.315	212.352	0.317	0.751898
L_inc_01	-369.200	131.331	-2.811	0.005929 **
L_inc_ch	114.551	182.396	0.628	0.531398
Unemp_01	13.761	5.238	2.627	0.009956 **
Unemp_ch	-6.573	5.943	-1.106	0.271349
L_pop_01	24.596	23.474	-1.048	0.297240
L_pop_ch	3441.275	153.338	22.442	< 2e-16 ***
Lq_man_01	19.628	25.393	0.773	0.441342
Lq_inf_01	160.601	40.129	0.669	0.505141
Lq_fin_01	402.623	203.362	1.980	0.050444
Lq_pro_01	-133.266	124.184	-1.073	0.285772
Lq_man_ch	-67.364	39.632	-1.700	0.092259
Lq_inf_ch	73.053	2 80.635	2.042	0.043759 *
Lq_fin_ch	-170.392	218.090	0.781	0.436459
Lq_pro_ch	96.262	98.370	0.979	0.330131
Postgrad_01	42.977	1296.986	0.033	0.973631
Postgrad_ch	-1179.092	1739.547	-0.678	0.499439
Bachelor_01	90.571	499.123	0.181	0.856370
Bachelor_ch	-2557.620	730.100	-3.503	0.000687 ***
Techquals_01	238.953	162.494	1.471	0.144524
Techquals_ch	-1484.946	294.507	-5.042	2.03e-06 ***
Symba_01	2 59.703	315.795	0.822	0.412798
Symba_ch	183.322	632.459	0.290	0.772521
Volunteer_11	2.412	2.367	1.019	0.310660
A_coast	-20.734	15.912	-1.303	0.195511
P_metro	4.405	21.777	0.202	0.840116
D_urban	-4.909	21.746	-0.226	0.821847
D_remote	84.127	42.356	1.986	0.049723 *
W_metro	-14.090	28.492	-0.495	0.621997

Residual standard error: 65.91 on 101 degrees of freedom
Multiple R^2 = 0.9414,
Adjusted R^2= 0.9229
F statistic: 50.73 on 32 and 101 DF, *p* value: < 2.2e-16

*=significant at 0.05 level;
**=significant at 0.01 level;
***=significant at 0.00 level

Source: The authors.

Table 4: Anselin Lagrange Multiplier test: Spatial Error and Spatial Lag Results

est	χ^2	df	*p* value
LM error	1.0049	1	0.3161
LM lag	1.3566	1	0.2441
Robust LM error	2.6684	1	0.1024
Robust LM lag	3.02	1	0.08224

Source: The authors.

Table 5: Moran's *I* Test Results

Moran's *I*	*z* value	*p* value
0.062399	1.814	0.06967

Source: The authors.

Table 6: Multicollinearity Test Results

Coefficient	VIF
Spec_01	8.907465
Spec_ch	8.835060
Sci	8.300719
Sci_ch	2.712929
L_inc_01	7.720642
L_inc_ch	6.698806
Unemp_01	6.533965
Unemp_ch	10.313893
L_pop_01	8.789758
L_pop_ch	2.708974
Lq_man_01	3.479791
Lq_inf_01	13.368863
Lq_fin_01	20.924515
Lq_pro_01	26.257744
Lq_man_ch	1.823345
Lq_inf_ch	1.653523
Lq_fin_ch	5.857960
Lq_pro_ch	4.123870
Postgrad_01	13.713052
Postgrad_ch	17.156961
Bachelor_01	28.413478
Bachelor_ch	6.886694
Techquals_01	4.083310
Techquals_ch	6.622777
Symba_01	14.158755
Symba_ch	16.353417
Volunteer_11	5.758360
A_coast	1.778726
P_metro	1.281645
D_urban	3.626887
D_remote	3.107093
W_metro	2.633234

Source: The authors.

5.2 The Backward Step-wise Regression Model

A *backward step-wise regression* (based on AIC) was run to derive an *OLS specific model* (Table 7). This reduces to 15 the number of independent variables that are relevant to explaining the dependent variable endogenous regional employment performance over the decade 2001-2011. Once more, the R^2 is quite high (0.937).

Twelve variables are significant, 10 having a positive effect, with two having a negative effect. Again, some variables have a different direction (positive/negative) to model outcomes in the Stimson et al. (2011) paper analysing the decade 1996-2006.

Table 7: Backward Step-wise Regression OLS Specific Model Results

Coefficient	Estimate	Std. Error	*t* value	*p* value
(Intercept)	486.664	257.791	1.888	0.061506 .
Spec_01	534.036	206.619	2.585	0.010966 *
Spec_ch	895.148	288.790	3.100	0.002423 **
Sci	1006.150	128.078	7.856	2.05e-12 ***
L_inc_01	-372.183	101.600	-3.663	0.000374 ***
Unemp_01	14.410	3.648	3.951	0.000133 ***
Unemp_ch	-5.928	3.941	-1.504	0.135236
L_pop_ch	3340.952	111.646	29.924	2e-16 ***
Lq_fin_01	195.943	87.959	2.228	0.027800 *
Lq_man_ch	-66.334	33.987	-1.952	0.053339
Lq_inf_ch	511.158	232.272	2.201	0.029705 *
Bachelor_ch	-2704.582	389.691	-6.940	2.26e-10 ***
Techquals_01	201.311	122.432	1.644	0.102783
Techquals_ch	-1531.763	218.177	-7.021	1.51e-10 ***
Volunteer_11	4.172	1.310	3.184	0.001858 **
D_remote	96.245	32.977	2.919	0.004212 **

Residual standard error: 63.26 on 118 degrees of freedom
Multiple R^2= 0.937,
Adjusted R^2= 0.9289
F statistic: 116.9 on 15 and 118 DF, *p* value: < 2.2e-16

*=significant at 0.05 level;
**=significant at 0.01 level;
***=significant at 0.00 level

Source: The authors.

The independent variables having a significant *positive* effect on FER endogenous regional employment over the decade 2001-2011 relate to:

- industry diversification/specialisation at the beginning of the period and for the change in it over time;
- the region's structural change index at the beginning of the decade;
- population change over time;
- the level of unemployment at the beginning of the decade;
- the change in the degree of concentration of jobs in information and in finance;
- the incidence of volunteering (as a surrogate measure of social capital); and
- the degree of regional remoteness.

Negative effects on endogenous regional employment performance are related to:

- the level of income at the beginning of the decade; and
- the change in the incidence both of people with bachelor qualifications and of people with technical qualifications.

Once more the Anselin's LM tests were run on the refined regression above (Table 8), along with the Moran's *I* test on residuals (Table 9), to test for spatial dependence. There is no spatial

dependence according to the Anselin LM tests, but there is significant (at the 0.05 level) error due to spatial dependence using the Moran's *I*.

Table 8: Anselin Lagrange Multiplier Test Results: Backward Step-wise Regression OLS Specific Model

Test	χ^2	**df**	***p* value**
LM error	2.3964	1	0.1216
LM lag	0.4289	1	0.5125
Robust LM error	3.7228	1	0.0537
Robust LM lag	1.7553	1	0.1852

Source: The authors.

Table 9: Moran's *I* Test on Residuals Results

Moran's *I*	***z* value**	***p* value**
0.096359	2.0674	0.0387 *

Source: The authors.

Once more the multicollinearity tests were run (Table 10). According to most of the literature, these results are quite acceptable, though some authors advocate for VIFs less than 6.

Table 10: Multicollinearity Test Results

Coefficient	**VIF**
Spec_01	6.646055
Spec_ch	5.755288
Sci	3.985473
L_inc_01	5.015021
Unemp_01	3.438619
Unemp_ch	4.922926
L_pop_ch	1.558675
Lq_fin_01	4.248533
Lq_man_ch	1.455343
Lq_inf_ch	1.229364
Bachelor_ch	2.129349
Techquals_01	2.515898
Techquals_ch	3.944820
Volunteer_11	1.915148
D_remote	2.044094

Source: The authors.

5.3 Spatial Regression Models

Spatial Error Model (SEM)

Given the possibility of spatial error dependence evidenced from the Moran's *I* test on residuals, the same variables were run in a *Spatial Error Model (SEM)*, which includes a lagged spatial error term (Table 11).

Table 11: Spatial Error Model Results

Coefficient	Estimate	Std. Error	z value	*p* value
(Intercept)	505.5062	241.1581	2.0962	0.0360679 *
Spec_01	586.9817	194.5074	3.0178	0.0025463 **
Spec_ch	1054.3037	274.7729	3.8370	0.0001245 ***
Sci	1010.0631	115.2328	8.7654	< 2.2e-16 ***
L_inc_01	-395.5645	94.4138	-4.1897	2.793e-05 ***
Unemp_01	13.8385	3.4481	4.0134	5.986e-05 ***
Unemp_ch	-5.0196	3.6979	-1.3574	0.1746421
L_pop_ch	3349.6546	109.5279	30.5827	< 2.2e-16 ***
Lq_fin_01	208.8935	88.2814	2.3662	0.0179705 *
Lq_man_ch	-60.5119	31.2101	-1.9389	0.0525192
Lq_inf_ch	582.1127	214.9754	2.7078	0.0067729 **
Bachelor_ch	-2569.5230	370.7719	-6.9302	4.202e-12 ***
Techquals_01	218.6299	120.1337	1.8199	0.0687761
Techquals_ch	-1442.5091	201.6122	-7.1549	8.376e-13 ***
Volunteer_11	4.4870	1.2194	3.6796	0.0002336 ***
D_remote	83.4578	30.5998	2.7274	0.0063836 **

Lambda: 0.23906, LR test value: 3.2081, p-value: 0.073276
Asymptotic standard error: 0.10888
z-value: 2.1956, p-value: 0.028124 *
Wald statistic: 4.8205, p-value: 0.028124 *
Log likelihood: -735.7494 for error model
ML residual variance (sigma squared): 3393.7, (sigma: 58.256)
Number of observations: 134
Number of parameters estimated: 18
AIC: 1507.5, (AIC for lm: 1508.7)

*=significant at 0.05 level;
**=significant at 0.01 level;
***=significant at 0.00 level

Source: The authors.

The results show there is little difference between the OLS and the SEM. Those variables that were significant in the OLS are still significant in the SEM, all coefficient directions are the same, and there are only minor variations in magnitudes. Regarding the SEM, the spatial error coefficient, lambda, is significant (*p* value 0.028) and the AIC is slightly lower, but the Likelihood Ratio test is not significant (*p* value 0.0733), thus pointing to the OLS model.

Spatial Autoregressive Model

For completeness and comparison, the *Spatial Autoregressive (SAR) Model* was also run, which includes a lagged dependent variable (Table 12).

In the SAR model, LQ_MAN_CH becomes significant, but otherwise the results are similar to those for the OLS model and the SEM. Importantly, the lagged dependent variable coefficient (rho) is not significant (*p* value 0.548) and the AIC is higher than for the OLS model.

Table 12: Spatial Autoregressive (SAR) Model Results

Coefficient	Estimate	Std. Error	*z* value	*p* value
(Intercept)	463.0629	243.9175	1.8984	0.0576380 .
Spec_01	541.2858	194.2695	2.7863	0.0053320 **
Spec_ch	898.9836	271.0777	3.3163	0.0009121 ***
Sci	1015.7014	121.0489	8.3908	< 2.2e-16 ***
L_inc_01	-366.9723	95.3511	-3.8486	0.0001188 ***
Unemp_01	14.5123	3.4177	4.2463	2.174e-05 ***
Unemp_ch	-5.9810	3.6942	-1.6190	0.1054405
L_pop_ch	369.3973	114.2799	29.4837	< 2.2e-16 ***
Lq_fin_01	192.5118	82.5667	2.3316	0.0197221 *
Lq_man_ch	67.3119	31.8483	-2.1135	0.0345563 *
Lq_inf_ch	469.4857	227.3773	2.0648	0.0389431 *
Bachelor_ch	-2674.0478	371.5417	-7.1972	6.148e-13 ***
Techquals_01	207.3834	115.3710	1.7975	0.0722507
Techquals_ch	-1533.2985	204.4728	-7.4988	6.439e-14 ***
Volunteer_11	4.2163	1.2306	3.4262	0.0006120 ***
D_remote	96.8746	3 0.9031	3.1348	0.0017198 **

Rho: -0.026617, LR test value: 0.39186, *p* value: 0.53132
Asymptotic standard error: 0.044357
z value: -0.60006, *p* value: 0.54846
Wald statistic: 0.36008, *p* value: 0.54846

Log likelihood: -737.1575 for lag model
ML residual variance (sigma squared): 3513.3, (sigma: 59.273)
Number of observations: 134
Number of parameters estimated: 18
AIC: 1510.3, (AIC for lm: 1508.7)
LM test for residual autocorrelation
test value: 4.032, *p* value: 0.044646 *

*=significant at 0.05 level;
**=significant at 0.01 level;
***=significant at 0.00 level

Source: The authors.

5.4 Summary

In summary, the *OLS* does appear to be the best model, negating the need for spatial models. This is an interesting finding, and it confirms the supposition that the use of a *functional* rather than a *de jure* spatial base should help overcome the issue of spatial autocorrelation.

By way of an aside, the Moran's *I* statistic for the REG_SHIFT variable is significant, meaning the REG_SHIFT itself shows some spatial dependence. However, it appears to go once in a model as in Table 12, which is interesting.

6. POLICY ISSUES

6.1 Regional Policy Interventions in Australia

In Australia it has been common to have government involvement in implementing explicit regional development policy, but that has waxed and waned over time. Such involvement has tended to have been focused almost exclusively on the non-metropolitan regions and rarely on

the metropolitan regions. Such policies are what O'Connor, et al. (2001) have referred to as *'place-specific'* policies. The interventions have typically been about, *inter alia*, the following:

- investments in infrastructure (including transportation projects, dams and irrigation systems);
- grants for community facilities;
- providing higher education facilities; and
- industry attraction schemes, which are essentially about 'picking winners' and which have a long history of failure.

Regional economic development policy and programs are almost exclusively the concern of the state/territory governments.

In addition, some government policy and programs that are 'people-specific' also can have regional impacts, one of the most notable being the immigration policy of Commonwealth governments, with immigrants overwhelmingly choosing to live in the major cities, especially Sydney and Melbourne and in specific areas within them.

Over the last two to three decades regional development policy has tended to be focused more on developing local capacity and enhancing competitiveness, which is about bolstering-up endogenous processes. But often the implementation of such policy approaches has been characterised by 'picking winners' as illustrated by the Western Australia experience discussed by Plummer, et al. (2014).

It is often the case that attention has been directed towards intervening in poorly performing/lagging regions, rather than making investments to further enhance the performance of successful regions.

6.2 Implications of the modelling for policy

What might be the implications for policy of the modelling undertaken for this paper? Several are evident if the purpose of regional policy programs is to enhance the *endogenous* performance of regions.

It is evident that marked differences persist in the pattern of endogenous regional employment performance across Australia, with the large majority of FERs displaying negative performance over the decade 2001-2011. There are marked divides between the regional and some the metropolitan region FERs, but that is not universal. And across regional and rural Australia there are pockets of positively performing FERs, so that it is not all 'gloom-and-doom' across Australia's regional and rural areas. But nor is it all booming across the metropolitan regions.

Of special concern from the experience of the 2000s is the negative performance of FERs in the Sydney metropolitan region, which was a reversal of the situation for prior inter-census decades. Was this a post-Olympics effect? And was it an outcome of planning policy restricting land release and a reaction to the Labor Premier of New South Wales, Bob Carr, declaring that Sydney was closed to expansion? For Australia's global city, this negative endogenous growth employment performance was a disturbing outcome.

It also continues to be disturbing that the Adelaide metropolitan region continues to be a negative performer.

The modelling certainly highlights the difficulty for regional development policy to be formulated in a global sense, suggesting the need for a region-specific policy approach rather than a 'one-size-fits-all' approach.

It is evident that using *functional* as against *de jure* regions as the target for regional policy would make more sense than continuing the common practice of directing programs and investment to Local Government Authorities. It is understandable that that there has been a focus on Local Government Authorities as the third-tier of government in Australia, and they are in fact the creatures of State governments. However, these *de jure* regions are largely historic in origin, although it is not uncommon for State governments to force Local Government amalgamations. At least regional development strategies and the investments associated with them should recognise that it is not often the case that a single local government entity equates with a functional economic region (a functional labour market), so that there should be an insistence that there be collaboration between the local government entities that might equate with a functional economic unit, and that a regional development strategy be formulated for such a functional entity.

From the modelling undertaken for this paper, it is clear key factors that seem to underpin *positive* endogenous regional employment performance relate to a region's industry diversity/specialisation and its structural characteristics, and the degree of concentration of employment in information jobs and in finance jobs. In addition, population growth seems to be positively associated with positive endogenous regional employment performance. Not surprisingly, the remoteness of a FER also seems to be a factor that enhanced the performance of some FERs as the decade 2001-2011 coincided with the remarkable resources boom experienced by Australia, with mining activities especially being highly concentrated in very remote locations and with many highly productive agricultural and pastoral regions that are in relatively remote inland areas. As a hallmark of what was referred to as Australia's 'two-speed' economy, the resources boom sucked jobs out the non-mining sector adversely impacting non-resource regions.

The reality is there is little that government interventions could do with respect to these factors that related to structural transition in the economy, with some regions being 'winners' while others were 'losers'. However, since the end of the 2000s, the resources boom ended abruptly, so it might be expected that future modelling focusing on endogenous regional employment performance for the current decade will reveal perhaps a different role being played by those regional factors.

The level of unemployment at the beginning of the decade 2001-2011 does appear to assume some significance in a positive way, possibly because many remoter regions would have seen jobs growth over the decade relating to the resources boom, with many such regions traditionally having somewhat higher than normal unemployment.

It is interesting that the modelling for the decade 2001-2011 did *not* reveal population size *per se* to be a statistically significant factor enhancing endogenous regional employment performance, while population growth over the decade did significantly affect *positive* performance.

Thus, positive performance was not necessarily the prerogative of large regional labour markets, and nor were small size FERs necessarily poor performers.

Similarly, and perhaps also surprisingly, regional income levels at the start of the decade were shown to, in fact, have a negative effect on endogenous regional employment performance.

But the most surprising result from the modelling was that factors relating to levels of regional human capital were *not* significant in explaining positive endogenous regional employment performance. Indeed, the modelling showed that change in the incidence of people with bachelor qualifications and change in the incidence of people with technical qualifications in fact had a *negative* influence on regional endogenous performance (at least for the decade 2001-

2011), which is a finding that is counterintuitive to much of the research on regional development postulating that improved levels of human capital will improve economic performance. This finding poses questions about the increasing investment that has been occurring in post-school education and training and the massive rise that has occurred in the number of students attending tertiary education institutions and, as a result the very large increase that has been occurring in the number of tertiary-educated young people of workforce age, which are the outcomes of public policy to encourage engagement in tertiary education.

In contrast, the supposed *positive* effect of increasing social capital - as measured, albeit inadequately, by the incidence of volunteering - does appear to be a factor that is a significant *positive* factor for enhancing endogenous regional employment performance. Enhancing social capital has been receiving some attention by governments.

Perhaps the most important lesson to take from the modelling for the decade 2001-2011 is that policy interventions to enhance endogenous regional employment performance might be those that relate to the structural characteristics of a region and enhanced diversification of employment, along with enhancing social capital. Interventions to enhance human capital might be worthwhile goals in themselves, but do *not* appear to be having a positive impact on endogenous regional employment performance.

7. CONCLUSION

This paper continues the research thrust initiated a decade or so ago to investigate endogenous regional employment performance across Australia's regions. That work has operationalised a model framework along the lines proposed by Stimson and his collaborators, and as set out in detail in Stimson et al. (2009).

The study reported here has focused on:

(a) analysing the patterns of endogenous regional employment performance for the decade 2001-2011; and

(b) modelling the potential determinants of variations in that performance.

A *functional* as against a *de jure* spatial base was employed using a new functional geography of FERs across both Australia's major metropolitan regions and beyond across the vast expanses of regional Australia that was developed by the authors and reported in a published paper by Stimson et al. (2016). The econometric modelling described in this paper indicates that using FERs appears to overcome the spatial autocorrelation issue inherent in using a *de jure* regional demarcation, which was also found to be the case in the earlier work by Stimson et al. (2011) which modelled the endogenous regional employment performance of FERs for the decade 1996-2006. A series of econometric models were run:

(a) first a full OLS model and then a backward step-wise regression OLS spatial specific model (for both models the Anselin Lagrange Multiplier (LM) and Moran's *I* spatial dependence tests were run, along with a multicollinearity test); and

(b) second spatial regression models were run, both a Spatial Error Model and also a Spatial Autoregressive Model.

The results from these models were discussed.

We judge that an *OLS model* would seem to be the preferred modelling approach using a *functional* spatial base to investigate which socio-economic and locational characteristics of FERs might be potential factors explaining the *positive* or *negative* performance of FERs on the dependent variable (REG_SHIFT) when measuring endogenous regional employment over

the decade 2001-2011. This finding confirms what Stimson et al. (2011) also found for their analysis for the decade 1996-2006. It certainly leads us to conclude that a *functional* spatial base is preferable to use than a *de jure* regional spatial base that has more commonly been used in econometric modelling investigating regional economic performance in Australia and which typically has been the focus for regional development policy interventions, which is probably not a suitable policy approach.

It is evident from the empirical findings of research investigating regional economic performance in Australia that considerable regional differentiation persists. The gaps are wide. That is particularly evident from the research explicitly focusing on measuring endogenous regional employment performance across the nation's FERs as reported in the paper by Stimson at al. (2011) for the decade 1996-2006 and in this paper for the decade 2001-2011.

Regarding the findings from the modelling - and depending on which model is used - investigating the factors that might explain the variation in the measure of endogenous regional employment performance across FERs for the decade 2001-2011, it appears that a *positive* influence is significantly related particularly to factors to do with:

- regional industry diversification/specialization at the beginning of the decade;
- the structural change index for the region; population change over time;
- the incidence of employment in information jobs and possibly in finance jobs;
- the initial level of unemployment;
- the level of social capital as measured by the incidence of volunteering; and
- regional remoteness.

A *negative* influence is significantly related to factors to do with:

- the initial level of regional income; and
- the incidence of people with bachelor qualifications and with technical qualifications.

There is a need for further work to be undertaken to enhance our understanding of endogenous regional employment performance across FERs in Australia. For example, it would be worthwhile to explicitly focus the modelling exclusively on FERs beyond the major metropolitan regions. It might also be worthwhile partitioning Australia into groups such as the capital city metropolitan regions and for regional Australia into size category or remoteness category FERs to explicitly analyse endogenous processes in the FERs encompassing the larger and smaller regional cities and towns. And it might be worthwhile to segment the analysis into the two five-year inter-census periods that comprise a decade.

We also need to be aware that, over time, there will be changes in the boundaries of FERs due to both improvements to the transport infrastructure and changes in the distribution of employment across space. In addition, we need to be cognisant that the macro-economic conditions within which the processes of endogenous regional performance play out do change over time and will be specific to an inter-census period and will have exogenous impacts on regional performance.

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Review of Mechanisms to Improve Housing Affordability in Queensland Regional Cities

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ABSTRACT

Despite softening rental rates and housing prices in regional Queensland cities, there are still housing affordability issues facing lower wage earners, welfare recipients, senior citizens, victims of family violence and the people with disabilities. This study aims to review the strengths and weaknesses of current mechanisms of housing affordability in regional Queensland cities through a case study of Rockhampton. This study adopted qualitative methodology and interviewed representative stakeholders from Queensland Government, Real Estate agencies, community service providers and property experts. After analysing strengths, weaknesses, opportunities and threats (SWOT) of both demand and supply side mechanisms of housing affordability, this study found most mechanisms followed quick fixes solution and some of them can even create more problems than what they would solve. In addition, many families are becoming dependent on the welfare-led housing systems generation after generation. Therefore, this study suggests adopting community-led and place based housing strategies to deliver both affordable and social housing as well as provide adequate funding in crisis housing sector.

1. INTRODUCTION

Housing affordability has been falling in Australia since 1990s, especially in metropolitan and regional cities of Queensland, New South Wales, Victoria and Western Australia (ABS, 2015). The proportion of people in rental stress (i.e., paying more than one-third of their household income on accommodation), rose from 35 per cent in 2007-08 to 41 per cent during 2011-12 and the mortgage payment increased from 30% to 37% over the same period (Browne, 2015). Both owner occupiers and private tenants are adversely affected by continuing decline of housing affordability as both housing price and rents have been rising much faster than the growth of household income (DHPW, 2016).

Women and single parents with lower wages in casual and part-time employment are most vulnerable to housing affordability (Beer and Faulkner, 2008). Elderly women and the distressed women who are victims of domestic and family violence are also seriously affected by housing unaffordability (AIHW, 2015). Young people, people with disability, health workers, Aboriginal and Torres Strait Islander people, people from culturally and linguistically diverse backgrounds are more likely to experience housing stress compared to the general population (Beer and Faulkner, 2008). Prevalence of these vulnerable groups is more in regional cities compared to metropolitan cities (ABS, 2015). State and the local governments have

enacted several monetary and planning mechanisms such as rental assistance, first home buyer grants and designated planning zone to increase the housing affordability among the people with housing stress (Gurran et al., 2008) but housing affordability is still declining in Queensland (DHPW, 2016) and people's financial, social and psychological sufferings are getting worse (Akbar et al, 2016).

In addition, house sale prices and rents in regional cities of Queensland increased by up to 300% during 2002-2012 because of mining boom (Akbar et al 2013; Akbar et al., 2009; McKenzie et al., 2009). However mining boom has been declining since 2012, and both home and rental price have been declining. In some mining towns such as in Emerald, Moranbah and mining services towns such as Mackay and Gladstone, this situation have been worsening since 2012 and there is up to 70% decline in some suburbs of these towns and cities (Akbar, Rolfe and Kabir, 2013). Despites this softening in rental and home sale price, some people from the lower income group are still suffering from housing affordability challenge. The reason for this deteriorating situation is either the current mechanisms are not working well or housing demand or supply forces are overshadowing the affordability mechanisms. To date, there was no study that examines the effectiveness of the housing affordability mechanisms in regional cities in Queensland by considering the effects of key demand and supply forces and changing demographic structure. The aim of this study is to assess the effectiveness of different mechanisms for addressing housing affordability in Queensland regional cities through a case study of Rockhampton in Queensland and to provide policy guidelines for improving housing affordability as well as to identify key issues for future research.

This introduction forms Section One of this paper followed by a brief literature review on affordable mechanisms in Australia in Section Two. Section Three explores the housing affordability mechanisms enacted in Rockhampton and Section Four describes the research methods. Section Five presents the analysis of the collected data, summarizes policy guidelines for improving housing affordability and outlines some key issues for future research. Finally, Section 6 concludes the paper.

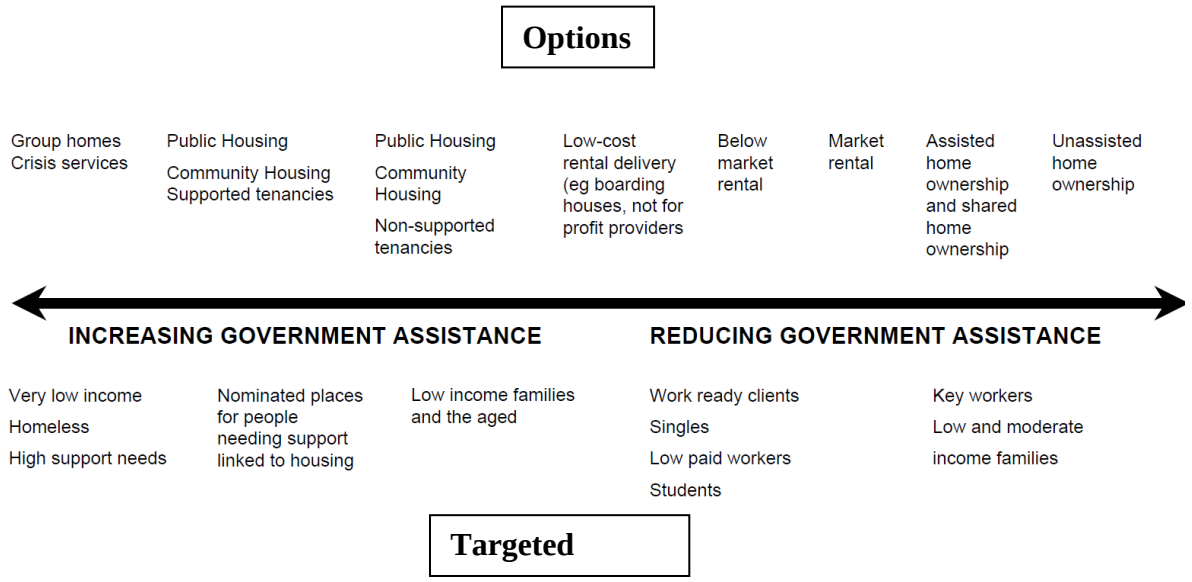
2. AFFORDABLE HOUSING MECHANISMS IN AUSTRALIA

In generally three factors are affecting the affordable housing situation in Australia and these are supply side factors, demand side factors and public interventions. Supply side factors include inputs of land, materials, production finance, human skills, management and initiatives; demand-side factors include household growth, purchaser finance, social and economic motivation and changes in locational accessibility to major services and transport systems; public interventions include planning and regulatory mechanisms provision of infrastructure and services on the supply side and governmental subsidy or assistance to the demand side, especially to the low income people (UDIA-NSW, 2003). In align with these factors of housing affordability, to date, all tiers of governments, some community based organisations and resources companies have adopted both supply and demand side mechanisms to make the dwellings affordable for no-income, low income and some medium income people in Australia. Both of supply and demand side mechanisms are very similar across Australian towns and cities except some mechanisms led by resources industries are only work for resource boom towns or cities as well as for some Aboriginal and Torres Strait Islander communities.

Supply side mechanisms include volume of dwelling supply, leveraging social housing stock and unlock planning regulation. Volume of dwelling supply include Federal and State government joint initiative to increasing housing stock via subsidy to home investors' program, low cost land development and facilitating greater scale and density by reforming land use regulation to promote residential development in the exiting urban areas and this is also known

as urban consolidation. Demand side mechanisms include first home buyer's grant, rental subsidy to the low income people, social and crisis housing option for the socially and economically disadvantaged peoples. Milligan et al 2007 summarised these mechanisms under several options of affordable housing for a range of groups (Figure 1).

Figure 1: Affordable Housing Options



Source: Adopted from Milligan et al (2007, p. 29).

This includes a range of affordable housing options include both supply and demand side mechanisms. These can be broadly termed as affordable housing strategies. The range of the options varied among the target groups and these include level of government subsidy involved, tenure ship and services provided and the delivery agency (Milligan 2007). This study evaluated some of the options that are available in Queensland regional cities through a case study of Rockhampton.

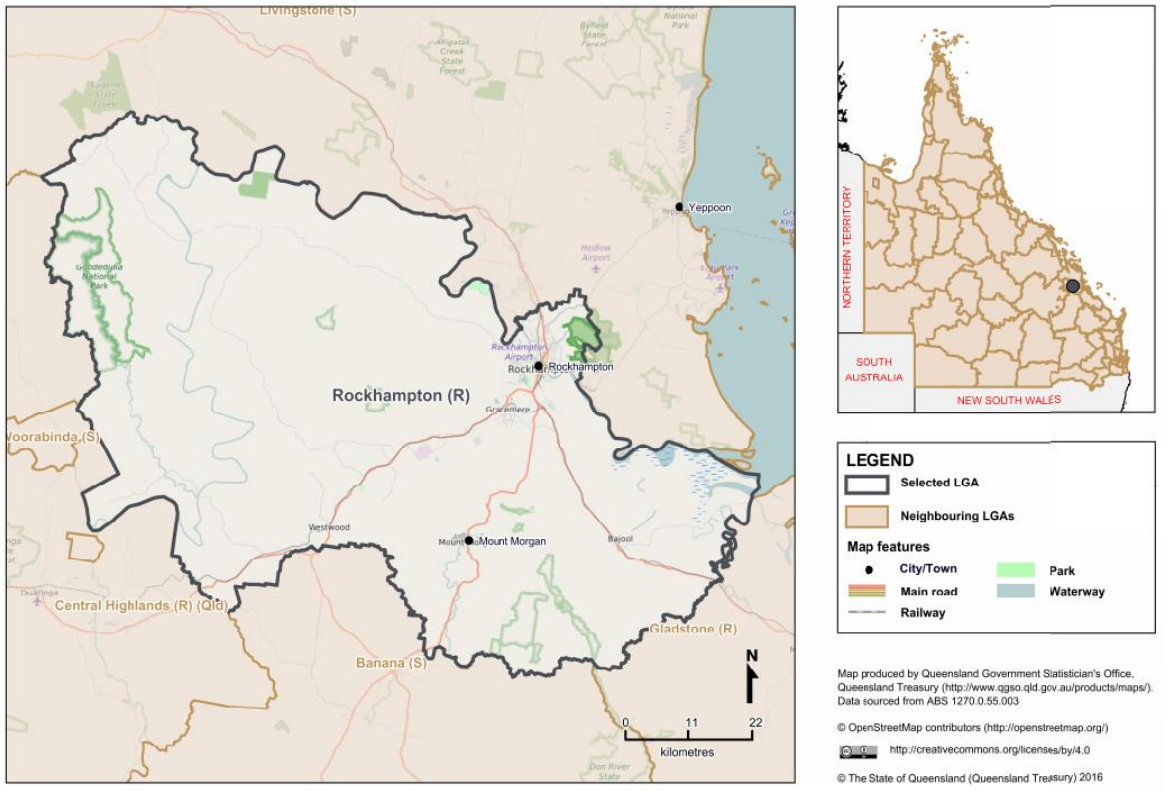
3. HOUSING AFFORDABILITY IN ROCKHAMPTON

Rockhampton is situated within the central Queensland (CQ) region in the State of Queensland (Figure 2), Australia and this is also the regional head quarter for Queensland Government's departments of social and human services. This region has a stable economy supported by agricultural, mining and services sectors. Internationally it is also known as "Beef Capital of Australia". This section briefly discusses the housing affordability situations in Rockhampton. It also outlines different housing service provisions that are accessible to nil to low income people in Rockhampton.

3.1 Socio-economic Profile

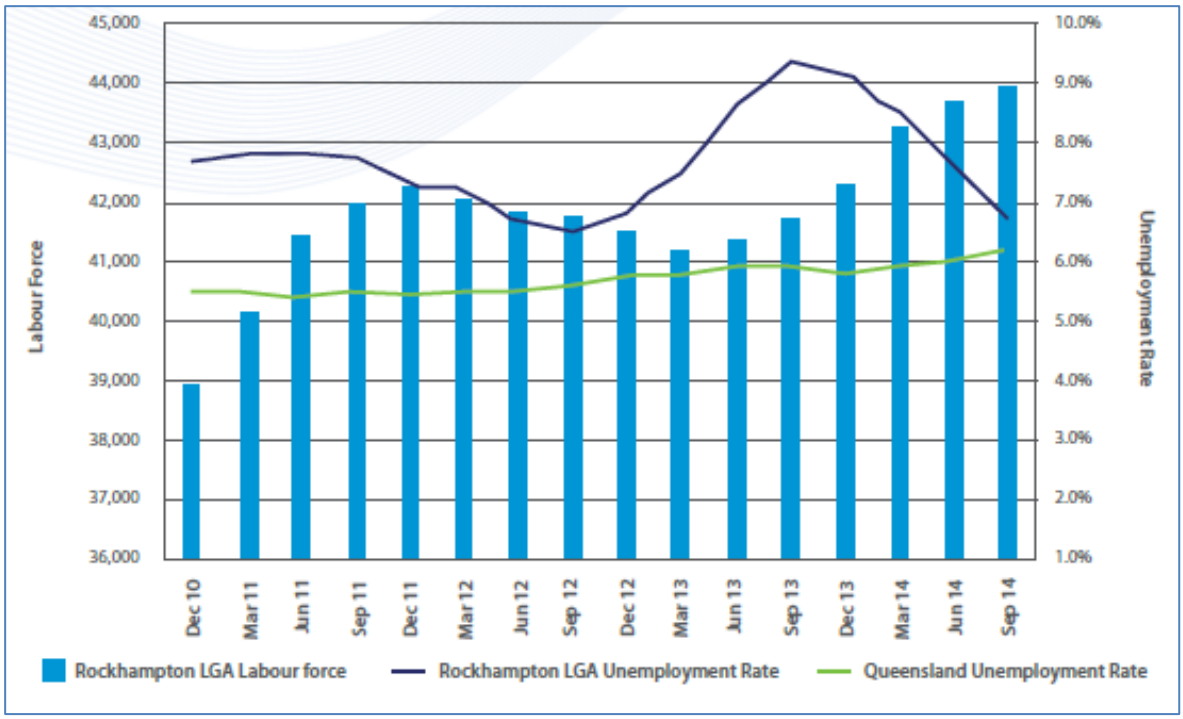
According to 2016 Australian Census, the total population of Rockhampton was 81,589 (ABS, 2016). The median age of the population was 35.3 compared to the national median of 37.2. The median total income (excluding Government pensions and allowance) was $49,932 (per year) at Rockhampton, while median was $46,854 (per year) nationally (ABS, 2016). The median equivalised total household income (per week) at Rockhampton was $784, while the median equivalised total household income (per week) was $877 nationally. Since 2013, unemployment rate is rising in Rockhampton (Figure 3.), which is an alarming situation for the overall housing market.

Figure 2: Rockhampton Local Government Area



Source: Qld Treasury (2016).

Figure 3: Labour Force and Unemployment Tate: Rockhampton LGA



Source: RRC (2015, pp.8).

The average household size at Rockhampton was 2.5, the national average being 2.6 (ABS, 2016). The average monthly household rental payment and average monthly household mortgage payment was $1,138 and $1,635 respectively. The national averages for these two payments were substantially higher, $1,524 and 1958 respectively (ABS, 2016).

3.2 Housing Affordability Situation

Although the figures in the previous section demonstrates the rental rates and housing prices in Rockhampton were better than national average, the housing affordability situations are still stressful for low wage earners and welfare recipients as explained below.

Table 1: Rental Affordability by Household Type and Percentage for Central Queensland

SL. No.	**Household Type**	**Payment Type**	**Number Affordable & Appropriate**	**Percentage Affordable & Appropriate**
1	Couple, two children (one aged less than 5, one aged less than 10)	Newstart Allowance (both adults)	252	18%
2	Single, two children (one aged less than 5, one aged less than 10)	Parenting Payment Single	170	12%
3	Couple, no children	Age Pension	404	28%
4	Single, one child (aged less than 5)	Parenting Payment Single	216	15%
5	Single, one child (aged over 8)	Newstart Allowance	61	4%
6	Single	Age Pension	104	7%
7	Single aged over 21	Disability Support Pension	104	7%
8	Single	Newstart Allowance	4	0%
9	Single aged over 18	Youth Allowance	2	0%
10	Single in share house	Youth Allowance	2	0%
11	Couple, two children (one aged less than 5, one aged less than 10)	Minimum Wage + FTB A (both adults)	587	41%
12	Single, two children (one aged less than 5, one aged less than 10)	Minimum Wage + FTB A & B (both adults)	421	30%
13	Single	Minimum Wage	176	12%
14	Couple, two children (one aged less than 5, one aged less than 10)	Minimum Wage + Parenting payment (partnered) + FTB A & B	509	36%

Source: Anglicare Australia (2017).

The rental affordability snapshot taken by Anglicare Australia (2017) found that on 1 April 2017, 1421 private rentals were advertised for rent in Central Queensland. The affordability snapshot reveals that 483 properties were appropriate for at least one household type living on income support payments, while 709 individual properties were appropriate for at least one household type living on minimum wage. Table 1 summarizes the rental affordability figures gathered from the rental affordability snapshot. The snapshot also reveals that the number of properties available during the snapshot was 362 less than last year in the same communities. The possible reason behind withdrawal of these properties can be the change in population due to downturn in local economy (Anglicare Australia, 2017). Moreover, the number of appropriate and affordable properties for couples Australia with children where both or one of the adults on the minimum wage dropped as much as 20% in Central Queensland. However, the number of appropriate and affordable rental properties for people on government income payments didn't change significantly.

The international housing affordability survey conducted by Demographia (2017) reveals that the median house price in Rockhampton was $287,000, while the median household earning was $69,700. This suggests that the cost of a house in Rockhampton is on average 4.1 times the average household income for a year. According to Demographia rating, the median multiple of 4.1 puts Rockhampton in the category of seriously unaffordable housing market.

3.3. Social Housing and Homelessness Service Provision

This section briefly describes the social housing and homelessness services that being operated and managed in Rockhampton.

Among social housing and homelessness services operating at Rockhampton, Public Housing including Aboriginal and Torres Strait Islander Housing (PH), Long-term Community Housing (LTCH), Community Rent Scheme (CRS), Same House Different Landlord (SHDL), Community-managed Studio Units (CMSU), Crisis Accommodation Program (CAP) are worth mentioning.

PH is a long-term housing scheme managed by Maryborough Housing Service Centre. LTHC housing scheme provides rental housing for low-income earners whose housing needs are not met otherwise (DHPW, 2013a). Some providers under this scheme are permitted to provide support to specific target groups only, such as pensioners or young people. CRS is a transitional housing scheme which provides rental housing for short to medium term to people who are urgently in need of housing (DHPW, 2013b). Under SHDL scheme, department of housing leases properties to community providers for renting to tenants (DHPW, 2013c). These properties are transferred back to department of housing, once the tenants move out of the properties after finding a long-term lease elsewhere. CSMU scheme allocates studio apartments temporarily or for long-term to applicants who are assessed as Very High or High Needs by Department of Housing (DHPW, 2013d). CAP scheme provides short-term accommodations to people who are in crisis (DHPW, 2016). SHS is another social housing scheme that receives funding from Queensland Government and Commonwealth Government through National Affordable Housing Agreement and National Partnership on Homelessness to provide accommodation to people who are homeless or at risk of homelessness.

4. METHODOLOGY

This section focuses upon the research approach, the scope of the study, data collection and analysis methods and techniques.

4.1 Case Study Approach and Qualitative Methodology

The study specifically focuses on understanding the mechanisms of housing affordability in regional cities in Queensland through a case study of Rockhampton by using in-depth stakeholder's opinion. A case study is a form of detailed investigation and a qualitative research approach. This approach mostly makes a contribution in developing a systematic framework to examine a problem. This approach is also well suited to the needs of policy analysis (Finn et al. 2000). In view of the above basic features of case study research, housing affordability issues in Rockhampton have been selected as the case to be studied because this is one of long-term regional resource cities in Queensland with a relatively stable workforce. In addition, this city also supports other stable workforce from the agriculture and public services sectors. Thus, this city exemplifies medium sized mining servicing cities in the Australian resources regions in terms of miners' socio-demographic dynamics and housing affordability.

4.2 Scope and Limitation of the Study

A qualitative methodology has been undertaken employing in-depth interview with the relevant stakeholders to understand the mechanisms of housing affordability in regional cities of Queensland through a case study of Rockhampton. This study did not account for the general people's opinion about those mechanisms nor did any cost-benefit analysis of those mechanisms.

4.3 Data Collection and Analysis Methods

The study conducted in-depth stakeholders' interview in Rockhampton. A number of semi-structured and open ended question were asked during the interview. The interviews were conducted between December 2016 and January 2017; however prior to conducting the formal interview, the study team lodged an ethics application with the CQU's Human Ethics Committee and then upon getting the approval, pilot testing of the interview questionnaire was done in November 2016. Eight stakeholders were selected from a range of relevant organisations including state government personnel, property experts, real estate agency and community service providers.

This study used a matrix of strengths, weaknesses, opportunities and threat (SWOT) analysis for the current housing affordability mechanisms. The SWOT is an established method of assessing policy mechanisms and formulation of strategy (Dyson, 2002). This aims to identify the strengths and weaknesses of the selected affordable housing mechanisms, opportunities to and threats on the society and the government. Therefore new strategy or mechanisms of affordable housing can be built on the strength, minimising the weaknesses, exploit the opportunities and counter the threat (Dyson, 2002).

5. INTERVIEW FINDINGS AND ANALYSIS

This section describes the interview findings which include stakeholders' socio-demographic characteristics, their perceptions about current housing affordability mechanisms, and what should be done to increase the housing affordability among the low income residents in Rockhampton and in other regional cities in general. The section also outlines the future priority issues for research in this area.

5.1 Stakeholder's Profile

We interviewed eight stakeholders in Rockhampton. The experience of the stockholders varied from 3 years to 35 years with housing affordability issues. Their occupations include state government employee, university academic and community housing provider staff. Their ages

range from 35 to 55. The lowest education qualification among the stakeholders was grade 10, the highest being PhD.

5.2. Housing Affordability Mechanisms – SWOT Analysis

Each interviewee was asked to address the strengths, weaknesses, opportunities and threats (SWOT) of three principal housing affordability mechanisms – first home buyer grants (FHBG), community based housing initiative, commonwealth rental assistance and any other housing mechanisms of their choice. The outcomes of the SWOT analysis for the housing affordability schemes addressed were presented in Tables 2-11. Each table contains popular opinions along with their frequencies. Opinions other than the popular ones are also presented separately.

Table 2: SWOT Analysis of First Home Buyer Grants (GHBG)

Dimension	Popular Opinions	Frequency	Other Opinions
Strengths	Give people opportunity to own a home.	7	• Help better community development by reducing volatility. • Develops safer community by increasing harmony. • Immediate and politically visible benefits to home buyers and also to the politicians (i.e., electorates). • Boosting public choice theory. • Quick response to the housing demand. • Meeting actual needs in the short term. • Positively affecting the building and construction industry. • New property supply in the market. • Relieve pressure on the rental market. • Increase borrowing capacity from banks.
Weaknesses	Price increases at the lower end of the market.	4	• Benefits go to vendors via purchasers. • Tax payers are funding unaffordable prices. • Causes market distortion. • Wealthy people are the winners. • Capital gains are not really helpful and ending up with severe affordability problem. • Its impact on old property buying is minimum. • Negative gearing should be targeted to new housing. • Now only 20K available to newly build houses. • Not helping many people in Rockhampton. • Stay upto six month within the first 12 months.
	Not designed for all low income people such as people with disability or the people with part-time or casual works.	2	
	May lead to financial burdens to the individual at a later stage, when they do not have a source of income.	2	

Opportunities	Should be applicable to low to medium income people.	2	• Government can save money in the longer term if the community is stable. • Only new houses should be eligible. • Immediate reaction to need (but certainly creates long term troubles). • Can be used during depression or recession period. • Long term application to the new properties. • Need to introduce this to the established home. • Incorporating something with superannuation, for example NZ has such a model that can replicate in OZ. • Direct reduction of grant from the principal but not at the end of purchasing the house. • May have affect on the building and construction industry. • May reduce the rental value in the market.
	Increase amount of home ownership.	3	
	Supporting the property market.	2	
Threats	May lead to oversupply of property.	4	• The scheme can't continue indefinitely. • The construction industry will suffer if the scheme is phased out. • Political dependence. • Market dependency on the scheme. • Political embarrassment if discontinued. • Does not change the affordability situation. • Economic pressure on federal budgets. • Reduce other grants. • Flow-on-effects on other community services. • Huge stocks development and then affecting the both rental and buying property markets. • Gap between purchasing and selling price is widening in the regional area. • Threat to the investors who are dependent on rental properties only. • May increase the vacancy rates. • May crash the property market like USA.
	May increase number of mortgage defaulters in the long run.	2	

Table 3: SWOT Analysis of Community based Housing Initiative

Dimension	Popular Opinions	Frequency	Other Opinions
Strengths	Being able to house the people otherwise in risks of homelessness.	5	• Immediate and politically visible benefits. • Rental subsidy and gap between the cost and rental is filled by the government. • In the last 12 month, there is a decrease in AUSCare facilities and increase in moving to private renting. • In-kind support from various organizations. • Provide transitional accommodation to the lower income group or the people in dire need.

			• Provide crisis accommodation and social and public housing. • Managing NRAS housing. • Aglicare has some protection policy of property damage management. • People progressively can have home ownership through community housing. • Lots of supports (housing and other social supports) from the providers.
Weaknesses	People are becoming dependent on the system and this can continue generation after generation.	2	• Fluctuation of demand over time and geography. • House ownership is falling. • Stocks sometimes are not enough to support the total need. • Low rental income and not steady income. • High property damages and high maintenance costs. • Ageing stocks and lack of suitability of stocks. • Artificial cap duration. • Not a well publicised initiative. • Focus on people who are within their group of interest. • Depending on government subsidy and budget constraints.
	Dysfunctioning the property market.	2	
	Agglomeration of socially disadvantaged people in one place may create violence and crime.	2	
Opportunities	Accommodation for the people in crisis.	4	• Potential for society - tiny part of the community. • Maintaining welfare in the society. • Social housing stocks development within all types of housing estates or suburbs. • Working with private sector. • Working together to the community engaged program. • It is able to improve the current circumstances.
Threats	Politically dependent whether government support them or not.	4	• People becoming increasingly dependent. • Wealthy people are becoming wealthier. • Payment comes from Centrelink payment and the revenue from individual payment only covers less than 10% of the total costs. • Not in my background (NIMB) behaviour of the mainstream people can decrease the stocks. • Wrong mix of people living in close proximity. • Increased level of drugs and alcohol use and socially unacceptable behaviours. • Conflicts between the people living within the blocks. • Many people are taking advantage of the system.

Table 4: SWOT Analysis of Commonwealth Rental Assistance

Dimension	Popular Opinions	Frequency	Other Opinions
Strengths	Supporting the dysfunctional housing or the poor income families.	6	• People with public housing do not get this assistance. • It is really a good system to support the lower income families. • Poor people can survive with such funds. • Financial assistance to low income people. • Helping people to meet the basic needs. • Government recognised rent as an important bill or cost to the households. • Helps with more disposable income.
Weaknesses	Increase people's dependency on the system.	5	• Community housing is not eligible for CRA. • Since subsidy is provided in the demand side, rental price goes up in many cases. • People are trying to fraud the system. • A large number of low income people's concentration to a low rental area. • Clumping people to a cheaper area. • It is a great expense to the government.
Opportunities	Opportunities for the financially, mentally or physically vulnerable people.	3	• This scheme could be made supply side to prevent price hike. • Less political risks. • It can be designed as an opportunity to be a financially resilient person. • Tag such funding with community models. • Can be paid directly to the land lord. • Rental assistance can be remodelled in such a way that the people cannot fraud. • Reduces lots of other social costs such as homelessness, anti-social behaviour, drugs and crimes.
Threats	Depending on the country's macro-economic situation, this may create financial burden to the government, especially during the down turn.	4	• Political dependency. • Current system is not smart enough to identify the people with needs.
	Uncertainty that Federal Government might put this scheme at risk.	3	
	Many people are not respecting the system.	2	

Table 5: SWOT Analysis of National Rental Affordable Scheme

Dimension	Popular Opinions	Frequency	Other Opinions
Strengths	This helps the market to deliver affordable housing in the short run.	2	• Very well system with strong governance framework.
Weaknesses			• This scheme is ineffective for casual workforce. • It solved the housing affordability problem for an interim period but it is yet to know what will happen after ten years. • Overstock of housing may lead to market failures.
Opportunities			• It attracted lots of mum and dad investors. • This program should be extended for another 10 years. This should include fully renovated houses,not only new houses. • This is a public housing scheme under private sector.
Threats			• In regional Australia, during the burst phase of the economy, it is detrimental to the housing market as well as to the investors. • Reduced rent for tenant can provide temporarily relief for the low to medium income people but it will bring serious financial shocks for the people who did not increase their level of income or whose circumstances changed. • Government has stopped this initiative and no money left for maintenance of those properties.

Table 6: SWOT Analysis of Council's Subsidy/Assistance to Low-cost Land Development

Dimension	Opinions
Strengths	This would increase the revenue for the council as number of properties grows.
Weaknesses	When properties are densely populated, there is lack of privacy and people tend to fight each other.
Opportunities	Joint venture with private sector can reduce the financial risk of the council. Reduction of car park requirement can allow more houses to be built.
Threats	This could induce anti-social behaviour if all low income people are living together.

Table 7: SWOT Analysis of Resource Industry's Rental Subsidy Scheme

Dimension	Opinions
Strengths	This would increase affordability for some local residences but not all.
Weaknesses	It is a one-off process and pushes property prices up.
Opportunities	Community housing providers can use this subsidy to help the people in need.
Threats	Huge market distortions once such subsidy is ceased at the end of the resource boom.

Table 8: SWOT Analysis of Urban Land Development Authority (ULDA) Scheme

Dimension	Opinions
Strengths	Usually surplus land is being used. Small blocks are produced in mining towns to accommodate more houses which lead to cheaper development.
Weaknesses	There could be backlash from existing residents.
Opportunities	User friendly and affordable housing design may improve the housing situation.
Threats	Oversupply of land could be a threat to private developers.

Table 9: SWOT Analysis of Community Housing

Dimension	Opinions
Strengths	Provide housing to very needy people who otherwise would be homeless.
Weaknesses	This scheme alone may not be sufficient as some people have complex needs that require some other facilities.
Opportunities	Community-private-public partnership would reduce financial risk.
Threats	Too much dependency on government funding.

Table 10: SWOT Analysis of Public Housing via Community-based Organisation

Dimension	Opinions
Strengths	Provide housing to very disadvantaged people who would otherwise be homeless.
Weaknesses	Clustering of very low income groups may escalate crime and socially inappropriate behaviour.
Opportunities	Better way to use government owned housing stocks.
Threats	Even though public houses are given free to the community based organisations there are huge costs of maintenance and operation and rental income from those properties cannot cover these costs. Eventually these organisations are becoming dependent on the government funding. Therefore, availability of government fund is a big issue in running such housing scheme.

Table 11: SWOT Analysis of NGO Services

Dimension	Opinions
Strengths	Make people self-reliant through housing, employment and social support, and integration of the refugees with the mainstream society.
Weaknesses	Not designed for other socially disadvantaged people.
Opportunities	Ensure sustainable settlements for migrants and refugees in the regional and rural areas, where there is a need for permanent labour force to rural and regional industries.
Threats	Inconsistency in the government funding may affect the outcomes of such services.

5.3 Strategies to Improve Housing Affordability – SWOT Strategy

Numerous suggestions were provided by the stakeholders to improve different housing affordability schemes. These are presented in order of their importance below.

i. Rental assistance or other types of housing support should be designed based on supply, demand and population characteristics. It should not be like all-fit-in-one-shoe but should be based on geographic region and social condition.

ii. At micro or local level, place based planning and development should be implemented. At macro level, it requires adoption of affordable rental legislation and political will to deliver affordable housing.

iii. Place-based decision making should be adopted to better suit the local needs.

iv. Affordable housing solutions should be customised to achieve the best value for dollar.

v. Paradigm of offering assistance is not the solution to the problem but people should be responsible for their own destiny and shelter.

vi. Community or social housing should not be as a part of lifestyle for generation after generation. Government should regulate the people who are living in public housing for a prolonged period of time.

vii. Theoretical development on the moral ground of providing affordable housing is essential.

viii. Need to have a government department to understand the needs and a governance system for social housing providers.

ix. Public-private partnership should be promoted to deliver affordable housing.

x. Small housing service providers need to be encouraged with some government incentives or by public-private partnership.

xi. Need to have more social housing providers with various models of dwelling facilities provision.

xii. Should make better use of land, specially using redevelopment.

xiii. Improvement of public transport facilities is needed to supplement housing facilities.

xiv. Some policy changes are necessary to make houses more affordable for lower income groups.

xv. Need to increase funding for crisis housing.

xvi. Innovative housing design (financial package and physical design) should be adopted for better affordability.

xvii. During the resource boom period, fly in and fly out opportunity with the capital cities should be included in the resource industries management model and then affordable housing plan could work in the regional cities.

xviii. Negative gearing and FHBG should be applicable to new properties only.

xix. Need to waive stamp duty to reduce purchase cost.

Furthermore, a number of issues were identified by the stakeholders, which require attention for future research or policy making. These are summarised in order of their importance below.

i. Longitudinal study to examine the availability of governments' various housing incentives versus housing affordability improvement.

ii. Research on how to increase the resilience of the people, especially to increase the people's expectation to have a better life with better housing and financial condition. Development of multiple models than can provide affordable housing to the low income people.

iii. Review of the relationship between Centrelink payment and affordability or housing market dynamics.

iv. Mechanisms to ensure accessibility to the basic human services by the low income people without compromising their dwelling need.

v. Future Research on demand management, alternative demand management models, availability of housing and the population characteristics.

vi. Research on Long term non-linear housing demand forecasting.

vii. Currently, cost of producing a new house is too much and is sold to the market less than its value. There should be some study on financial and physical mechanisms that can produce house with lower cost.

viii. Policies should be in place for zoning of low-cost housing near the inner city boundaries.

ix. We usually define affordability with 30% of housing costs. But it require a better definition with comprehensive costs of living, its risk assessment etc.

x. Research on how good the national regularity system for community housing (NRSCH) is working; secondly, how it could be made work better, rather than conducting some annual audit.

xi. Fundamental work on the relationship between community development, economic growth and housing policies.

xii. Evaluation of 2001 social housing policy, especially its effectiveness and comparison of this policy with the new policy.

xiii. Critical review of the economic theories and political economics.

6. CONCLUSIONS AND RECOMMENDATIONS

Housing affordability in the regional cities has particular pattern and characteristics. In this study, housing affordability mechanisms in Rockhampton City, Central Queensland region has been examined. The study found that most of the existing housing affordability mechanisms are effective in helping people in hardship to rent or own a house. However, the demand side mechanisms may push property prices or rents up, while the supply side mechanisms may lead to overstock of properties ending up in market distortions. Since almost all the schemes are heavily dependent on government funding, there is a fair bit of uncertainly whether these schemes would be viable if the government stops funding in future. Community housing is playing a vital role in providing crisis accommodation. People who are long-term beneficiaries of this system tend to become increasingly dependent on it and get reluctant to live on their own. Clustering of low income population in community housing areas could escalate crime and anti-social behaviour.

The study also found that community-public-private partnership to provide affordable housing could minimise the financial risk for the government. The government can save money in the longer term if a stable community can be built around the affordable dwellings. Some schemes, like first home buyer scheme, could be an effective instrument to support the property market and construction industry during recession or depression.

Most of the housing mechanisms examined in this report have been proven to increase housing affordability in one way or the other. However, if they are continued indefinitely without proper regulatory mechanism in place, it might induce various difficulties. The most significant problem is families, who are excessively dependent on the system, may become less resilient and more vulnerable in the long run. Inadequately designed mechanisms could benefit the society in short term but may lead to serious problems in the long run. Housing mechanisms built on robust economic models could provide sustainable solutions towards affordable housing. Proper governance system should be in place to oversee the operation of social housing schemes. Also there is no one-size-fits-all solution for the affordable housing problem. Hence, place based decision and planning should be adopted to better suit the local needs.

Though this study has some limitations, such as it didn't include general people's (beneficiaries) participation because of the nature of the study as well as time and budget constraints. The findings can be generalised to similar cities in regional Australia. Future study could be done on examining the availability of government's various housing incentives versus housing affordability improvement. Future research could look into how to increase the resilience of the people, especially to raise the people's expectation to have a better life with improved housing and financial condition.

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Predicting Workforce Demand and Skill Development for Low-carbon Energy Sector in Queensland

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ABSTRACT

The climate transition strategy of Queensland Government has targeted low carbon economy includes a greater use of low carbon technologies. This study aims to predict low carbon workforce demand and their skilling need for Queensland. This study used a prediction model to forecast future workforce required for a successful transition to a low carbon electricity generation based on the available secondary data and literature. In addition this study conducted an employer survey on the requirement of the skilled workforce and the level of professional skills. The research results indicated that more than 5,300 new workforce will be required in construction, commissioning and servicing of new and/or existing power plants and facilities, with most of these being located in regional Queensland. The study results also suggest the need for a workforce transition policy and planning that may include retraining and skilling traditional workforce to the newly emerged sector.

1. BACKGROUND AND AIM

Federal and state governments in Australia have been trying to produce more low carbon energy, create green jobs and retrain existing workforce for a while (Energy Skill Queensland, 2011). A report by DRET, GA and ABARE (2010) has showed that Australia's total electricity demand is expected to double by 2030.The growing community preference for cleaner energy sources, combined with the need to transition to lower-carbon industries and communities, are the two key challenges that have emerged in the Australian energy sector in recent years. Meeting these will require innovation through research and development (R&D) for both new technologies and new business practices.

To date, the key governmental reforms in the Australian energy sector have involved new governance and legislative arrangements, including the establishment of the Australian Energy Market Operator (AEMO) in 2009; revisions to laws governing electricity networks; and the creation of new laws governing gas networks (Commonwealth of Australia, 2010). One of the most important federal influences on the Australian energy sector is the expanded national Renewable Energy Target (RET) scheme, which has implemented a target of 20% of Australian electricity supply to be based on renewable sources by 2020. This target will accelerate the development and use of lower-emissions technologies in the shorter term. Furthermore, the anticipated introduction of a carbon pollution reduction scheme (CPRS) will also help cleaner technologies to become embedded into the market over time. It is expected that these RET and

CPRS measures will combine may create an alternative energy sector that is 30 times larger than its present size by 2050 (Commonwealth of Australia, 2010).

According to DIIS (2016), energy consumption in Queensland was increased by 8% between 2014 and 2015 while electricity generation was increased by 13% on the same period of time and Liquefied Natural Gas (LNG) industry played significant role in this increase in electricity generation. Gas fired electricity generation is also considered as low carbon electricity sector. In this context, it is imperative to identify the required labour force for low-carbon electricity generation in Queensland. Therefore this paper aims to predict the potential workforce in this sector of Queensland and to identify the training needs for new works force and retraining the existing workforce

This introduction forms Section One of this paper followed by a literature review on low carbon energy in Queensland in Section2. Section 3 describes the methods used for this study. Section Four presents the findings of the industry survey and potential workforce demand prediction respectively. Section Five concludes this paper.

2. LOW CARBON ELECTIVITY GENERATION

Low carbon energy refers to the technologies of energy production with lower amount of CO_2 comparing to the fossil fuel. The Queensland Government has adopted low-emission coal technologies as a test case for utilizing Australian coal with low cost electricity generation (DEEDI, 2010) and these inclidecarbon capture and storage (CCS) technologies. These technologies would reducethe emissions of greenhouse gas (GHG) to the atmosphere from energy production. A number of technologies can help reduce GHG emission from coal-fired power generation; however, this study considers the following clean-coal operations:

- Pre-combustion capture, also known as integrated gasification combined cycle (IGCC);
- Post-combustion capture (PCC); and/or
- Pulverised coal oxyfuel combustion.
- Geosequestration (carbon storage)

In pre-combustion capture, CO_2 is removed from the coal before it is burnt, by converting it into a gas consisting of carbon monoxide and hydrogen (GA and ABARE, 2010). Pre-combustion capture technology has already been shown to be economically feasible under specific conditions and is already widely applied in fertilizer manufacturing and in hydrogen production (Metz et al., 2005). Integrated Gasification Combined Cycle (IGCC) is currently the key method of pre-combustion capture. IGCC plants are not only creating less CO_2 emissions but also reduced emissions of sulphur oxides, nitrous oxides and particulates and alsoable to operate with reduced water demand. A number of IGCC commercial-sized demonstration plants are currently operating globally, including several in the United States and Italy (WCA, 2010).

In contrast, post-combustion capture (PCC) involves separating CO_2 from the gas stream produced after the coal is burnt; by using a combination of solvent (liquid) and steam to capture carbon dioxide (CO_2) from power station flue gases (CSIRO, 2008). Cuirrently this is the most developed carbon-capture technology in the world (Paterson, 2006). In Australia, PCC pilot plants already exist in New South Wales, Victoria and Queensland.

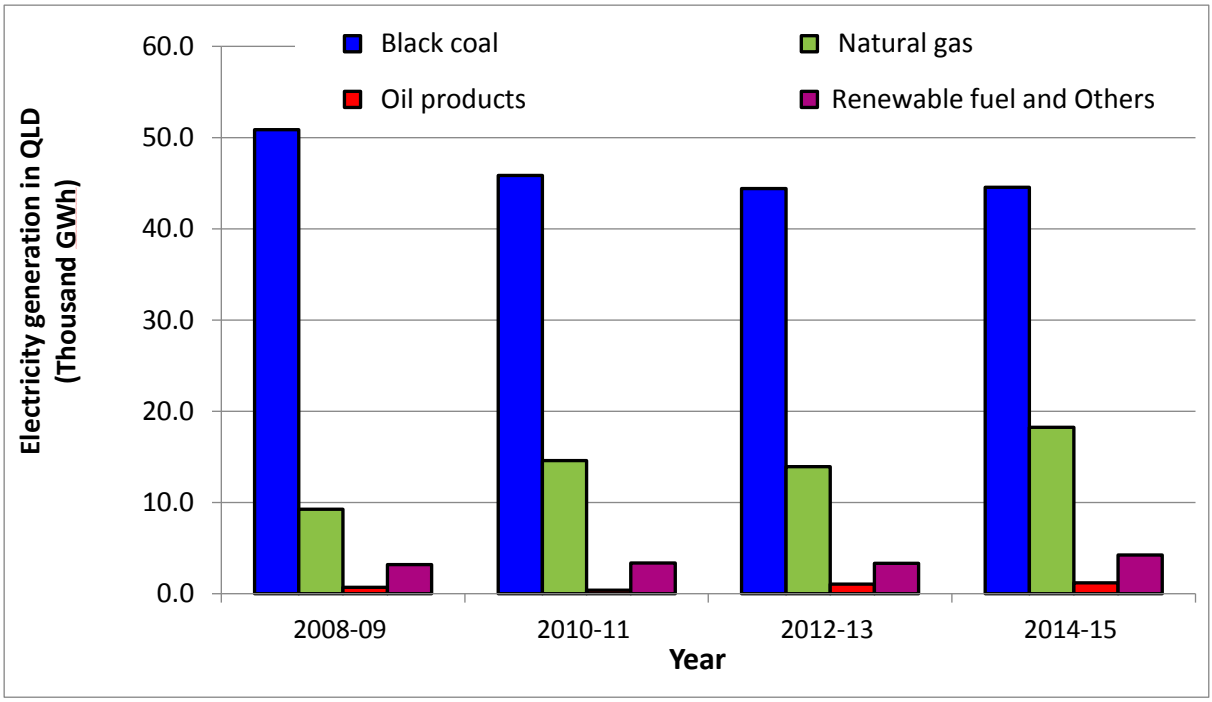
Finally, pulverised coal oxyfuel combustion capture (‘oxyfuelling’) is a special form of post-combustion capture that involves using concentrated oxygen (instead of air) to combust coal in a boiler. The principal difference between oxy-firing and air-firing of pulverised coal is the

relative composition and quantities of gases passing through the boiler andthis results in different combustion characteristics and then consequently, different flue emissions (CCSD, 2007). Oxyfuelling is advantageous in being a relatively simple and comparatively low-cost process and can be applied via retrofit to many boiler/firing systems (GA & ABARE, 2010). After retrofit of the Callide Power Station with oxyfuelling technology, it was tested in central Queensland.

Geosequestration technology has been developed since the mid-1990s, and storage sites have been operating in Northern Europe and the United States for over a decade, particularly where the injected CO_2 is used to improve oil recovery (Paterson, 2006). In Australia, the two principal types of geosequestration sites are saline water saturated rocks (where the CO_2 dissolves into the saline water), usually at depths below 800m; and depleted oil and gas fields (ACA, 2010). Geosequestration can also occur in other niche storages, such as coal seams and beneath the sea floor. Other emerging sequestration options include the use of algae to capture emissions (biosequestration), with the algal biomass later being harvested for agricultural purposes, or used as a feedstock for bioenergy production; and that of carbon mineralization, where CO_2 reacts with minerals to form new compounds (ACA, 2010).

Natural gas can be classified based on their chemistry, physical features and source into four major categories: liquefied natural gas, liquefied petroleum gas, coal seam gas and waste coal mine gas. All these categories are basically a combustible mixture of hydrocarbon gases including methane, ethane, propane, butane, pentane, nitrogen, carbon dioxide and hydrogen sulphide (GA and ABARE, 2010; Roarty, 2008). One of the key benefits of gas-fired generation in the electricity sector is that this produces low-carbon electricity and it is economically feasible and affordable to the consumers (APPEA, 2007). This is in direct contrast to coal where low-carbon technologies are still not producing low cost electricity.Currently, there are two principal types of gas-fired technologies available for use in power generation: open cycle gas combustion turbines (OCGTs) and combined-cycle gas turbines (CCGTs), which are operated by a single air compressor and gas turbine connected to an electricity generator.

Figure 1: Electricity Generation in Queensland, by Fuel Type



Source: DIIS (2016a) Australian Energy Statistics, Table O4.

This study specifically aims to predict the workforce required for two types of power generation industry: Oxy-fuelled coal fired power industry and gas fired power industry because the majority of power generated in Queensland is from thesetwo types of industries. Figure 1 shows the current electricity production from power plants with different types of fuel. The figure indicates that electricity generation from black coal has declined about 12% over the last 7 years. In contrast aatural gas and oil fired power stations have generated about 97% and 68% more electricity respectively in 2014-15 compared to 2008-09. Electricity production from renewable fuels has shown a great potential with a 70% increase in the same period.

3. METHODOLOGY

The research used a mix of survey data together with aggregate workforce figures and power generation capacity of various sites as available from the literature. Labour force data had been collected from Gas fired power plant through the industry consultations survey. These data were combined to generate an assumed production capacity-employee ratio (current and potential operations), in order to forecast the labour force at construction, commissioning,operation and maintenance stages that will be required in Queensland' gas-fired power industry to 2025. The ability to cross-check the production-to-employee ratio through the industry intelligence means that this method has greater rigour compared with modelling that is based on linear prediction methods. However, complete accuracy of the approach is still not realised and the key assumptions and limitations of the research method are described below.

The following baseline equations were used to generate overall employment figures for gas-fired power stations out to 2025:

$$W_C = D_C \times P_R \quad (1)$$

$$W_F = W_C + D_P \times P_R \quad (2)$$

$$W_R = W_F - W_E \quad (3)$$

W_C = Workforce for the currently operated plants

D_C = Forecasted Demand from the current currently operated plants by 2025

P_R = Production-ratio

W_F = Future workforce

D_P = Nameplate capacity of the proposed plants that will be commissioned by 2025

W_R = Required workforce

W_E = Existing workforce

Production ratio was generated though a ratio method between a known source of electricity production or production capability (e.g., megawatt hour) and a standard source of labour force requirement (number of persons), for a particular type of technology used for gas-fired power generation (e.g., open-cycle turbines).

All modelling exercises are associated with assumptions on which modelling is based, in order guide the context and accuracy of findings and ensure that results are interpreted correctly. The current growth rate of gas fired power generation will continue until 2025; and that predicted gas supply will be continue until 2030; no major technological change is assumed occurs in this sector before 2025; state and national energy generation policies would remain similar until 2025; key generation technologies for the gas-fired sector have been considered under one of two groups: either open-cycle gas turbine (OCGT) or combined-cycle gas turbine (CCGT).

In addition to these assumptions, the modelling was done on the basis of collated data from as survey conducted on 2011 and any changes that have occurred in the workforce pattern after that till date are not considered. Secondly, there are a number of inherent challenges associated with predicting labour force requirements in the gas-fired power generation sector in Queensland, as well as with identifying labour force supply and relevant education and training facilities. For example, any modelling is dependent on rigorous baseline data from existing operations, in terms of both aggregate (total workforce) and detailed (job-role specific) personnel numbers.

In extent to the workforce modelling this study also approaches to identify the requirement of the skill set for the future labour force. Finally, the modelling is considered to be a conservative estimate of workforce demand, due to the forecast industry growth rate being based on the current industry growth rate. Considering that the likely introduction of a public policy instrument for carbon management (e.g., carbon tax or emissions trading scheme) would favour the gas industry, it is very likely that the actual generation capacity and sector share represented by gas will be higher than expected by 2025.

4. INDUSTRY SURVEY FINDINGS

Conducting consultation with the clean-coal industry in Queensland proved was very challenging with research efforts being hampered by factors like the timing of surveying (at the end of the year), the distractions of the Queensland flood crisis and the difficulty of finding current contact details for the extremely small number of clean-coal installations that exist in Queensland (either planned, or operational). During one telephone conversation, an industry employee acknowledged that information around clean-coal developments, and the outlook of the sector generally, was very poorly understood, with an acute lack of data. After unsuccessful attempts to gain data from Queensland and Australia, about 15 international company was contacted to collect some information. Unfortunately this attempt was not fruitful as only two companies were responded with refusal on providing any data. To get an idea of summative workforce, a few case studies has been employed. Some data was collected from Environmental Impact Assessment statements of three clean coal projects namely, Callied Oxyfuel plant, Galilee Power Project and Wandoan Power Project.

4.1 Callide Oxyfuel

Callide Oxyfuel operated by CS Energy Limited represents a world-first retrofit of oxyfuel combustion and carbon storage to an existing power station. Current status of three power stations are as follows in Table 1 (CS energy, 2016).

Table 1: Status of the Units of Callide Power Plant

Power station	Production	Status	Clean coal technology
Callide A	120 MW	decommissioned	Oxyfuel combustion with geosequestration
Callide B	700 MW	Operating	N/A
Callide C	810 MW	Operating	N/A

Callide A was retrofitted with oxyfuel technology and then commissioned in 2012 to generate electricity with low emissions. Callide A operated in oxyfuel combustion mode for more than 10,000 hours from 2012 – 2015 and is now being decommissioned. According to their project

director, the plant has demonstrated successful carbon capture technology for two years of test run and now it is ready for commercial application. The current permanent workforce is 205 workforce (QG, media statement 2017) and the major portion of the workforce are operator technician as per the collected data for this project back in 2011.

4.2 Galilee Power Project

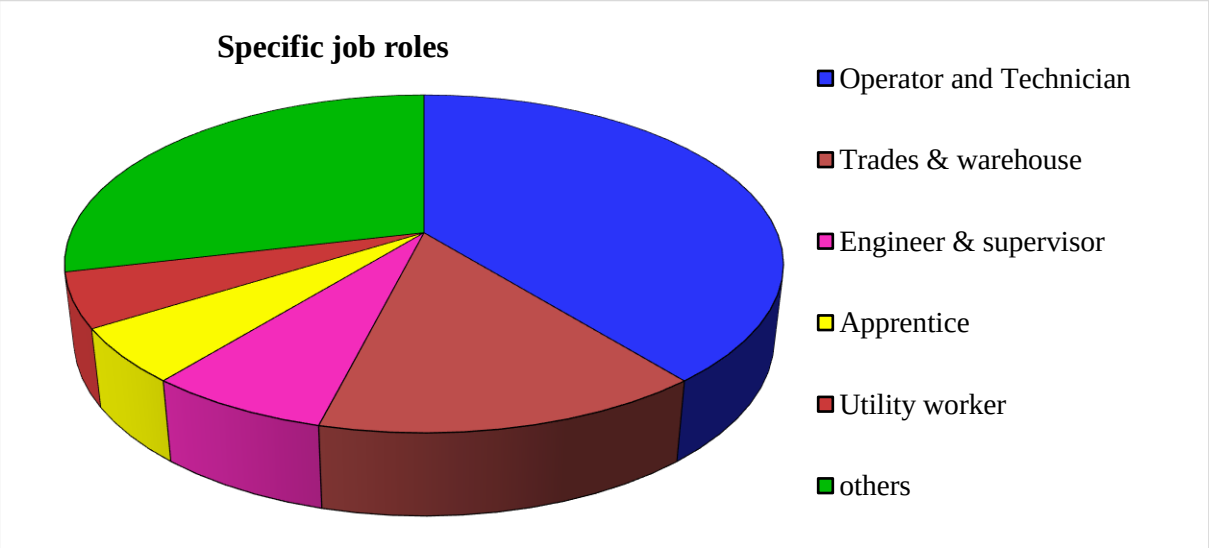
Waratah Coal Ltd (Galilee Power Pty Ltd) has a pre-feasibility study underway for a new 450 MW (stage 1) power station to complement the proposed China First coal mine in the central west of Queensland. An additional 450 MW may be available through an additional module (plant upgrade), subject to demand from the National Electricity Market. The station is tentatively scheduled for first coal production in late 2013, with the power plant operations in 2017 (initial advice statement). The initial advice statement provided to the Queensland Department of Infrastructure and Planning indicated that the power station will utilise waste coal from Waratah Coal's tenements as power station feedstock, and will use IGCC as the preferred power generation technology (Waratah Coal, 2009). The proposal also noted the intention to incorporate CCS technologies into the power station design and to sequester the compressed CO_2 produced from the power station at one or more sites in the Galilee Basin.

4.3 Wandoan Power Project

The Wandoan Power project will establish a 510 MW power plant (334 MW net) with CCS capable of capturing 90% of CO_2 emissions, through the use of IGCC pre-combustion CCS technologies (DEEDI, 2010). Identification of suitable storage sites is now being undertaken by the Wandoan Power Consortium between Stanwell, Xstrata Coal and GE Energy. Successful assessment and funding support would be required to move to the feasibility study stage (Wandoan Power, 2011). A two year design and development period, followed by a four- to-six year construction timeline is expected.

According to the consultation survey it was identified that approximately 2,000 personnel is expected for the construction/commissioning phases of the planned clean-coal operations, but that less than 40% of this workforce will be needed for ongoing operations and routine maintenance.

Figure 2: Expected Workforce Requirements for Callide Power Plant



Source: Industry consultation, data provided to ESQ in 2010.

Detailed workforce data, where employee numbers are provided for specific job roles, was only available from one generator: this indicated that the operational labour force of the Callide power plant will require a large proportion of technical specialists in control systems, electrical and mechanical fields (Figure 2). As it was mentioned earlier that a detail workforce analysis was not initiated due to lack of information and the uncertainties around the support for, and growth of, the clean-coal sector in Queensland. However, the case studies provide a general information of the workforce requirement in the clean coal energy sector.

Recent data from Australian energy market operator indicate that in Queensland about 26% of electricity is produced from gas fired power station (AEMO, 2017). Table 2 shows that the in addition to the current production facility, 2045 MW capacity OCGT power stations are proposed for the coming years (AEMO, 2017).

Table 2: Queensland Existing and Potential New Developments by Generation Type (MW)

Status	Coal	CCGT	OCGT	Gas & other	Renewable	Total
Existing	8186.0	1210.5	1894.5	208.4	1064.3	12563.7
Announced Withdrawal	0.0	0.0	34.0	30.0	0.0	64.0
Existing less Announced Withdrawal	8186.0	1210.5	1860.5	178.4	1064.3	12499.7
Committed	0.0	0.0	0.0	0.0	462.3	462.3
Proposed	0.0	0.0	2045.0	0.0	5043.2	7088.2

This study initially targeted to collect data from all the gas fired power station through a telephone survey. However, this task proved to be extremely difficult as obtaining the contact details of the right person was complicated due to ownership changes, different managerial hierarchy and lack of responses. Eventually, contact was made with ten of the natural gas-fired plants and to increase the acceptability, data had also been collected for other three power plant from different parts of Australia. The majority of the surveyed generators were new installations operating since 2009 (though one had been operating since 2000); and the expected infrastructure lifespan ranged from 25 years to 30-40 years per unit. The reported length of periodic maintenance shutdowns was quite variable across generators, but following the general pattern of repeated, short-interval breaks (e.g. operations of one unit are suspended for two weeks per annum).

Among the surveyed power stations, approximately 50% staff were working in general operation and maintenance of the plant, 30% are represented by specialist technicians and 20% are engineering or administrative personnel. Few of the participating gas-fired generators were able to report the staffing requirements for their research and development phases, regardless of the technology type (e.g. OCGT compared with CCGT). In order to align with the workforce modelling component of the research project, the data for both the 'construction and commissioning' and 'operations and maintenance' phases of gas-fired generators were treated in terms of the two different technology types (OCGT and CCGT). According to the industry consultation results, the labour force required during the construction and commissioning

phases of gas-powered installations appear to be usually supplied by the contractors. Based on the survey results the production ratios has been identified and used for workforce prediction.

Furthermore, based on this approach, two different set of ratio were used to prepare overall workforce numbers for two existing technology (table 3). Unfortunately, these are difficult to compare with existing (published) multipliers, since the latter use different units of expression. For example, Wei et al. (2010) provided figures based instead on job-years (0.11 job-years per GWh for direct jobs associated with gas-fired technologies); and Kammen et al. (2004) quoted that more personnel were associated with operations, maintenance and fuel processing than for construction, manufacturing and installation (0.70 and 0.25 jobs per installed MW, respectively).

Table 3: Coefficients (Multipliers P_R) used to Calculate Total Workforce Numbers for Gas-powered Generators

Technology Type	Operational phase	Co-efficient
OCGT	Construction and commissioning	2.333 persons / MWh
	Operations and maintenance	0.162 persons / MWh
CCGT	Construction and commissioning	0.796 persons / MWh
	Operations and maintenance	0.058 persons / MWh

One of the important finding through the survey was the case of periodic shutdowns, which require a mixed workforce comprising specialised engineers in the electrical and/or mechanical fields, manager and skilled labour roles (electrical tradespersons, welders and fitters). Although these represent relatively small workforce requirements, it is important to recognise the additional pressure that periodic shutdowns place on the available labour supply, given that these are often conducted annually and on a revolving unit-by-unit basis. In many cases, staff are hired from other power stations or contracted in to cover workforce needs during these times. Several survey respondents indicated that shutdown staff are sourced through a tendering process: this may result in a considerable movement of the mobile contracting workforce through different sites year-to-year. However, there are also cases were the permanent (in-house) staff are seconded to special duties during annual maintenance periods, reverting to normal duties for the remainder of the year. Highly specialist expertise may also be sourced from the original engine manufacturers, and this often means international sourcing of professionals.

5. POTENTIAL WORKFORCE DEMAND

Modelling of the aggregate (total) workforce numbers for the gas-fired sector in Queensland revealed a difference in figures between the OCGT and CCGT technology types. For example, in 2010, the industry consultation showed that some 3,778 persons were working in the construction and commissioning phases of Queensland's operating OCGT power stations. A further 310 persons are also working to support the operations and maintenance phases. The desktop modelling indicated that a new labour force of 4,764 persons will be required by 2025 in order to supply the workers required for construction and commissioning of the proposed OCGT power stations (table 4), with a further 331 permanent persons being required to run these OCGT installations. However, it should be noted that aggregate workforce numbers does not include personnel required during periodic shutdown intervals, given that this typically represents a mix of both permanent and mobile (contracted) workers.

On the other hand, the modelling estimates showed that in 2010 Queensland currently had 764 persons employed in the construction and commissioning of CCGT power stations across the state, with 54 persons working in the operations and maintenance phases. By 2025, the labour force requirements for Queensland CCGT-based gas generation sector will include some 199 new roles in construction and commissioning, and 16 new roles in operations and maintenance, based on an expected CCGT-based plants (table 5).

Table 4: Gas Fired Power Generation Labour Force Forecast until 2025: OCGT Technology

Phase(s)	Construction and commissioning	Operation and maintenance	Total Personnel
Existing Labour force, W_E	3,778 people	310 people	4,069
Total LF until 2025, W_F	8,542 people	641 people	9,164
New labour force, W_R	4,764 people	331 people	5,095

Table 5: Gas fired Power Generation Labour Force Forecast until 2025: CCGT Technology

Phase(s)	Construction and commissioning	Operation and maintenance	Total Personnel
Existing Labour force, W_E	764 people	54 people	818
Total LF until 2025, W_F	963 people	70 people	1,033
New labour force, W_R	199 people	16 people	215

NB: Retraining is not included in these figures.

5.1 Job-role Specific Workforce Demands (Priority Roles)

The survey also revel the number of priority job roles for Queensland's gas-fired power generation sector, if considered based on the highest number of created positions. For example, 347 new operation and maintenance jobs to be created until 2020 by growth within the sector and the key job roles will include control systems operators, mechanical technicians (tradespeople), overhaul engineers, utility maintenance workers and administrative support personnel (Table 6).

Survey respondents also identified the following roles as being areas posing current recruitment problems:

- High voltage switching operators;
- Electrical (power) and instrumentation engineers and operators;
- Commercial staff specialising in gas and electricity transactions;

- Electrical tradespeople; and
- Sales personnel (relevant to the energy sector).

In addition, respondents anticipated that recruitment of professional staff in gas-generation power station managers and mechanical engineers were likely to pose a recruitment challenge in the future.

Table 6: Job Role Specific New Labour Force Requirements until 2025 in Gas Fired Power Stations in Queensland: Operation and Maintenance

Job / Roles	Persons	Proportion (%)
Site Manager	4	1.24
Engineering superintendent	4	1.24
Overhaul & Operation superintendent	7	2.07
Maintenance superintendent	4	1.24
Control systems		
Engineer	6	1.80
Supervisor/coordinator	4	1.24
Operators	63	18.12
Technician/trade person	23	6.64
Mechanical		
Engineer	9	2.49
Supervisor/coordinator	6	1.80
Technician/trade person	21	6.09
Apprentice	11	3.04
Electrical		
Engineer	9	2.49
Supervisor/coordinator	11	3.04
Technician/trade person	12	3.60
Apprentice	11	3.04
Overhaul & Planning		
Engineer/Planner	16	4.56
Supervisor/coordinator	4	1.24
Project Officer	9	2.49
Technician/trade person Fabrication & others)	6	1.80
Water and chemical		
Engineer/Scientist	4	1.24
Supervisor/coordinator	9	2.49
Utilities & facilities & IT		
Team Supervisor	2	0.55
Refrigeration Mechanic	4	1.24
Maintenance Worker (Technical & Ute)	19	5.39
IT Specialist	4	1.24

Job / Roles	Persons	Proportion (%)
Administrative and others		
HR/management support officer	6	1.80
Admin support officer	21	6.09
Commercial officer	5	1.52
Environment Officer	4	1.24
Health, Safety and Rehabilitation Coordinator/Officer	6	1.80
Supply Coordinator & purchasing officer	6	1.80
Warehouse Officer	11	3.04
Security guard	4	1.24
Total	**347**	

5.2 Current Skill Development and Training Pathways

Generators who participated in the research survey reported a mixture of opinions on education and training pathways available in the sector. There was a perception that training of management staff was something that had to be undertaken in-house, rather than by external training organisations. This was of benefit since site-specific knowledge could be incorporated into the role. This same is also likely to be true for technical staff.

TAFEs were most commonly identified by research participants as the key education providers and/or registered training organisations that were supporting the sector. A few additional companies also mentioned sourcing more specialist knowledge about particular manufacturer's components and infrastructure from providers such as:

- The 'HRSG' Academy (which provides training in 'heat-recovery steam generators', and operates from an Australian office in Glen Waverley, Victoria);
- The TAE Group (a repair agent for Honeywell turbine engine fuel components)

It was also identified that overseas training might be required for specialist areas of expertise as the respondents identify the lack of relevant training institution and learning program in Australia.

A review of secondary data (grey literature and online material) has shown that there are a number of strategies already in operation relating to skills needs for the CSG and LNG industries, though these do not focus directly on the power generation sector. According to the predicted workforce figures at least 347 operation and maintenance staff need to be educated and trained to meet demand in the state natural gas sector to 2025. It is also expected that further pressure will also be placed on education and training through demand from clean-coal developments and other parts of the energy sector (particularly renewables). A preliminary scan of Queensland's existing tertiary institutions, TAFEs and other training organisations demonstrates that relevant courses in a number of expertise areas are widely available.

6. CONCLUSION AND RECOMMENDATION

Though there is a recent indication of reduction in gas supply, the gas-fired power generation is expected to continue in the next decade in Queensland, with yet further expansion likely following policy changes in the areas of renewable energy and carbon management. Conservative modelling based on the current and planned installations for Queensland to 2025 indicate that a new workforce of approximately 4963 will be needed for construction and

commissioning, and 347 will be needed for operations and (routine) maintenance of the state's gas fired power plants, respectively. This mix of personnel workforce will require development through a range of skilling and training options, but ensuring that the workforce continues to be applied to the natural-gas sector will require careful consideration around supply side issues, particularly in attraction and retention.

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How Does Immigration Impact Metropolitan and Non-Metropolitan Income Distributions in New Zealand? Evidence from 1996 to 2013

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ABSTRACT

Since the 1980s, inequality in New Zealand has been a growing concern - particularly in metropolitan areas. At the same, foreign-born as a proportion of total population has increased as well. This paper investigates the impact of immigration on the distribution of income by means of decomposition methodologies. Data are obtained from the 1996, 2001, 2006 and 2013 Census of Population and Dwellings. We find that the increasing immigrant share in the population is inequality increasing but the changing distribution of migrant incomes is inequality reducing. These results apply to both metropolitan and non-metropolitan areas. These effects combine to contribute to relatively small changes in the distribution of incomes of people aged 25 to 64 in New Zealand over the 1996 to 2013 period.

DISCLAIMER

Access to the data used in this study was provided by Statistics New Zealand under conditions designed to give effect to the security and confidentiality provisions of the Statistics Act 1975. The results presented in this study are the work of the author, not Statistics New Zealand.

1. INTRODUCTION

New Zealand has experienced rapid rates of growth in immigration and inequality particularly since the 1980s; however, the impact of immigration on the distribution of income has not previously been investigated explicitly at national or sub-national levels.

International migration may affect the overall distribution of income in a destination area through three specific channels, which are: 1) the compositional channel – due to differences between the aggregate income distributions of migrants and locals, and the relative proportions of these groups in the population; 2) the migrant-specific income distribution channel whereby income distributions of migrants change differentially from those of locals; and 3) the general equilibrium effect of immigration on the income distribution of locals.

International migrants typically have a different income distribution when compared to locals. For example, migrants may have a different skill distribution from locals and migrant skills

may be rewarded differently in the labour market such that an increase in immigration may widen or narrow the distribution of income. In addition, an increase in the number of immigrants effectively serves as an increase in labour supply and depending on whether migrants serve as substitutes or complements to locals, migration may increase or decrease labour market income of locals. This will have an impact on the overall distribution of income. The impact of immigration on the earnings of locals is one of the most actively researched areas in the labour economics literature (see, e.g., Card, 1990, Borjas, 2003, Borjas et al., 1997, D'Amuri, Ottaviano and Peri, 2010). Finally, international migrants are not a homogenous group. They may represent different age groups, skills, languages, ethnicity, etc. International migration may then impact on the overall distribution of income through changes in the distribution of income among migrants themselves,

Empirically, the evidence suggests that immigration has small effects on individual earnings of locals (for New Zealand evidence, see Maré and Stillman, 2009; Card, 2009, for US evidence, and Longhi et al. 2005 for a meta-analysis of the international evidence). The present study focuses on the other two channels in which migration can affect the overall income distribution: the population composition effect and migrant-specific distribution effect.

Through decomposition methodologies, we categorise international migrants into six different groups and examine the impact of changes in these groups on overall distribution of income between 1996 and 2013 – a period of rising rates of immigration to New Zealand. As well as examining the overall effect, we account for the fact that migrants are disproportionally attracted to metropolitan areas. Recent events like the Brexit vote in the UK has shown that space matters for changes in the income distribution and how people respond to that. Focusing on national effects may be misleading or hide significant differences.

We focus our analysis on the urban area population aged 25 to 64 earning positive income[1]. This way, we aim to capture labour market effects[2,3]. There are certain important considerations in evaluating the role of international migration on the distribution of income in New Zealand: firstly, it is expected that the impact of international migration on the distribution of income will depend on the type of migrant (including New Zealand-born returning from abroad). Secondly, the length of stay of migrants in New Zealand is another important factor to account for when analysing the effect of international migration on inequality. There is existing evidence of convergence in incomes of migrants and locals, the longer migrants stay in host countries (see Stillman and Maré, 2009 for New Zealand evidence). Hence we expect the impact of international migration on the distribution of income to be dependent on the type of migrant as well as their length of stay. We classify migrants by skill level into two groups – *High* and *Medium/Low Skilled*; as well as by their length of stay into *Newly Arrived* and *Existing* migrants. Apart from these groups, there is also a flow of returning New Zealand-born people who were previously residing overseas. It is expected that this groups may have a different impact on the distribution of income than other immigrants and we therefore include them separately.

We find that increases in the international migrant share between 1996 and 2013 have had an inequality increasing effect. The magnitude of the effect is similar across metropolitan and non-metropolitan areas. On the other hand, changes in the migrant-specific distribution of income have had an overall inequality reducing effect. In metropolitan areas, the positive, i.e. inequality increasing, composition effect dominates the negative migrant-specific distribution effect. Together these effects led to migration having a slight inequality increase effect in metropolitan areas. We also find evidence of an income inequality reducing effect of increasing duration of stay in New Zealand among international migrants.

The rest of the study proceeds as follows: Section 2 provides a brief review of the literature on the relationship between migration and the distribution of income. Section 3 describes the decomposition methodologies. Section 4 describes the data and provides some description of the changes in immigration as well as of the distribution of income in New Zealand between 1996 and 2013. Section 5 presents the results and section 6 concludes.

2. LITERATURE REVIEW

Here we will therefore remain brief and focus only on three channels through which international migration affect the distribution of income in destination countries:

- The composition, or shares, effect
- The effect on incomes of locals
- The migrant-specific distribution effect.

2.1 The Composition / Shares Effect

Immigrants typically possess different characteristics from the native born and these differences could impact on local inequality. Immigrants typically have a different skill composition as well as having different returns to skills. Both factors can influence inequality. Card (2009, p. 19) found that immigrants are clustered at the high and low ends of the educational distribution and tend to have higher residual inequality than natives. Immigrants are typically self-selected and the compositional difference could have implications for the overall distribution of income in their destination countries. In New Zealand's case, the compositional effect may be important as a focus of migration policy is to attract migrants to address skill shortages. The impact of this selectivity on local inequality will depend on where most immigrants fall in distribution of income in the destination areas (dependent on the skill distribution of this area and how migrants are rewarded). There is existing evidence that New Zealand migrants are different from local-born and are rewarded differently in the labour market (Stillman and Maré, 2009). Thus, given the pattern of difference between migrants and locals in the skill distribution as well as in returns to skills, it is expected that the compositional effect might be particularly relevant for New Zealand.

2.2 Migration and Distribution of Income of Locals

There has been a lot of effort into understanding the effect of immigration on labour market outcomes of locals in destination countries. This area of research is very important because migrants are typically an addition to the labour supply and a big part of the debate of the impact of immigration on locals is typically framed around the impact of immigration on wages and employment. Card (2001) and Borjas (2003) reported that immigrants lowers the wages of locals[4].While Dustmann, Fabbri and Preston (2005), Cortés (2008), Manacorda, Manning and Wadsworth (2012), and Card (2005) have found that immigrants do not have statistically significant effects on the wages of locals, Card (2009), Winter-Ebmer and Zweimüller (1996), and Foged and Peri (2016) showed that immigrants increase wages of locals. New Zealand evidence from Maré and Stillman (2009) finds little evidence that immigrants negatively affect either the wages or employment opportunities of the average New Zealand-born worker. They find some evidence that increases in the number of high-skilled recent migrants have small negative impacts on the wages of high-skilled New Zealand-born workers, which are offset by small positive impacts on the wages of medium-skilled New Zealanders.

Although the direction of the relationship seems inconsistent with an abundance of positive, negative and insignificant results in the literature, the evidence points towards the effects being quantitatively small in most cases. Meta-analysis of the literature by Longhi, Nijkamp and Poot

(2008) on the labour market impacts of immigration on native workers in terms of wages and employment reveals small effects[5]. We conclude that we expect the effect of immigration on the overall distribution of income through its impact on the income of locals to be quantitatively small. This study excludes this channel and focuses on the composition and migrant-specific distribution channels.

2.3 Migrant-specific Distribution Effect

Immigrants are not a homogenous group and any income differences among migrants themselves may affect the overall distribution of income in destination areas. In New Zealand, besides the targeted "Skilled Migrant" category, there are a whole range of other migrant streams. Many of these are not selective on skills (e.g., family reunification). Indeed, it is highly likely that the distribution of income within the migrant community is wider than among locals (see Card, 2009 for US evidence). Furthermore, there is evidence that the effect of recent immigration on the labour market is mostly felt by earlier migrants, with recent and earlier migrants acting as substitutes in the labour market. For example, Cortés (2008) shows that the negative impact of low skill immigration are felt by earlier immigrants with immigration lowering the wages of earlier immigrants (also confirmed by the meta-analysis by Longhi et al. 2005). Thus, depending on the size of the migrant group, immigration may affect the overall distribution of income through the changes in the within migrant group distributions.

3. METHODOLOGY

This section presents the decomposition methodologies used in this study. Our measure of inequality is the Mean Log Deviation (MLD). The MLD is part of the family of generalised entropy indices. These measures have the advantage of being additively decomposable (i.e. inequality in the whole can be expressed as a sum of inequality between and within the parts).We use the MLD as opposed to the slightly more popular Theil measure because our focus is on how changes in the shares of migration have affected the distribution of income and unlike the Theil (which weights by the income share), the MLD weights by the population share and since we are concerned about the effect of changes in population shares, this makes it a natural fit for purpose. The MLD can be defined as:

$$MLD = \sum_{\mathrm{m}=1}^{M} \frac{N_m}{N} \log\left(\frac{Y/N}{Y_m/N_m}\right) = \sum_{\mathrm{m}=1}^{M} \pi_m \log\left(\frac{1}{r_m}\right) \quad (1)$$

The aggregate income of all those in migrant group m is Y_m. N_m is the population in migrant group m. N is the overall population. Total income in the economy is $Y = \sum_{m=1}^{M} Y_m$. Finally, we denote average income in the economy by $\mu = Y/N$, average income of migrant group m by $\mu_m = Y_m/N_m$, and relative income of migrant group m by $r_m = \mu_m/\mu$. MLD can be decomposed into sum of within-migrant-group inequality and between-migrant-group inequality:

$$MLD = \sum_{m=1}^{M} \pi_m MLD_m + \sum_{m=1}^{M} \pi_m \log\left(\frac{1}{r_m}\right) \quad (2)$$

$\sum_{m=1}^{M} \pi_m MLD_m$ is the migrant-share-weighted sum of within-migrant-group inequality and $\sum_{m=1}^{M} \pi_m \log\left(\frac{1}{r_m}\right)$ the migrant-share-weighted sum of the logarithm of the inverse of migrant -group-relative income (i.e., between-migrant-group inequality).

3.1 Population Sub-group Decomposition of Mookherjee and Shorrocks (1982)

Using a measure of inequality such as MLD, change in the MLD between two periods, can be expressed exactly as follows:

$$\Delta MLD = \underbrace{\sum_{m=1}^{M} \overline{\pi_m} \Delta MLD_m}_{\substack{aggregate\ change\ in\ within-migrant\ group\ inequality\ for\ given\ migrant\ shares \\ C1}} + \underbrace{\sum_{m=1}^{M} \overline{MLD_m} \Delta \pi_m}_{\substack{aggregate\ change\ in\ within-migrant\ group\ inequality\ due\ to\ changing\ migrant\ shares \\ C2}} + \underbrace{\sum_{m=1}^{M} \overline{\log\left(\frac{1}{r_m}\right)} \Delta \pi_m}_{\substack{aggregate\ change\ in\ between-migrant\ group\ inequality\ due\ to\ changing\ migrant\ shares \\ C3}}$$
$$+ \underbrace{\sum_{m=1}^{M} \overline{\pi_m} \Delta \log\left(\frac{1}{r_m}\right)}_{\substack{aggregate\ growth\ in\ amigrant\ group\ relative\ income\ for\ given\ migrant\ shares \\ C4}} \quad (3)$$

where a bar over an expression represents the simple arithmetic average of the variable over the two periods, i.e. $\overline{MLD} = \frac{1}{2}(MLD_t + MLD_{t+1})$. Mookherjee and Shorrocks (1982) methodological contribution was to suggest an approximate decomposition of ΔMLD which which will explicitly include migrant-specific mean income growth[6]. We use this approximate decomposition, such that changes in inequality is expressed as:

$$\Delta MLD \approx \underbrace{\sum_{m=1}^{M} \overline{\pi_m} \Delta MLD_m}_{C1} + \underbrace{\sum_{m=1}^{M} \overline{MLD_m} \Delta \pi_m}_{C2} + \underbrace{\sum_{m=1}^{M} (\overline{r_m} - \overline{log r_m}) \Delta \pi_m}_{C3'} +$$
$$\underbrace{\sum_{m=1}^{M} (\overline{\pi_m r_m} - \overline{\pi_m}) \Delta \log \mu_m}_{C4'} \quad (4)$$

Where:

- $C1$ is the aggregate change in within-migrant group inequality for given migrant-shares
- $C2$ is the aggregate change in within-migrant group inequality due to changing migrant-shares
- $C3'$ is aggregate change in between-migrant group inequality due to changing migrant-shares
- $C4'$ is aggregate growth in migrant-group mean income for given migrant-shares

The sum of $C2$ and $C3'$ thus represent the migrant-shares or composition effect and the sum of $C1$ and $C4'$ represent the migrant group-specific distribution effect.

3.2 Density Decomposition Method of DiNardo, Fortin and Lemiux (1996)

The income distribution can be expressed as a density which may have a different shape for different groups. We can use any dispersion measure to quantify inequality in a distribution of income of individuals or households. DiNardo et al. (1996) developed a method to decompose overall change in inequality into a contribution from *within-group* inequality change and *between-group* change. In our case we identify *within-group* inequality change by means of a counterfactual income distribution in which population composition across migrant groups is assumed to have stayed the same, and a contribution from *between-group* change calculated for

a counterfactual income distribution for which inequality within groups is assumed to remain the same. One advantage of this approach is that it provides in our context a visual representation of the roles of the migrant composition effect and the migrant-specific distribution effect.

This approach uses a re-weighting procedure to create counterfactual densities based on holding the migrant-composition or the migrant-specific distribution constant. Let

$$f_Y^{UT}(y) = \underbrace{\sum f_{Y|m}^{UT}}_{\substack{migrant-specific \\ conditional \\ distibution}} \underbrace{Prob^{UT}(M=m)}_{\substack{Compositional\ or \\ shares\ effect}}$$

represent the general distribution of income, aggregated with respect to migration groups *m* in an area *U* at time *T*. The impact of immigration on the overall distribution of income could be through either a migrant composition effect i.e. changes in $Prob(M=m)$ or changes in the migrant-specific conditional distribution of income $f_{Y|m}^{UT}$.

We wish to calculate the effect of inter-temporal changes in the income distributions of migrant groups as well as the effect of changes in migrant composition in each area *U*. Let:

- $f_{(y)}^{UT} = \sum f_{y|m}^{UT}\, Prob^{UT}(M=m)$ represents the actual distribution of income in urban area *U* based on *U*'s conditional migration-specific distribution ($f_{y|m}^{UT}$) and *U*'s shares of people in each migrant group at time *T*;
- $f_{(y)}^{N96} = \sum f_{y|m}^{N96}\, Prob^{N96}(M=m)$ and $f_{(y)}^{N13} = \sum f_{y|m}^{N13}\, Prob^{N13}(M=m)$ represents the actual 1996 and 2013 distribution of incomes respectively at the national level *N*;
- $\check{f}_{(y)}^{N13|N96} = \sum f_{y|m}^{N13}\, Prob^{N96}(M=m)$ represents a 2013 counterfactual distribution, based on 2013 migrant-specific conditional distribution of incomes but 1996 shares of people in each migrant group

3.3 Inter-temporal Changes – Migrant Composition and Migrant-Specific Distribution Effect

To examine the effect of inter-temporal changes in migration between 1996 and 2013, we compare $f_{(y)}^{N13}$ to its counterfactual distribution $\check{f}_{(y)}^{N13|N96}$. This estimates the effect of the changes in the migrant composition between 1996 and 2013 while holding the migrant-specific conditional distribution constant. Conversely, to estimate the effect of changes in the migrant-specific conditional distribution, we compare the counterfactual distribution $\check{f}_{(y)}^{N13|N96}$ to the 1996 original distribution $f_{(y)}^{N96}$. The difference in these distributions can be displayed graphically or alternatively through the calculation of summary inequality measures. In terms of MLD introduced in the previous section, we can write

$$\Delta MLD = MLD\left(f_{(y)}^{N13}\right) - MLD\left(f_{(y)}^{N96}\right) = \left[\underbrace{MLD\left(f_{(y)}^{N13}\right) - MLD\left(\check{f}_{(y)}^{N13|N96}\right)}_{\substack{Migrant\ composition \\ effect}}\right] +$$

$$\left[\underbrace{MLD\left(\check{f}_{(y)}^{N13|N96}\right) - MLD\left(f_{(y)}^{N96}\right)}_{\substack{Migrant-specific\ distribution \\ effect}}\right] \qquad (5)$$

It is possible to estimate the role of spatial variations in migrant composition and in migrant-specific distributions effect play in overall inequality across areas. This can be done for each urban area but here we simply consider the distinction between metropolitan and non-metropolitan areas. We group the 40 urban areas into metropolitan and non-metropolitan areas[7].

4. DATA AND DESCRIPTIVE

4.1 Data

The data used are from the unit record data of the usually resident New Zealand population from each Census of Population and Dwelling from 1996 to 2013[8]. Our target population are residents of the 40 Main and Secondary urban areas[9]. New Zealand Census data capture information on current area of residence, place of residence at last Census, place of birth and qualification. We use this information to classify New Zealand-born and international migrants. We identify international migrants in each Census as people who are usually resident in New Zealand but whose country of birth is outside of New Zealand (foreign-born). We divide this group by their length of stay into newly arrived and existing migrants. Newly Arrived are migrants who arrived in the last inter-censal period. Because of information on place of residence five years ago, we could identify a group of "Returning New Zealand-born"- these are New Zealand born people who had been overseas five years before the census date and resident of New Zealand at the time of the census. We consider this group separately as we expect that their effect on the distribution of income might be different from that of New Zealanders who lived in New Zealand continuously between two censuses. As well as classifying migrants by length of stay, we also divide each migrant category into high skilled and medium/low skilled based on qualification. High skilled are those with minimum of a Bachelors degree qualification while all other qualifications below Bachelors are in the Medium/Low Skilled category. Thus, the total population is divided into eight categories:

- New Zealand-born – High Skilled and Medium/Low Skilled
- Returning New Zealand-born – High Skilled and Medium/Low Skilled
- Existing Migrants – High Skilled and Medium/Low Skilled
- Newly Arrived – High Skilled and Medium/Low Skilled

Addressing labour market shortages has been one of the big policy motivations for allowing immigration in New Zealand. Hence we restrict our analysis to the population aged 25 to 64 and focus on those who reported positive incomes to make our analysis reflect labour market incomes. Although Census data is available for the population 15+, we restrict our analysis to 25-64 earning positive incomes because the majority of the population 15-24 and 65+ are likely to have had most of their income from non-labour market sources[10] while negative incomes are likely to be reported by those who are self-employed and not an outcome of the labour market[11]. While there are other data sources like the Household Economic Surveys that may provide better information on labour incomes, the Census remains the most comprehensive dataset for analysis at the sub-national level where surveys typically suffer from sampling errors and bias.

The income data represent total personal income before tax of people earning positive income in the 12 months before the census night. It consists of income from all sources such as wages and salaries, self-employment income, investment income, and superannuation. It excludes social transfers in kind, such as public education or government-subsidised health care services.

Instead of recording actual incomes, total personal incomes are captured in income bands in each census with the top and bottom income bands open ended. For example, the top band in the 2013 census data captures everybody earning $150,000 and over. An important issue with

the open-ended upper band is the calculation of mean income in the open-ended band. At the national level, this is not a problem as Statistics New Zealand publishes an estimate of the midpoint of the top band for the country based on Household Economic Survey (HES) estimates. However, HES top-band mean incomes for sub-national areas are not reliable due to sampling errors. To resolve this problem, Pareto distributions have been fitted to the upper tail of the area specific distributions[12]. The midpoints of these distributions have been calculated by means of the Stata RPME command developed by von Hippel et al. (2016).

4.2 Descriptive

This sub-section provides a descriptive summary of the changes in the income distribution between 1996 and 2013. We start the analysis by comparing all immigrant groups against the New Zealand-born.

Table 1 presents the MLD, relative mean income and population share of New Zealand-born and international migrants by area.

The results show that immigration has become an increasingly important component of the overall population. In all areas combined, in 1996, immigrants represented about 26 percent of the total population under consideration but by 2013 this has increased by to 35 percent. Spatially, immigrants are a bigger proportion of the population in metropolitan areas with the proportion of immigrants in metropolitan areas is almost double that of non-metropolitan areas in each census period.

With respect to inequality, inequality is higher among immigrants that locals in both metropolitan and non-metropolitan areas. This is as expected as the immigrants typically have a wider distribution of income because of the selectivity in migration. Although inequality fell slightly for both New Zealand-born and immigrants between 1996 and 2013, there are spatial differences in the changes. In non-metropolitan areas, inequality fell in percentage terms more amongst New Zealand-born. This is opposite to the changes in metropolitan areas where inequality fell more amongst international migrants. Consequently, in both areas combined, New Zealand-born and international migrants have similar rates of decline in inequality of around 2.3 percent less than in 1996.

The previous analyses have compared New Zealand-born with international migrants and treated international migrants as a homogenous group, but immigrants to New Zealand are not identical and apart from skill level, differences also exist within this group by length of stay in New Zealand. We categorise international migrants by skill level and length of stay and compare them to New Zealand-born (classified by skill level) in terms of within-group inequality, relative mean incomes and population share. Table 2 presents for all urban areas[13] the MLD, relative mean income, and population share for the six international migrant groups (Returning New Zealand-born – High Skilled and Medium/Low Skilled, Existing migrants - High Skilled and Medium/Low Skilled, and Newly Arrived migrants – High skilled and Medium/Low Skilled) and two categories of New Zealand-born (High skilled and Medium/Low Skilled).

All international migrant groups excluding Low Skilled Returning New Zealand-born increased as a proportion of the population between 1996 and 2013. The trend in the Medium/Low Skilled Returning New Zealand-born group is mostly driven by events in Australia. More than half of the Returning New Zealand-born groups are returnees from Australia, thus the size of this group is very sensitive to economic changes in Australia. The 2006-2013 period coincided with buoyant economic conditions in Australia and particularly the growth in the mining sector and higher real wages in Australia meant lower inflows of Medium/Low Skilled New Zealand-born from Australia.[14]

Table 1: Comparison of New Zealand-born and International Migrants on Relative Incomes, Population Share and Inequality by Area

Non-metropolitan					
		1996	2001	2006	2013
Nzers	MLD	0.3258	0.3254	0.2961	0.3047
	Relative mean income	0.99	0.99	0.99	0.99
	Real mean income in 2013 $	37,245	40,044	44,071	45,797
	Pop share	84.1%	84.6%	81.5%	79.3%
International migrants	MLD	0.3768	0.3891	0.3516	0.3671
	Relative mean income	1.04	1.04	1.02	1.02
	Real mean income in 2013 $	38,906	42,183	45,421	47,168
	Pop share	15.9%	15.4%	18.5%	20.7%
Combined population	MLD	0.334	0.3354	0.3065	0.3177
	Relative mean income	1.00	1.00	1.00	1.00
	Real mean income in 2013 $	37,510	40,374	44,321	46,080
	Pop share	100.0%	100.0%	100.0%	100.0%
Metropolitan					
Nzers	MLD	0.3465	0.3474	0.3220	0.3427
	Relative mean income	1.03	1.03	1.04	1.05
	Real mean income in 2013 $	46,421	51,750	56,353	58,539
	Pop share	69.8%	69.0%	63.5%	59.7%
International migrants	MLD	0.4049	0.4227	0.3851	0.3943
	Relative mean income	0.94	0.93	0.92	0.92
	Real mean income in 2013 $	42,256	46,533	49,876	51,244
	Pop share	30.2%	31.0%	36.5%	40.3%
Combined population	MLD	0.3651	0.3719	0.3468	0.3656
	Relative mean income	1.00	1.00	1.00	1.00
	Real mean income in 2013 $	45,165	50,133	53,987	55,602
	Pop share	100.0%	100.0%	100.0%	100.0%
All urban areas combined					
New Zealand-born	MLD	0.3450	0.3473	0.3200	0.3370
	Relative mean income	1.01	1.01	1.02	1.03
	Real mean income in 2013 $	43,460	48,115	52,516	54,579
	Pop share	73.9%	73.2%	68.2%	64.7%
International migrants	MLD	0.4004	0.4177	0.3798	0.3904
	Relative mean income	0.97	0.96	0.96	0.95
	Real mean income in 2013 $	41,669	45,836	49,156	50,622
	Pop share	26.1%	26.8%	31.8%	35.3%
Combined population	MLD	0.3596	0.3664	0.3395	0.3565
	Relative mean income	1.00	1.00	1.00	1.00
	Real mean income in 2013 $	42,992	47,504	51,446	53,182
	Pop share	100.0%	100.0%	100.0%	100.0%
Total population 25-64		1,209,630	1,212,705	1,372,773	1,415,343
Proportion of all urban population in metropolitan areas		71.6%	73.2%	74.0%	74.7%

Note: 1) The Returning New Zealand-born categories are excluded from the New Zealand-born category and counted with the international migrant category.
2)Relative mean income calculated as group-mean income divided by overall mean income for that area

Table 2: Comparison of MLD, Relative Mean Income, and Population Share for All International Migrant Groups and New Zealand-born in All Areas Combined

		New Zealand-born		International migrants						
		HS NZ-born	M/LS NZ-born	HS Ret. NZ-born	M/LS Ret. NZ-born	HS Exist	HS Newly Arrived	M/LS Exist	M/LS Newly Arrived	Total
		All areas combined								
1996	MLD	0.3354	0.3195	0.3499	0.2997	0.3632	0.6172	0.3333	0.499	0.3596
	Rel.inc	1.77	0.92	1.65	0.92	1.66	1.09	0.87	0.75	1.00
	Pop share	7.7%	66.1%	0.6%	2.4%	2.5%	1.8%	15.7%	3.1%	100.0%
2001	MLD	0.3251	0.3215	0.3574	0.3308	0.3797	0.5085	0.3544	0.4798	0.3664
	Rel.inc	1.66	0.91	1.59	0.92	1.51	1.14	0.84	0.72	1.00
	Pop share	10.3%	62.9%	0.7%	1.7%	3.7%	2.2%	14.9%	3.6%	100.0%
2006	MLD	0.2997	0.2983	0.3261	0.3008	0.3509	0.4144	0.338	0.3926	0.3395
	Rel.inc	1.51	0.91	1.50	0.95	1.33	1.06	0.81	0.75	1.00
	Pop share	12.5%	55.7%	1.2%	2.0%	5.7%	3.5%	14.9%	4.6%	100.0%
2013	MLD	0.3248	0.3093	0.3701	0.3504	0.3465	0.4393	0.3462	0.4299	0.3565
	Rel.inc	1.46	0.89	1.44	0.91	1.26	1.05	0.78	0.71	1.00
	Pop share	15.3%	49.4%	1.1%	1.4%	9.4%	3.0%	17.0%	3.3%	100.0%
Abs pop share change (%pts)		7.6	-16.7	0.5	-1.0	6.9	1.2	1.3	0.2	0.0
Act pop change		131.2%	-12.6%	114.2%	-34.3%	349.5%	101.0%	26.7%	24.3%	17.0%

Note:

- Absolute and Actual pop (population) changes reported are changes between 1996 and 2013. Absolute change is the percentage point difference in the proportion of each group between 1996 and 2013 (prop2013-prop1996). Actual pop change is the percentage change in the population of each group between 1996 and 2013 calculated as: (Population 2013-population 1996)/population 1996 for each group.
- HS NZ-born and M/LS NZ-born represent High Skilled and Medium/Low Skilled New Zealand-born respectively; HS Ret. NZ-born and M/LS Ret. NZ-born represent High Skilled and Medium/Low Skilled Returning New Zealand-born ; HS Exist and LS Exist represent High Skilled and Medium/Low Skilled Existing migrants ; HS N.A and M/LS N.A represent High Skilled and Medium/Low Skilled Newly Arrived

Focusing on the absolute changes which ranged from 0.5 to 8 percentage points may mask the scale of immigration increase to New Zealand. If we examine the relative population increase of immigrants (relative to their 1996 population), we find that High Skilled Existing migrants increased by around 351 percent, High Skilled Newly Arrived migrants increased by 101 percent while Medium/Low Skilled Existing and Medium/Low Skilled Newly Arrived increased by around 26.8 percent and 24.5 percent respectively. The relative changes are quite important as research from the US has shown that the impact of immigration is most likely felt by earlier migrants who are close substitutes with recent arrivals in the labour market (see LaLonde and Topel, 1991 and Cortés, 2008). Though the changes experienced by the international migrant groups in New Zealand have been small in absolute terms, the changes may have bigger implications for the migrant-specific distribution of income and by extension the overall distribution of income.

Examining changes in the distribution of income between 1996 and 2013 in all areas combined, inequality fell in all groups between 1996 and 2013 apart from the Returning New Zealand-born groups (Medium/Low Skilled and High Skilled) and the Medium/Low Skilled Existing migrant categories where inequality rose. In all areas, inequality fell most within the High Skilled Newly Arrived category at 29 percent and the Medium/Low Skilled Returning New Zealand-born had the highest rate of growth in inequality at 18 percent.
In conclusion, the descriptive tables have shown the differences between the various migrant groups and changes over time in terms of population share and distribution of income. We also show that the patterns for immigrants groups are not identical with differences existing between immigrant groups by skill level and length of stay.

5. DECOMPOSITION RESULTS

In this section, we focus on the changes in the distribution and present the results from our decomposition methods.

5.1 Density Decomposition Methodology of DiNardo, Fortin and Lemieux (DFL)

As described in the methodology and shown above, the distribution of income can be expressed in densities. Over time, changes in densities can be decomposed into changes from the population composition (dF_M^U) or changes in the migration-specific distribution income($f_{y|m}^U$). Using a re-weighting approach, we create a 2013 counterfactual distribution and benchmark the 1996 and 2013 distributions to this counterfactual distribution. As described in the methodology section, the difference between the 2013 original distribution (2013 OD) and the 2013 counterfactual distribution (2013 CF) represent the composition- effect while the difference between the 2013 counterfactual distribution and 1996 original distribution (1996 OD) represents the group-specific distribution effect. To quantify the effect, we calculate the MLDs for the 1996 and 2013 original distributions as well as the 2013 counterfactual distribution. This is presented in Table 3 below.

In each of the areas, the composition effect is positive indicating that changes in the population composition in New Zealand between 1996 and 2013, specifically the increases in the shares of international migrants has increased inequality. This is not surprising; international migrants have higher within-group inequality and coupled with an increase in population share, their overall effect will be inequality increasing. Intuitively, the increase in immigration between 1996 and 2013 represent an increase in the share of a population group with higher inequality. The overall effect of this change will be to increase inequality. In all areas combined, the changes in the population composition will have increased inequality by around 0.0189 MLD points but changes in the within-group specific distribution are negative and mitigated this increase. The sum of both effect meant inequality declined slightly by 0.0031 MLD points.

Table 3: Estimates of Composition and Group-specific Distributional Effects, Measured by MLD, using the Density Decomposition Approach

				Composition effect	Within-group specific distribution effect	Total effect
	2013OD	2013CF	1996OD	2013OD-2013CF	2013CF-1996OD	2013OD-1996OD
Non-metro	0.3177	0.3012	0.3341	0.0165	-0.0329	-0.0164
Metro	0.3656	0.3482	0.3651	0.0174	-0.0169	0.0005
All areas combined	0.3565	0.3376	0.3596	0.0189	-0.0220	-0.0031

Spatially, magnitude of the composition effect is larger in metropolitan areas and this is not surprising given that metropolitan areas have experienced greater increases in immigration. The inequality increasing composition effect in these areas dominated the inequality-reducing group-specific distribution thus inequality ended up rising slightly in metropolitan areas. If net immigration to New Zealand continues to increase, particularly to metropolitan areas, we can expect inequality to continue to rise in these areas.

One limitation of the DFL approach is the fact that it is not possible to calculate the contribution of each migrant group to overall change. Although the composition effect is positive and the proportion of immigrants have increased, the descriptive chapters have shown that migrants are not homogenous and it is quite important to understand the contribution of each migrant group to the overall composition and group-specific distribution effect. Fortunately, with our second decomposition method, we can decompose changes over time into the contribution from each migrant group as well as migrant-share and migrant-specific distribution effects. The next section presents the results from the Mookherjee and Shorrocks sub-group decomposition approach.

5.2 Moookherjee and Shorrocks Decomposition by Sub-groups

Table 4 presents the by-group contributions to the changes in MLD between 1996 and 2013. By examining the by-group contributions, we can now answer the question - what role has immigration and particular migrant groups played in the changes in the distribution of income between 1996 and 2013? We find that immigration had an inequality-increasing effect in New Zealand urban areas. Intuitively, the changes for the immigrant groups can be interpreted as increases in the share of groups that are generally more unequal than New Zealand-born. Thus it is not surprising that the contributions from these groups are inequality-increasing. Although there are two exceptions to the inequality-increasing role of immigration: 1) the contribution of Medium/Low Skilled Returning NZ-born is inequality-reducing and this is because unlike other immigrant groups, this group experienced a reduction in population share. The share of this group declined and this ensured that their contribution to total changes was inequality reducing. 2) For the Medium/Low Skilled Newly Arrived group, the changes in this group were inequality reducing because even though population share increased slightly, within-group inequality fell. Thus the changes for this group represent a slight increase in the size of an increasingly equal group. However, this begs the question – why is the contribution from High Skilled Existing and High Skilled Newly Arrived groups inequality-increasing while Medium/Low Skilled Newly Arrived group inequality- reducing since these three groups qualitatively have the same type of changes (all three groups had increased population share and falling within-inequality)?

Table 4: Contribution to Changes in Mean Log Deviation (MLD) between 1996 and 2013 by Migrant Group for using the Mookherjee and Shorrocks Approach for Metropolitan and Non-metropolitan Areas

	Components of change (see Eq. 4)				Total change	Composition effect C2+C3’	Group specific distribution effect C1+C4’
Non-metropolitan							
Migrant Status	C1	C2	C3’	C4’			
HS NZ-born	-0.0016	0.0229	0.0864	-0.0031	0.1046	0.1093	-0.0047
M/LS NZ-born	-0.0151	-0.0362	-0.1220	-0.0100	-0.1832	-0.1581	-0.0251
HS Ret NZ-born	0.0002	0.0015	0.0046	0.0000	0.0063	0.0061	0.0002
M/LS Ret NZ-born	0.0006	-0.0020	-0.0064	-0.0003	-0.0082	-0.0084	0.0002
HS Existing	-0.0006	0.0103	0.0335	-0.0006	0.0426	0.0439	-0.0012
HS Newly Arrv.	-0.0012	0.0048	0.0098	-0.0001	0.0133	0.0146	-0.0013
M/LS Existing	-0.0017	0.0003	0.0010	-0.0014	-0.0018	0.0013	-0.0032
M/LS Newly Arrv.	-0.0011	0.0042	0.0101	-0.0004	0.0129	0.0143	-0.0014
Sum	-0.0207	0.0060	0.0170	-0.0159	-0.0135	0.0230	-0.0365
Metropolitan							
Migrant Status	C1	C2	C3’	C4’			
HS NZ-born	-0.0013	0.0249	0.0841	0.0029	0.1105	0.1090	0.0016
M/LS NZ-born	-0.0026	-0.0558	-0.1763	-0.0077	-0.2423	-0.2321	-0.0103
HS Ret NZ-born	0.0002	0.0019	0.0059	0.0005	0.0085	0.0078	0.0006
M/LS Ret NZ-born	0.0011	-0.0040	-0.0124	-0.0003	-0.0156	-0.0164	0.0008
HS Existing	-0.0011	0.0294	0.0889	-0.0014	0.1158	0.1183	-0.0025
HS Newly Arrv.	-0.0053	0.0070	0.0132	0.0001	0.0149	0.0202	-0.0052
M/LS Existing	0.0035	0.0047	0.0140	-0.0036	0.0186	0.0187	-0.0001
M/LS Newly Arrv.	-0.0026	-0.0008	-0.0018	-0.0019	-0.0071	-0.0026	-0.0045
Sum	-0.0082	0.0073	0.0156	-0.0115	0.0033	0.0229	-0.0197

Table 4 (Continued: Contribution to Changes in Mean Log Deviation (MLD) between 1996 and 2013 by Migrant Group for using the Mookherjee and Shorrocks Approach for All Areas Combined

	Components of change (see Eq. 4)				Total change	Composition effect C2+C3’	Group specific distribution effect C1+C4’
All urban areas							
Migrant Status	C1	C2	C3’	C4’			
HS NZ-born	-0.0012	0.0250	0.0863	0.0014	0.1114	0.1113	0.0002
M/LS NZ-born	-0.0059	-0.0526	-0.1682	-0.0095	-0.2362	-0.2208	-0.0154
HS Ret NZ-born	0.0002	0.0019	0.0058	0.0004	0.0082	0.0076	0.0005
M/LS Ret NZ-born	0.0010	-0.0035	-0.0108	-0.0003	-0.0136	-0.0143	0.0007
HS Existing	-0.0010	0.0248	0.0761	-0.0013	0.0985	0.1008	-0.0023
HS Newly Arrv.	-0.0043	0.0067	0.0127	0.0003	0.0153	0.0193	-0.0040
M/LS Existing	0.0021	0.0044	0.0132	-0.0030	0.0167	0.0176	-0.0009
M/LS Newly Arrv.	-0.0022	0.0009	0.0020	-0.0014	-0.0007	0.0030	-0.0036
Sum	-0.0114	0.0075	0.0171	-0.0135	-0.0003	0.0246	-0.0249

To answer this question, the magnitude of the population-group share changes becomes important. Unlike the Medium/Low Skilled Newly Arrived group, the High Skilled Existing and High Skilled Newly Arrived groups had greater increases in population share which made the composition effect (inequality-increasing) dominate the within-group distribution effect (inequality-reducing)[15].

Spatially, as shown with the previous decomposition methods, the aggregate changes for both metropolitan and non-metropolitan areas are similar. However, when we focus on the by-group contributions, some distinctions appear. For example, the inequality-increasing effect of immigration is higher in metropolitan areas than non-metropolitan areas. This is not surprising because metropolitan areas have had greater increases in the shares of immigrants. Although the contribution of immigration is larger in metropolitan areas, overall aggregate changes are similar to non-metropolitan areas because of the role changes in the Low Skilled New Zealand-born have played. Changes in the Low Skilled New Zealand-born are more inequality-reducing in metropolitan areas compared to non-metropolitan areas.

6. CONCLUSION

Debate on the impact of immigration in destination countries have continued to take centre stage in most western countries. There is lot of evidence on the impact of immigration on several social and economic outcomes but the distributional implications remain relatively under researched, particularly in New Zealand. Using New Zealand data, we focus on the distributional impact of immigration on labour market incomes at the sub-national level. A big part of immigration to New Zealand is meant to address labour market shortages and while there is evidence of its minimal impact on average incomes, there is sparse evidence on the overall distributional impacts of immigration. Using two decomposition methodologies, we contribute to the literature by examining two channels through which immigration may affect the distribution of income in New Zealand and provide evidence on the role of immigration on changes in the distribution of income between 1996 and 2013 - a period of relative high immigration to New Zealand. We find that income inequality fell for 25-64 earning positive incomes nationally (-1 percent) The trend for metropolitan and non-metropolitan areas are different with inequality falling by about 5 percent in non-metropolitan areas compared to a 0.1 percent increase in metropolitan areas. We show there has been rapid rate of immigration to New Zealand between 1996 and 2013. Nationally, immigrants increased from around 26 percent of the population aged 25 to 64 in 1996 to 35 percent in 2013. The national figures mask the spatial disparity in the location of immigrants. Immigrants share of the population in metropolitan areas are almost double that of non-metropolitan areas.

Across all areas, changes in the population composition between 1996 and 2013 have had an inequality increasing composition effect but an inequality-reducing group-specific distribution effect. The opposing but all most equal magnitude of both effects is responsible for the small changes in the overall distribution of income of 25 to 64 across areas.

NOTES

[1] The urban area population 25 to 64 earning positive income accounted for 77 percent of total population in 1996 and 2001, around 87 percent in 2006 and about 90 percent in 2013.

[2] Strictly speaking, income captured for the 25-64 group in Censuses includes other non-labour income like investment income but Statistics New Zealand estimates that wages and salaries contribute more than two-thirds of overall income (Statistics New Zealand, 1999).

[3] Other data sources like the Household Economic Surveys may provide better information on labour market incomes, the Census remains the most comprehensive dataset analysis at the sub-national level where surveys typically suffer from sampling errors and bias.

[4] In some results, immigrants lower wages of certain types of locals. For example, Card (2001) finds that immigrants lower wages of skilled locals.

[5] Evidence from studies like Altonji and Card (1991) and Card (2001, 2005 and 2009) also find small effect of immigration on the distribution of income of locals.

[6] Mookherjee & Shorrocks (1982) note that this approximation appears sufficient for computational purposes (p.897). It is clear that C3' – C3 = $\sum_{m=1}^{M} \overline{r_m} \Delta\pi_m$. Experimentation with a range of changing income distributions shows that the sign of *C*3 can be sometimes different from that of *C*3' and, similarly, the sign of *C*4 can be different from that of *C*4*'*. This may lead to slightly different interpretations. In this paper, we follow Mookherjee & Shorrocks (1982) and use the approximate decomposition. Results for the exact decomposition are available upon request.

[7] Metropolitan areas are the New Zealand cities of Auckland, Wellington, Christchurch, Hamilton, Tauranga, Dunedin, and Palmerston North. All other urban areas are considered non-metropolitan areas.

[8] New Zealand Censuses were held in 1996, 2001, 2006, and 2013.

[9] The 40 urban areas were grouped into metropolitan and non-metropolitan areas. Metropolitan areas are the urban areas in the six largest cities of Auckland, Christchurch, Wellington, Hamilton, Tauranga and Dunedin. We use 2013 Statistics New Zealand definition of urban areas.

[10] Superannuation for 65+ and Student allowance for those aged 15-24 years.

[11] Hence people not in paid employment and business owners reporting a loss have been excluded.

[12] The proportion in the top open ended band across censuses ranged from 3 to 7 percent in metropolitan areas and between 1 and 3 percent in non-metropolitan areas.

[13] Metropolitan and non-metropolitan area results available on request.

[14] Return migration from Australia sharply increased after the end of our observation period, March 2013. See e.g. Statistics New Zealand, "Kiwi exodus to Australia bungees back", 21 July 2016.

[15] Unlike the Medium/Low Skilled Newly Arrived group, due to the bigger share increases for High Skilled Existing and High Skilled Newly Arrived groups, the inequality-increasing compositional effects (C2+C3') dominate the inequality reducing within-group distribution effect (C1+C4').

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The Supporting Role of It Clusters in Open Innovation: A Comparative Study of Different It Organisation Sizes

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ABSTRACT

Earlier innovation studies perceived open innovation to be associated with large organisations, but it is becoming relevant to small and medium-sized organisations due to global competition and turbulent market conditions. Open Innovation (OI) model combines external knowledge with internal knowledge by facilitating purposive inflows and outflows of knowledge. The success of open innovation model is dependent on organisations' interaction with other organisations. Literature highlights the location importance and organisation size in enabling interactions among participants and promoting collaboration. This paper presents the results of a survey conducted among Indian IT organisations within and outside the IT cluster on open innovation practices. The results indicate that the organisations in a cluster are ahead in terms of open innovation activities. This study reveals the differences among small, medium and large IT organisations in relation to open innovation practices.

1. INTRODUCTION

Ever since Chesbrough (2003) introduced the term 'open innovation', it has evolved into a concept over the last decade. Built on the principles of integrating external resources with internal research and development (Morris et al., 2008), this concept implores organisations to open up innovation processes to include stakeholders and facilitate free flow of knowledge and technology. The open innovation studies in European countries focussed on studying the level of open innovation efforts by the local organisations in general (Rangus and Drnovsek, 2013; Huang and Rice, 2013). In fact, there are very few studies that were intended to gain an in-depth understanding of the need for open innovation in SMEs, but these were limited to open innovation in the Indian manufacturing sector (Hungund and Kiran, 2016; Tripathi, 2016). The previous studies explored the benefits and challenges associated with both closed and open innovation (e.g. Christensen et al., 2005; Laursen and Salter, 2006) and open innovation strategies in larger organisations (Chesbrough and Crowther, 2006; van de Vrande et al., 2009). Recently, scholars have conducted research on open innovation in the context of smaller organisations, comprehensive reviews and its future directions (e.g. Giannopoulou et al., 2010; Huizingh, 2011). For example, a study conducted by Rahman and Ramos (2010) outlines the challenges faced by small and medium-sized organisations (SMOs) with adopting open innovation practices (Van de Vrade et al., 2009). Some scholars argue that SMOs can overcome challenges and improve innovation capabilities through open innovation (Enkel et al., 2009; Parida et al., 2012), but Zeinalnezhad et al. (2011) emphasize that clusters facilitate collaborative environment resulting in knowledge transfer from larger organisations to small

and medium-sized organisations. Although, clusters offer SMOs networking and knowledge sharing opportunities and increase their participation in research activities, there is limited evidence to support the role of IT clusters in open innovation practices by small and medium-sized organisations. Thus, this study aims to investigate the state of open innovation among different IT organisations in India and the role of IT clusters on open innovation practices. This paper addresses the following research questions.

RQ1. Do organisations within a cluster actively participate in open innovation activities compared to the organisations outside the cluster?

RQ2. Does organisation size influence organisations' inbound and outbound innovation activities and technological spill-overs?

2. LITERATURE REVIEW

Clusters and Open Innovation

Theories such as industrial districts (Marshall, 1920), regional economies and clusters (Porter, 1998), business incubators (Pinho, 2011), regional innovation systems (Nie and Sun, 2014) accept the role of location in promoting innovation. Clusters are a geographically proximate group of interconnected organisations and associated institutions in the same line of business (Porter, 1998; Mohring 2005). Whereas, an IT Cluster is a group of organisations that cooperate and compete within a geographic location, offers opportunities for open innovation through technological externalities (Antonelli, 1994; Belussi, 1999).

Scholars argue that clusters are the focal points of regional growth (Mohring, 2005) and lay foundation to the idea of collaborative processes that supports open innovation as it requires collaboration and participation from other organisations (Chesbrough, 2006). Open innovation is based on level of cooperation and knowledge sharing among participants (Chesbrough, 2003; West et al., 2006). It mainly allies with IT organisations and high technology organisations (West et al., 2006). Coupled with innovation culture, co-location of organisations can promote participation of other organisations in research and development projects (Chesbrough, 2006). Literature suggests that clustering enables organisations to explore and exploit knowledge in the surrounding environment. However, there is limited evidence to highlight the role of clusters in fulfilling organisations' vision to benefit from open innovation (Vanhaverbeke, 2006).

Inbound and Outbound Innovation

Inbound innovation refers to organisations' efforts to explore and exploit external resources for internal innovation in the form of insourcing, collaboration and acquisition. It infers organisations can rely on external sources for developing new technologies, products and services (Chesbrough, 2003; Morriset al., 2008). Van de Vrande et al. (2009) and Busarovs (2013) point out that inbound innovation is associated with collaborative networks and organisations' capability to search and source external knowledge will influence its innovation performance.

Outbound innovation efforts are aimed at commercialising internal inventions to generate revenue (Van de Vrande et al., 2009). Outbound innovation refers to an organisation's expansion of open innovation processes outward freely with a monetary component (Dahlander and Gann, 2010) in the long run through commercialisation of internal inventions (Busarovs, 2013) in the form of licensing payment, spin-off and open-sourcing (Van de Vrande et al., 2009). Open innovation processes include building partnerships and collaborating with other organisations to enhance knowledge flow both inward and outward, outward IP licensing and knowledge sharing (Van de Vrande et al., 2009).

Small and Medium-sized Organisations adopt innovation practices due to lack of marketing capability (Narula, 2004), not being able to meet customer demands, unable to adjust to dynamic business environment, insufficient research and development capabilities (Kim and Park, 2010). Earlier studies found that the size of an organisation may influence open innovation strategies as larger organisations have access to vast resources compared to small and medium-sized organisations (Sandulli et al., 2012). However, according to Rigby and Zook (2002), internal innovations can be accelerated by importing new ideas and exporting proprietary technologies can generate income.

Technological Spill-overs

Technological spill-overs are the externalities caused by commercial activities with agents that were unable to completely benefit from their own Research and Development (R&D) activities (Dumont and Meeusen, 2000). These are generally caused by the voluntary exchange of information, movement of workforce from one organisation to another and interaction between employees and the stakeholders. This type of knowledge exchange can be seen in the same cluster where it was aimed to promote innovation activity leading to economic growth, but often these technological spill-overs are ignored by the organisations (Nemet, 2012).

The technological spill-overs can be put to better use, if the organisations have similar product line or services or business processes (Lovely and Popp, 2008), which is one of the common characteristics of a cluster as defined by Mohring (2005). The organisations in a cluster can improve productivity by simply observing nearby organisations and copying their technology. The amount and nature of spillovers within sectors and regions may vary based on the diffusion mechanism (de Fuentes and Dutrenit, 2013). A study conducted by Aghion and Jaravel (2015) suggest that the learning component may change significantly by organisation size.

Open Innovation Practices in Small and Medium-sized Organisations

Earlier research perceived open innovation to be associated with well-established and larger organisations. However, there has been growing interest about the relevance of open innovation to small and medium-sized organisations (Chesbrough, 2003; Chesbrough and Crowther, 2006). For example, a study conducted by van de Vrande et al. (2009) explored the presence and level of open innovation usage in small and medium-sized organisations.

Majority of these studies identified positive relationship between organisation size and open innovation practices (Laursen and Salter, 2006). A study conducted by Bianchi et al. (2011) suggests that large organisations tend to participate more in open innovation activities compared to small and medium-sized organisations because of their collaboration efforts in innovation processes (Sandulli et al., 2012). Small and medium-sized organisations assist in economic growth, but suffer from resource scarcity and lack of infrastructure (Rahman and Ramos, 2010). Narula (2004) points out that SMOs weak points stem from their size. In fact, researchers used organisation size as a variable to study its influence on adoption of open innovation practices.

3. RESEARCH METHOD

A cross-sectional survey design is used to investigate the relevance of the co-location on innovation practices among different IT organisations in India. This study administered an online survey questionnaire during 2016-2017 to collect data from Indian IT organisations. The survey includes quantitative instruments (5 point Likert scale) to reflect on various constructs such as ‘Inbound innovation’, ‘Outbound innovation’ and 'technological spill-overs'. A total of 307 surveys are collected. These include 247 responses from Hyderabad IT cluster and 60 responses from outside this cluster. Indian IT organisations are chosen for this study as there

was limited research into open innovation activities in IT organisations. Indian IT organisations are the service providers to local and overseas organisations (Sarkar and Mehta, 2005). As IT industry in India is the major contributor for national economic growth, studying them will reveal the role of clusters and organisation size on organisations efforts with open innovation activities.

Survey respondents are from Business Process Management, Consulting, Corporate function/Leadership, Education and Training, Marketing/Sales, Research & Development and Technology fields. The sample consists of 35.82% small and medium-sized organisations with up to 200 employees and 64.16% large organisations with more than 200 employees. Reliability tests are conducted to evaluate the degree of consistency between multiple measurements of a variable with a goal to achieve internal consistency among the variables in a summated scale (Hair et al. 2006). The Alpha coefficient method, Cronbachs's alpha is a measure of reliability which ranges from 0 to 1. It is suitable for likert scale items ranging from "1: strongly disagree to 5: strongly agree" (eg. 1-5) (Ercan et al., 2007). The alpha values for the constructs inbound innovation, outbound innovation and technological spill-overs are 0.803, 0.860 and 0.871 respectively. The alpha values are above 0.7 and these are considered to be efficient and reliable for internal consistency. Kaiser-Meyer-Olkin measure of sampling adequacy values (KMO) for Inbound innovation, outbound innovation and technological spill-overs are 0.771, 0.797 and 0.869 respectively. The KMO values greater than 0.7 indicate the sampling adequacy (Hair et al., 2006).

4. RESULTS

The Kruskal-Wallis test was used to compare statistically significant differences between two independent groups (Ercan et al., 2007), (1) IT organisations within and outside Hyderabad IT cluster and (2) small and medium-sized organisations and large organisations.

Results presented in Table 1 indicate that there are significant differences with regards to open innovation activities between organisations within and outside the cluster. The organisations within the cluster are ahead in terms of searching potential partners for innovation projects, adopting business practices to acquire external knowledge and willingness to purchase IP rights from others. The organisations outside the cluster are generally behind in terms of making investments in other organisations, sharing knowledge with competitors, acquiring knowledge from other external sources and cooperating with others in their research and development activities. Also, they have shown less interest in supporting internal research and development activities with external knowledge and joint ventures compared to the organisations within the cluster.

The results presented in Table 2 indicate that there are significant differences with regards to technological spill-overs, inbound and outbound innovation activities between SMOs and large organisations in the cluster. Although, small and medium-sized organisations are generally behind in terms of open innovation activities, they scored above 3 out of 5 except for willingness to purchase IP rights from other organisations, sale of internal knowledge with little cost and sale of IP rights to others.

The results presented above in Table 3 do not show significant differences between SMOs and large organisations located outside the cluster except for knowledge sharing with stakeholders and competitors. The average mean scores suggest that large organisations are generally more open to sharing knowledge with stakeholders. Interestingly, the small and medium-sized organisations outside the cluster are ahead in sharing knowledge with their competitors compared to large organisations. The SMOs outside the cluster scored high for allowing others to access their knowledge to develop new products and services, sale of internal knowledge

with little cost compared to the other group. However, large organisations achieved high scores for searching potential partners, adopting standard business processes to acquire external knowledge, willingness to purchase and acquisition of IP rights, sale of IP rights, making investments in other organisations, interest in joint ventures, external knowledge for internal research and development, acquiring knowledge from external sources and supporting others in their research and development efforts compared to SMOs.

Table 1. Open Innovation Activities by the Indian IT Organisations within and outside the IT Cluster

Open innovation activities	Organisations within cluster (N=247)		Organisations outside cluster (N=60)		Kruskal-Wallis Test	
	Mean score (Out of 5)	Std. deviation	Mean score (Out of 5)	Std. deviation	Chi-Square	Asymp. Sig.(2-tailed)
Inbound innovation						
Allow others to access its knowledge to develop new products and services	3.84	1.027	3.67	1.160	0.787	0.375
Willingness to purchase IP rights	3.61	1.124	3.20	1.005	8.282	0.004
Search for potential partners	3.99	0.915	3.63	0.956	7.246	0.007
Standard business processes to acquire external knowledge	4.11	0.894	3.65	1.132	8.623	0.003
Outbound innovation						
Knowledge sharing with stakeholders	3.72	1.063	3.35	1.087	5.665	0.017
Sale of internal knowledge with little cost	3.38	1.180	2.87	0.999	10.096	0.001
Acquisition of IP rights	3.66	1.161	3.25	1.068	7.525	0.006
Sale of IP rights	3.17	1.321	2.65	1.246	7.470	0.006
Technological spill-overs						
Investments in other organisations	3.90	0.958	3.38	1.136	11.377	0.001
Interest in external knowledge for internal R&D	4.11	0.783	3.53	1.016	17.784	0.000
Interest in Joint ventures	4.09	0.836	3.50	0.966	19.881	0.000
Acquire knowledge from external sources	3.85	0.950	3.30	0.997	14.392	0.000
Cooperate and support others in their R&D efforts	3.91	0.922	3.27	0.989	20.792	0.000
Knowledge sharing with competitors	3.46	1.287	3.10	0.969	5.894	0.015

* Statistically significant at $P<0.05$.

5. DISCUSSION

This study examined whether open innovation is widespread in a cluster and how organisation size influences involvement in open innovation practices. First, we investigated whether clustering has any effect on organisations participation in inbound, outbound innovation activities and technological spill-overs. The results suggest that the organisations within the cluster are actively participating in open innovation activities compared to the organisations outside the cluster. These results presented in Table 1 are in line with the view of Chesbrough (2006) that clusters promote open innovation activities and cause technological spill-overs.

Table 2. Open Innovation Activities by the Small and Medium-sized Organisations and Large Organisations within the IT cluster

Open innovation activities	Small and Medium-sized organisations (N=75)		Large organisations (N=172)		Kruskal-Wallis Test	
	Mean score (Out of 5)	Std. deviation	Mean score (Out of 5)	Std. deviation	Chi-Square	Asymp. Sig.(2-tailed)
Inbound innovation						
Allow others to access its knowledge to develop new products and services	3.43	1.117	4.02	0.933	15.953	.000
Willingness to purchase IP rights	2.93	1.245	3.91	0.926	32.579	.000
Search for potential partners	3.71	0.912	4.12	0.891	11.835	.001
Standard business processes to acquire external knowledge	3.89	1.034	4.21	0.811	4.685	.030
Outbound innovation						
Knowledge sharing with stakeholders	3.28	1.180	3.91	0.948	15.489	.000
Sale of internal knowledge with little cost	2.97	1.185	3.56	1.135	12.313	.000
Acquisition of IP rights	3.01	1.351	3.94	0.944	25.584	.000
Sale of IP rights	2.55	1.398	3.45	1.191	22.521	.000
Technological spill-overs						
Investments in other organisations	3.51	1.032	4.08	0.872	17.817	.000
Interest in external knowledge for internal R&D	3.79	0.874	4.26	0.696	16.722	.000
Interest in Joint ventures	3.79	0.874	4.22	0.786	14.562	.000
Acquire knowledge from external sources	3.49	1.095	4.00	0.838	10.866	.001
Cooperate and support others in their R&D efforts	3.53	0.977	4.08	0.848	17.125	.000
Knowledge sharing with competitors	3.03	1.335	3.65	1.221	11.608	.001

* Statistically significant at $P<0.05$.

Second, we investigated whether organisation size has any influence on open innovation. A study conducted by Van de Vrande et al. (2009) suggests the differences in open innovation practices in relation to organisation size. The results presented in Table 2 are consistent with the view of Chesbrough (2003) and West et al. (2006) that interactions with other organisations can influence open innovation and these interactions are prevalent in clusters.

Third, we studied the impact of organisation size on open innovation activities in IT organisations outside the cluster. A study conducted by Michelin et al. (2014) suggests that organisation size has no influence on inbound innovation and a negative effect on outbound innovation. While Kruskal-Wallis test suggest no differences except for knowledge sharing with competitors or stakeholders, the comparison of mean scores in Table 3, between SMOs within and outside the cluster revealed that SMOs outside the cluster scored high for allowing others to access its knowledge, preparedness to purchase IP rights, acquire and sale of IP rights and sharing knowledge with competitors. The activities relating to technological spill-overs are above average, suggesting the influence of clusters.

Fourth, McAdam and Reid (2001) view that the small and medium-sized organisations are less advanced in terms of knowledge creation and do not rely much on social interaction. Bozbura (2007) suggested that leaders in smaller organisations prevent outflow of knowledge and

knowledge sharing. The analysis suggests that large organisations within the cluster are more involved in open innovation practices compared to other large organisations outside the cluster. The cluster-based effects are noticeable with larger organisations in a cluster.

Finally, this study compared IT organisations within and outside the cluster to examine the relevance between organisation size and technological spill-overs. Liu (2008) pointed out that spill-over effect will be high among organisations with similarities in a cluster. However, results suggest that all organisations have achieved a mean score of 3 or above out of 5 for technological spill-overs except for knowledge sharing with competitors by large organisations outside the cluster.

Table 3. Open Innovation Activities by the Small and Medium-sized Organisations and Large Organisations outside the IT Cluster

Open innovation activities	Small and Medium-sized organisations (N=35)		Large organisations (N=25)		Kruskal-Wallis Test	
	Mean score (Out of 5)	Std. deviation	Mean score (Out of 5)	Std. deviation	Chi Square	Asymp. Sig.(2-tailed)
Inbound innovation						
Allow others to access its knowledge to develop new products and services	3.69	1.105	3.64	1.254	0.012	0.981
Willingness to purchase IP rights	3.11	0.932	3.32	1.108	0.478	0.452
Search for potential partners	3.54	0.886	3.76	1.052	1.500	0.346
Standard business processes to acquire external knowledge	3.63	1.003	3.68	1.314	0.412	0.572
Outbound innovation						
Knowledge sharing with stakeholders	3.14	1.061	3.64	1.075	3.201	0.090
Sale of internal knowledge with little cost	2.91	1.067	2.80	0.913	0.457	0.550
Acquisition of IP rights	3.17	0.954	3.36	1.221	0.155	0.467
Sale of IP rights	2.57	1.170	2.76	1.363	.031	0.594
Technological spill-overs						
Investments in other organisations	3.26	1.120	3.56	1.158	1.547	0.258
Interest in external knowledge for internal R&D	3.46	1.039	3.64	0.995	0.314	0.563
Interest in Joint ventures	3.43	0.917	3.60	1.041	0.244	0.476
Acquire knowledge from external sources	3.23	0.973	3.40	1.041	0.129	0.589
Cooperate and support others in their R&D efforts	3.26	0.980	3.28	1.021	0.138	0.721
Knowledge sharing with competitors	3.37	0.808	2.72	1.061	9.134	0.009

* Statistically significant at $P<0.05$.

6. CONCLUSION

This research provides supporting results in relation to the environment in which open innovation benefits can be improved. The results suggest that organisations in a cluster are involved in open innovation activities, but the level of involvement increased with the size of an organisation. Large organisations led the way compared to small and medium-sized organisations. This suggests the supporting role clusters play to some extent in exploring and

exploiting external knowledge, commercialising internal innovations and sharing knowledge with other organisations.

As with any research, this study is not free from limitation. The main limitation with this research is it utilises the data collected form the organisations within and outside IT cluster in India. Future research into the comparison of data collected from organisations in various IT clusters can help compare different IT clusters. In addition, research into the comparison of data collected from the organisations outside India can elaborate the potential of clusters in facilitating open innovation.

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The Geography of Economic Composition and Structural Change in Australia, 2006-2016: Insights from a Shift-Share Analysis

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ABSTRACT

Albeit mostly cushioned from any calamitous effects of the Global Financial Crisis (GFC), the Australian economy experienced significant policy changes and economic shifts from 2005/06 to 2010/11. Mining boom coincided with the local effects of the GFC in 2009, and a number of significant policy changes came into effect, including the introduction of the Fair Work Act (2009) and the removal of subsidies for the manufacturing sector. The following half a decade (2010/11 – 2015/16) saw a continuation of this transition with the peak of the mining boom and the decline of the automotive industry. This paper examines the effects of these economic dynamics on industry-specific employment across Australian regions (i.e. states and capital cities). A shift-share analysis is undertaken for the periods 2005/06–2010/11 and 2010/11–2015/16 to decompose the change of employment into its component parts – i.e. a national effect, an industry-mix effect and a competitive effect – in order to account for the regional specialisation. The findings suggest national employment growth has elevated regional employment; regional specialisation has brought about employment growth in certain regions such as Greater Perth, Rest of Qld, Greater Sydney and Northern Territory; and industry-specific circumstances (e.g. removal of assistance to automotive industry, mining boom/bust) are reflected in the sectoral changes in employment.

INTRODUCTION

Despite the ups and downs in the 1990s, the Australian economy entered the 2000s in a healthy state (Gerard and Kearns, 2011). Strong economic growth, decline in unemployment, increase in productivity, low inflation, general macroeconomic stability and the resilience to the Asian financial crisis reflected this generally positive outlook. The relative stability was built upon a number of economic policies such as trade, investment, finance and tax reforms. For instance, the financial market reforms included the introduction of inflation targeting in the 1990s.

However, later in the 2000s, the Australian economy experienced a number of transformations. In and around 2009, in addition to the modest impact of the largest international financial crisis since the Great Depression, the resource boom occurred, and significant policies such as the Fair Work Act and stimulus to the automobile industry were also implemented. In the following half a decade, both the Australian mining industry and the automobile industry witnessed considerable declines. With these transformations, one would expect some regions to grow on the expense of others depending on the availability of resources in regions and the nature of policy changes.

These important policy changes and industry-specific dynamics in Australia provide an ideal case study to investigate how regional employment responds to economic shifts of this nature. This paper sets out to investigate the changes in regional employment by industry during two important time periods in Australia: the first (2005/06-2010/11) is associated with the introduction of the Fair Work Act and the beginning of the resource boom; the second (2010/11-2015/16) is related to the resource bust and the decline of the automotive industry. Different policies and economic circumstances can result in different sources of change for specific industries, and the paper aims to show how the industry-specific employment changes over time. The analysis will decompose the change in employment to a national effect, an industry mixed effect and a competitive effect using the shift-share analysis.

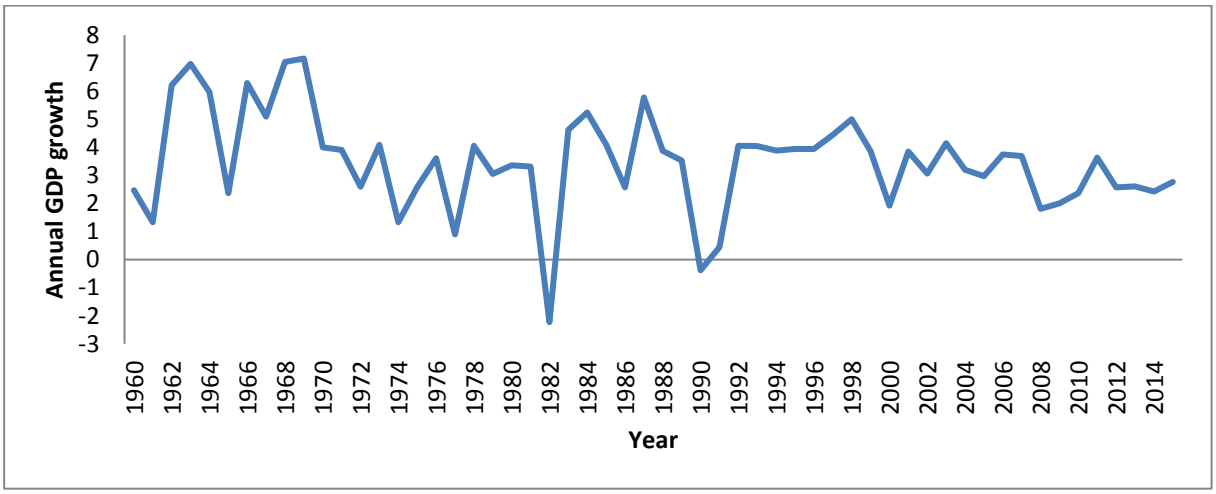
Regional employment analyses have been carried out in Australia using data prior to 2006 (Beer and Clower, 2009; Dixon and Freebairn, 2009; Stimson et al., 2009). However, the potential impact of recent policy changes (i.e. post 2005) on regional variation of employment hasn't been investigated to date. This paper thus addresses an important research gap by updating the findings of previous analyses. This first Australian two-period shift-share analysis demonstrates how different economic dynamics can lead to differential impacts on regional employment change. By comparing two periods, one prior to and the other post-2010/11, this study explores the potential impact of multiple events on industry-specific employment.

The paper is structured as follows: Section 2 discusses the profile and recent trends in industrial composition in Australia, including an account of significant policy changes during the period from 2005/06 to 2015/16; Section 3 presents the theoretical framework applied in this research; Section 4 and Section 5 describe methodology adopted and the data used. The main findings are discussed in Section 6; and Section 7 concludes the paper with some policy implications.

THE CHANGING AUSTRALIAN ECONOMY

The Australian economy has historically experienced relatively consistent annual economic growth levels; however, there were a number of years spread across the past fifty years with intrinsic recessions and economic expansions (see Figure 1).

Figure 1: GDP Growth (Annual %), 1961-2016, Australia



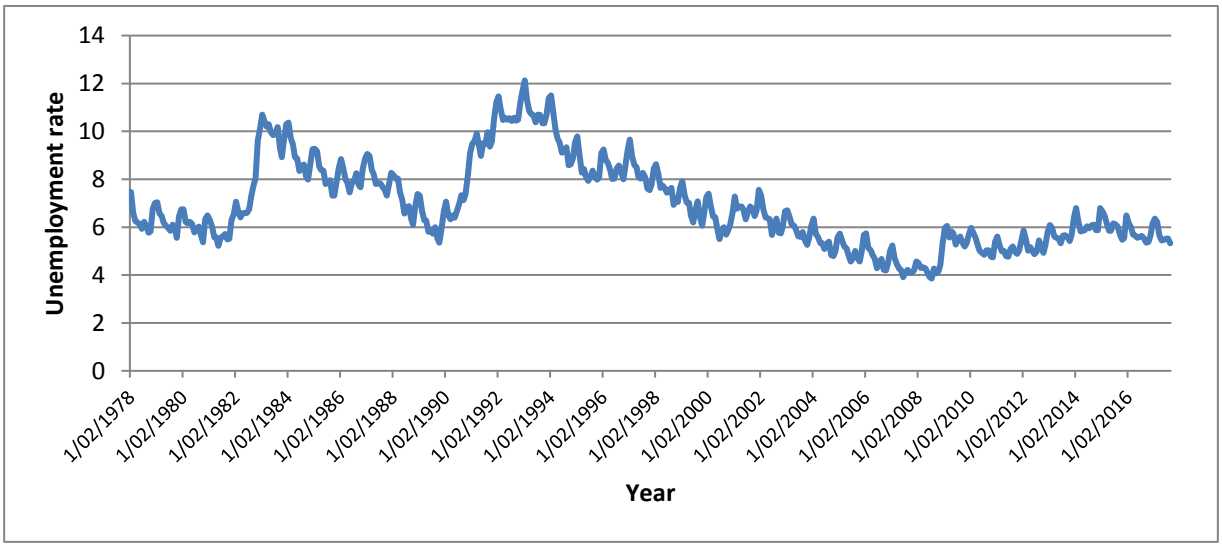
Notes: Annual percentage growth rate of GDP at market prices based on constant local currency. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Source: World Bank national accounts data, and OECD National Accounts data files.

Apart from the 1960-61 recession, the post-World War boom continued into the mid-1960s. Mining and manufacturing sectors peaked and the agriculture sector remained significant (10%) in the 1960s (Henry, 2001). This decade also saw low inflation (averaging 2.5 per cent) and low unemployment (averaging less than 2 per cent). The sharp decline of the economy in the early 1980s was linked to 'failures within the national economic system' (Kelly, 2000), and unemployment rates went above 10 per cent. Reforms to enhance the competitiveness of product markets and the flexibility of factor markets (Henry, 2001) helped the economy return to accelerated economic growth in the mid-1980s. The notable economic decline in the early 1990s was indicative of high unemployment (10%) and high inflation. As a consequence, interest rates were set as high as 17 per cent, subsiding consumption and sending inflation from around 7 per cent to 2 per cent.

The strong economic growth in the early 2000s is reflected in the low unemployment rate and soaring consumer confidence. Since the 2000s, Australia's economic reforms continued (see below) and the openness to trade improved. Trade, investment, finance and tax reforms of the 1990s and 2000s contributed to the stronger economic growth in the early 2000s. Macroeconomic stability occurred in the form of higher growth, lower unemployment and relatively lower inflation compared to the 1990s.

These trends in GDP growth are reflected in the historical unemployment rates in Australia (Figure 2). The recessions in the early 1980s, early 1990s and early 2000s exhibit spikes in unemployment rates. Fig 2 also reveals that unemployment rate starts to increase from 2008 onwards. This was associated with a declining GDP growth from 2007 (see Figure 1).

Figure 2: Unemployment Rate, 1978-2017, Australia



Source: ABS Labour Force Survey (6202.0 - Labour Force), Australia, Sep 2017,

The brief history of the Australian economy above highlights two important points:

1. Recent economic recessions were mainly blamed on international shocks (e.g. 1990s and 2009), and only occasionally on national causes (i.e. 1980)
2. On the surface, the Australian economy has performed strongly in recent times but in the inside our cities and regions may have faced different levels of opportunities as well as challenges. The question of interest here is 'did all regions in Australia share the increases and decreases of historical GDP and employment growth equally?'.

In the below section, we look into these observations in detail. To that end, we discuss a number of changes that occurred within the Australian economy, including significant industry-related legislation and sector-specific expansions and contractions. These will illustrate whether the recent positive outlook of the Australian economy has hidden regional economic dynamics, particularly since 2005/06.

Recent Trends in Industry Growth and Industry-specific Employment

The employment in Australia increased by 19 per cent between 2005/06 and 2015/16, with regional growth rates ranging from 5 per cent (Rest of SA) to 35 per cent (NT) – see Table 1. The regions with highest growth rates have common as well as specific dominant sectors. Though both Northern Territory and Greater Perth have thriving construction and health care and social assistance sectors, Northern Territory is also home to a large public administration and safety sector, whereas Greater Perth has a large retail trade sector. Consistent with the recent political discourse on lack of growth and limited employment opportunities in South Australia and Tasmania, remote areas of these states have recorded the slowest employment growth rates alongside their capital city counterparts from 2005/06 to 2015/16.

Table 1: Employment Change in Regions, 2005/06 – 2015/16

Region	Employment change (numbers)	Employment change (%)
Northern Territory	34,250	34.6
Greater Perth	259,050	32.2
Greater Melbourne	449,175	23.9
Greater Brisbane	212,475	21.9
Greater Sydney	407,675	19.2
Rest of Queensland	171,450	17.0
Rest of New South Wales	167,800	15.5
Rest of Victoria	77,750	13.2
Rest of Western Australia	32,300	12.8
Australian Capital Territory	23,575	12.6
Greater Adelaide	56,775	9.9
Greater Hobart	9,400	9.9
Rest of Tasmania	7,200	5.6
Rest of South Australia	8,100	4.9
Australia	1,917,325	19.2

Source: ABS Labour Force, Australia, Detailed, Quarterly (6291.0.55.003).

The compositional change that has occurred at the national level in Australia between 2005/06 and 2015/16 is depicts the significance of some industries has diminished between 2005/06 and 2015/16 (see Table 2). The industries that witnessed their significance declined include manufacturing, retail trade, agriculture, forestry and fishing, wholesale trade, and information media and telecommunications. Meanwhile, some industries such as health care and social assistance, professional, scientific and technical services, education and training, mining and, accommodation and food services have increased their share within the Australian economy by 2015/16. In 2005/06, retail trade (12 per cent) had the largest share of national employment, but this sector was outnumbered by health care and social assistance (13 per cent) in 2015/16.

Table 2: Employment by Industry, 2005/06 and 2015/16, Australia

	2005/06		2015/16	
	Number Employed	%	Number Employed	%
Agriculture, Forestry and Fishing	345,375	3.5	321,500	2.7
Mining	127,200	1.3	227,625	1.9
Manufacturing	1,012,425	10.2	877,125	7.4
Electricity, Gas, Water and Waste Services	104,250	1.0	143,900	1.2
Construction	863,550	8.7	1,050,250	8.8
Wholesale Trade	372,575	3.7	371,725	3.1
Retail Trade	1,159,200	11.6	1,266,450	10.7
Accommodation and Food Services	663,275	6.7	825,800	7.0
Transport, Postal and Warehousing	497,250	5.0	623,775	5.2
Information Media and Telecommunications	236,875	2.4	208,775	1.8
Financial and Insurance Services	375,075	3.8	431,175	3.6
Rental, Hiring and Real Estate Services	186,700	1.9	211,600	1.8
Professional, Scientific and Technical Services	707,575	7.1	989,775	8.3
Administrative and Support Services	351,300	3.5	422,175	3.6
Public Administration and Safety	610,825	6.1	740,850	6.2
Education and Training	741,175	7.4	937,150	7.9
Health Care and Social Assistance	1,024,025	10.3	1,532,800	12.9
Arts and Recreation Services	175,175	1.8	226,575	1.9
Other Services	410,775	4.1	472,900	4.0
Total employment	9,964,600		11,881,925	

Source: ABS Labour Force, Australia, Detailed, Quarterly (6291.0.55.003).

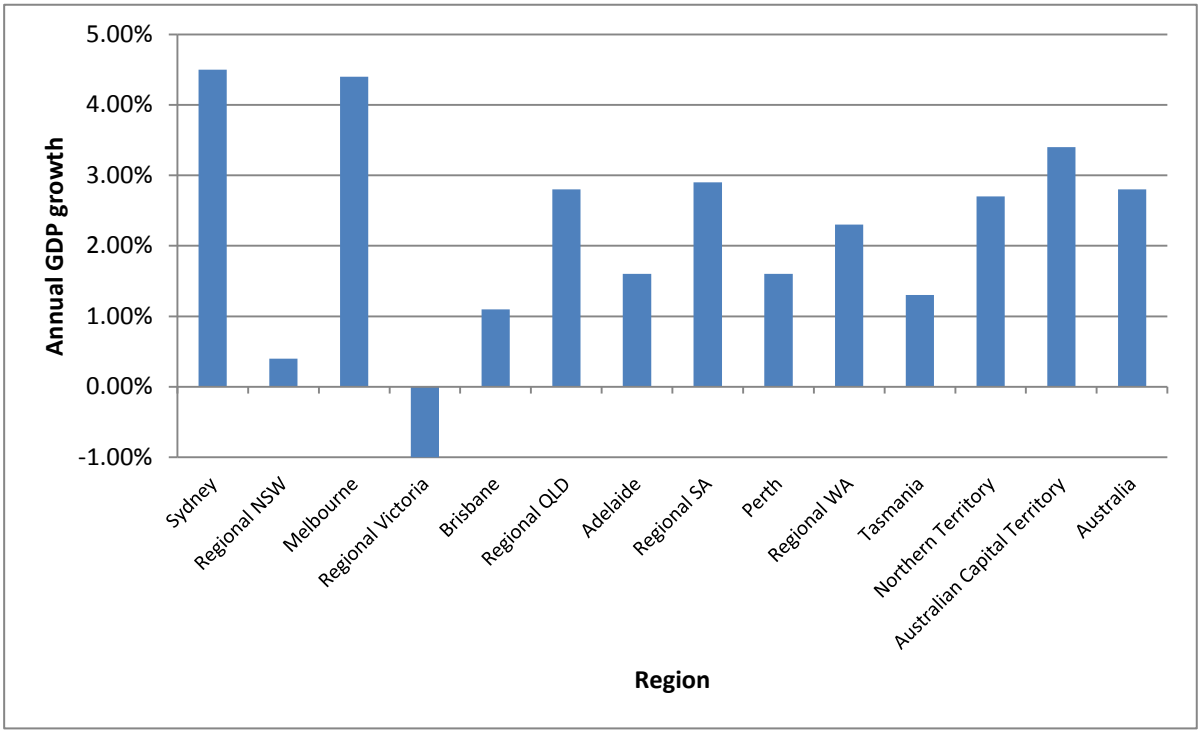
As illustrated in Figure 3, the regional level GDP growth can vary substantially from the national GDP growth rates. In 2015/16, large cities such as Sydney (4.5 per cent), Melbourne (4.4 per cent) and the Australian Capital Territory (3.4 per cent) experienced healthy growth rates alongside mining-led regions such as Regional SA (2.9 per cent) and Regional QLD (2.8 per cent). Other regions recorded below-national level growth rates. Notably, Regional Victoria reported an economic decline (1 per cent) due to reduced production in manufacturing and agriculture.

Different GDP growth rates are indicative of the changing composition of industry-specific employment in our cities and regions. As presented in Figure 4, economic expansions and contractions over the period 2005/06-2015/16 have led to positive or negative changes in industry-specific employment in Australian regions. Figure 4 looks closely at the contributions each industry made to a region's employment change between 2005/06 and 2015/16. The bars in the upper panel (thus showing an increase) denote the magnitude of employment growth for an industry, whereas bars in the lower panel (thus exhibiting a decrease) denote the extent of employment decline.

The industries that contributed markedly (i.e. a decrease of 3% or more) to employment decline were: Manufacturing (all regions except Northern Territory reported declines); Retail Trade (Northern Territory); Agriculture, Forestry and Fishing (Rest of WA and Rest of Tas.); and Accommodation (Northern Territory). Significant contributions to employment growth (i.e. an increase of 3% or more) emanated from the following industries: Health Care and Social

Assistance (all regions except Northern Territory, Greater Perth, Australian Capital Territory and Rest of SA recorded growth), Mining (Rest of WA) and Construction (Northern Territory). The most overarching changes in employment over the period 2005/06-2015/16 have been the decline of manufacturing and the growth in health care and social assistance across most regions. In terms of magnitude, Agriculture, Forestry and Fishing sector recorded an 11 per cent decline in Rest of WA, whereas Mining recorded a 6 per cent growth in Rest of WA.

Figure 3: GDP Growth Rates in Australian Cities and Regions, 2015/16



Source: Australian National Accounts: State Accounts, Cat. No. 5220.0 and SGS Economics and Planning (2016)

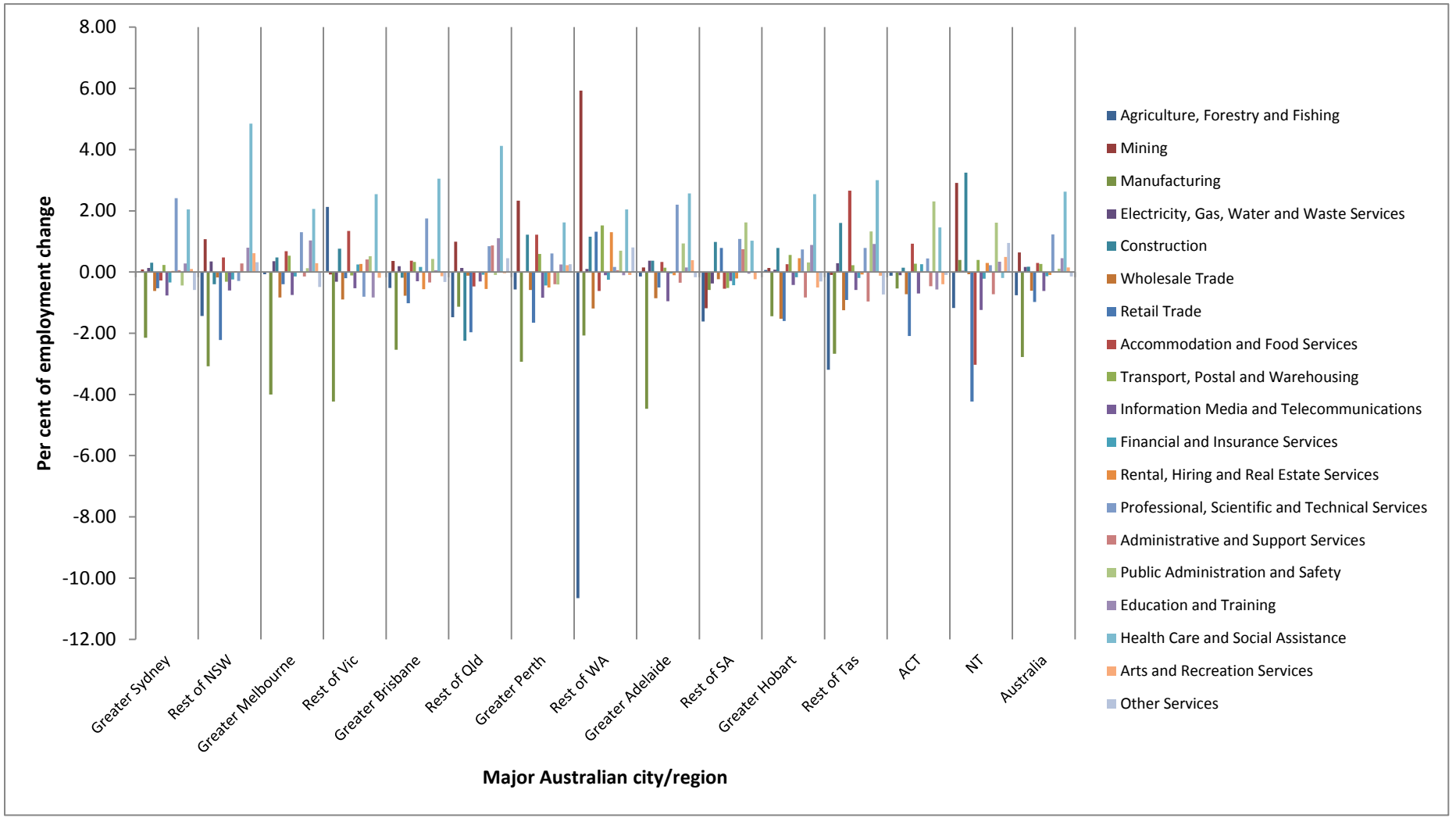
In this paper, we consider significant national and international economic events in examining the associated change in regional employment by industry. In order to ascertain how different economic dynamics can lead to differential impacts on regional employment, we distinguish between two periods: 2005/06 to 2010/11 and 2010/11 to 2015/16.

The First Wave of Economic Changes 2005/06 – 2010/11

Between 2005/06 and 2010/11, Australia experienced various shocks in the employment market and these would have had impact on industrial employment structure in Australian states and territories. Some of these shocks included: removal of assistance for automotive industry in and around 2006; resource boom in 2009; Fair Work Act of 2009; and the global financial crisis in 2009.

The automotive industry has long received government support. After the decline of tariff assistance to the automotive industry in 1984, a series of industry-specific budgetary measures were implemented to help the industry. These measures, known as *automotive industry stimulus*, were discontinued after 2006. However, assistance kept coming back to the automotive industry, as the governments were anxious about the car manufacturers leaving Australia. The Automotive Transformation Scheme (ATS) was introduced in 2008-09 to support the industry to 2020-21. This was aimed at encouraging competitive investment and innovation in the industry and placing it on an economically sustainable position.

Figure 4: Sources of Employment Change, Australian Regions, 2005/06-2015/16



Notes: The classification of regions in Figure 4 (and the analysis that follows) is slightly different to that used in Figure 3 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. Source: ABS - Labour Force, Australia, Detailed, Quarterly (6291.0.55.003).

A number of Australian regions also experienced a significant resource boom during this period. Since the mid-2000s, Australia's increased terms of trade due to mining sector boom led to increased mining sector investment, an appreciation of the Australian $, and a considerable resource allocation in the economy as a whole. These resulted in upward changes in both aggregate employment and the composition of employment. The mining boom peaked around 2009 and flattened around 2011.

From a policy perspective, the Fair Work Act came into effect on 1 July 2009 replacing the existing Work Place Relations Act of 1996. The new Act incorporated new obligations towards union activities and enforced enterprise agreements and unfair dismissal laws, with the aim of stabilising the labour market. New National Employment Standards that came into effect from 1 January 2010 incorporated an additional one year unpaid parental leave, up to twenty weeks redundancy pay and flexible working arrangements for parents having children under school age.

Albeit to a lesser extent compared to its Western counterparts, Australia was somewhat affected by the Global Financial Crisis (GFC) in 2009. The impact of the *Australian Financial Crisis* was lessened mainly due to the health of the Australian banking system and partly because the Crisis coincided with the resource boom in 2009. Though Australian banks did not require any capital provisions from the Government, a large decline in equity prices occurred, reducing the wealth of Australian households by nearly 10 per cent by March 2009 (ABS, 2010). From July 2008 to mid-2009, the Australian dollar depreciated by over 30 per cent. The Reserve Bank of Australia intervened in the market to enhance liquidity.

The Second Wave of Economic Changes 2010/11 – 2015/16

The resource boom peaked in 2012, in the middle of the period covered in the second part of the analysis. The mining industry slowly declined afterwards until early 2016 (RBA, 2016). Whilst some believe mining tax and carbon tax contributed to constrain production capabilities of mining companies, others put the blame on China for decreasing revenues. The alternative view suggests mining production hasn't declined but only the prices (and thus revenues) have decreased, indicating the industry's productive capacity remains intact.

The period 2010/11-2015/16 also saw a remarkable decline in the automotive industry in Australia. Whilst subsequent assistance to automotive industry introduced in 2008/09 continued into 2010/11, in 2014, the Productivity Commission considered that ongoing industry specific assistance to the automotive manufacturing industry is not warranted. The Budget 2014–15 reflects the Government's decision to terminate the ATS on 1 January 2018.

In parallel to these policy developments, the historically high value of the Australian dollar and relatively expensive labour has put the automotive industry under competitive pressure, both from cheaper imports and its effect on export competitiveness. These have hindered efforts to improve scale issues through expanded production for export, ultimately resulting in diseconomies of scale. As a result, three out of four car manufacturers (i.e. Holden, Ford and Toyota) have decided to cease their operations in Australia by the end of 2017.

The economic/industry policy changes are likely to have an impact on industry specialisation of regions and industry-specific employment patterns. Below, we discuss key literature on regional specialisation to provide a foundation for the analytical section.

THEORETICAL FRAMEWORK

A wealth of research exists on sectoral change and regional specialisation. Krugman (2009) argues that trade theorists ignored geography by not considering trade within countries, or the location of production in space. However, he deliberates "… the theory of international trade

and the theory of economic geography to have developed in tandem, and in close relationship to each other, with a joint empirical research program (p. 566)". Though not trivial, the importance of increasing returns to geographical patterns or regional specialisation (for example, semiconductors production in Silicon Valley) is often ignored (Krugman, 2009).

Regional specialisation occurs mainly due to economies of scale, lower transport costs and a declining farm share in the economy. People tend to move to the regions at the periphery to obtain higher real wages and a greater variety of goods and services. City at the core tends to grow and regions at the periphery tend to become more specialised. To capture the qualitative change, the new economic geography accommodates *core-periphery model* of Krugman (1991) (a model of agglomeration) incorporating regional specialisation in different industry system of cities.[1] Industry localisation by regions generates knowledge spillovers, labour market pooling and talented suppliers. Government intervention towards international trade and region specific policies has consequences on the industrial structure and the degree of employment specialisation across regions within an economy. The *core-periphery model* triggers the empirical works on regional variations in industrial specialisation. However, empirical research on regional specialisation of employment has not been limited to *core-periphery model* alone and other approaches such as Coefficient of Regional Specialization (CRS) and Coefficient of Absolute Regional Specialisation (CARS) have also been used (Robson, 2009).

Theoretical perspectives on inter-temporal and geographic shifts in industrial employment structures have been empirically explored in number of studies in Australia. Dixon and Freebairn (2009) conclude that regional specialisation, captured by the Coefficient of Regional Specialisation[2], has fallen due to de-specialisation in manufacturing following substantial tariff reductions over the period 1985 – 2006. In contrast, Beer and Clower (2009), using regression analysis for the period 1996 – 2001, argue that deregulation has contributed to the growth of some regional cities in Australia. Hicks et al. (2014), examining employment specialisation in Australia from 2001 and 2006, conclude there is little evidence that employment specialisation occurred in general; and regions appear to have a higher level of employment specialisation relative to metropolitan centres.

Research on *industry specialisation* in employment in Australia is rare. Existing research findings on employment specialisation have been somewhat mixed revealing evidence of decreasing and increasing levels of employment specialisation across regions and cities. The results may not be comparable as these studies adopted different methodologies (i.e. Coefficient of Regional Specialisation, regression analysis, and shift-share analysis), examined different levels of regions (e.g. city, local government area and state level) and covered different time periods (mostly prior to 2006).

Amongst the regional specialisation analyses, the shift-share analysis decomposes the aggregate change in each region's employment over the study period, expressed as a deviation from the national average into more useful components such as a national share, an industry-mix share and a competitive share. This method helps answering the question as to 'why employment is growing or falling in a regional industry'. This is achieved via the estimation of an industry-mix, revealing the changes in employment across various industry sectors within a region as a result of government policies and various investment strategies, and a competitive shift, identifying the changes of employment due to regional competitive advantage.

METHODOLOGY

Shift-share analysis is the key analytical technique applied to decompose the employment change at the regional level to show regional variation in the sources of employment growth between 2005/06 and 2015/16. This regional analysis tool divides the change between two

periods into component parts that can be linked to national circumstances (national effect), regional emphasis on fast-growing sectors (industry-mix effect) and regional competitiveness (competitive effect). Using this technique, the industry-level employment change in regions between two periods is compared against a benchmark region.

The method disaggregates the change of employment between two periods into three effects:

$$\Delta P_i^r = N_i^r + M_i^r + C_i^r \quad (1)$$

The national effect (N_i^r) captures the increase in industry *i*'s employment in region *r* that would have been expected if it grew at the same rate as the nation as a whole. 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 fast at the national level. The competitive effect (C_i^r) measures the contribution of specific characteristics of region *r* to overall employment change.

According to Arcelus (1984), the competitive effect is composed of two components – overall employment increase at the region level and the actual competitive portion that would be the result of regional level industries growing faster than their national level counterparts:

$$C_i^r = R_i^r + RM_i^r \quad (2)$$

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

An additional extension suggested by Arcelus (1984) subdivides each component in equation (1) into two further subcomponents. The 'expected' portion is the increase (or decrease) of employment that would have been expected if the region had the same employment composition as the nation. The 'regional specialisation' portion is the share of change that is attributable to the region's deviation from the nation.

The estimation of a regional industry's 'homothetic employment' (HP_i^r) is required to accomplish this subdivision (Franklin, 2014). This represents region *r*'s hypothetical employment in industry *i* if the region's employment structure (i.e. sectoral composition) was the same as the nation's employment structure. Homothetic employment is calculated as follows:

$$HP_i^r = P^r * \frac{P_i^n}{P^n} \quad (3)$$

where P^r is the total regional employment, P_i^n is the industry *i*'s national employment and P^n is the total national employment, all for the first period.

The shift-share components are thus calculated as follows:

$$N_i^r = HP_i^r * P^n + (P_i^r - HP_i^r) * P^n \quad (4)$$

$$M_i^r = HP_i^r * (P_i^n - P^n) + (P_i^r - HP_i^r) * (P_i^n - P^n) \quad (5)$$

$$C_i^r = HP_i^r * (P_i^r - P_i^n) + (P_i^r - HP_i^r) * (P_i^r - P_i^n) \quad (6)$$

Note in each equation, the first part is the 'expected' portion and the second part is the 'regional specialisation' portion for each effect as mentioned above.

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

$$R_i^r = HP_i^r * (p^r - p^n) + (P_i^r - HP_i^r) * (p^r - p^n) \quad (7)$$

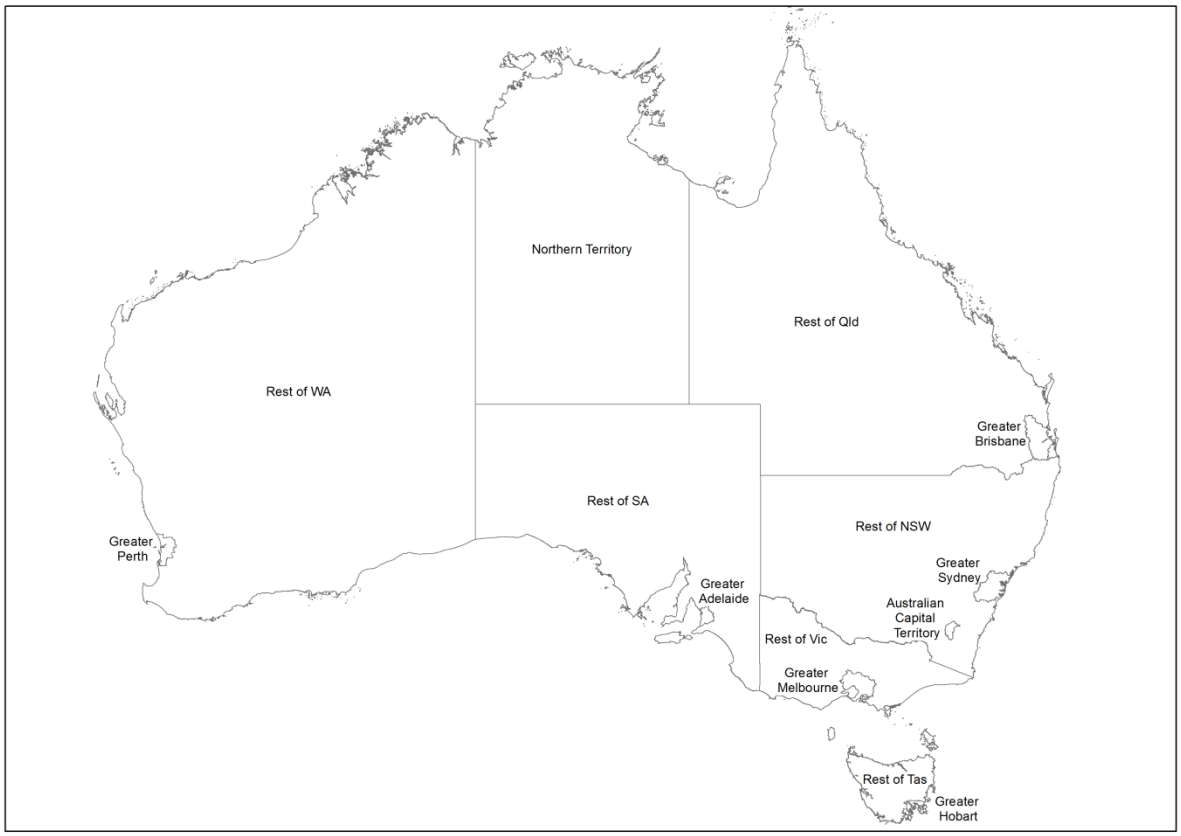
$$RM_i^r = HP_i^r * [(p_i^r - p^r) - (p_i^n - p^n)] + (P_i^r - HP_i^r) * [(p_i^r - p^r) - (p_i^n - p^n)] \quad (8)$$

where P_i^r is region *r*'s employment in industry *i* in 2005/06, p^n is national employment growth rate between 2005/06 and 2010/11, p_i^n is national growth rate in industry *i*'s employment between 2005/06 and 2010/11, p^r is regional employment growth rate between 2005/06 and 2010/11, and p_i^r is region *r*'s employment growth rate in industry *i* between 2005/06 and 2010/11. In the second part of the analysis (see below) the growth rates are calculated for the period between 2010/11 and 2015/16.

DATA

This paper uses employment by industry data for Australia and its regions between 2005/06 and 2015/16. The dataset is sourced from the Australian Labour Force Survey (LFS), a key source of employment data in Australia, as held in the Australian Bureau of Statistics (ABS) databases. LFS includes 'employed persons by Greater Capital City and Rest of State (ASGS)' classified by 'industry division of main job (ANZSIC)[3]'. Data collection is undertaken in February, May, August and November each year, spanning from the 4th quarter of 1984 up until the 1st quarter of 2017 (Australian Bureau of Statistics, 2017).

Figure 5: Major Cities and Regions of Australia



Source: Based on ABS 2011 digital boundaries [ABS digital boundaries for Greater Capital City Statistical Areas (GCCSAs) and States have been combined to produce the relevant geographies for the Labour Force Survey data].

However, given our focus on recent economic change, only data from 2005/06 to 2015/16 are analysed. The analysis is progressed in two stages to examine whether different economic dynamics can lead to differential impacts on regional employment change. The first part of the analysis covers the period between 2005/06 and 2010/11, whereas the second part covers the period from 2010/11 to 2015/16.

To limit 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 2005/06 is the average of employment in this sector in quarters 3 and 4 of 2005 and quarters 1 and 2 of 2006.

The regions covered include all the state capital cities Sydney, Melbourne, Brisbane, Perth, Adelaide and Hobart, and other regions including the Australian Capital Territory, 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 5 shows the locations of these regions within Australia.

RESULTS

Shift-share analysis sheds light on industry contributions and growth trends in the economy at the national, regional and industry levels. Shift-share is used to allocate employment change at the city and region level to a national effect, an industry-mix effect and a competitive effect (see methodology section). Unlike the background section that discusses employment change from 2005/06 to 2015/16, the findings reported in this section undertakes the analysis covering two separate periods (2005/06 to 2010/11 and 2010/11 to 2015/16). These phases observed significant compositional and policy changes and allows an investigation into the dynamics of industry-specific employment change in Australian regions.

The Homothetic Employment

The analysis commences by examining the 'homothetic employment' – i.e. the employment the region would have in each industry were its distribution the same as the nation's. This can show the contribution made to each effect that results from the region's specialization in particular industries, or in other words, this is able to show industry-level differences from the national norm.

A comparison of the actual employment distribution to the homothetic distribution for Melbourne, the region with the highest growth in employment between 2005/06 and 2010/11, and for Sydney, the region recording the highest growth between 2010/11 and 2015/16 is presented in Table 3.

Greater Melbourne had fewer employed in agriculture, forestry and fishing, mining, public administration and safety, accommodation and food services and, electricity, gas, water and waste services in 2005/06 than it would have if its employment distribution were the same as the nations. This is simple to explain in terms of the former two industries given Greater Melbourne's urban character, however reasons for the underrepresentation of the latter three industries in the region is less straight-forward. In contrast, Greater Melbourne's manufacturing, professional, scientific and technical services, wholesale trade, financial and insurance services, information media and telecommunications and, administrative and support services are overrepresented compared to the nation as a whole. Thus, Greater Melbourne has a specialisation in these industries.

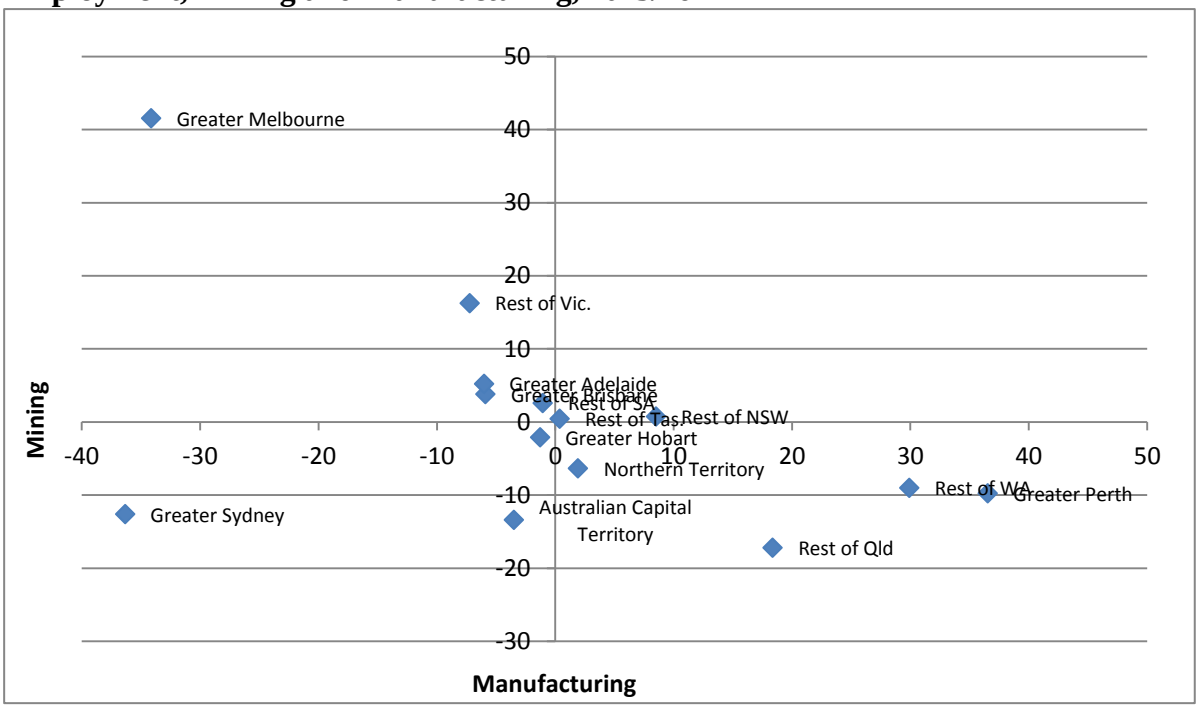
Greater Sydney, on the other hand, had a higher share of employed in the professional, scientific and technical services, financial and insurance services, information media and telecommunications, transport, postal and warehousing and wholesale trade in 2010/11. In other words, Greater Sydney specialised in those industries. Industries that were underrepresented included agriculture, forestry and fishing, mining, public administration and safety, construction, retail trade and manufacturing.

Table 3 – Actual versus Homothetic Employment Distribution, Greater Melbourne (2005/06) and Greater Sydney (2010/11)

	Greater Melbourne (2005/06)			Greater Sydney (2010/11)		
	Actual employment distribution	Homothetic distribution	Difference	Actual employment distribution	Homothetic distribution	Difference
Agriculture, Forestry and Fishing	13,525	65,083	-51,558	9,425	70,015	-60,590
Mining	4,250	23,970	-19,720	5,750	42,093	-36,343
Manufacturing	245,950	190,783	55,167	188,800	201,425	-12,625
Electricity, Gas, Water and Waste Services	14,900	19,645	-4,745	25,175	30,693	-5,518
Construction	159,300	162,729	-3,429	186,450	209,234	-22,784
Wholesale Trade	84,000	70,209	13,791	103,875	84,144	19,731
Retail Trade	213,625	218,442	-4,817	232,975	249,090	-16,115
Accommodation and Food Services	108,050	124,989	-16,939	158,175	156,930	1,245
Transport, Postal and Warehousing	97,025	93,703	3,322	142,600	119,512	23,088
Information Media and Telecommunications	56,225	44,637	11,588	67,575	43,841	23,734
Financial and Insurance Services	86,325	70,680	15,645	141,525	83,023	58,502
Rental, Hiring and Real Estate Services	31,025	35,182	-4,157	44,600	41,880	2,720
Professional, Scientific and Technical Services	161,575	133,337	28,238	239,775	175,703	64,072
Administrative and Support Services	76,650	66,200	10,450	85,475	81,228	4,247
Public Administration and Safety	86,750	115,105	-28,355	120,250	144,767	-24,517
Education and Training	132,875	139,669	-6,794	168,200	176,341	-8,141
Health Care and Social Assistance	192,225	192,969	-744	255,950	263,049	-7,099
Arts and Recreation Services	38,800	33,010	5,790	39,650	41,169	-1,519
Other Services	74,675	77,407	-2,732	90,825	92,913	-2,088

Source: Author calculations

Figure 6: Cross-comparison of Regional Differences between Homothetic and Actual Employment, Mining and Manufacturing, 2015/16



Note: Patterns were very similar for the same comparison using 2005/06 data (available on request).
Source: Author calculations.

The policy changes explained in the background section would likely have had an impact across industries. However, as discussed, mining and manufacturing were two key industries that underwent substantial transformation over the study period. Due to space reasons, only a cross-comparison of regional differences between homothetic and actual employment for mining and manufacturing industries are presented in Figure 6.

In mining and manufacturing sectors, two clear patterns were apparent across the nation: an overrepresentation of manufacturing and an underrepresentation of mining (Greater Melbourne, Rest of Vic, Greater Adelaide, Greater Brisbane and Rest of SA); and an overrepresentation of mining and an underrepresentation of manufacturing (Rest of Qld, Greater Perth, Rest of WA and Northern Territory). The former is a result of the active automotive industry in the states of Victoria, South Australia and Queensland, whereas the latter reflects the dominant role of mining in Queensland and WA – these highlight industry specialisations of these regions. Rest of NSW and Rest of Tasmania have a higher share of mining and manufacturing than they would if their employment distribution were the same as the nation as a whole, but their deviations are minimal. Greater Sydney and the ACT stand out as regions with an underrepresentation of both industries. This clearly indicates the regions specialising in the mining and manufacturing sectors across the nation. Interestingly, these patterns were consistent between 2005/06 and 2010/11.

Detailed Shift-Share Results – Greater Melbourne and Greater Sydney

The shift-share analysis uses the homothetic employment and the difference between actual and homothetic employment to capture the share of employment change that would accrue to the region for each effect if its employment distribution matched the nation's distribution ('expected effects') and the increase (decrease) in employment it gains (suffers) by specialising in particular industries, relative to the nation.

Similar to the previous section, Table 4 and 5 present the results of the shift-share analyses for the regions with the highest growth in employment in each period – Greater Melbourne in 2005/06-2010/11 and Greater Sydney in 2010/11-2015/16. In the analysis, each effect is the sum of expected and specialisation calculations, and the competitive effect is the sum of regional and regional industry-mix effects (see Methodology section above).

As expected, the national effect is positive for all industries in all regions. This is because national effect solely measures the potential growth attributable to national employment growth. The specialisation component is either positive or negative depending on whether Greater Melbourne's share of employment in a particular industry is larger or smaller than the share at the national level. The expected and specialisation elements can be positive or negative for the industry-mix effect, regional effect and regional industry-mix effect depending on the employment composition in the regions and the nation.

The decline of employment between 2005/06 and 2010/11 in the manufacturing and information media and telecommunications industries in Greater Melbourne is mostly explained by that region's specialisation in industries that are growing slow at the national level (industry mix effect). The manufacturing decline is also partly attributable to the weakening of employment in that industry in the Greater Melbourne region (regional industry mix effect).

During this period, Greater Melbourne saw substantial increases in employment across six industries. The growth in health care and social assistance and, professional, scientific and technical services can be explained by national growth of these industries as well as Greater Melbourne's specialisation in those industries that are growing fast at the national level. The most common combination of sources of employment among growth industries was observed in relation to education and training, accommodation and food services, and financial and insurance services – these were national effect and regional industry mix effect. The construction industry in Greater Melbourne presented itself as a unique industry as all four sources of employment contributed to its growth.

Between 2010/11 and 2015/16, Greater Sydney recorded a decline of employment in both manufacturing and wholesale trade industries. These reductions originated from the industry mix effect and the regional effect. In other words, employment decline in those industries at the national level and overall employment decline in Greater Sydney have led to negative employment outcomes for this region.

The sector reporting the largest growth in employment in Greater Sydney, professional, scientific and technical services was helped by the national effect, industry mix effect and the regional industry mix effect. The industry with the second largest growth, health care and social assistance industry, reported the national effect and the industry mix effect as main sources of employment change. The most common combination of sources of employment change however was the national effect and the regional industry mix effect. They were prevalent within retail trade, education and training, financial and insurance services, and construction.

Region-level Shift-Share Results

As mentioned previously, the national effect is positive for all regions because employment in the nation as a whole grew during both study periods (see Tables 6 and 7). Generally, regions that experienced higher rates of employment growth during both periods tended to have positive values for the competitive effect, and the regions that saw lower levels of growth, or decline as in the case of Greater Hobart in 2010/11-2015/16, have negative values. Based on this indicator, Greater Melbourne, Greater Brisbane and Greater Perth performed well in generating employment during the first period (2005/06-2010/11). During the second period (2010/11-2015/16), Greater Sydney joined in as a top performer, whereas Greater Brisbane dropped out.

Table 4: Detailed Shift-Share Results, Greater Melbourne, 2005/06-2010/11

	National effect			Industry mix effect			Regional effect			Regional industry mix effect		
Industry	Expected	Speciali-sation	Total	Expected	Speciali-sation	Total	Expected	Speciali-sation	Total	Expected	Speciali-sation	Total
Agriculture, Forestry and Fishing	7,515	-5,953	1,562	-9,032	7,155	-1,877	1,792	-1,420	372	4,417	-3,499	918
Mining	2,768	-2,277	491	11,478	-9,443	2,035	660	-543	117	-10,535	8,667	-1,868
Manufacturing	22,030	6,370	28,400	-29,939	-8,657	-38,597	5,253	1,519	6,772	-10,550	-3,051	-13,600
Electricity, Gas, Water and Waste Services	2,268	-548	1,720	5,952	-1,438	4,515	541	-131	410	-1,906	460	-1,445
Construction	18,790	-396	18,394	8,444	-178	8,267	4,481	-94	4,386	590	-12	578
Wholesale Trade	8,107	1,592	9,699	-1,921	-377	-2,299	1,933	380	2,313	-2,790	-548	-3,339
Retail Trade	25,223	-556	24,667	-17,516	386	-17,130	6,015	-133	5,882	1,514	-33	1,481
Accommodation, Food Services	14,432	-1,956	12,476	3,055	-414	2,641	3,442	-466	2,975	10,709	-1,451	9,257
Transport, Postal and Warehousing	10,820	384	11,203	3,982	141	4,124	2,580	91	2,672	-1,785	-63	-1,848
Information Media and Telecommunications	5,154	1,338	6,492	-9,988	-2,593	-12,581	1,229	319	1,548	330	86	415
Financial and Insurance Services	8,161	1,807	9,968	-3,464	-767	-4,231	1,946	431	2,377	9,835	2,177	12,011
Rental, Hiring and Real Estate Services	4,062	-480	3,582	-1,222	144	-1,077	969	-114	854	2,541	-300	2,241
Professional, Scientific and Technical Services	15,396	3,261	18,657	10,788	2,285	13,072	3,671	778	4,449	-972	-206	-1,178
Administrative and Support Services	7,644	1,207	8,851	-97	-15	-112	1,823	288	2,111	-7,988	-1,261	-9,249
Public Admin. and Safety	13,291	-3,274	10,017	3,037	-748	2,289	3,169	-781	2,389	-723	178	-545
Education and Training	16,127	-784	15,343	4,304	-209	4,095	3,846	-187	3,659	15,219	-740	14,478
Health Care and Social Assistance	22,282	-86	22,196	23,571	-91	23,480	5,313	-20	5,293	-69	0	-69
Arts and Recreation Services	3,812	669	4,480	555	97	653	909	159	1,068	3,444	604	4,049
Other Services	8,938	-315	8,623	-1,989	70	-1,919	2,131	-75	2,056	2,452	-87	2,365

Source: Author calculations.

Table 5: Detailed Shift-Share Results, Greater Sydney, 2010/11-2015/16

	National effect			Industry mix effect			Regional effect			Regional industry mix effect		
Industry	Expected	Speciali-sation	Total	Expected	Speciali-sation	Total	Expected	Speciali-sation	Total	Expected	Speciali-sation	Total
Agriculture, Forestry and Fishing	4,830	-4,179	650	-8,114	7,022	-1,092	-4,830	4,179	-650	39,686	-34,343	5,342
Mining	2,904	-2,507	397	2,249	-1,942	307	-2,904	2,507	-397	-1,700	1,468	-232
Manufacturing	13,894	-871	13,023	-33,265	2,085	-31,180	-13,894	871	-13,023	24,970	-1,565	23,405
Electricity, Gas, Water and Waste Services	2,117	-381	1,737	-2,942	529	-2,413	-2,117	381	-1,737	3,552	-639	2,913
Construction	14,433	-1,572	12,861	-5,679	618	-5,061	-14,433	1,572	-12,861	28,067	-3,056	25,011
Wholesale Trade	5,804	1,361	7,165	-12,794	-3,000	-15,794	-5,804	-1,361	-7,165	9,452	2,216	11,669
Retail Trade	17,182	-1,112	16,071	-3,411	221	-3,190	-17,182	1,112	-16,071	35,432	-2,292	33,140
Accommodation, Food Services	10,825	86	10,911	3,647	29	3,676	-10,825	-86	-10,911	-3,994	-32	-4,026
Transport, Postal and Warehousing	8,244	1,593	9,837	1,714	331	2,045	-8,244	-1,593	-9,837	2,351	454	2,805
Information Media and Telecommunications	3,024	1,637	4,661	-3,533	-1,912	-5,445	-3,024	-1,637	-4,661	5,268	2,852	8,120
Financial and Insurance Services	5,727	4,035	9,762	744	524	1,268	-5,727	-4,035	-9,762	11,341	7,991	19,332
Rental, Hiring and Real Estate Services	2,889	188	3,077	-850	-55	-905	-2,889	-188	-3,077	7,118	462	7,580
Professional, Scientific and Technical Services	12,120	4,420	16,540	17,613	6,423	24,035	-12,120	-4,420	-16,540	26,171	9,544	35,715
Administrative and Support Services	5,603	293	5,896	795	42	836	-5,603	-293	-5,896	11,749	614	12,364
Public Admin. and Safety	9,986	-1,691	8,295	-983	166	-817	-9,986	1,691	-8,295	7,905	-1,339	6,567
Education and Training	12,164	-562	11,602	6,008	-277	5,730	-12,164	562	-11,602	16,926	-781	16,145
Health Care and Social Assistance	18,145	-490	17,655	36,951	-997	35,954	-18,145	490	-17,655	6,676	-180	6,496
Arts and Recreation Services	2,840	-105	2,735	3,018	-111	2,907	-2,840	105	-2,735	2,666	-98	2,568
Other Services	6,409	-144	6,265	-1,168	26	-1,142	-6,409	144	-6,265	2,370	-53	2,317

Source: Author calculations.

Table 6: Shift-Share Results, Regions of Australia, 2005/06-2010/11

			Competitive effect			
	National effect	Industry mix effect	Total	Regional effect	Regional industry mix effect	Total change
Greater Sydney	245,524	-7,472	-57,327	-64,799	7,472	180,725
Greater Melbourne	216,821	-14,652	66,355	51,704	14,652	268,525
Greater Brisbane	112,100	3,083	19,867	22,950	-3,083	135,050
Greater Adelaide	66,392	-1,567	-10,324	-11,892	1,567	54,500
Greater Perth	92,863	15,558	44,279	59,837	-15,558	152,700
Greater Hobart	11,007	539	-2,071	-1,532	-539	9,475
Rest of New South Wales	125,232	-1,996	-24,286	-26,282	1,996	98,950
Rest of Victoria	68,060	-7,035	-3,675	-10,710	7,035	57,350
Rest of Queensland	116,485	8,340	3,150	11,490	-8,340	127,975
Rest of South Australia	19,275	-2,118	-11,031	-13,150	2,118	6,125
Rest of Western Australia	29,182	3,447	-21,554	-18,107	-3,447	11,075
Rest of Tasmania	14,722	-1,642	-7,430	-9,072	1,642	5,650
Northern Territory	11,414	2,399	8,087	10,486	-2,399	21,900
Australian Capital Territory	21,549	3,113	-4,422	-1,309	-3,113	20,241

Source: Author calculations.

Table 7: Shift-Share Results, Regions of Australia, 2010/11-2015/16

			Competitive effect			
	National effect	Industry mix effect	Total	Regional effect	Regional industry mix effect	Total change
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 New South Wales	81,638	-5,380	-7,408	-81,638	74,230	68,850
Rest of Victoria	44,614	-9,168	-15,047	-44,614	29,568	20,400
Rest of Queensland	78,415	-1,406	-33,533	-78,415	44,881	43,475
Rest of South Australia	11,937	-3,765	-6,197	-11,937	5,740	1,975
Rest of Western Australia	18,197	-2,453	5,481	-18,197	23,678	21,225
Rest of Tasmania	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: Author calculations.

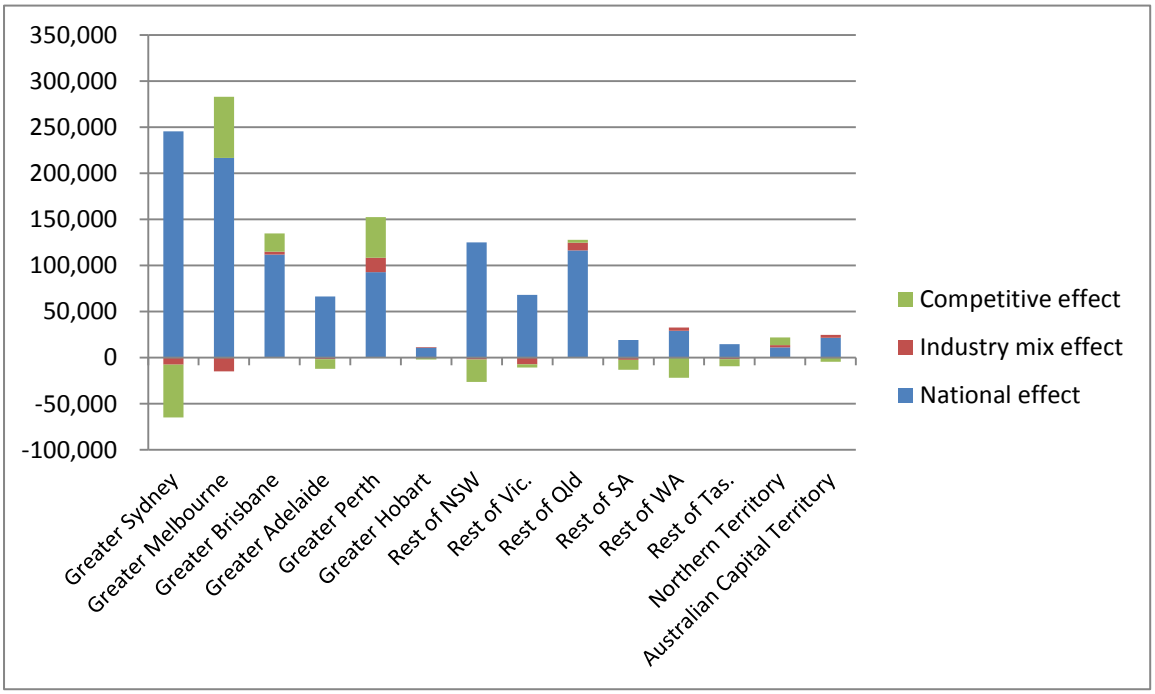
In the first period, growth of specific industries at the national level has elevated employment in Greater Perth and Rest of Qld (notably, mining-related), and a national decline of industries that are prevalent in Greater Sydney and Greater Melbourne have negatively affected employment in those regions. Whilst industry mix in Greater Melbourne has favoured employment growth, the same in Greater Perth has slowed that region's growth. This demonstrates regional specialisation can have differential impacts on different regions.

The second period saw the national employment growth in certain industries have elevated employment in Greater Sydney and Greater Perth due to their specialisation in those industries. However, some regions, particularly Rest of NSW and Rest of Vic, experienced a decline of employment due to specialisation in industries deteriorating at the national level.

Notably, a majority of metropolitan city regions (i.e. Greater Sydney, Greater Melbourne, Greater Brisbane and Greater Perth) experienced regional industry mix effect, meaning their employment growth is primarily attributable to the industry growth at the specific-region level.

The competitive effect is the element of the analysis that highlights regional competitiveness in specific industries. A positive competitive effect indicates that regional industries are outperforming their national level counterparts. Between 2005/06 and 2010/11, prevalent industries in Greater Melbourne, Greater Perth and Greater Brisbane seem to have had more employed in industries that are growing faster in those regions than the national level (see Figure 7). The corresponding competitive regions in the period 2010/11-2015/16 were Greater Sydney, Greater Perth and Greater Melbourne (see Figure 8).

Figure 7: Shift-share component contributions to employment change, Regions in Australia, 2005/06 – 2010/11

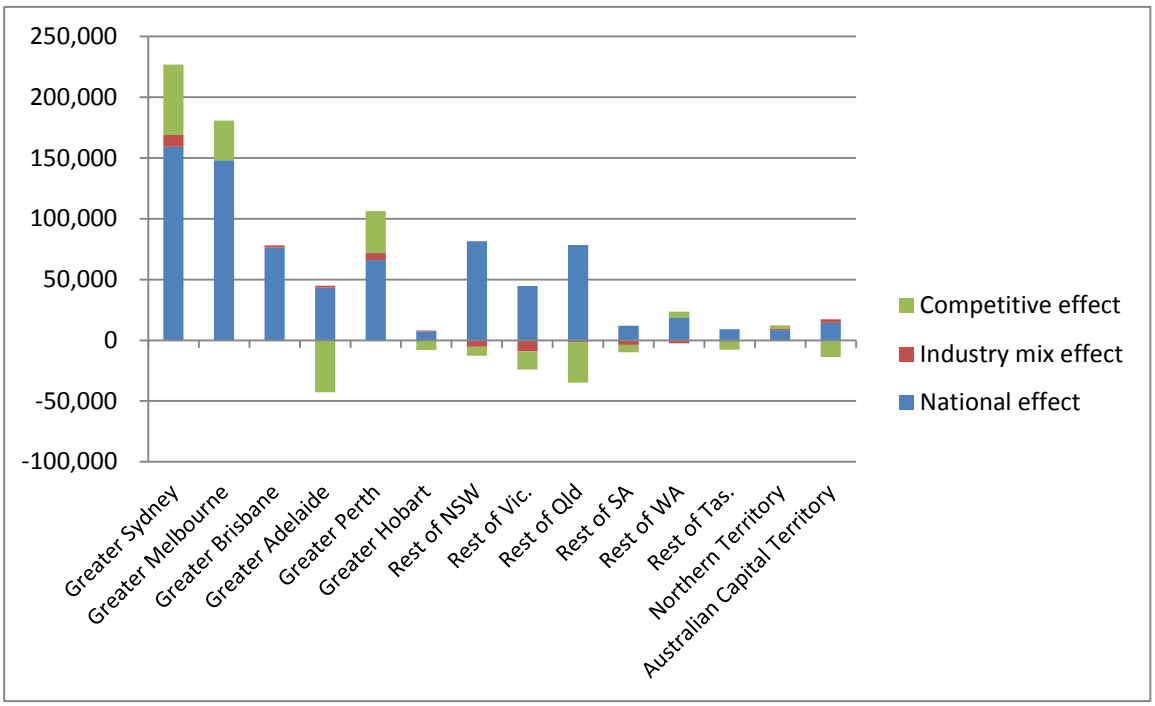


Source: Author calculations.

Comparison of component values for each region suggests that a regions' increase in employment can be primarily explained by overall national growth or some combination of the three effects. Clearly, national effect is the most dominant source of employment growth across regions over both periods. In fact, national effect was the only contributor to employment growth in Greater Sydney, Greater Adelaide, Rest of NSW, Rest of Vic, Rest of SA and Rest

of Tas during 2005/06-2010/11, and Rest of NSW, Rest of Vic, Rest of Qld, Rest of SA and Rest of Tas during 2010/11-2015/16. This suggests employment growth in a number of 'Rest of City' regions have been greatly contributed by national employment growth.

Figure 8: Shift-Share Component Contributions to Employment Change, Regions in Australia, 2010/11 – 2015/16



Source: Author calculations.

In addition, metropolitan city regions in Australia tend to have a combination of factors at play. For instance, competitive effect has played a significant role in employment growth in Greater Melbourne, Greater Perth and Greater Brisbane in the first period, and in Greater Sydney, Greater Melbourne and Greater Perth in the second period. It should be noted however that the same competitive effect has created a downward pressure on employment in some other regions – e.g. Greater Sydney, Rest of NSW and Rest of WA (first period) and Greater Adelaide, Rest of Qld and Rest of Vic (second period). Greater Sydney finding is particularly striking, as it demonstrates how quickly the competitiveness of regions changes – the sharp negative effect has become a stark positive effect over a half a decade.

The measure of regional specialisation (i.e. industry mix) has a sizeable positive effect on employment in Greater Perth, Rest of Qld and Greater Brisbane in the first period as well as in Greater Sydney, Greater Perth and ACT in the second. The same regional specialisation has negatively affected employment in Greater Melbourne, Rest of Vic and Greater Sydney in the first period and Rest of Vic, Rest of NSW and Rest of SA in the second.

CONCLUSIONS

The Australian economy underwent substantial changes between 2005/06 and 2015/16. These included economic shifts such as the mining boom, mining bust and the decline of the automotive industry, and significant policy changes such as the introduction of the Fair Work Act (2009) and the removal of subsidies for the manufacturing sector. The national economy was also somewhat impacted by the effects of the GFC. This paper examined the effects of these economic dynamics on the industry-specific employment across Australian regions.

Though our purpose of disaggregating the analysis into two periods was to compare the impact of different economic dynamics on employment outcomes, the differences between actual and homothetic employment estimates were similar in the two periods for the key industries mining and manufacturing. This means the employment the region would have in each industry were its distribution the same as the nation's has stayed the same over both periods.

A shift-share analysis was undertaken for the periods 2005/06 – 2010/11 and 2010/11 – 2015/16 to decompose the change of employment into its component parts – i.e. a national effect, an industry-mix effect and a competitive effect – in order to account for the regional specialisation. The initial findings related to the homothetic employment estimates found Greater Melbourne, Rest of Vic, Greater Adelaide, Rest of SA and Greater Brisbane specialised in manufacturing. As revealed subsequently, this specialisation in manufacturing has contributed to the decline of employment in Greater Melbourne from 2005/06 to 2010/11. In contrast, Greater Melbourne's specialisation in health care and professional industries has accelerated employment in that region. The homothetic employment estimates also established that Rest of Qld, Greater Perth, Rest of WA and Northern Territory specialised in mining. As revealed through shift-share analysis later, this specialisation has contributed positively to the growth of employment in Greater Perth and Rest of Qld.

We hypothesised at the beginning of this research that national and industry policy changes and economic dynamics should be reflected in the sectoral changes in the economy and employment. Shift-share component contributions to employment change over the two periods provide evidence to this effect. The effects of regional specialisation (industry mix effect) contributed to employment growth in Greater Perth and Rest of Qld during the first period (2005/06-2010/11) and in Greater Sydney, Greater Perth and Northern Territory during the second period (2010/11-2015/16). Different economic events – removal of assistance for automotive industry, resource boom, Fair Work Act and the global financial crisis during the first period and mining bust and the decline of the automotive industry during the second period – may have impacted upon regional employment differently. We, however, acknowledge the limitation of this paper that it does not identify the impact of an individual policy change on net employment.

The competitiveness of regions (competitive effect) had a positive effect on employment in Greater Melbourne, Greater Perth, Greater Brisbane and Northern Territory during the first period, and in Greater Sydney, Greater Melbourne, Greater Perth and Rest of WA during the second period. Notably, Greater Sydney experienced a considerable negative competitive effect in the first period. In the balance, number of regions experiencing downward pressure from competitiveness effect on employment outnumbered those reporting positive contributions during both periods, suggesting the competitiveness of regions deteriorated over both periods.

Though a number of national and international economic events and policies have impacted upon industrial performance, clear patterns of regional specialisation and competitiveness are apparent within Australian regions, strongly indicating the resilience of regions to internal and external shocks. Governments need to provide an efficient regulatory environment to ensure these regional industries thrive.

NOTES

[1] Krugman (1991) introduced Krugman Index to show regional specialisation which lies between the values of 0 (both distributions are the same) and 2 (both distributions have nothing in common).

[2] Alternative to Krugman Index, some studies use the Coefficient of Regional Specialisation (industry composition of employment) which lies between 0 (no specialisation) and 1 (one region specialises in one activity where the other region has no one employed in that activity).

[3] The ABS and Statistics New Zealand jointly developed this classification in 2006 to improve the comparability of industry statistics between the two countries and internationally.

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Economic Vulnerability to Global Shocks: Impact of the 2007 Global Financial Crisis on the Slovak Local Units

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ABSTRACT

The capacity of cities and regions to respond to severe global depressions, shocks and hazards is a crucial factor of long-term growth. The resistance to external shocks is in a close relation to economic prosperity as well as to formation and amplification of regional disparities. Global economic shocks can be in essence integrated into a general group of external shocks, causing enormous damage. In practice, the effects of the economic recession are hardly evenly distributed across different countries, regions or cities. The reaction of any socio-economic system to an external shock or disturbance depends significantly on its current state, specific context and external relations. Vulnerability to recessive shocks in terms of rising unemployment varies according to unknown factors that are behind their responses.

The 2007 global financial and economic crisis provides an opportunity to investigate the vulnerability of municipalities to its effects, taking into account several factors such as size, prosperity or regional affiliation. The factors of prosperity in relation to vulnerability are to be assessed by considering cities, middle-sized towns and smaller local units separately, after the onset of the 2007 financial crisis. The most appropriate variable for the economic recession evaluation is the unemployment rate, which was statistically recorded from its beginning to offset, during the whole period of crisis 2007-2011. All 2891 local units in the Slovak Republic are subject to the empirical analysis, comparing their state before the start (2007) and at the end of the crisis in 2011. Prosperity has been proved in a short-term more as a disadvantage, manifested as a negative externality of vulnerability to external global disturbances. The lower ability to respond concerns mainly regional centres, larger cities and the smallest local units.

INTRODUCTION

Repeated periods of economic growth and decline, recession and recovery represent an intrinsic part of the market economy. Since 1970, there have been a series of economic recessions and crises around the world which have had extensive and often severe consequences. This phenomenon of crisis can be linked to various types of natural threats. Economic recessions and shocks are analogous to natural disasters of lower intensity, which are frequently going on in the earth's crust. Similarly, there are a number of small recessions in every economy, some of which grow into major economic crises. In practice, the effects of the economic downturn are only rarely evenly distributed across national or regional economies (Davies et al., 2010). The reaction of any socio-economic system to an external shock or disturbance depends significantly on its current state, specific context and external relations.

When faced with local natural disasters, cities tend to be more resilient then rural areas (Berke and Campanella, 2006). The 2007 financial and economic crisis (or climate change impact) goes further by inspecting the vulnerability and resilience of municipalities to effects of a global nature. Regions and cities challenged business insolvencies and the loss of jobs. Vulnerability to recession shocks varies from place to place according to the rise of unemployment, and there are certain factors behind the responses to recessions which need to be identified. This paper is aimed at investigating three critical factors of vulnerability – prosperity, size and regional affiliation.

1. PROSPERITY, RESILIENCE AND VULNERABILITY

Natural disasters, armed conflicts, global migration, the impact of climate change as well as and poor financial management pose threats to the prosperity of cities and regions. This may provoke a related research question. Can the previous long-term prosperity of the city or region assure a lower exposure and a faster response to external shocks, perhaps even lower damage and overall higher resilience?

There are several approaches to the measurement of the signs of prosperity and living standards - economic growth, socio-economic development, quality of life, etc. Most studies regard prosperity as an economic phenomenon and use mostly living standards economic variables such as income, productivity, or GDP growth to analysis. (Blok et al, 2015; Hacker and Loewentheil, 2012; Murphy et al., 2014; NCSG, 2012). High economic performance and the wealth of cities/regions/countries are clearly the essential structural elements of prosperity. Although the image of today's prosperity would not be complete without taking into account the aspects of infrastructure, sustainability, democracy, equality and quality of life. The notion of prosperity should take into account the efficiency of the labour market, sufficiency and number of jobs, opportunities for career advancement or stimulation of the working environment.

Therefore, the prosperity of cities is comprised of more facets than just the economic one. Urban prosperity has also been stressed as a multi-dimensional concept in the UN-Habitat flagship report (UN-Habitat, 2012). In a broader sense, the prospect of prosperity goes beyond its former narrower understanding as an economic success, instead it advocates a socially broad, stable and durable development that combines both material and intangible aspects. This new and broader approach to prosperity has also brought an evaluation tool, named the City Prosperity Index (CPI). The CPI consists of the five basic dimensions: (1) productivity; (2) infrastructure development; (3) equity and social inclusion; (4) quality of life; (5) environmental stability.

The evaluation or benchmarking of cities not only represent a shift to a lower unit level, but even more importantly, it amplifies their role as engines of prosperity. It appears that bigger and globally connected cities are as the first impacted by a global crisis also because of the massive concentration of production. Rapid localised strike on site also means that there is a faster possibility of concentrating resources in cooperation with public authorities to trigger rapid recovery and absorption of external shock. Based on that argument, prosperous cities are more vulnerable in a case of global shock due to their direct dependence on global movements and the high concentration of production. On the other side, they have at the same time excellent conditions for an adequate response to external shocks and a quick recovery that is part of the concept of resilience. According to this logic, rural settlements can behave opposite to urban centres - they are expected to be less vulnerable than cities to global effects, but also are less adaptable due to a lack of resources.

Resilience is anticipated as the capacity of the economy, built system, institutions, citizens and community to be prepared, to respond and to accommodate the adverse effects of the external

shocks and hazards they deal with. The external pressures can be long-lasting or acute, global or local (ARUP, 2014; Lhomme et al., 2013). The primary concern of the resilience study is to understand the mechanism and the way the local and regional economies respond to disturbances and disruptions. The first part of the definition highlights the system capacity to absorb external shock. The second feature of resilience relates to adaptation gained through self-organisation and subsequent recovery, leading possibly even to self-transformation into an adapted system with altered core functions, identity, structure and feedback loops. It is therefore necessary to design and test various effective measures to enhance the capacity of the territorial system to absorb failures and maintain its essential functions and properties (Desouza and Flanery, 2013).

The closely related vulnerability concept deals more with the sensitivity and exposure of the system or one of its parts and addresses the harmful effects of external shocks (Seeliger and Turok, 2013). Vulnerability refers to structural changes in the system caused externally and implies changes in stability settings. While exposure can be considered a relationship attribute, vulnerability is the characteristic of the system itself that is revealed when the system is exposed to an external shock (Gallopín, 2006). The vulnerability of a system can be in general explained by three different elements – exposure, sensitivity and capacity to respond. Economic vulnerability as a narrower notion is reflected as an endogenous state of the country or region in a relation to exogenous shocks, while the notion of economic resilience refers to a series of steps and actions that are realised to support the country or region to resist the negative shock and/or adapt to it (Briguglio et al., 2009). The external shock, such as the global economic crisis, has an asymmetric territorial impact and can be clarified in terms of economic vulnerability, measured as a rise in the unemployment rate during the crisis. An interesting question is how to interpret the reaction of local units to unpredictable exogenous shock and which factors are behind higher or lower or higher economic vulnerability.

Vulnerability dynamics activated by the recent economic crisis of 2007/2008 has shown a substantial adverse impact in urban and peripheral rural regions. A lower vulnerability has been recognised in the middle-sized cities or rural areas nearby to centres of regions (Dijkstra et al., 2013). Middle- and small-sized cities have exhibited less negative annual GDP growth rates than the capital cities. In several examples of European countries (Germany or Austria) most of the cities performed better than their capital cities (Parkinson et al., 2014). The first-rank metropolitan cities show their position of growth engines in production performance in comparison with the medium and small cities in the time of general growth (Camagni et al, 2016). However, the dynamic view during the crisis does not confirm evidence of the superiority of the major cities.

2. RESEARCH QUESTIONS

Subsequently, there is a reasonable motivation to inspect the relationship between prosperity and economic vulnerability. Therefore, the central research question is the exposure and capacity of municipalities and cities to respond to a global crisis, and how prosperity relates to vulnerability. The factors of prosperity in relation to vulnerability are to be assessed by considering separately local units of different size – cities, middle-sized towns and smaller local units (LU) after the onset of the 2007 financial crisis. The most appropriate indicator of the economic downturn is considered the unemployment rate, which was statistically recorded from the beginning of the crisis in 2007 until its offset in 2011. The following analysis is done for almost 3 thousand of Slovak local units (2891 LU, territorial level LAU-2), by comparing their state before the start (2007) and at the end of the global economic crisis (2011).

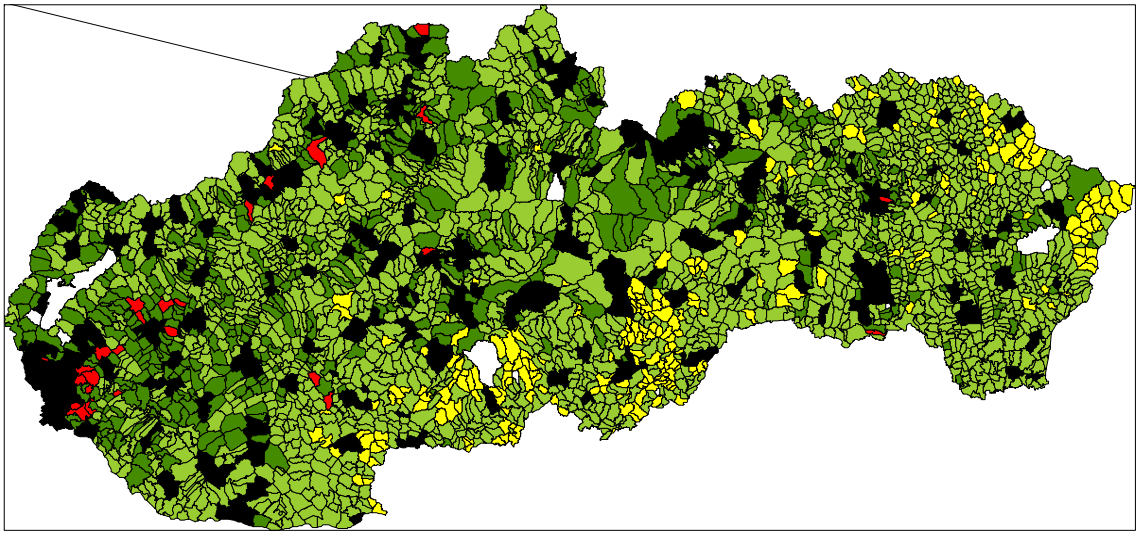
The four research questions are formulated and examined below.

- Which factors explain the higher or lower prosperity of the rural areas?
- What is the impact of the size, location and geography in explanation of economic vulnerability?
- How are related prosperity and economic vulnerability of cities, middle-sized towns and smaller LU?
- How are the effects of global external shocks propagated in space, what is the impact of proximity?

3. Prosperity of Rural Local Units

Geography and causalities of rural prosperity are studied first on the lowest possible level of settlements and combining quantitative and qualitative approaches. Altogether, 2741 municipalities of the size between 20 and 5000 inhabitants have been subject of study. It means the cities are excluded from the first part of the analysis. The "Municipal Prosperity Index" proposed in this approach combines six sub-categories of variables – civic participation, demography, finance and economy, infrastructure and mobility. The TOP 25 prosperous municipalities have been analysed in detail to show which factors have led to their higher prosperity. The qualitative analysis has confirmed the most substantial impact of location on the prosperity of municipalities such as the occurrence of the large producer in their proximity but also tourism attractiveness such as well-established skiing resort facility. However, the most critical factor is the closeness to the capital of the country Bratislava or another regional capital.

Figure 1: The Prosperity of the Rural Local Units in Slovakia



As the Figure 1 shows, the most of the TOP 25 prosperous municipalities (in red) are located in the proximity of the capital Bratislava (Southwest) and along the industrial region in the Northwest of the country. On the contrary, the lagging rural local units are situated in the South and Northeast. Eight of 25 prosperous municipalities take an advantage to be located close to the country capital, at a distance to Bratislava ranging between 15 and 25 km. Another 6 LUs are located near the regional capital, within 20 km distance. A relatively unique case is the municipality, which succeeded to build an industrial park and to attract foreign investors. Interestingly, three municipalities make a good profit from a nuclear power station at a distance, thanks to special state subsidy. Tourism and historical monuments explain prosperity in 5 other municipalities. Not surprisingly, large producers (Kia Motors, Volkswagen, Slovnaft) gave rise to prosperity in 6 another municipalities.

4. PROSPERITY VERSUS VULNERABILITY

The following Table 1 represents the territorial division of Slovakia, counting the number of local units and the total regional population. The numbering of the regions from SK1 to SK4 is essential as it is articulating the location from the west to the east of the country.

Table 1: The Administrative-Territorial Division of Slovakia

Region NUTS2	SK1	SK2	SK2	SK2	SK3	SK3	SK4	SK4
Region NUTS3	1	2	3	4	5	6	7	8
Region name	Bratislava	Trnava	Trencin	Nitra	Zilina	Banská Bystrica	Prešov	Košice
Number of local units	89	251	276	354	315	516	664	461
Total population	610850	557151	599831	706758	695698	654668	801939	774103

The City Prosperity Index (CPI) developed by the UN-Habitat (2012/2013) is adjusted here to the conditions of all Slovak local units (municipalities, towns and cities) and taking into account their size to differentiate between the smaller municipalities, middle-sized towns and cities. The prosperity is studied in relation to the economic vulnerability defined as the relative change in the unemployment rate. The model includes four dimensions of the Prosperity Index (Table 2) related to economic vulnerability: (1) Economic performance; (2) Infrastructure development; (3) Equity and social inclusion; (4) Quality of life.

Table 2: Prosperity Index Dimensions and Indicators

Economic performance
1. *Municipality output* (value added of enterprises per capita) **2.** *Unemployment rate*
Infrastructure development
3. *Piped water* (percentage of households connected to the water supply) **4.** *Sewerage* (percentage of households connected to the sewage system) **5.** *Gas* (percentage of households connected to the gas system) **6.** *Mobile* (percentage of households owning a mobile phone) **7.** *Internet* (percentage of households connected to the internet) **8.** *Time accessibility* to the district capital city
Equity and social inclusion
9. *Housing equity* (the ratio of households with an apartment size more than 120 square meters and apartment size smaller than 40 square meters) **10.** *Older unemployment* (proportion of inhabitants over 50 out of work) **11.** *Women unemployment* (women out of work) **12.** *Voter participation* (voter participation in the parliamentary elections)
Quality of life
13. *Higher education* (percentage of inhabitants with higher education) **14.** *Lower education* (percentage of inhabitants with basic or no education) **15.** *Average age* **16.** *Health* (deaths per capita) **17.** *Net migration* (the local unit migration inflow minus outflow)

The open question is whether prosperity can be a proper protective mechanism to cope with an external global shock, or other factors are more crucial in amplification of higher or lower resilience and adaptive capacity. As before, the research question is studied on the 2007 economic crisis patterns of development. For measuring the response to the global recession,

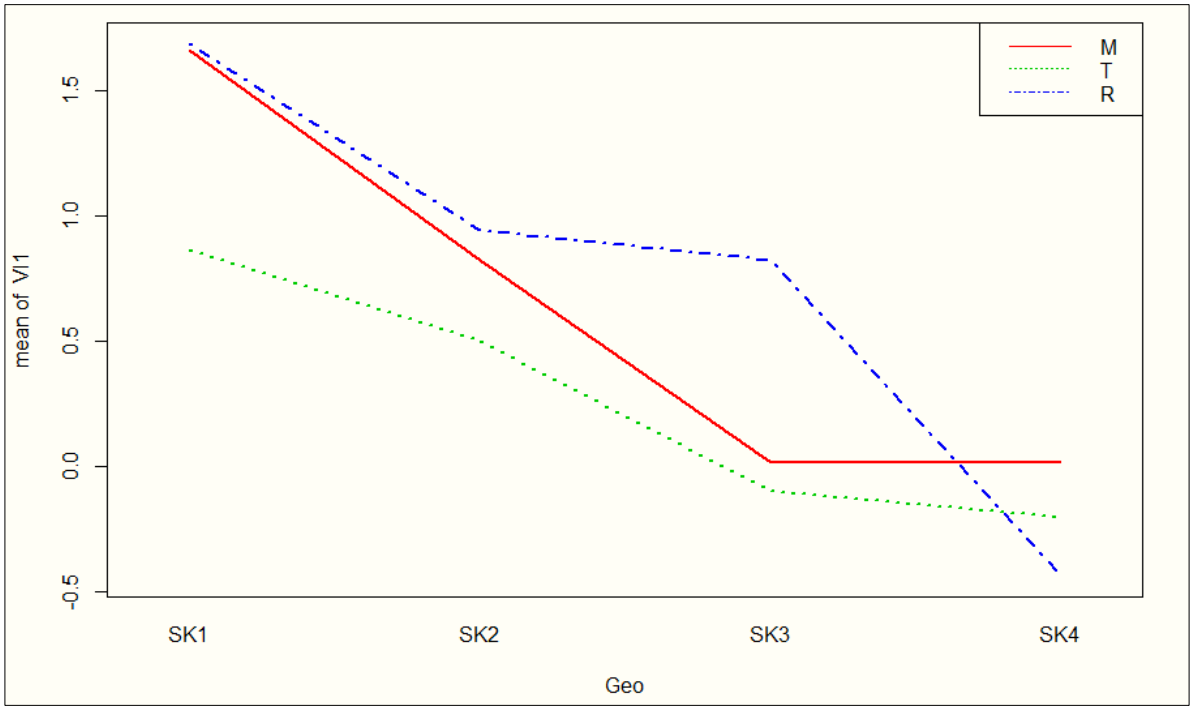
the ratio of unemployment relative growth of a local unit to the average unemployment growth in the country can be used. Thus, the unemployment rate change for the country serves as a benchmark to measure the relative resistance of local units and regions (Lagravinese, 2014; Martin, 2012):

$$\lambda = \left[\left(\Delta X_d / X_d \right) - \left(\Delta X_N / X_N \right) \; / \left| \Delta X_N / X_N \right| \right]$$

where $\left(\Delta X_d / X_d \right)$ and $\left(\Delta X_N / X_N \right)$ represent the relative changes in unemployment at the local unit and the national level respectively.

The positive value of λ indicates higher economic vulnerability (VI1 - Vulnerability Index catching the strongest crisis impact in the period 2007-2011). Analogously, the negative value of λ refers to lower vulnerability, or higher absorption of the shock than the national average. The empirical analysis exhibits higher vulnerability of the more prosperous western local units regardless of their size. The Figure 2 shows the highest exposure to the crisis in the SK1 Bratislava region and explains how vulnerability varies according to the size, which is mostly seen in the SK1 and SK3 regions. The middle-sized towns (T, in green) show a lower exposure to the effects of the crisis than the smaller local units (M, in red) and regional centres (R, in blue). It should be added, that there is much higher variability in the group of smaller local units; several of them were critically affected by the crisis.

Figure 2: The Vulnerability Outline of the Three Categories of Local Units According to the Regional Affiliation from West to East (SK1 to SK4)



The visualisation of the vulnerability suggests its dependence on the status of the city (municipality, smaller local unit (M), the middle-sized towns (T), the regional centre (R) as well as on the regional affiliation (NUTS2 level regions: SK1, SK2, SK3, SK4). The spatial autocorrelation approach based on simultaneous features of locations and variables can assess whether the existing spatial patterns are either clustered or random and to identify localised areas with strongly positive or negative associations of the data values. Local spatial patterns

are studied using the method of Local Indicators of Spatial Association – LISA via the nearest neighbour matrices.

The map (Figure 3) displays the values of the Prosperity Index in all Slovak local units, including towns and cities before the start of the crisis. The areas with clustered high prosperity values (HH) are found around the capital Bratislava, along with the western border with the Czech Republic as well as a smaller red area assigned to the second largest city of Košice in the East. The growth pole of the capital Bratislava influences its neighbouring areas in the form of positive externalities - spread effects.

On the other hand, the city of Košice, the East-Slovak metropolis, is an island of prosperity which has a strong economic basis that creates benefits for its citizens or newcomers. In fact, there is rather a negative backwash effect of Košice which can be identified in the neighbouring areas characterised by persisting stagnation. The low prosperity (low-low) areas in dark blue embody the second category of larger homogenous areas. These broader connected areas are of a lower quality of life and have either an agricultural, mining or mountain character. The smaller tessellated areas in the Northeast or Southeast are significantly marked by their low accessibility and peripherality.

The LISA method applied to vulnerability (Figure 4) confirms its spatial spread by several areas of high-high and low-low vulnerability. The multinational companies are mostly located in the red shaded areas in the west of Slovakia. The higher prosperity is also shown to have the other side of vulnerability risk if a global shock happens. Other areas can be identified as not so prosperous, but as less open to external global influences are therefore less vulnerable to global shocks.

Figure 3: Spatial Distribution of the Prosperity Index: 2891 Slovak Local Units

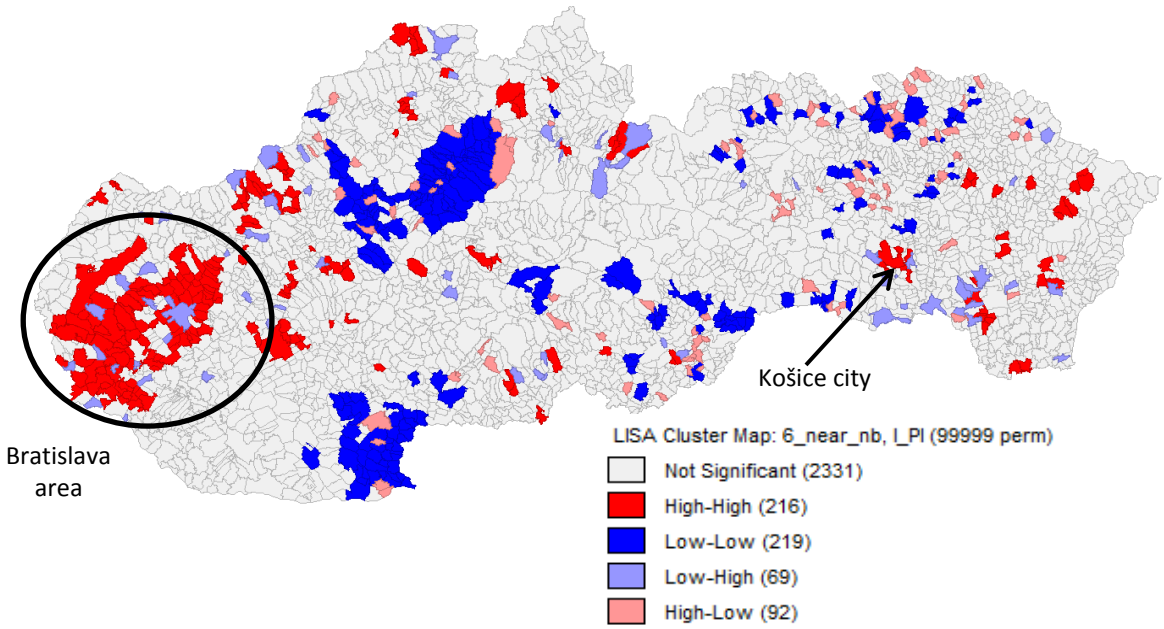
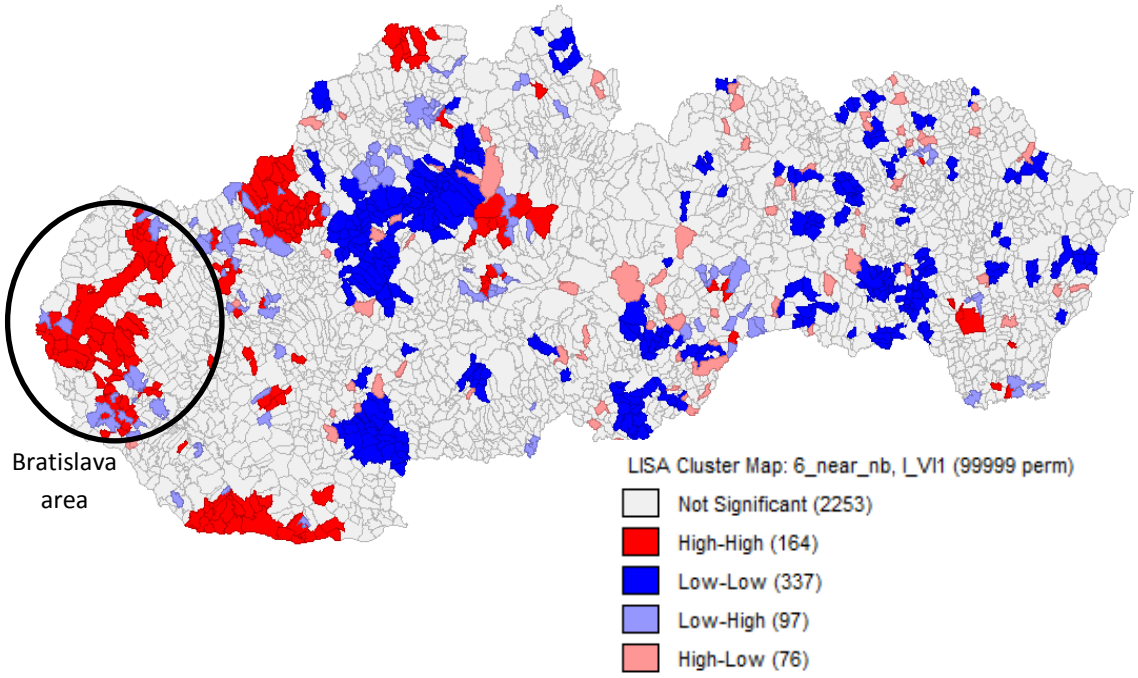


Figure 4. Spatial Distribution of Vulnerability to the 2007 Crisis: 2891 Slovak Local Units



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5. Size and Geography as Factors of Vulnerability

The last research question integrates the previous models of prosperity versus vulnerability. This considers the geography factor of location within a more urban or rural environment together with the size of the local units as the critical factors influencing vulnerability. The grouping of data by a factor of the size of the local units is carried out in two stages following a hierarchical principle.

Level 1: Status of the local unit is again defined as municipality – smaller local unit (M), the middle-sized town (T) or the regional centre municipality (R).

Level 2: Each group of M, T, R is divided into cluster intervals based on the quantiles method.

Table 3: Assignment of the Local Units to Categories

	Municipalities: smaller local units					Middle-sized towns			Regional centre municipalities
Levels	M1	M2	M3	M4	M5	T1	T2	T3	R
Borders	Lowest	<250	<470	<750	<1338	Lowest	<7500	<15750	All
Number of cities	531	543	547	572	557	40	39	51	46
Total population	410766	472970	478790	505978	550172	635535	502372	716328	1128087

The idea was to identify a natural number and size intervals of the local units and to respect at the same time the status of the three categories M, T and R. Thereafter the idea was to keep the total population in each group approximately the same and in that way to cluster local units into comparable categories (Table 3). By law, Bratislava and Kosice consist of several

municipalities (city wards) which are considered as single units in the analysis, and all of them are part of the same regional labour market (the variable is the unemployment rate), and this group is accordingly named as regional centre municipalities.

As the normality of the distribution is not met, the Kruskal-Wallis one-way analysis of variance by ranks is used. The Kruskal-Dunn test (Table 4) returns the lower triangle of the matrix that contains the p-values of the pairwise comparisons. Therefore, the size factor is significant in relation to vulnerability and other categories especially in the case of M1, M5, R categories ($p<0.05$). In particular, the smallest units M1 have a much higher variability of responses to the crisis. The strategic situation is evidently a barrier for better resilience to economic shocks in the M5 group. These consist of the larger local units without the city status, having fewer measures and possibilities for urban development. The most stable, coherent and comparable are the middle-sized towns in the T1-T3 categories.

Table 4: The Pairwise Comparison of the City Size Effects on Vulnerability between Nine Types

```
posthoc.kruskal.dunn.test(x=VI1, g=Size, p.adjust.method="none")
```

```
##  Pairwise comparisons using Dunn's-test for multiple
##                          comparisons of independent samples
## data:  VI1 and Size
##    M1       M2     M3     M4     M5     T1     T2     T3
## M2 0.0017   -      -      -      -      -      -      -
## M3 0.0027   0.8820 -      -      -      -      -      -
## M4 4.9e-06  0.1627 0.1219 -      -      -      -      -
## M5 8.3e-08  0.0267 0.0180 0.4006 -      -      -      -
## T1 0.2913   0.9030 0.9470 0.5239 0.3445 -      -      -
## T2 0.4738   0.6546 0.6946 0.3384 0.2072 0.8096 -      -
## T3 0.2111   0.9475 0.9968 0.5204 0.3237 0.9610 0.7616 -
## W  0.0265   0.3290 0.3009 0.6646 0.9147 0.4301 0.3022 0.4307
```

6. CONCLUSIONS

The concepts of local and regional resilience and vulnerability have the capacity to improve the understanding of external shocks and their consequences and should be considered in the strategic management of cities and regions. The results of the "prosperity versus vulnerabilty" analysis have shown that prosperity has a dark side of higher vulnerability to global external shocks or disturbances. A worse response mainly relates to regional centres, larger cities as well as the smallest local units. The middle-sized towns represent a sympathetic balance of low vulnerability and reasonable prosperity.

Therefore, the political decision-makers and experts should explore mechanisms that work differently depending on the size of cities and the region of their location. An active approach of the local government in promoting economic resilience largely determines the response and process of adaptation of the local system to the impacts of external shocks (Dawley et al., 2010; Lang, 2010). Cities are becoming an effective platform for strategies reinforcing local responses to global crises. The quality of urban planning and management are vital to achieving prosperity, sustainable development and resilience to the increasing global pressures. Thus, an integrative urban planning would have the power to overcome existing sectoral policy silos, and an inclusive development programme can provide a balance between various spatial and

functional dimensions (Wong, 2014). The economic resilience of the city or region is often derived from its unique conditions and each local system requires individual measures and interventions. Another problem of effective actions by local governments is the constant dynamics of the local system. Active and effective intervention by the local government requires a response with minimum delay in obtaining information about the local system and the subsequent implementation of actions (Boschma and Frenken, 2007).

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Recurrent Property Taxation: Experiences and Challenges in Australia and New Zealand

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ABSTRACT

Local government rates are a recurrent tax assessed on different bases of value and are the primary own source revenue collected by local government in Australia and New Zealand. State land tax in Australia is assessed on land also known as site value, while rates are assessed on either land / site value, capital improved value or assessed annual value. While economic theory proffers land as the most efficient base on which to assess a recurrent tax, in practice the determination of value does not always meet the principles of 'good tax design' and in particular the principles of simplicity, transparency and in some instances efficiency.

In examining the determination of the most commonly used basis of value, land / site value, this paper is a study of the valuation practices used to determine this basis of value. A hypothetical main street retail strip has been developed to monitor the practices of valuers in the valuation of land for the assessment of rates in New South Wales Australia. The paper demonstrates that if land is to be used as the bases of value for the assessment of property taxes in Australia and New Zealand, a standard methodology of valuation is essential. The paper concludes that the valuation of land underpins the integrity of the rating and taxing of land and that improved economic efficiency is achieved through greater uniformity, simplicity and transparency of the valuation process.

INTRODUCTION

This paper commences with a review of the status of recurrent land taxation revenue among the OECD countries and specifically Australia and New Zealand. This provides a prelude to the underpinning challenge of taxing land and determining the basis of value on which this tax is assessed. The paper reviews the various bases of value on which this tax is assessed across the taxing jurisdictions of Australia and New Zealand and provides a brief history of the evolution of these basis in defining the rationale for land as a base of this tax. An experiment has been developed that simulates the valuation process in which 23 statutory valuers participated in providing insight to how land value is determined. This process is measured against the principles of 'good tax design.' The paper concludes with a number of recommendations that assist in maintaining the integrity of land as the base of this tax into the future.

In contrast to many OECD countries, where recurrent land taxation predominantly operates as a local government tax, in Australia this tax operates at the local and state government level and is assessed on a variety of different bases of value. The dual imposition of this tax by state and local government in Australia has advantages over its sole imposition by local government

in other countries, where the evolving rationale has become a quid pro quo tax for services provided. While a taxpayer rationale exists for rates and services at the local level, a far less defined rationale exists for state land tax, which is more aptly viewed as a consolidated revenue tax. New Zealand ceased its dual imposition of this tax in 1992 when it introduced a goods and services tax, handing sole responsibility for recurrent property taxation to local and regional government as council rates.

In contrast to state land tax in Australia, which expends revenue through exemptions to the principle place of residence, primary production land and provides an investor threshold in each State, council rates are imposed on all property with very few exceptions. Mangioni (2016:16) states that "state land tax is imposed on less than 20 per cent of all property in Australia." Despite the imposition of a dual recurrent land tax in Australia, the tax revenue collected from both state and local government is low in contrast to other OECD countries including New Zealand, United States, Canada and United Kingdom where it is solely imposed by local government. As shown in Table 1, Australia is ranked 10th among the 34 OECD nations in revenue raised from recurrent land taxation. This ranking is determined as a percentage of GDP in which Slack and Bird (2004) define this as the most accurate measure for assessing tax effort.

Of further note in Table 1, is the change in revenue as a percentage over the past four to five decades across the countries shown. While revenue has dropped as a percentage of total tax collected, which is primarily driven by the addition of taxes such as value added and goods and services taxes over this period, there is little rationale for the reduction of this revenue source as a percentage of GDP. In summary, land tax is one of the least popular and visible taxes, that is directly remitted by the taxpayer (property owners). This factor alone raises additional accountability by taxpayers on governments imposing this tax. While not the focus of this paper, a brief commentary is provided in the following section that further articulates this challenge in Australia.

In reforming land tax revenue and policy in Australia, Australia's Future Tax System Review (AFTS) (2009) specifically identified that further revenue should be raised from recurrent land tax and more specifically, from a tax on land in improving the tax effort of the lower tiers of government which lags many industrialised countries. The recommendation to increase revenue from land tax is mirrored in New Zealand, where the Tax Working Group (TWG) (2010:67) has recommended the reintroduction of a broad based land tax as one of the fiscal reforms measures.

Table 1: Recurrent Property Tax as a Percentage of Total tax and of GDP

	Percentage of total tax			Percentage of GDP			Ranking % GDP OECD
Country	**1970**	**2014**	**% change**	**1970**	**2014**	**% change**	
United Kingdom	3.36	3.08	-8.1	9.6	9.6	0.4	**1**
Canada	3.30	3.02	-8.5	10.9	9.7	-11.2	**2**
United States	3.17	2.62	-17.3	12.3	10.1	-17.7	**3**
France	0.94	2.58	173.8	2.8	5.7	102.4	**4**
Israel	..	2.06		..	6.6		**5**
Japan	0.84	2.05	143.6	4.4	6.4	45.7	**6**
New Zealand	1.94	1.96	1.4	7.7	6.0	-21.7	**7**
Iceland	0.36	1.63	346.7	1.4	4.2	207.1	**8**
Italy	0.27	1.56	478.9	1.1	3.6	228.9	**9**
Australia	1.25	1.56	24.9	5.9	5.6	-5.3	**10**
Denmark	1.56	1.39	-11.1	4.2	2.8	-33.1	**11**
Belgium	0.28	1.33	371.4	0.9	3.0	248.4	**12**
Poland	..	1.25			3.9		**13**
Spain	0.07	1.18	1500.0	0.5	3.5	628.8	**14**
OECD-Total	**0.93**	**1.09**	**16.7**	**0.932**	**1.088**	**16.7**	

Source: OECD Tax Statistics Table 4100 at 2015

BASES OF VALUE, VALUATION METHODS AND CHALLENGE

Recurrent land taxation commenced in South Australia in 1884 and at the time of Federation this tax was imposed by all three levels of government in some States of Australia. New South Wales ceased taxing land in 1906, strengthening local government's opportunity to collect this tax in conjunction with the Commonwealth, now known as council rates (Simpson and Figgis, 1998). In 1942 the Commonwealth removed the States powers to collect income taxes and ceased imposing land tax in 1952, allowing the States to resume collection of this tax in conjunction with local government, (Smith, 2005). When land tax was introduced in Australia it was assessed on the unimproved value (UV) of land, meaning the value of land in its en-globo or original untouched state.

As more land became urbanized and was the subject of clearing, excavation, levelling and retention, unimproved value ceased to exist by virtue of the fact that these changes, known as site improvements were viewed as improvements to the land. Mangioni (2016) distinguishes site improvements from improvements on which constitute buildings and structures. It is further highlighted that land and site value are in essence the same basis of value which different labels (Ibid). By 1990, five States had moved to either Land Value (LV) or Site Value (SV) as the base of state land tax. In 2010 Queensland was the last state to move from UV to SV for the assessment of state land tax as set out in Table 1, the differential in value between these two bases is accounted for in land improvements that equate to approximately 12 percent.

In contrast to state land tax, local government rates are assessed on a number of different bases across Australia of which local government in some states have options to assess rates on more than one basis of value. In South Australia and Victoria rates are predominantly determined on Capital Improved Value, with assessed annual value the basis of value used in Melbourne City as shown in Table 2. In contrast, New South Wales and Queensland assess local government rates on land and site value, the same basis of value on which state land tax is assessed. The primary rationale for not introducing alternate bases of value is the additional resourcing cost of producing and maintaining more than one bases of value.

Up until 1985 land value was the preferred base on which land tax was assessed in New Zealand, however by 2006-2007 fiscal year, capital value had become the tax base for the majority of local authorities (Franzsen 2009:37). The rationale for the transition to CIV in the cities of New Zealand was due to the limited transaction of vacant land (McCluskey 2006). Despite the transition to CIV in the capital cities of New Zealand, the use of land value as the base of the property tax remains strong in regional New Zealand (Shand 2007). Four of the main cities of New Zealand (Auckland, Wellington, Christchurch and Hamilton) all utilize a capital or annual value rating system (Ibid 389). Improved value is said to be the best means to achieving equity between the ratepayers based on their ability to pay.

Table 2: Bases and Premise of Value Used to Assess Recurrent Land Taxes

Land and Property Taxation			
State / Country	**State Land Tax**	**Local Gov't Rates**	**Valuation Cycle**
New Zealand	N/a	Site and Improved Value	3 yearly
New South Wales	Land Value	Land Value	Annually
Queensland	Site Value	Site Value	Annually
Victoria	Site Value	Improved, Site & Assessed Annual Value	2 yearly
South Australia	Site Value	Improved Value/Site Value	Annually
Western Australia	Site/Unimproved Value	Gross Rental Value*	Up to 15 years
Tasmania	Land Value	Gross Rental Value *	Up to 3 yearly
Northern Territory	N/a^	Unimproved Capital Value	5 yearly
ACT	Unimproved Value^	Unimproved Value	Annually
United States	N/a	Improved Value	2 to 5 yearly
Canada	N/a	Improved Value	3 to 5 yearly
Denmark	Transitioned from land to Improved value in 2016	Imposed by local gov't on behalf of regional gov't.	2 yearly

* Denotes the option of assessing council rates on more than one basis across different LGA's.

Sources: State Valuation of Land legislation across Australia.

Land and Site Value: The Emerging Challenge

Considerable confusion surrounds the measurement in practice of land value and in particular its determination on highest and best use. In the early twentieth century, the use of land value as the basis of taxing property was determined on the sufficiency of undeveloped (unimproved or vacant) land sales as the basis for assessing value (McCluskey *et al* 2010:122). This approach was underpinned by the fact that vacant land transacts reflected the potential highest and best use of land. However, with the development of highly urbanized locations where vacant land sales have become the exception, valuers could no longer rely on vacant land sales as a measure of land values (Ombudsman 2005).

The evolution of land taxation in urbanised locations provides an insight into the challenges confronting cities when imposing land tax. This has resulted in an additional layer of complexity which requires accounting for the added value of improvements in the valuation of land process (Ombudsman 2005:7). With this approach has come a lack of 'transparency' and 'simplicity' and increasing pressure for the adoption of alternate bases of value for the assessment of recurrent property taxation. The lack of land transactions on these two principles of 'good tax design' are clearly defined as the rationale for the move to CIV in other international jurisdictions including New Zealand (Franzsen, 37 and 41, in Dye and England eds. 2009).

The lack of consistency in accounting for the added value of improvements and the inability for valuers to articulate how land value has been determined from improved value has raised questions as to whether land remains the most suitable base on which to assess the property tax in highly urbanized locations. What is clear from the review of the historical evolution of this tax, is that land tax is constantly under challenge in terms of appeals and objections against the base on which it is assessed.

One consequence of the lack of sufficient vacant land transactions in a particular location has resulted in the practice of valuers being forced to use land transactions from adjoining locations (Bahl 2009:9). Another practice has been for land value to be determined by deducting the added value of improvements from improved property sales. (Ombudsman 2005). This emerging latter valuation process and in particular, the determination of the added value of improvements on land value, has raised questions about its potential to compromise the economic efficiency, simplicity and transparency of land tax (Arnott & Petrova 2002:3).

The New South Wales Ombudsman (2005:iv) when reviewing several local government areas summarised the extent of the issues arising from the lack of consistency of sales analysed and in some locations the limited number of vacant land sales as follows;

> We found only 31% of sales on average met the strict 5% margin of error and only 66% of sales across the sample were within the acceptable 15% margin of error. We found 21% of the sample districts had more than half their sales outside the acceptable 15% standard and 44% had more than 40% of their sales outside the range.

In New Zealand a very similar observation was noted by Shand (2007:136) in the review of land values used to assess local government rates, in the following;

> In the case of land value (LV) rating, in most areas (particularly urban ones), there are very few land sales upon which rateable values can be generated. This raises questions about the reliability of assessed values under LV rating. Capital value (CV) rating, on the other hand, benefits from the availability of much richer sales information.

In response to a lack of primary evidence (vacant land sales) for determining land values, valuers were forced to either use land (or site) transactions from adjoining locations (Bahl 2009:9), or to deduct the added value of improvements from improved property sales. For

taxpayers, the use of land sales outside of the location of their land meant that LV or SV was potentially inaccurate as it did not sufficiently account for the location value of their land (Ibid). The alternative approach was to deduct the added value of improvements from improved property sales, but this approach potentially compromises the simplicity and transparency of the resulting land value used to assess land tax.

VALUATION METHODS

We now provide an overview of the valuation methods used to assist in defining the challenges confronting statutory valuers in determining the value of land for rating and taxing purposes. The methods of valuation used to value land are the direct comparison method, cost approach and income method (Australian Property Institute 2007). Direct comparison is the most fundamental method of valuation in which one land parcel (the sale land) is directly compared with another (the land being valued). Direct comparison is the foundation of all other valuation methods, 'the principle of comparison underpins all valuation methods but it is also a valuation method in its own right' (Wyatt 2007:111).

The direct comparison method is supported over other methods due to its simplicity in which it is asserted that "actual sales are a far more reliable index of market value than are any available forms of evidence, such as estimates based on a capitalization of prospective earnings" (Bonbright 1938:136). In the absence of vacant land sales more complex methods of valuation is needed to either separate the added value of improvements from land, or to first calculate the improved value, after which the added value of the improvements are separated from the sale price to determine the land value. The process requires two additional methods of valuation be applied before direct comparison can be employed.

The income method of valuation is used to assess the improved value of property based either on its income or income earning potential in cases where the property is vacant or owner occupied. This method may also be the initial step in determining improved value, from which the improvements are deducted to determine the land value (Cost method). Alternatively, it is used as a primary method of assessing the capital improved value of property in locations where the property tax is determined on the rental income or assessed annual value derived from the property. While a universally recognized method of valuation, it is not without issue as there is no uniform classification of income or outgoings in order for a uniform net rent to be deduced and capitalized in determining the improved value (Whipple 2006).

In the analysis of property transactions using the capitalization method, will depend on which outgoings are deducted from the gross rent and which allowances such as leasing up and vacancy are adopted in determining the net rent (Bardouil and Malaquin cited in Adair 1996*)*. Inconsistency exists in the use of the capitalization method of valuation and it is stated, "There is no standard practice and it is for valuers to use and justify their approach with each valuation" (Ibid 115).

The use of the paired sales method of analysis is undertaken in locations where land sales do not exist, and where the improvements on the land are highest and best use. In adjoining locations where land sales have transacted, the land sale is deducted from similar improved sales, in which the residual value is the added value of the buildings. Also referred to as the residual or abstraction method, it is cited as being the most common method used to value land in urbanized location in the absence of vacant land sales (Bell, Bowman, and German cited in Dye and England Eds. 2009).

This approach is best used in determining differences in land values across locations where improvements are relatively homogeneous. In addition to being used as a land residual

technique, it may also be used as a building residual technique (Australian Property Institute 2007:474-5). The use of this method and its interchange between land and buildings as the residual component and is an internationally recognized method of valuation (Hudson 2001). In the case of rating and taxing valuations, these techniques may be used to assess the added value of improvements, also known as a paired sales analysis (Dept of Land NSW 2009:11).

In addition to the use of this method in Australia and the US, it is specifically recognized for rating and taxing valuations of land in countries which still retain land or part land as the basis of a recurrent property tax and are specifically used where vacant land sales are scarce (Falk-Rasmussen and Muller 2010). In cases where the paired sales method has limited application, due to limited or no vacant land sales in adjoining locations, or where significant variability exists in the type of improvements across locations, the cost method is an important option recognized in rating and taxing valuation purposes (French and Gabrielli 2007).

This method best applies to cases where the improvements on land are either new, or near new and reflect highest and best use in which no or nominal account for depreciation is needed. Where new, or near new improvements have transacted, the analysis of these transactions may be considered by partitioning the value of their component parts. This is referred to a 'land share of value', or 'contribution value' (Dye and England 2009). Such an approach requires an additional layer of statistical analysis (Ibid:176). It is not insurmountable that such an approach be given further consideration as a tool of valuation practice.

In summary paired sales analysis and more so the cost method of valuation asks two crucial questions of the valuer in the sales analysis process. These are 1) are existing improvements the highest and best use of the land and do they add value to land, 2) If they do add value, what the added value of these improvements and how is this determined. The challenge is, if land value is to be maintained as the basis of value on which rates are to be assessed, how are land values to be derived in a simple, transparent and economically efficient manner. In addressing this challenge, it is first necessary to observe how land values are actually determined for rating and taxing purposes, a primary research objective of this paper.

RESEARCH METHODOLOGY

The research method developed for this paper is an experiment method that has been designed to measure the outcomes derived from the processes used by valuers to measure the value of land. In the social sciences, simulations in the form of experiments are used to monitor and test outcomes of a particular situation. This method transports the key aspects of a situation to an experiment setting as defined by (Jones 1996). Cavana *et al* (2001) further defines that a simulation lies somewhere between a lab and field experiment, insofar as the environment is artificially created but not very different from reality. The experiment developed in this study uses a pre and post simulation that assists the researcher to isolate the factors that impact the determination of value across of the same property across a population of valuers.

In developing this method, an initial and a revised simulation in the form of a pre-study / post-study or before and after study design is used. Kumar (2014) explains that a before-and-after design can be described as two sets of cross-sectional observations on the same population to find out the change in the phenomenon or variable(s) between two points in time. In the simulations developed, this approach has been adapted to measure changes in value resulting from variability in information and valuation approach. Parigi *et al* (2017:2 in referring to Zelditch 1969) states "the purpose of most experiments in general is to ''construct and test theories'' by creating ''theoretically relevant aspects of social situations under controlled conditions." The refinement of controlled data in the simulations allows the researcher to define factors that adversely impact the determination of value.

Research Approach

In undertaking this research the Valuers-General of New South Wales and New Zealand were advised of the proposed objectives and scope of the project. The Australian Property Institute (NSW Division) assisted by issuing invitations to the chairs of the Institutes study groups seeking participation by statutory valuers (valuers qualified in rating and taxing valuations) to participate in an experiment to observe how values were determined. In addition the participating valuers were asked a number of questions through a survey about the valuation process and frequency in NSW. Following the compilation of results two focus groups were conducted with the valuers that participated in the experiment, property lawyer's, economists and government contract valuation managers.

The simulation in this study was conducted in Sydney Australia and involved 23 property valuers that participated, the participation rate is set out in Table 3. The valuation simulation comprised a main street retail strip with shops and one level of offices above was developed. The properties were located on land zoned for their existing use (see Figure 1). To assess requirements for consistent valuations across valuers of the retail land, the simulation comprised an initial and a revised task.

Table 3: Participation Rate

Response Type	Retail
Gross simulations issued	40%
Completed/returned simulations	23%
Non-returned	14%
Returned & incomplete	3%
Net responses	23%
Response rate completed & returned	57.5%

In this experiment valuers participate in an initial followed by a revised simulation. In the initial simulation there were no vacant land sales and three improved sales, each with improvements at varying degrees of dilapidation. Valuers were informed of the sale price and sale date, land area and dimensions, permitted use, gross building area, net lease area, lease details, age/last upgrade of improvements and cost $\$/m^2$ for new improvements. All premises are highest and best use, but each with improvements of varying degrees of dilapidation, one sale with improvements that were structurally and cosmetically refurbished within the past seven years; a second sale which had improvements similarly refurbished approximately 15 years ago; and the third sale was dilapidated, requiring total refurbishment and upgrade.

Once the initial simulation was completed, valuers were required to re-assess their initial values simulation but now incorporating additional sources of information. Firstly, an additional sale, a fully refurbished property (structurally and cosmetically) which sold within 3 months of the date of valuation, this is highlighted as No 22 Main Street in the plan. Secondly, information was provided on the area average of how the added value of improvements degrades with time and thirdly, on the area average ratio of land value to the added value of improvements. The objective of this revised simulation was to provide insight into how the sale of a recently improved property combined with information on the level and degradation of improvements could inform valuers of the underlying value of land. A plan of the experiment is included at the end of this paper.

Figure 1: Main Street Retail Sales & Land Value Assessment Plan

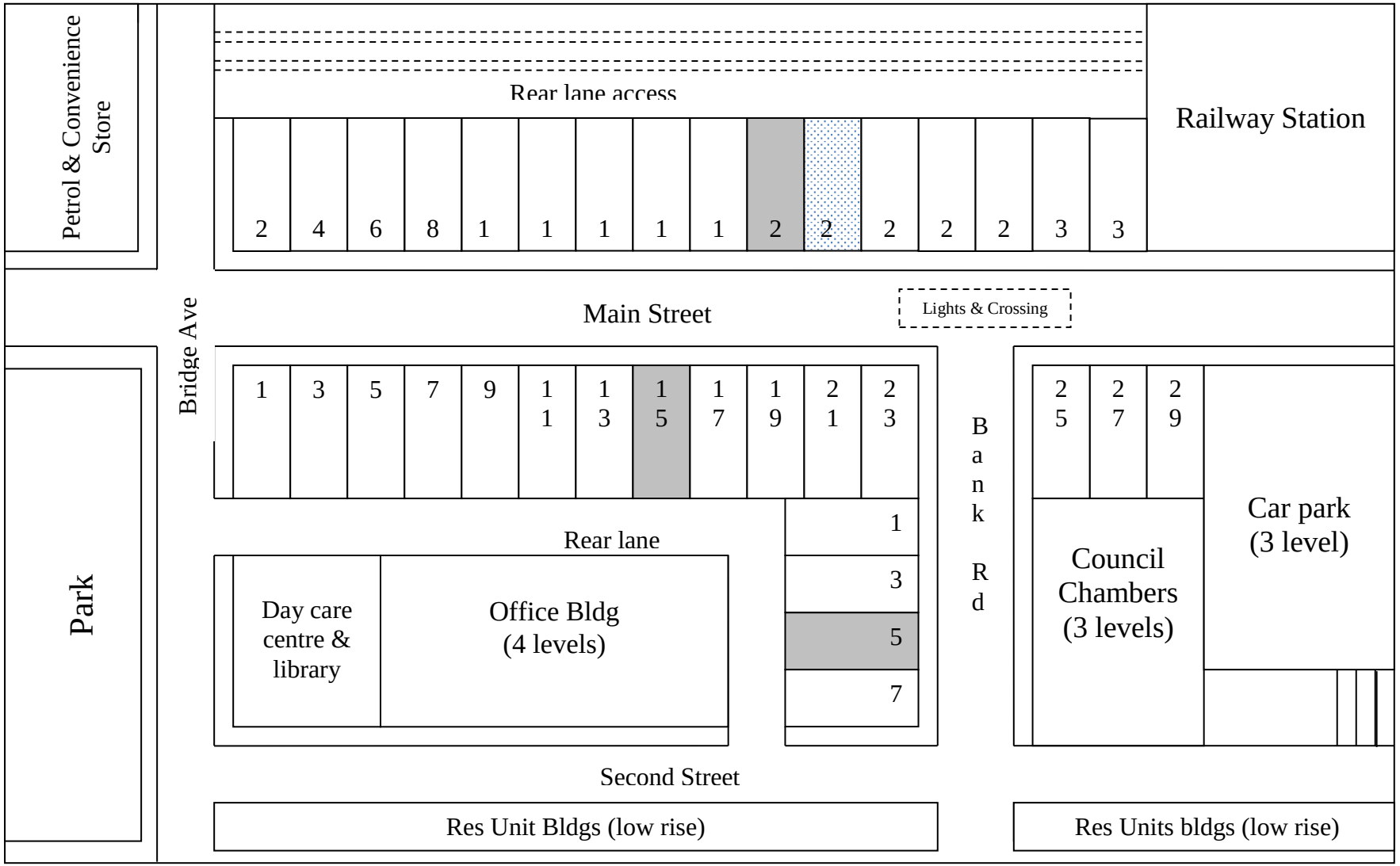

Table 4: Retail Experiment Result Summary

	22 Main Street		20 Main Street		5 Bank Road		15 Main Street	
Sale Price	$900,000		$640,000		$830,000		$860,000	
Land Value Mean Initial Sim	N/a		$566,989		$583,889		$566,467	
Land Value Mean STDEV Initial Experiment	N/a		8.19%		9.79%		10.18%	
Land Value Mean Revised	$542,152		$531,439		$541,939		$549,890	
Land Value Mean STDEV Revised Sim & Add Sale	1.89%		5.97%		6.52%		4.44%	
Land : Improved Value Ratio Revised Mean	60%		83%		65.3%		63.9%	
Age / last upgrade of improvements	1 month		50 years		15 years		7 years	
Size m^2 of improvements	$130m^2$		$130m^2$		$130m^2$		$130m^2$	
	Not available in the initial experiment		**20 Main Street**		**5 Bank Road**		**15 Main Street**	
			No	**%**	**No**	**%**	**No**	**%**
Most relevant sale			17	73.9%	0	0	6	26.1%
Least relevant sale			4	17.4%	12	47.8%	7	30.4%
Most valuable location			11	47.8	8	34.8	4	17.4
Valuers who identified most valuable location but did not assign highest land value	**Total No** 7	**Total %** 28	4	17.4%	0	0%	3	13%

Insights into two key questions were sought from the study of the valuation process:

Question 1 Does a structured or codified process for analyzing improved sales result in a simpler, transparent and economically efficient land value?

Question 2 What can New Zealand and Australia (NSW) learn from one another in reforming the respective bases of value that underpin their property taxes?

Question 1: Simulation Results

A review of the standard deviations of the three sales in the initial simulation shows that all three sales are within the acceptable margin of error of +/- 15 per cent. This margin is used within rating and taxing valuation practice, (NSW Ombudsman 2005). 20 Main Street resulted in a standard deviation of 8.19 per cent, 5 Bank Rd, 9.79 per cent and 15 Main Street 10.18 per cent. A summary of these results are included in Table 4.

In adopting a codified approach to the analysis in accounting for the added value of improvements a different outcome resulted across all three properties. 15 Main Street resulted the lowest standard deviation of 4.44 per cent and the largest improvement of 56.4 per cent of the three sales in the revised simulation. This was followed by 5 Bank Rd resulting in a standard deviation of 6.52 per cent, an improvement of 33.5 per cent and finally 20 Main Street resulted in a reduction of the standard deviation to 5.97 per cent, an improvement of 27.2 per cent.

A review of the results from the second task of the initial simulation qualifies the processes and judgment adopted by the valuers in the sales selection process. As set out in Table 4, a review of the sale valuers ranked as the most relevant in deducing the underlying value of land was 20 Main Street. 17 of 23 valuers representing 73.9 per cent selected 20 Main Street as the most relevant, followed by 6 valuers representing 26.1 per cent, who selected 15 Main Street as the second relevant sale. 5 Bank Street was not selected by valuer as the most relevant sale.

The third task valuers were instructed to undertake, was to rank the most valuable to least valuable location of the three sales. It is reiterated that all of the parcels of land are the same size and shape and sold within the same time period, close the date of valuation. Once the added value of improvements are accounted for and deducted from the sale price, the deduced land value ultimately reflects the value of the location of the land. It is noted in Table 4, that 7 valuers, representing 30.4 per cent, did not assign the highest land value to the property selected as the most valuable location in the initial simulation.

Results from the revised simulation show that a structured approach to accounting for the added value of improvements enhances transparency in demonstrating how values are determined. This provides the ability for valuers to explain to taxpayers and taxing authorities how land value is deduced and the direct comparison method of valuation is applied in assigning land values. This in turn improved the consistency and economic efficiency of the tax in addressing the under valuation noted by the NSW Ombudsman where vacant land sales are limited.

Question 2: New South Wales and New Zealand: Lessons to be Learnt

On the question of the valuation cycle and frequency, it was found that the present annual valuation cycle used in NSW was considered too frequent by the valuers surveyed. The valuers highlighted that distinguishing the value of each parcel of land at 1 July (base date) each year was challenging under the Computer Assisted Mass Appraisal system. This was due to the fact that one in three values were required to be verified by inspection each year by the 90 statutory valuers in NSW that valued the 2.5 million parcels of land across the state. The valuers in NSW most frequent response to the most relevant frequency for undertaking statutory valuations was two point five years, being very close to the New Zealand valuation cycle frequency.

The valuation challenges confronting New South Wales, Queensland, ACT and Northern Territory using land or site value as the base of assessing council rates are not experienced in parts of New Zealand, or in the states of Victoria or South Australia where improved value is used. The valuers and property lawyers that participated in the focus groups following the experiment pointed to the difficulties that land value presents in the absence of comparative evidence drawn from vacant land sales. Conversely valuers, economists and government administrators also identified the importance of land / site value particularly for state land tax in Australia.

It was highlighted that Improved Value worked fine where the existing use of the land was highest and best use. However in urban renewal and transitional use locations, land value is a more neutral base and not distorted by obsolete improvements and land uses, that are captured when improved value existing use is used to assess this tax. Despite New Zealand discontinuing its national land tax, it was recommended that a land tax be considered again in New Zealand, particularly as a means of funding infrastructure projects that serve or link multiple local government areas and are funded by the Commonwealth. On this basis, New Zealand should it consider reintroducing land tax, would benefit from the lessons and experiences in administering this tax in Australia.

CONCLUSION

The definition of value is a well-defined concept within the property profession. However, within taxation the meaning of value is subsumed under the principles of 'good tax design' particularly in assessing land taxes. In summary, the value determined and used to assess recurrent property tax is a manufactured process in the absence of vacant land sales. While requiring some resemblance to market value as defined in the Spencer Test, the standard defined state of value and its manufacture is the key to an economically efficient recurrent land tax in Australia and potentially in New Zealand. This brings to the fore, the importance that all bases of value are assessed on the same footing and more specifically, all land or property in the case of capital improved value or assessed annual value is assessed on the highest and best use when that is not the existing use.

The primary rationale argued for land over other bases of value, is that improvements are accounted for in the sales analysis process when valuing land. This is in contrast to including improvements in the tax base and hence attempting to communicate to the tax payer that CIV, is not what is on their land, but should be on their land where improvements are not maximally productive. The conclusion drawn is that a codified process of selecting, analyzing and determining value (the valuation process) results in a more consistent result across a population of valuers, of which the process is clearly communicable and simple to explain to the taxpayer. This process ultimately conforms to the principles of 'good tax design', results in a simpler and more transparent tax while maintaining its economic efficiency.

In the first instance, it has been observed that the success of taxing land on its highest and best use depends largely on the valuation practices adopted (Gaffney, 1975, Hudson, 2008 & Oates & Schwab 1997). If land value is to remain the basis of recurrent land taxation, it will be necessary to ensure that valuers firstly define the land's highest and best use before the added value of improvements can be determined in a simple and transparent manner and improve the economic efficiency of the tax. A framework for determining the highest and best use of land therefore has the potential to facilitate the application and harmonization of a recurrent tax on land within and across land use categories and jurisdictions (local governments) of Australia.

The additional complexity of valuing land in highly urbanized locations requires a standard in accounting for the added value of improvements in the absence of vacant land sales. It is shown

in the experiment in this paper, that the selection of sales of which improvements are maximally productive and highest and best use is the first important step in the valuation process. This paves the way for the second step of the valuation process to be further explored, that is defining a standard for the added value of improvements within a designated defined valuation location or land use category. On this approach the tax principles of consistency, economic efficiency and transparency will be strengthened considerably in the views of taxpayers.

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Estimates of Productive Capital Stock for the States and Territories of Australia, 1990-2014

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ABSTRACT

The article is an attempt to narrow the gap in capital stock data availability for the states and territories of Australia. Closely following the methodology of the Australian Bureau of Statistics and the recently developed modelling techniques in Mikhailitchenko (2017), the study presents productive capital stock series for the states and territories of Australia for the period 1990-2014, which is analogous to that used for productivity analysis for Australia as a whole. The precision of the derived series of each type is assessed by comparing the aggregated estimates with the national data published by the Australian Bureau of Statistics.

1. INTRODUCTION

Productivity is widely believed to be the key factor behind the wealth and prosperity of a country. However, the lack of capital stock data prevents researchers from conducting reliable productivity analysis at sub national level. To the date, data for productive capital stock data used for productivity analysis for Australia as a whole does not exist at the state level, making researchers rely on experimental Net Capital Stock series developed for Australian states (see, for example, Levtchenkova and Petchey (2000), Louca, 2003, Mikhailitchenko et al. (2005) and Mikhailitchenko (2017)). The study is the first to present the estimates of Productive Capital Stock (PCS) at sub-national level for Australia, which brings researchers one step closer to developing the Capital Services series for the Australian states and territories with the final step remaining of adding the land and inventories inputs and using rental prices for weighing the stocks into capital services flows.

Mikhailitchenko (2017) presented a model for estimating Net Capital Stock (NCS) and Consumption of Fixed Capital (COFC) data for regional Australia that, with some modifications, allows deriving Productive Capital Stocks using the same methodology and parameters of Perpetual Inventory Model (PIM). The only difference between the model for NCS and the model for PCS is in the combination of the age-price profiles with the survival functions for the former, while the later employs a combination of the age-efficiency profile and the retirement function (OECD, 2009). Similar to Mikhailitchenko (2017), the process adopted in this study doesn't need any initiation of the series and, thus, avoids the errors associated with two rounds of initial allocation of stocks, present in Mikhailitchenko et al. (2005). The assets in the PIM process retire from their corresponding stocks according to the Winfrey (1938) S3 or S0 functions and are discounted for the loss of efficiency according to parameters with values similar to those used by the Australian Bureau of Statistics (ABS, 2012).

The major issue remains the same as per Mikhailitchenko (2017) and all other research attempts to produce these series and are related to a lack of disaggregated Gross Fixed Capital Formation (GFCF) data. Two aspects should be mentioned here with the first one being a higher level of aggregation of the state investment data compared to that at the national level. Secondly, the length of the capital stock series for Australian states and territories is much shorter than that of the corresponding series at the national level. These issues result in a major flaw on this study, namely, the low reliability of the estimates in most series with one exception for Cultivated Biological Resources, where the mean service life of assets is short enough to allow estimating PCS from 1995 with no proxies for GFCF used.

The reminder of the article is organised as follows. Section 2 presents the model for estimating productive capital stock series and provides a short review of data availability for the states and territories as per Mikhailitchenko (2017). Section 3 gives the derived estimates of NCS and COFC for Australian states and territories and compares them with the data published by the Australian Bureau of Statistics. Concluding comments are given in Section 4.

2. THE MODEL AND INPUT DATA[1]

The PIM used by ABS for estimating PCS requires several inputs for estimating PCS with the first one, - and the most problematic one, given a lack of these. data, - is investment or Gross Fixed Capital Formation data. Further, it requires the age-efficiency profile for each type of asset as given by equation **(1)** below (ABS 5216.0, 2000).

$$\boldsymbol{E_t = \frac{M - A_t}{M - bA_t}} \qquad (1)$$

where $\boldsymbol{E_t}$ is the efficiency of a capital asset at a point of time t, $\boldsymbol{M}$ is the service life of an asset according to the Winfrey (1938) distribution, $\boldsymbol{A_t}$ is the current age of an asset (equals t – τ in equation (**3**)), **b** is the asset-specific efficiency reduction parameter.

Finally, it requires the survival (or retirement) profile of assets as per equation **(2)** below (Winfrey, 1938).

$$\boldsymbol{F_T = F_0\left(1 - \frac{T^2}{a^2}\right)^m} \qquad (2)$$

where $\boldsymbol{F_T}$ is the proportion of the cohort retiring at the time period T, $\boldsymbol{F_0}$ is the proportion of the cohort retiring at the mean asset service life, **a** the parameter that determines the time periods (e.g. a = 10 for deciles), **m** is the parameter that determines the flatness of the distribution.

In Mikhailitchenko (2017) NCS data was derived as shown in equation **(3)** as a sum of GFCF discounted for a loss of value due to normal tear and wear and an outflow from the stock due to retirement.

$$\boldsymbol{K_t^j = \sum_{\tau=0}^{T} I_{t-\tau}^{ij}(1 - \delta_\tau^{ij})(1 - \theta_\tau^{ij})} \qquad (3)$$

where $\boldsymbol{I_{t-\tau}^{ij}}$ is the real value of investment of type **i** in a region **j** with the remaining service life of **t-τ**; $\boldsymbol{\delta_\tau^{ij}}$ is the accumulated loss of efficiency of an asset when it reaches the age τ; $\boldsymbol{\theta_\tau^{ij}}$ is the accumulated value of loss of assets due to their retirement from the stock.

[1] This section draws heavily on Mikhailitchenko (2017) and provides a short description of the model and the data used to avoid duplication of work already published.

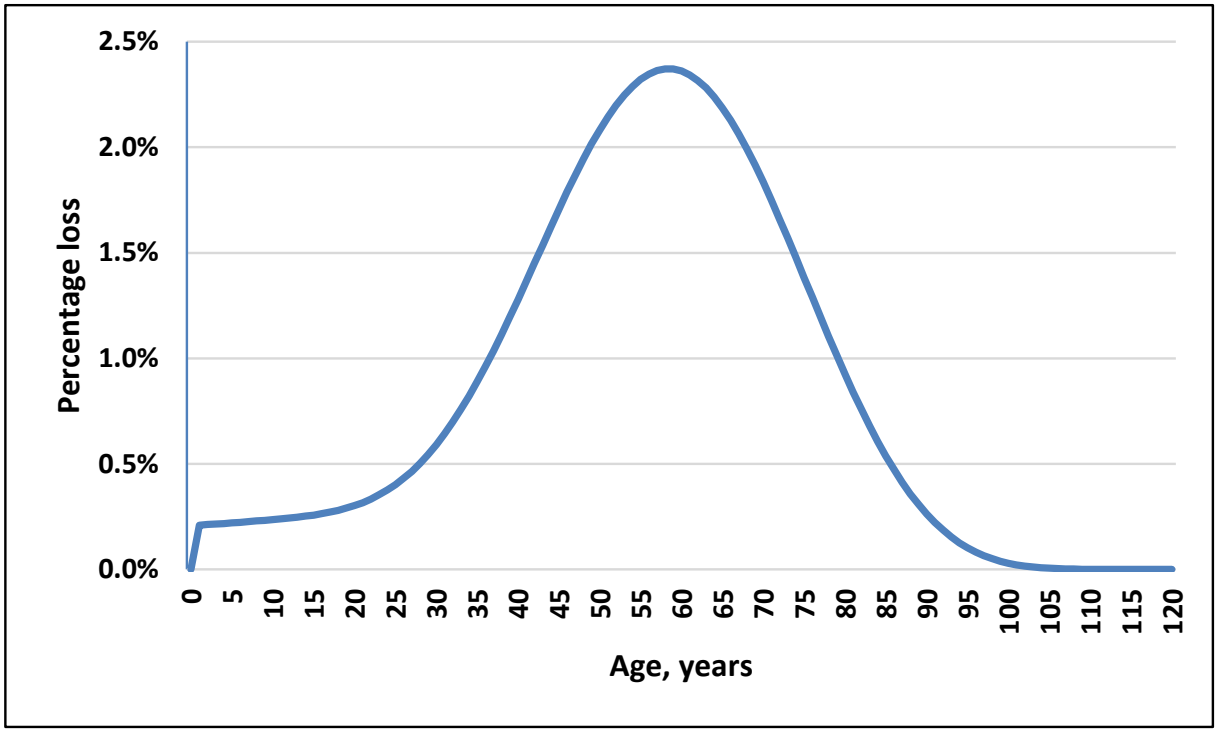
When estimating NCS, Mikhailitchenko (2017) initially overlooked the possibility of estimating PCS using almost the same approach with the only change needed of replacing the age-price profile in equation (3) by the age-efficiency profile represented by equation (1). However, after examining the process applied by the ABS (1351.0055.004, 2005: 22), it became obvious that with a minor adjustment the model would provide all inputs needed for estimating PCS, which was absolutely impossible in Mikhailitchenko *et al.* (2005). Equation (4) presents the model for estimating PCS for the states and territories of Australia.

$$K_t^j = \sum_{\tau=0}^{T} I_{t-\tau}^{ij} E_\tau^{ij} \left(1 - \theta_\tau^{ij}\right) \qquad (4)$$

where $I_{t-\tau}^{ij}$ is the real value of investment of type **i** in a region **j** with the remaining service life of **t-τ**; E_τ^{ij} is the efficiency of an asset when it reaches the age τ; θ_τ^{ij} is the accumulated value of loss of assets due to their retirement from the stock.

Figure 1 below presents the density function for a combined age-efficiency-retirement profile applied for estimating PCS of dwellings with a mean service life of 60 year and retirement pattern according to Winfrey's *S3* function as an example of the process used in this study and to provide an opportunity for other researchers in the area to compare it with profiles used by OECD (2009) and ABS (2012).

Figure 1: Combined Age-Efficiency-Retirement Profile: Dwellings



Source: Author's estimates.

The lack of GFCF data, as has already been mentioned, is the major problem for estimating capital stock at sub national level. Compared to the investment data for Australia as a whole, where the data is available from 1960, GFCF series for Australian states and territories are much shorter and start only in 1986. In addition, GFCF series at subnational level come highly aggregated compared to the corresponding series for Australia as a whole.

For example, at the national level, intellectual property products series (INTEL) are disaggregated into research and development (RD), mineral and petroleum exploration (MPE), computer software (CS) and artistic originals (AO), while for the states these statistics are given only as a total INTEL. Major differences in the retirement patterns and age-efficiency profiles of RD, MPE, CS and AO cause errors of unknown size in the estimates when equation (4) is applied with a combined profile of intellectual property product on an unrealistic assumption that the proportional composition of the sub types in INTEL is the same for all states.

An additional problem is caused by the GFCF for Ownership Transfer Cost (OTC) data. OTC used for capital services index for Australia as a whole doesn't include dwellings, while at the state level, in the OTC GFCF series dwellings are included. To address the issue, the OTC was discounted for dwellings according to the proportion of private NCS excluding dwellings in Mikhailitchenko (2017). No other alternatives to address this issue are known to the author.

Privatisation of large public companies might also contribute to additional errors in the absence of information regarding the age and type composition of assets within the stocks of these companies. For example, privatisation of public asset in banking, telecommunication and utilities industries might cause significant problems in estimating capital stocks for smaller states such as South Australia and Tasmania, where departure of assets resulted in negative flows of GFCF in late 1990s and early 2000s. Although this type of error is expected to diminish over time, the composition of the privatised stocks should be taken into account. With a large proportion of NDC in privatised assets implies that the error term will converge to zero over a very long period of time due the length of service life of assets in NDC. The estimates of capital stocks for ME and INTEL are less affected by privatisation.

In this study, as in all previous ones, the author was forced to use proxies as substitutes for investment data. In most cases, similar to the methodology in Mikhailitchenko *et al*. (2005), GFCF growth was assumed to follow the population growth pattern in each state, with an exception for dwelling construction, where relatively reliable information for the number and value of dwelling constructed could be collected from *Year Books* (ABS 1300.0-1300.8, various years) starting from 1947 for most states and territories. However, given the assumed service life of some dwellings of up to 120 years, even these series require proxy data starting from the end of the 19th century.

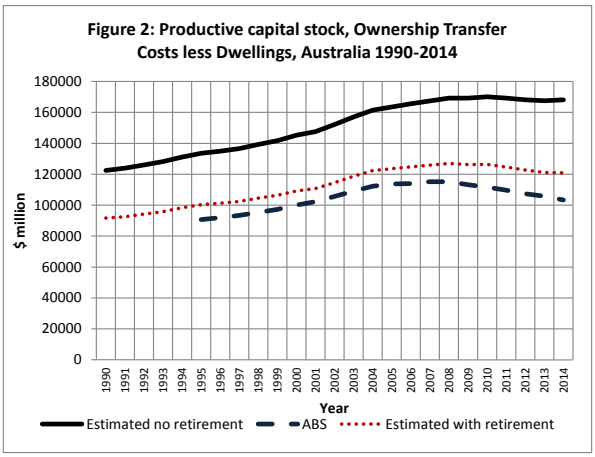
Using proxies should not be considered a major flaw despite they do cause additional measurement errors. Proxying in estimating capital stock is an inevitable choice and is used by the ABS for dwelling where the length of service life might reach up to 176 years for houses with brick walls implying that the data must be available from the mid-19th century, which is obviously not the case. However, given the shortness and the high level of aggregation of the GFCF series at the state level, it is necessary to acknowledge that the size of the measurement errors in the estimates presented in this study are expected to be much larger than those published by ABS for Australian as a whole.

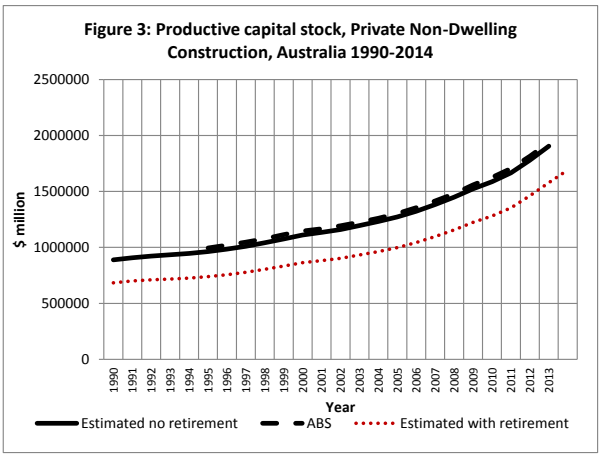
3. Estimates of Productive Capital Stock for Australian States and Territories and Discussion of Results

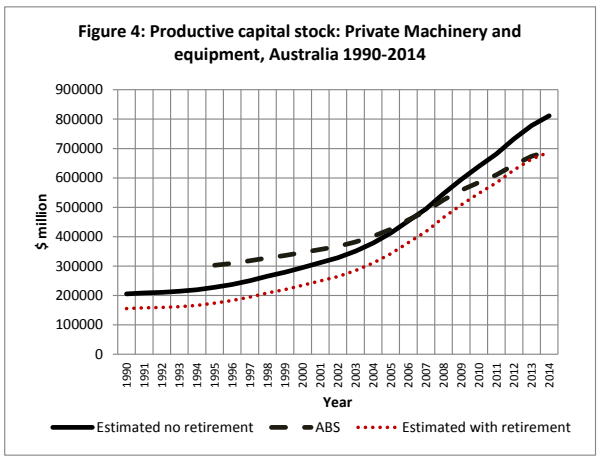
ABS estimates PCS for five types of assets: OTC, NDC, ME, CBR and INTEL (ABS, 2014, Cat.5260.055.002). DW and Public Capital Stock (PUB) series are not considered as inputs for the capital services flows despite common sense suggests that rental dwellings, representing around a third of total stock of DW, and public infrastructure, accounting approximately 90 percent of PUB, might contribute to the aggregate economic activity of the country. In this paper, the author presents the estimates of PCS for the five assets to compare the developed series to that of the ABS. The estimates of PCS in DW and PUB are available on request.

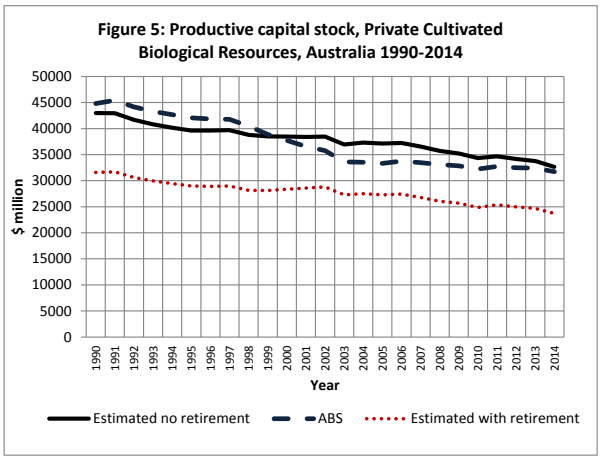
After applying equation (4) to derive PCS the author noticed that he significantly underestimates of PCS both for individual assets and the total, compared to Australia as a whole. However, the estimates fit very well if the retirement function removed from equation (4). As it is impossible to make any conclusions regarding the quality of the estimates without looking at the actual ABS spreadsheets, it might be worth to double-check the formulae actually used in estimating the PCS for Australia as a whole. To make further discussion regarding this matter possible, the author acknowledges the authority of Australian statistical agency and presents both sets of series, with and without a discount for retirement of assets from the stocks.

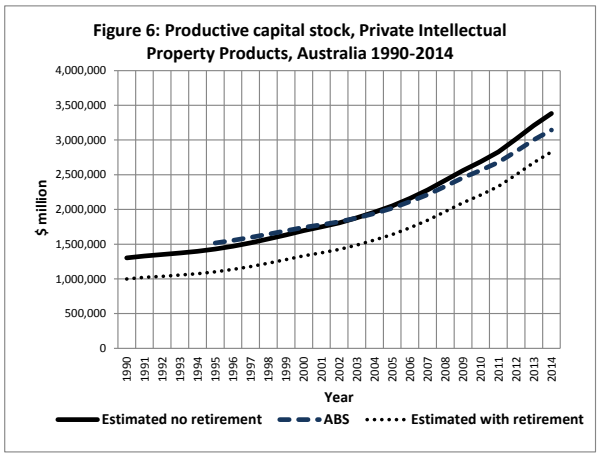
Figures 2 to 7 present the estimated total for PCS for Australian states and territories by type of asset and compare the estimates with the data published by the ABS, while the actual data series by type of asset by state are provided in Appendix 1 in Tables A.1 to A.8.

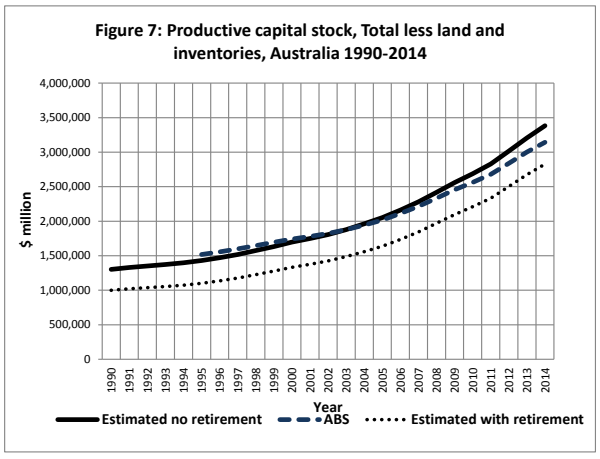












As can be seen from Figures 2 to 7, estimates of PCS are the closest to the data published by ABS for all types of asset, whereas application of equation (4) in default, results in a significant downward bias with an exception for OTC. The upward bias in the estimates of OTC can be explained by the imperfections of the discounting for dwellings technique and, taking into account the small proportion of this stock in the total and the similarity of the shapes in Figure 2, these series can be considered as satisfactory for analytical purposes. The most striking coincidence of the estimates and the ABS series is for NDC, shown in Figure 3, where the average percentage error is -2.5 percent if the retirement function is excluded from equation (4).

For both ME and CBR the average percentage error is 4 percent for estimates with no adjustment for retirement. However, the maximum percentage errors for these two productive stocks are -24.7 percent and 11.3 percent respectively. The likely sources of these large errors is the heterogeneity of the assets in GFCF of the corresponding types and high aggregation level investment data published by ABS. The estimates with no retirement adjustment for INTEL show larger differences than all other types of capital stock with an average percentage error of 8.9 percent compared to ABS data. The error term varies from -22.3 to 28.7 percent, which is caused by the high level of aggregation of published GFCF data and larger than in all other stocks differences in PIM parameters for assets included in the INTEL stock.

For the total PCS, the percentage error is rather small and, on average, is only 0.9 percent. However, the error term varies from -5.7 percent in 1995, the first year when the ABS data for PCS becomes available, and 7.5 percent in 2014. Despite the small size of average percentage error, the results should be treated with caution due to a likely effect of the imperfections of the proxies used and the errors associated with the unrealistic but inevitable assumption of proportionality of GFCF of each subtype across Australian states and territories.

The author doesn't claim that there are any issues with the PCS series published by the ABS. However, given the closeness of the estimates when the retirement function is dropped from PIM and the stocks are adjusted only for the loss of efficiency, the statisticians might find it worthy to re-examine the formulae as these appear on the spreadsheets for estimating capital stocks, especially for estimating PCS and Consumption of Fixed Capital (COFC).

4. CONCLUSION

The study presents the newly developed series for Productive Capital for the states and territories of Australia for the period 1990-2014. Following closely the PIM process applied by ABS and OECD, the author makes the next step towards developing the estimates of capital services at sub national level, which is widely used as an input for multifactor productivity analysis. Similar techniques were used for estimating PCS for PUB and DW for the states and territories as an indicator of the input from the public infrastructure into the regional economic activity. The later series are available on request.

Needless to say that the results should be treated with caution due to a range of possible errors of unknown size in the estimates. While the effects from the errors associated with proxies diminish and even completely disappear for the stocks with shorter service lives such as CBR and ME, the errors resulting from the aggregation level of GFCF remain in the estimates and might even grow when the actual investment departs further from the assumed similarity between the states in the composition of GFCF in INTEL and ME.

Therefore, the author acknowledges the flaws in the developed data sets. However, given limited capital stock data availability, with some caution in drawing conclusions, this series might be used for productivity analysis for Australia at sub national level. The author plans to

proceed with his research in the area of regional capital stocks, complete the capital services series and conduct multifactor productivity analysis for the states and territories of Australia within the same frameworks as it is done by the ABS and OECD.

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APPENDIX

Table A.1: Productive Capital Stock, $million, New South Wales, 1990-2014

	With retirement					Without retirement				
	OTC	NDC	ME	CBR	Intel	OTC	NDC	ME	CBR	Intel
1990	37309	205817	46993	8847	6871	50014	273718	62632	11807	7039
1991	37505	214244	47914	9277	8119	50014	283154	63749	12212	8302
1992	38121	220041	48382	9161	9556	50014	289983	64405	12067	9769
1993	38497	223457	49279	9084	11372	50014	294454	65484	11961	11634
1994	39160	226451	50440	9005	13230	50014	298527	66829	11879	13571
1995	39742	232206	52994	8754	15261	50014	305387	69582	11683	15716
1996	39943	239713	55281	8572	17510	50014	314027	72101	11614	18124
1997	40320	246759	58120	8289	20031	50014	322234	75224	11458	20853
1998	41056	255237	61576	7729	22662	50014	331902	79025	10973	23744
1999	41749	265188	65118	7357	25369	50014	343076	82976	10592	26765
2000	42907	275327	70285	7090	28333	50014	354472	88610	10216	30096
2001	43395	280332	76014	6838	31783	50014	360765	94854	9811	33965
2002	44753	284491	80608	6664	35391	50014	366247	99998	9475	38043
2003	46127	290724	85928	6110	39378	50014	373839	105906	8795	42552
2004	47188	298293	92516	6034	43559	50014	382801	113130	8635	47306
2005	46955	306885	101905	5908	47889	50014	392826	123234	8391	52263
2006	46724	316723	111804	5905	52427	50014	404138	133965	8268	57484
2007	46509	326175	120612	5768	57483	50014	415108	143768	8030	63278
2008	46400	336593	132965	5603	63225	50014	427094	157318	7763	69816
2009	46011	347127	142901	5490	68464	50014	439248	168678	7572	75915
2010	45789	356038	154153	5296	73793	50014	449840	181594	7333	82175
2011	44899	367847	163727	5452	79250	50014	463397	193077	7444	88641
2012	43930	379815	173255	5368	85309	50014	477184	204775	7334	95790
2013	43149	397464	179928	5284	91136	50014	496732	213929	7232	102795
2014	43161	410968	184817	5073	97084	50014	512222	221688	6993	110016

Table A.2: Productive Capital Stock, $million, Victoria, 1990-2014

	With retirement					Without retirement				
	OTC	NDC	ME	CBR	Intel	OTC	NDC	ME	CBR	Intel
1990	23309	162995	36639	6720	5055	31916	214480	49069	9197	5141
1991	23325	165760	36816	6711	5984	31916	218090	49393	9168	6082
1992	23382	166908	36702	6534	6992	31916	220115	49416	8970	7113
1993	23370	168607	37208	6497	8265	31916	222725	50051	8905	8424
1994	23566	169759	38250	6580	9625	31916	224823	51219	8949	9844
1995	23841	170864	39587	6624	11052	31916	226910	52690	8949	11358
1996	23980	173792	41581	6890	12654	31916	230856	54842	9174	13080
1997	24167	178763	45128	7251	14385	31916	236881	58581	9508	14967
1998	24866	183262	48367	7387	16176	31916	242471	62051	9627	16954
1999	25425	190309	51315	7599	18005	31916	250645	65269	9838	19017
2000	26274	196056	55189	7903	20058	31916	257553	69441	10172	21342
2001	26993	200993	59406	8045	22449	31916	263685	73977	10370	24044
2002	28081	206397	63889	8037	24969	31916	270316	78793	10440	26909
2003	29320	214057	69777	7705	27817	31916	279234	85038	10217	30137
2004	30270	221952	76275	7620	30750	31916	288414	91943	10253	33483
2005	30865	230970	84273	7468	33858	31916	298745	100438	10187	37040
2006	31403	241291	94084	7376	37026	31916	310403	110884	10151	40692
2007	31797	251331	104038	7106	40570	31916	321805	121657	9905	44755
2008	32381	263332	114542	6843	44615	31916	335187	133196	9600	49354
2009	32425	274710	123867	6784	48289	31916	347968	143787	9461	53623
2010	32760	284763	133363	6661	52012	31916	359442	154787	9259	57987
2011	32845	295143	141875	6754	55742	31916	371262	165040	9266	62412
2012	32617	305618	149596	6791	59785	31916	383198	174758	9227	67209
2013	32357	311273	156000	6892	63661	31916	390334	183471	9277	71901
2014	32365	321078	160472	6703	67694	31916	401641	190640	9048	76820

Table A.3: Productive Capital Stock, $million, Queensland, 1990-2014

	With retirement					Without retirement				
	OTC	NDC	ME	CBR	Intel	OTC	NDC	ME	CBR	Intel
1990	11261	128540	26220	7806	6628	14415	166915	34131	10578	8070
1991	11723	130847	26510	7590	7055	14415	169887	34608	10336	8503
1992	12293	132512	26578	7101	7536	14415	172235	34868	9812	8994
1993	12935	134394	26666	6649	8189	14415	174820	35156	9319	9664
1994	13664	136492	27420	6261	8902	14415	177643	36116	8903	10406
1995	14216	140317	28383	6068	9814	14415	182215	37297	8701	11357
1996	14515	144237	30003	6070	10914	14415	186907	39150	8693	12513
1997	14812	149096	32189	6148	12009	14415	192562	41589	8714	13682
1998	15124	153202	34387	6083	13018	14415	197492	44059	8522	14782
1999	15354	158194	37075	6341	13941	14415	203335	47032	8609	15815
2000	15692	163475	39884	6616	14905	14415	209496	50129	8696	16908
2001	15923	167674	42116	6996	16087	14415	214603	52642	8954	18238
2002	16712	172032	45085	7381	17407	14415	219902	55880	9342	19727
2003	17635	177544	49625	7106	18949	14415	226385	60684	9161	21460
2004	18692	183038	55489	7490	20634	14415	232883	66827	9674	23361
2005	19176	189404	62579	7657	22448	14415	240285	74246	9948	25417
2006	19634	198341	71492	7981	24465	14415	250293	83581	10364	27704
2007	20236	210046	81625	7918	26845	14415	263105	94267	10378	30382
2008	20786	222989	94728	7824	29548	14415	277190	108079	10347	33407
2009	20685	238857	106478	7750	32083	14415	294239	120710	10329	36288
2010	20726	251221	114345	7453	34877	14415	307821	129638	10094	39450
2011	20314	270029	122666	7586	37803	14415	327887	139213	10267	42767
2012	20050	302579	133603	7356	41274	14415	361736	151632	10080	46653
2013	19754	338711	144180	7152	44422	14415	399208	163996	9890	50248
2014	19576	373385	151285	6807	47305	14415	435261	173292	9528	53615

Table A.4: Productive Capital Stock, $million, South Australia, 1990-2014

	With retirement					Without retirement				
	OTC	NDC	ME	CBR	Intel	OTC	NDC	ME	CBR	Intel
1990	7356	50348	15257	2136	3990	9992	66015	20662	2977	5111
1991	7421	51488	15167	2149	4131	9992	67431	20635	2970	5253
1992	7506	51732	15086	2078	4240	9992	67962	20613	2878	5367
1993	7631	51642	14892	2084	4487	9992	68173	20474	2864	5619
1994	7787	51400	14695	2103	4736	9992	68243	20332	2860	5878
1995	7845	51240	15114	2149	4990	9992	68410	20806	2884	6145
1996	7824	51345	15264	2245	5324	9992	68854	21016	2965	6496
1997	7800	51737	15800	2373	5776	9992	69599	21619	3089	6968
1998	7817	52855	16584	2439	6220	9992	71083	22475	3154	7437
1999	7858	53268	16827	2548	6644	9992	71875	22790	3269	7889
2000	7990	58728	17346	2703	7025	9992	77727	23375	3437	8304
2001	8081	60997	18169	2765	7553	9992	80398	24253	3523	8870
2002	8297	62437	19169	2820	8104	9992	82251	25291	3605	9467
2003	8471	64180	20989	2708	8786	9992	84415	27131	3534	10203
2004	8602	66188	23199	2648	9484	9992	86854	29355	3524	10965
2005	8654	68192	25718	2551	10272	9992	89296	31893	3468	11830
2006	8702	69899	28208	2420	11242	9992	91448	34424	3373	12890
2007	8790	72124	30407	2306	12443	9992	94121	36701	3280	14195
2008	8916	73983	32285	2187	13834	9992	96434	38706	3159	15705
2009	8896	76269	33956	2137	14875	9992	99177	40566	3083	16880
2010	8867	78268	35758	2075	15829	9992	101633	42627	2980	17983
2011	8737	80796	37509	2114	16868	9992	104619	44720	2964	19186
2012	8545	83884	39542	2042	18129	9992	108164	47196	2835	20627
2013	8394	87548	40617	1983	19420	9992	112283	48841	2737	22119
2014	8283	91032	41229	1866	20719	9992	116220	50174	2590	23635

Table A.5: Productive Capital Stock, $million, Western Australia, 1990-2014

	With retirement					Without retirement				
	OTC	NDC	ME	CBR	Intel	OTC	NDC	ME	CBR	Intel
1990	9007	90323	21902	4161	10146	11661	113989	27946	5669	12569
1991	9076	91371	23196	4095	10664	11661	115527	29389	5580	13094
1992	9237	92196	24257	3967	11171	11661	116862	30595	5422	13614
1993	9520	93100	26210	3938	11855	11661	118297	32692	5357	14320
1994	10089	94979	27731	3844	12627	11661	120728	34358	5234	15126
1995	10470	96898	29925	3770	13610	11661	123223	36710	5150	16160
1996	10711	99730	32841	3562	14655	11661	126656	39810	4949	17274
1997	10994	102607	35201	3370	16065	11661	130160	42396	4766	18774
1998	11312	110220	39622	3051	17393	11661	138428	47103	4437	20214
1999	11578	114151	42057	2787	18558	11661	143043	49903	4150	21513
2000	11802	117311	43921	2595	19406	11661	146919	52222	3907	22518
2001	11803	118682	45217	2426	20624	11661	149037	54066	3669	23914
2002	12035	121747	46510	2312	21537	11661	152882	56000	3482	25024
2003	12295	127820	48030	2110	22671	11661	159766	58251	3211	26378
2004	12566	133616	51473	2091	23954	11661	166404	62511	3104	27903
2005	12841	139873	54750	2067	25237	11661	173535	66692	2978	29457
2006	13263	152216	59738	2061	26514	11661	186782	72666	2886	31032
2007	13413	169279	65022	1998	29121	11661	204780	79010	2761	33967
2008	13383	188012	72967	1917	32789	11661	224477	88065	2647	37988
2009	13149	211297	80847	1850	36983	11661	248755	97065	2561	42559
2010	13093	233548	88159	1756	40551	11661	272028	105465	2466	46521
2011	12789	260694	95040	1800	44109	11661	300222	113367	2504	50483
2012	12506	305350	106860	1774	47822	11661	345951	126133	2466	54604
2013	12463	352204	118189	1751	52105	11661	393904	138368	2428	59301
2014	12449	395220	123935	1699	55329	11661	438043	145096	2352	62943

Table A.6: Productive Capital Stock, $million, Tasmania, 1990-2014

	With retirement					Without retirement				
	OTC	NDC	ME	CBR	Intel	OTC	NDC	ME	CBR	Intel
1990	1925	14078	4840	879	2116	2645	19333	6526	1263	3062
1991	1916	13988	4818	888	1993	2645	19318	6519	1252	2937
1992	1918	14183	4739	858	1894	2645	19590	6453	1202	2836
1993	1930	14182	4644	853	1829	2645	19668	6372	1178	2767
1994	1931	14110	4574	856	1776	2645	19679	6316	1165	2706
1995	1938	14109	4623	832	1747	2645	19762	6381	1130	2666
1996	1916	14216	4584	854	1756	2645	19956	6359	1147	2657
1997	1881	14328	4657	871	1786	2645	20156	6455	1165	2664
1998	1840	14377	4680	873	1877	2645	20294	6504	1169	2725
1999	1799	14416	4600	892	1920	2645	20424	6451	1188	2732
2000	1767	14470	4630	908	1974	2645	20569	6508	1203	2745
2001	1750	14394	4717	908	2084	2645	20587	6618	1200	2811
2002	1765	14817	4821	898	2223	2645	21102	6738	1189	2905
2003	1834	14943	5075	846	2356	2645	21322	6998	1141	2996
2004	1911	15208	5376	829	2517	2645	21681	7295	1134	3121
2005	1931	15547	5951	811	2735	2645	22114	7858	1123	3310
2006	1945	15855	6736	800	2953	2645	22516	8627	1116	3511
2007	1962	16356	7006	773	3193	2645	23110	8881	1090	3744
2008	1955	16949	7712	756	3527	2645	23796	9574	1061	4084
2009	1951	17634	8570	761	3780	2645	24573	10427	1053	4353
2010	1954	18036	8977	754	4019	2645	25066	10840	1034	4618
2011	1935	18465	9484	768	4241	2645	25584	11367	1037	4875
2012	1898	18815	10327	772	4478	2645	26021	12253	1035	5155
2013	1858	19077	10710	780	4689	2645	26367	12711	1041	5418
2014	1834	19383	10864	763	4889	2645	26755	12985	1024	5673

Table A.7: Productive Capital Stock, $million, Northern Territory, 1990-2014

	With retirement					Without retirement				
	OTC	NDC	ME	CBR	Intel	OTC	NDC	ME	CBR	Intel
1990	420	16931	1726	1042	1974	529	18446	2188	1503	2049
1991	439	16895	1807	977	2205	529	18526	2289	1417	2284
1992	471	16803	1786	909	2360	529	18562	2288	1327	2447
1993	507	16758	1741	853	2535	529	18657	2263	1250	2635
1994	542	16853	1744	809	2747	529	18904	2288	1184	2867
1995	568	16905	1697	784	2998	529	19122	2264	1140	3147
1996	593	17098	1847	733	3254	529	19494	2439	1071	3444
1997	616	17245	1930	668	3382	529	19834	2548	990	3624
1998	644	17686	1958	599	3638	529	20483	2603	902	3946
1999	672	19448	2056	585	3766	529	22468	2726	869	4153
2000	692	20048	2202	566	3807	529	23305	2894	832	4283
2001	695	20393	2454	617	3786	529	23903	3164	867	4359
2002	704	21678	2698	681	3878	529	25455	3422	916	4549
2003	713	23500	3005	680	3819	529	27558	3737	900	4589
2004	735	25487	3367	769	3725	529	29838	4104	974	4587
2005	760	27440	3671	823	3739	529	32097	4412	1016	4688
2006	789	29431	4130	890	4010	529	34404	4876	1081	5037
2007	814	31277	4622	902	4264	529	36575	5379	1106	5359
2008	823	32409	5699	909	4523	529	38040	6479	1140	5676
2009	829	35089	6565	909	4757	529	41057	7379	1169	5957
2010	831	35802	7399	878	4894	529	42112	8264	1164	6131
2011	815	36241	7770	900	5003	529	42894	8704	1203	6267
2012	804	39192	8309	868	5291	529	46189	9334	1185	6572
2013	804	46833	8693	844	5517	529	54171	9832	1162	6808
2014	806	54410	9197	797	5947	529	62085	10477	1114	7238

Table A.8: Productive Capital Stock, $million, Australian Capital Territory, 1990-2014

	With retirement					Without retirement				
	OTC	NDC	ME	CBR	Intel	OTC	NDC	ME	CBR	Intel
1990	1087	14692	1650	0	235	1362	15733	2145	0	235
1991	1182	14962	1571	0	302	1362	16087	2089	0	302
1992	1325	15266	1528	0	374	1362	16482	2069	0	375
1993	1485	15542	1503	0	466	1362	16858	2063	0	467
1994	1622	15762	1505	0	562	1362	17187	2084	0	564
1995	1725	15993	1431	0	668	1362	17536	2027	0	672
1996	1782	16163	1391	0	784	1362	17834	2003	0	792
1997	1830	16363	1361	0	912	1362	18173	1988	0	926
1998	1884	16994	1383	0	1048	1362	18954	2023	0	1071
1999	1943	17609	1393	0	1189	1362	19730	2044	0	1224
2000	2042	17955	1520	0	1347	1362	20250	2177	0	1398
2001	2118	18143	1648	0	1532	1362	20624	2306	0	1602
2002	2219	18527	1850	4	1721	1362	21207	2502	4	1815
2003	2303	18898	2231	4	1931	1362	21788	2871	4	2051
2004	2345	19053	2634	5	2151	1362	22167	3256	5	2300
2005	2365	19242	3131	4	2373	1362	22592	3733	4	2556
2006	2369	19904	3584	4	2605	1362	23501	4166	4	2824
2007	2384	21026	4006	3	2863	1362	24882	4573	4	3121
2008	2388	21968	4356	2	3156	1362	26094	4914	3	3457
2009	2374	22688	4820	1	3423	1362	27095	5383	3	3771
2010	2378	23423	5248	1	3694	1362	28119	5834	3	4090
2011	2373	24232	5466	0	3970	1362	29225	6097	2	4419
2012	2371	25112	5740	0	4275	1362	30410	6445	2	4780
2013	2378	25756	6097	0	4573	1362	31364	6909	1	5140
2014	2387	26132	6163	0	4884	1362	32054	7120	0	5517

Innovation in Non-metropolitan Regions: A Review of the Literature

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ABSTRACT

It is increasingly recognised in regional science and innovation studies that non-metropolitan regions have been overlooked in innovation studies, leading to calls for more innovation studies focusing on these types of regions. This paper argues that a clear inventory of the current state of knowledge on innovation in non-metropolitan regions is required to provide a solid foundation for future innovation research in these regions. Underpinned by this argument, the purpose of this paper is to provide a comprehensive review of the literature on innovation in non-metropolitan areas published in scholarly journals between 1998 and 2016. By highlighting (1) the authorship characteristics of scholars publishing this research; (2) the design used; (3) the scope of this research; (4) the methodologies and (5) the themes discussed; this review provides valuable insights for advancing innovation research in non-metropolitan regions.

1. INTRODUCTION

One of the many paradoxes in the current era of a globalised knowledge economy is the continued importance of the region (in the sense of a sub-national division of a country) as the level at which competitiveness is shaped and governed (Camagni 2002; Coe et al. 2004). The impact of innovation on regional competitiveness is well established, and both scholars and policy makers agree that competitiveness through innovation represents the high road to regional development (Asheim, Moodysson & Tödtling 2011; Christensen et al. 2016). Regions' ability to innovate, however, depend on their endowment, with large metropolitan regions often considered as the loci of innovation (Florida, Adler & Mellander 2017; Shearmur 2012). Not surprisingly, most of the literature on regional innovation has focused on these regions (Asheim & Coenen 2005; Isaksen & Sæther 2015).

The geography of innovation, however, extends beyond metropolitan regions (Escalona-Orcao et al. 2016; Fitjar & Rodríguez-Pose 2011; Grillitsch & Nilsson 2015). Thus, a small but increasing body of research on innovation outside these regions has been published over the years. This paper is concerned with the literature on innovation in non-metropolitan regions, broadly defined as regions located between metropolitan regions and rural areas. A great variety of regions might therefore fall within this spectrum as individual countries use different criteria. For the purpose of the current study, old industrial regions falling within this interval are excluded. There is an extensive body of literature is dedicated to old industrial regions, for example Benneworth (2007), Tödtling et al. (2013) and more recently, Hu (2017).

The term non-metropolitan itself might be considered a fuzzy concept (Markusen 1999; Suorsa 2014), due to the various terminologies used. They are most commonly called: peripheral regions (Mudambi & Santangelo 2016, p. 1967); small regions (Isaksen & Sæther 2015, p. 65); non-metropolitan areas (Escalona-Orcao et al. 2016, p. 112); peripheral areas (McAdam, Reid & Shevlin 2014, p. 66), less-favoured regions or simply regional areas (Eversole 2015, p. 2). Whatever terminology is used, the core idea is that these regions are dominated by small and medium size enterprises, have a low level of research of development and innovation, and lack the critical mass necessary for triggering agglomeration economies. In theoretical term, these regions are referred to as thin regions (Isaksen 2014; Tödtling & Trippl 2005).

There have been recent calls for more innovation studies in these types of regions (Isaksen & Karlsen 2013; Isaksen & Sæther 2015). This paper argues that an inventory of the current state of the research on innovation in non-metropolitan regions might provide a solid foundation for future research in these regions.

Underpinned by the above argument, the purpose of this paper is to provide a comprehensive review of the literature on innovation in non-metropolitan regions published in scholarly journals between 1998 and 2016. As noted by Jungmann, Baur and Ametowobla (2015) innovation research is dominated by two distinct lines: systems of innovations and ethnographies of innovation. Studies on regional innovation fall under the regional systems of innovation approach pioneered by Cooke, Gomez Uranga and Etxebarria (1997). Therefore, the current review excludes all publications concerned with ethnographic approaches to innovation. The review highlights (a) the sources and nature of articles published on innovation in non-metropolitan regions; (b) their authorship characteristics; (c) the designs used; (d) the scope of this research; (e) the methodologies adopted and (f) the themes discussed in this literature.

The remainder of this paper is structured as follows: the next section presents the methodology used to undertake this review, followed by the presentation of findings, which precedes the discussion. The paper ends by concluding and presenting some avenues for future research.

2. RESEARCH METHOD

This paper adopts a systematic review approach. A systematic review is appropriate for gathering evidence in the literature to answer specific questions (Boell & Cecez-Kecmanovic 2015), as it is the case in this paper. Compared to other types of reviews (for example: thematic or historical reviews), it offers a rigorous, transparent, replicable and scientific process (Becheikh, Landry & Amara 2006; Okoli & Schabram 2010).

The current review spans across a sixteen year period between 1998 and 2016. The choice of 1998 as the lower limit follows the argument by Doloreux and Porto Gomez (2017). The year 1998 was marked by a major publication by Braczyk, Cooke and Heidenreich (1998) titled *"Regional innovation systems: The role of governance in a globalised word"* – clarifying and exemplifying the concept of regional innovation systems (RISs). Since this publication, the number of publication on regional innovation have increased significantly (Doloreux & Porto Gomez 2017).

According to Doloreux and Porto Gomez (2017), establishing the inclusion criteria, identifying and selecting the potential articles and, classifying them is essential when undertaking a systematic review. Four criteria were developed for inclusion in the study. First, the term region in each article must refer to a sub-national division of a country. Second, at least a non-metropolitan region must be analysed in the study. Third, the article had to be published in a peer reviewed journal between 1988 and 2016. Fourth, one of the following terms: "innovation", "non-metropolitan regions", "non-metropolitan areas", "peripheral regions",

"peripheral areas", "small regions", "lees-favoured region", "regional areas" or "thin regions" has to be found in the title, abstract, or keywords of each article.

With regard to the identification and selection of the articles, a three stage approach was used. First, keyword searches using the combination of the terms "Innovation" AND "non-metropolitan regions", "innovation" AND "non-metropolitan areas", "innovation" AND "peripheral regions", "innovation" AND "peripheral areas" and "innovation" AND "small regions" were used. Each of these combinations were used in the search engines Scopus, Web of Science and ProQuest. The initial selection included articles published between 1988 and 2016 including one of the above words in its title, abstract or keywords. This initial step led to the identification of a total of 331 articles (Table 1). After correcting for duplicated articles and reading the all the remaining abstracts, a total of 85 articles was deemed relevant. When the abstracts were not clear enough for a decision to be made, full articles were read.

Table 1: Initial Number of Articles Identified

Keywords	**Search engines and number of hits**		
	Scopus	**Web of Science**	**ProQuest**
"innovation" AND "non- metropolitan regions"	7	2	1
"innovation" AND 'non-metropolitan areas"	3	2	3
"innovation" AND "peripheral regions"	101	62	6
"Innovation" AND "peripheral areas"	30	23	7
"innovation" AND "small regions"	14	5	3
"innovation" AND " less- favoured regions"	17	8	3
"innovation" AND "regional areas"	20	8	2
"Innovation'' AND "thin regions"	2	2	0

Source: Author.

With regard to the classification of articles, the coding framework for 'undertaking a systematic and replicable investigation of text and documents with the objective of quantifying content using pre-set categories' proposed by (Leonidou et al. 2010) and Gomes, Barnes and Mahmood (2016, p. 17) was used. Each article was analysed using content analysis, a reliable method for systematically classifying and comparing data (Krippendorff 2004). In accordance with Doloreux and Porto Gomez (2017), Gomes, Barnes and Mahmood (2016) and Leonidou et al. (2010), the analysis of each article covered six dimensions as follows:

1. Source and nature of articles (i.e. journal name and publication year);
2. Characteristics of authors (i.e. number of authors, number of countries, location of country, number of institutions, number of disciplines);
3. Research design (i.e. problem crystallization, variable association, research environment, communication mode, topical scope, and time dimension);

4. Scope of research (i.e. type of study, countries involved, reference region, nature of country, product focus, and unit of analysis)
5. Research methodology (i.e. sampling design, conceptual framework used, data collection, sample size, response rate, data analysis technique) and;
6. Thematic areas (i.e. institutional actors, firms, region).

The 85 articles were divided into three categories in order to appraise the evolution of publications in the last sixteen years: 1998-2005 (early interest on the topic), 2006-2010 (moderate interest in the topic) and 2011-2016 (increased awareness for the need for more research on the topic).

3. STUDY FINDINGS

3.1 Sources and Nature of Articles

The 85 articles published are dispersed across 44 different journals. The rate of publication ranged from 2 article per year (1998-2005) to an average of 4 per year (2006-2010) and 11 per year (2011-2016). As per Table 2, *European Planning Studies* is the main source of publications on the topic of innovation in non-metropolitan regions, accounting for 23.5% of the articles published. It is followed *by Norsk Geografisk Tidsskrift (9.4%), Entrepreneurship & Regional Development* (5.6%), *Regional Studies* and *Research Policy* (4.7% respectively). *European Urban and Regional Studies* and *Journal of the Knowledge Economy* each contributed 3.5%. These seven journals account for more than half the articles published on innovation in non-metropolitan regions, the remaining thirty-seven journals contributing 44.7%. Innovation research in non-metropolitan regions is essentially empirical.

Table 2: Journals Publishing Articles on Innovation in Non-metropolitan Regions*

	Total	Time period			Article type	
		1998-2005	2006-2010	2011-2016	Theoretical	Empirical
Journals	(n=85) %	(n=14) %	(n=17) %	(n=54) %	(n=2) %	(n=83) %
Entrepreneurship & Regional Development	(5) 5.6	0 0.0	(1) 5.9	(4) 7.4	0 0.0	(5) 6.0
European Planning Studies	(20) 23.5	(5) 35.7	(6) 35.3	(9) 16.7	(1) 50.0	(19) 22.9
European Urban and Regional Studies	(3) 3.5	0 0.0	(1) 5.9	(2) 3.7	0 0.0	(3) 3.6
Journal of the knowledge Economy	(3) 3.5	0 0.0	0 0.0	(3) 17.6	0 0.0	(3) 3.6
Norsk Geografisk Tidsskrift	(8) 9.4	0 0.0	0 0.0	(8) 14.8	0 0.0	(8) 9.6
Regional Studies	(4) 4.7	0 0.0	0 0.0	(4) 7.4	0 0.0	(4) 4.8
Research Policy	(4) 4.7	(1) 7.1	(2) 11.8	(1) 1.9	(1) 50.0	(3) 3.6

***** Only journals having three or more publications are included in this table. There are 37 journals that published less than three articles related to innovation in non-metropolitan regions. Thus, the sum of the percentage column is not 100%.

Table 3: Key Researchers Publishing on the Topic of Innovation in Non-metropolitan Regions

Authorship characteristics	Total (n=85) %	Time period			Trend direction[1]
		1998-2005 (n=14) %	2006-2010 (n=17) %	2011-2016 (n=54) %	
Number of authors					
One	(20) 23.5	(4) 28.6	(6) 35.3	(9) 16.7	Λ
Two	(35) 41.1	(10) 71.4	(6) 35.3	(23) 42.6	V
Three or more	(30) 35.3	(3) 21.4	(5) 29.4	(22) 40.7	↑
Number of countries					
One	(68) 80.0	(7) 50.0	(15) 88.2	(46) 85.2	Λ
Two	(11) 12.9	(4) 28.6	0.0	(7) 13.0	V
Three or more	(4) 4.7	(1) 7.1	(2) 11.8	(1) 1.8	Λ
Not mentioned	(2) 2.4	(2) 14.3	0.0	0.0	↘
Location of countries					
North America	(8) 9.1	(1) 7.1	(2) 11.8	(5) 9.3	Λ
Europe	(69) 81.2	(13) 92.9	(13) 82.4	(43) 79.6	↓
Asia	(4) 4.7	0.0	(1) 5.9	(3) 5.6	Λ
South America	(2) 2.6	0.0	0.0	(2) 3.7	↗
Others	(2) 2.6	0.0	(1) 5.9	(1) 1.8	Λ
Number of institutions					
One	(31) 36.5	(8) 57.1	(9) 52.9	(14) 26.0	↓
Two	(34) 40.0	(6) 42.9	(7) 41.2	(21) 36.8	↓
Three or more	(20) 23.5	0.0	(1) 5.9	(19) 35.2	↑
Academic disciplines					
Business/Management	(28) 32.9	(2) 14.3	(4) 23.5	(22) 40.7	↑
Economics	(13) 15.3	(2) 14.3	(2) 11.8	(9) 16.7	V
Geography	(13) 15.3	0.0	(2) 11.8	(11) 20.4	↑
Innovation	(11) 12.9	(1) 7.1	(3) 17.6	(7) 13.0	Λ
Regional Science	(17) 20.0	(7) 50.0	(3) 17.6	(7) 13.0	↓
Not mentioned	(6) 7.0	(2) 14.2	(1) 5.9	(3) 5.6	↓
Others	(26) 30.6	(4) 28.6	(7) 41.2	(15) 27.7	Λ

[1] (↑) Increasing; (↓) decreasing; (↗) Constant and then increasing; (Λ) Increasing and then decreasing; (V) Decreasing and then increasing. Note that the sum percentage for location of countries is not equal to 100 because of cross country studies, similar for academic disciplines.

3.2 Authorship Characteristics

Collaboration between authors is a key characteristic of innovation research in non-metropolitan regions, probably due to the fact that it lies at the intersection of two disciplines: Regional Science and Innovation Research. Consequently, the least number of articles were single-authored, representing 23.5% of published articles, while 35.3% were written by three or more authors (Table 3). Single authorship slightly increased from 2006-2010 but has declined since then. Articles authored by three or more have increased overtime. Most of the articles (41.1%) were double-authored and this type decreased by half in the 2006-2010 period before increasing anew in the next. Regarding the number of countries covered, 80% were single country studies with this trend on the rise. The remaining studies dealt with two (12.9%) and three or more (4.7%) countries respectively. Europe is the main location of scholars publishing research on innovation in non-metropolitan regions with above 80% of total contribution, though this dominance has slightly declined over the year. North American

authors accounted for 9.1% of articles with the remainder shared by other continents. Authors from different institutions produced most of this literature, with 40.0% involving two institutions while 23.5% involved three or more institutions.

Authors publishing articles on innovation in non-metropolitan regions come from a variety of backgrounds. Above thirty percent (32.9%) of authors were located in business/management faculties, with this trend increasing over time. A good number of authors are spread across other faculties (30.6%), including just to mention few: sociology; technology or social studies. Regional scientists wrote 20% of the papers; geographers, 15.3%; economists, 15.3% and innovation scholars, 12.9%. While the number of business/management scholars and geographers have increased over time that of regional scientists have decreased on the contrary. There have been some fluctuations in the number of economists and innovation scholars.

3.3 Research Design

The research design of the 83 empirical published articles on innovation in non-metropolitan region are shown in Table 3. Most articles (66.2%) were exploratory in nature - had no predetermined hypotheses. Formalised studies – those with a well-defined structure in place and predetermined hypotheses- accounted for 33.7% and increased in the last period, following a sharp decline from 2006 to 2010. Over time, both formalised and exploratory studies oscillated in terms of their regularity. Exploratory studies increased in the 2006-2010 period before declining in the following period. Formalised studies on the contrary first declined sharply in the 2006-2010 period before a hike in the next.

With respect to the research environment, half (50.6%) of the articles collected data through fieldwork. Those that did not require fieldwork – laboratory – accounted for 39.8%. Others include studies combining both field research and laboratory work. The research environment has fluctuated over the year by either decreasing and then increasing (field) or increasing and then decreasing (laboratory and others).

In terms of topical scope, case studies feature in about 75% of studies while statistical studies make up 18%. There was a remarkable decline in the number of statistical and others studies in the 2006-2010 period but a hike in the number of case studies in the same period (93.3%). Regarding the time dimension, 54.2% of studies deal with cross-sectional data while 31.8% analyse longitudinal data. Cross-sectional studies have steadily increased over time while longitudinal studies fluctuated slightly on the contrary.

In terms of communication mode, most articles (65%) were observational – analyse the behaviour of the sample – whereas survey studies (21.7%) are those generally dealing with large data. Survey studies declined significantly in the 2006-2011 period before picking up again. Observation studies have somewhat been steady, though with a slight increase in the 2006-2010 period.

Regarding variable association, the majority of articles are descriptive, account for 67.5% of studies, and more than doubled in the second period before a slight decline in the next one. Causal studies – explaining relationships between variables – decreased by more than half in the 2006-2010 period before a small increase in the subsequent one.

3.4 Scope of the Research

Table 5 presents the scope of the empirical articles on innovation in non-metropolitan regions. Though most studies (43.4%) analyse three or more regions, this trend is on the decline. This decline can be explained by the increasing number of studies dealing with two or one region. There was a rise in single region studies and the period 2006-2010 and in two regions studies in the period 2011-2016.

Table 4: Resign Design of Innovation in Non-metropolitan Regions Literature

Research design		Time period			Trend direction[1]
	Total (n=83)	1998-2005 (n= 12) %	2006-2010) (n= 17) %	2011-2016 (n=54) %	
Problem crystallisation					
Exploratory	(55) 66.2	(8) 66.7	(16) 94.1	(31) 57.4	Λ
Formalised	(28) 33.7	(4) 33.3	(1) 5.9	(23) 42.6	V
Research environment					
Field	(42) 50.6	(6) 50.0	(6) 35.3	(30) 55.6	Λ
Laboratory	(33) 39.8	(6) 50.0	(7) 8.4	(20) 37.0	V
Others	(8) 9.6	0.0	(4) 23.5	(4) 7.4	Λ
Topical scope					
Statistical study	(15) 18.0	(4) 33.3	(2) 11.8	(9) 16.7	V
Case study	(62) 74.7	(6) 50.0	(15) 88.2	(41) 75.9	Λ
Others	(6) 7.2	(2) 16.7	0.0	(4) 7.4	V
Time dimension					
Cross-sectional	(45) 54.2	(4) 33.3	(8) 47.0	(33) 61.1	↑
Longitudinal	(29) 34.9	(7) 58.3	(5) 29.4	(17) 31.5	V
Others	(9) 10.8	(1) 8.4	(4) 23.5	(4) 7.4	
Communication mode					
Survey	(18) 21.7	(4) 33.3	(1) 5.9	(13) 24.0	V
Observational	(54) 65.0	(7) 58.3	(12) 70.6	(35) 64.8	Λ
Others	(11) 13.3	(1) 8.4	(4) 23.5	(6) 11.1	Λ
Variable association					
Descriptive	(56) 67.5	(7) 33.3	(13) 76.5	(36) 66.7	Λ
Causal	(24) 28.9	(4) 58.3	(3) 17.4	(17) 31.5	V
Others	(3) 3.6	(1) 8.4	(1) 5.9	(1) 1.8	↓

[1] (↑) Increasing; (↓) Decreasing; (Λ) Increasing and then decreasing; (V) Decreasing and then increasing.

Table 5: Scope of the Non-metropolitan Innovation Research

Scope of research	Total (n=83) %	Time Period			Trend direction[1]
		1998-2005 (n=12) %	2006-2010 (n=17) %	2011-2016 (n=54) %	
Number of regions analysed					
1	(28) 33.7	0.0	(8) 47.0	(20) 37.0	Λ
2	(16) 19.3	(2) 16.7	(1) 5.9	(13) 24.0	V
3 or more	(36) 43.4	(9) 75.0	(8) 47.0	(19) 35.2	↓
No region specified	(3) 3.6	(1) 8.3	0.0	(2) 3.7	V
Location of the region					
Europe	(66) 79.5	(10) 83.3	(13) 76.5	(43) 79.6	V
North America	(4) 4.8	(1) 8.3	(1) 5.9	(2) 3.7	↓
South America	(1) 1.2	0.0	0.0	(1) 1.8	↗
Asia	(4) 4.8	0.0	(1) 5.9	(3) 5.6	Λ
North America & Europe	(4) 4.8	(1) 8.3	(1) 5.9	(2) 3.7	↓
North & South America	(1) 1.2	0.0	0.0	(1) 1.8	↗
Others	(3) 3.6	0.0	(1) 5.9	(2) 3.7	Λ
Nature of the region					
Developed	(73) 88.0	(12) 100.0	(16) 94.1	(45) 83.3	↓
Developing	(10) 12.0	0.0	(1) 5.9	(9)16.7	↑
Types of regions					
Purely non-metropolitan	(75) 90.4	(10) 83.3	(16) 94.1	(49) 90.7	Λ
Non-metropolitan and others	(8) 9.6	(2) 16.7	(1) 5.9	(5) 9.25	V
Types of studies					
Single country	(70) 84.3	(8) 66.7	(15) 88.2	(47) 87.0	Λ
Cross country studies	(13) 15.7	(4) 33.3	(2) 11.8	(7) 13.0	V
Country of the region					
Norway	(15) 18.0	-	(1) 5.9	(14) 25.9	↑
Spain	(9) 10.8	(2) 16.7	(4) 23.5	(3) 5.6	Λ
Finland	(9) 10.8	-	(3) 17.6	(6) 11.1	Λ
Sweden	(9) 10.8	(2) 16.7	(1) 5.9	(6) 11.1	V
Canada	(8) 9.6	(1) 8.3	(2) 11.8	(5) 9.25	Λ
England	(4) 4.8	(1) 8.3	(2) 11.8	(1) 1.8	Λ
Portugal	(3) 3.6	-	(3) 17.6	-	Λ
Republic of Ireland	(3) 3.6	(1) 8.3	-	(2) 3.7	V
France	(3) 3.6	-	(2) 11.8	(1) 1.8	Λ
Poland	(3) 3.6	-	(1) 5.9	(2) 3.7	Λ
Scotland	(3) 3.6	(1) 8.3	-	(2) 3.7	V
Greece	(3) 3.6	(3) 25.0	-	-	↘
China	(3) 3.6	-	(1) 5.9	(2) 3.7	Λ
Germany	(3) 3.6	(1) 8.3	-	(2) 3.7	V
Northern Ireland	(2) 2.4	-	-	(2) 3.7	↗
Switzerland	(2) 2.4	-	-	(2) 3.7	↗
Austria	(2) 2.4	-	-	(2) 3.7	↗
Belgium	(2) 2.4	-	(2) 11.8	-	Λ
Israel	(2) 2.4	(2) 16.7	-	-	↘
Australia	(2) 2.4	-	(1) 5.9	(1) 1.8	Λ
Czech Republic	(2) 2.4	-	-	(2) 3.7	↗

[1] (↑) Increasing; (↓) Increasing; (↗) Constant and then increasing; (↘) Constant and then decreasing; (Λ) Increasing and then decreasing; (V) Decreasing and then increasing.

As per the location of regions, the European continent stands far above others as four fifths of the articles are concerned with European regions with three European Nordic countries (Norway, Finland and Sweden) contributing about half of this percentage. Norway in particular is the country where most of the research on innovation in non-metropolitan regions has occurred. North America is far behind Europe, accounting for 4.8% of region analysed, with the number of studies focusing on North American regions decreasing over time. North America is represented by Canada, which accounts for 9.6% of articles, with slight fluctuations over the years.

Almost all the regions (88%) analysed are within developed countries, though this is a decreasing trend. Scholars are increasingly interested in non-metropolitan regions of developing countries which now account for 12%. While non-metropolitan regions are the major focus of studies (90.4%), they are in some instances analysed with other types of regions.

Studies analysing regions in a single country account for 84.3% of the articles while those dealing with regional comparison across countries accounted for 15.7%. Both studies analysing regions in a single country and those comparing regions in two or more countries have fluctuated over time.

Table 6: Study Methodology of Innovation in Non-metropolitan Regions Articles

Study methodology	Total (n=83) %	Time period			Trend direction[1]
		1998-2005 (n=12) %	2006-2010 (n=17) %	2011-2016 (n=54) %	
Sampling design					
Probability	(4) 4.8	0.0	(1) 5.9	(3) 5.6	↓
Non-probability	(67) 80.7	(8) 66.7	(13) 76.5	(46) 85.1	↑
Not available	(12) 14.5	(4) 33.3	(3) 17.6	(5) 9.3	↓
Data collection					
Secondary information	(21) 25.3	(4) 33.3	(7) 41.2	(10) 18.5	Λ
Existing database	(17) 20.5	(4) 33.3	(2) 11.8	(11) 30.4	V
Mail/email survey	(7) 8.4	(3) 25.0	(1) 5.9	(3) 5.6	↓
Face to face survey	(1) 1.2	0.0	0.0	(1) 1.8	↗
Telephone survey	(2) 2.4	0.0	0.0	(2) 3.7	↗
Personal interviews	(17) 20.5	0.0	(2) 11.8	(15) 27.8	↑
Others	(18) 21.7	(1) 8.3	(5) 29.4	(12) 22.2	Λ
Data analysis					
Qualitative	(52) 62.6	(7) 58.3	(13) 76.5	(32) 59.3	Λ
Quantitative	(16) 19.3	(2) 16.7	(3) 17.6	(11) 20.4	↑
Modelling (formula)	(11) 13.3	(3) 25.0	(1) 5.9	(7) 13.0	V
Other	(4) 4.8	0.0	0.0	(4) 7.4	↗
Analytical technique					
Descriptive	(37)	(7) 58.3	(8) 47.0	(22) 40.7	↓
Uni-Bivariate	(1)	0.0	(1) 5.9	0.0	Λ
Multivariate	(25)	(5) 41.7	(3) 17.6	(17) 31.5	V
Others	(20)	0.0	(5) 29.4	(15) 27.8	Λ

[1] (↑) Increasing; (↗) Constant and then increasing; (Λ) Increasing and then decreasing; (V) Decreasing and then increasing.

3.5 Research Methodology

Regarding the methods of investigation of the empirical studies, Table 6 depicts the sampling design, the approach to data collection, the type of data analysis and the analytical technique. In terms of sampling design, non-probability sampling is on the increase and is the main design

employed (80.7%). Less than five percent of articles use probabilistic sampling with the remaining (14.5%) failing to mention the sampling approach.

Pertaining to data collection, the use of secondary data (25.3%) is the dominant approach found in most articles with some fluctuations over time. A significant number of articles (21.7%) use multiple methods to collect data. The use of personal interviews increased over time and they are present in 20.5% of articles. Articles using existing databases also represented 20.5% of the sample but with some variations over time. On the other hand, using mail surveys declined and their representation stands at 8.4%.

More than half of the articles (58.3%) qualitatively analysed data. The percentage of articles using qualitative analysis increased in the period 2006-2010 before reducing in the 2011-2016 period. Articles adopting quantitative analysis (16.7%) are on the increase while those using formula modelling (25%) increased in the 2011-2016 period, following a sharp decline in the 2006-2010 period. Other articles (6%) used mixed methods, especially featuring in the last period.

With regard to the analytical technique, though over half of the studies were descriptive (58.3%), this trend has decreased over time. The use of multivariate analyses (41.7%) decreased by more than half in the 2006-2010 period before almost doubling in the 2011-2016 period.

3.6 Structure of the Research on Innovation in Non-metropolitan Regions

As per the content dimension, the articles on innovation in non-metropolitan regions were characterised into four broad areas: research topic of interest; the vehicles for innovation analysed; the types of factors influencing the innovation process and the main stakeholders analysed (Table 7).

With regards to research topics, a substantial number of articles (77.1%) deal with factors promoting or hindering innovation either at the firm or the regional level in non-metropolitan regions. The number of these articles slightly oscillated over time but remains high. Publications focusing on conceptual approaches to innovation in non-metropolitan regions account for 14.5% with this topic gaining interest in the 2011-2016 period.

As per the vehicles for innovation, most articles (37.3%) examine the role played by industries in innovation promotion in non-metropolitan regions, a trend is on the rise. One fifth of the articles look at the role played by institutional actors while 10.4% of them focus on knowledge organisations. Some articles consider both industries and institutional actors (15.7%) while others combine a focus on business organisations and industries (8.4%). A smaller number of studies (8.7%) consider triple helix actors (University-industry-institutional actors).

In terms of innovation process, though on decline, the majority of articles (63.8%) consider both internal and external factors related to innovation in non-metropolitan regions. Some articles however either on internal (13.3%) and external (22.9%) factors.

In relation to stakeholders, 42.2% of studies focus on the region, 34.9% combine a firm and regional focus while 22.9% look at the firm. Some fluctuations are observed in all categories and the last period has witnesses an increase focus on both firm and region.

4. DISCUSSION

With recent calls for more innovation research in non-metropolitan regions, the current state of knowledge on the topic is needed for advancing innovation research in these types of regions. Following this review, it is evident that research on innovation in non-metropolitan regions has received little attention in the literature, with just 85 articles published in eighteen years (1998-2016). Though scattered in various journals, two of them – *European Planning Studies* and

Norsk Geografisk Tidsskrift – published about 34.5% of the innovation in non-metropolitan regions research. Very few articles were published in highly ranked journals such as *Regional Studies*, *Research Policy*, *Urban Studies* and *Journal of Economic Geography*. Similarly, this topic is only sporadically discussed in the top ten regional science journals, as classified by Rickman and Winters (2016). The three journals included in this category: *Annals of Regional Science*; *Papers in Regional Science* and *Regional Studies* contributed six articles representing less than ten percent of the publications dealing with this topic. This might be justified by the decrease observed in the number of regional scientists publishing this research over time. The fields interested in this topic in recent years are Business/Management, Geography and to some extent Economics. While contributions from the first two fields continue to increase, a minor drop was observed in articles written by economist in the 2006-2010 period.

Table 7: Structure of the Research on Innovation in Non-metropolitan Regions

Thematic areas	Total (n=83) %	Time period			Trend direction[1]
		1998-2005 (n=12) %	2006-2010 (n=17) %	2011-2016 (n=54) %	
Research topics					
Innovation drivers or inhibitors in non-metropolitan regions.	(64) 77.1	(10) 83.3	(16) 94.1	(38) 70.4	Λ
Analytical frameworks for analysing and promoting innovation in non-metropolitan regions	(12) 14.5	0.0	0.0	(12) 22.2	↗
Others	(7) 8.4	(2) 16.7	1 (5.9)	(4) 7.4	↓
Vehicles for innovation					
Knowledge organisations	(9) 10.4	0.0	(3) 17.6	(6) 11.1	Λ
Industries	(31) 37.3	(2) 16.7	(6) 35.9	(23) 42.6	↑
Institutional actors	(16) 19.7	(4) 33.3	(3) 17.6	(9) 16.6	↓
Industries and knowledge organisation	(7) 8.4	(2) 16.7	(1) 5.9	(4) 7.4	↓
Industry and institutional actors	(13) 15.7	(2) 16.7	(2) 11.8	(9)16.7	V
Triple helix actors	(7) 8.4	(2) 16.7	(2) 11.8	(3) 5.6	↓
Innovation Process (influenced by)					
Internal practices	(11) 13.3	0.0	(4) 23.5	(7) 13.0	Λ
External sources	(19) 22.9	(1) 8.3	(1) 5.9	(17) 31.5	V
Both internal and external factors	(53) 63.8	(11) 91.7	(12) 70.6	(30) 55.6	↓
Stakeholders					
Firms	(19) 22.9	(4) 33.3	(6) 35.3	(9) 16.6	Λ
Region	(35) 42.2	(5) 41.7	(9) 52.9	(21) 38.9	Λ
Firm and region	(29) 34.9	(3) 25.0	(2) 11.7	(24) 44.4	V

[1] (↑) Increasing; (↗) Constant and then increasing; (Λ) Increasing and then decreasing; (V) Decreasing and then increasing.

The research designs reported in articles on innovation in non-metropolitan regions have been systematic in the last five years (2011-2016), as reflected in the increase use of formalised hypotheses and interest in causal relationship among variables. This research, however, continues to be dominated by cross-sectional designs and case studies. Though the time and resources needed for longitudinal studies might act as limiting factors, case studies with longitudinal designs might help identify variations over time and design appropriate policies. The large number of case studies and the preference for field research is an indication that scholars interested in the topic are more interested in gaining in-depth knowledge than pragmatic knowledge on innovation in non-metropolitan regions. Research on innovation in non-metropolitan regions will greatly benefit from both in-depth and pragmatic knowledge.

Research on innovation in non-metropolitan regions is concentrated in Europe and dominated by single-country studies often analysing three or more regions. This single country focus limits the transferability of their outcome to other countries' regions. Cross country studies might contribute towards the development of specific theoretical frameworks for analysing and promoting innovation in non-metropolitan regions. This is especially important as a grand theory for innovation in non-metropolitan regions is still missing. More theoretical studies might advance the theoretical debate and equally lead to such an outcome.

Methodology wise, non-probability sampling is the prevailing trend in the literature on innovation in non-metropolitan regions. This is likely due to the small size of firms in non-metropolitan regions, limiting the use of probability sampling. The rise of personal interviews might be attributed to the desire for in-depth knowledge, a key characteristic of case studies. The use of sophisticated analytical techniques (multivariate analysis) and modelling in these studies is limited due to sample size constraints. Not surprisingly, therefore, data are qualitatively analysed and descriptive. The other main methods of data collection are the use of secondary information and that of existing databases, which have both had fluctuations over the years.

Whether in relation to firms or the region, the literature on innovation in non-metropolitan regions is mainly concerned with how to alleviate the barriers to innovation in these regions at the firm and at the regional level. There is an increased awareness that frameworks specific for analysing and promoting innovation in such regions are needed. Most studies on this topic still utilise frameworks primarily modelled on large regions, often without questioning their underlying assumptions (Isaksen & Sæther 2015). Though scholars concur that innovation promotion in such regions entails a combined focus on internal and external factors, this is trend has decreased over time, due to studies concerned either with internal or external factors gaining more popularity. Industries are and continue be analysed as main vehicles for innovation in the articles analysed. Emphasis on institutional actors as drivers of innovation in non-metropolitan regions has waned overtime, though some influential contributions have been made regarding the role played by institutions (see for example: Pike, Rodríguez-Pose & Tomaney 2016; Rodríguez-Pose 2013). While some interest has also been shown in the role played by knowledge organisations in the last two periods, not the same can be said of triple helix actors. Studies with a more holistic approach to innovation in non-metropolitan regions might provide a better picture of the bottlenecks at all levels. The quadruple helix approach might serve as a key framework for such studies. Not surprisingly, emphasis is often on the region, with recent trends showing a combined focus on the firm and the region. The low attention paid to firms in the 2011-2016 period is rather alarming, especially given their central role in driving innovation in these types of regions (Isaksen & Karlsen 2013). Concepts such as absorptive capacity (Cohen & Levinthal 1990; Zahra & George 2002) and innovation capability (Lawson & Samson 2001) might serve as key lenses for looking inside the firms located in non-metropolitan

regions. Looking inside firms located in such regions and strengthening their internal capability might render strategies aimed at enhancing access to external knowledge more fruitful.

5. CONCLUSION

This review was concerned with the literature on innovation in non-metropolitan regions over a 16 years period based on six dimensions. It has not only revealed some key facts regarding each of the dimension analysed but also some interesting gaps to be examined by future research. The first gap pertains to the need for conceptual approaches tailored to non-metropolitan regions innovation research. Current studies on innovation in non-metropolitan regions borrow concepts 'here' and 'there', often applying them without scrutiny. Though not an easy task, given differences observed in region classification across country, such a theory might eventually be developed either by testing and refining some existing models more adapted to other types of regions. More theoretical debate might also produce the same outcome. The second gap relates to the failure of this literature to incorporate recent advances in innovation research. In particular, concepts such as knowledge bases and open innovation apply to all types of regions but have seldom been utilised as framework for studying innovation in non-metropolitan regions. The knowledge base concept is best modelled in terms of occupation driving innovation at the firm level and might be key to identifying and then completing these occupations. Open innovation on the other hand might compensate for the lack of related variety at the non-metropolitan level. Lastly, this research will greatly benefit from a more holistic approach to innovation in these regions combining a focus on academia, industry, government and the community.

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The Impact of Location Factors on Housing Price Variation in Melbourne: A Case Study of Western Melbourne Metropolitan Region

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ABSTRACT

The spatial factors such as accessibility of community services such as schools, neighbourhood shopping centres, distance from regional shopping centres, CBD and tertiary education centres affect the housing price variation among different localities within a city. This paper examines the effects of locational factors that contribute to median house price rise in Western Melbourne Metropolitan (WMM) region in Victoria. Location factors and housing price data of each of the suburbs within WMM in 2001, 2006 and 2016 were collected from Corelogic and spatial data Victoria. This study found that rise of median house price varied among the suburbs and also was attributed to the availability, distance and distribution of location factors within WMM.

1. INTRODUCTION

Affordable housing is defined as an appropriate housing needs for low income households, so that they would be able to meet other basic needs such as food, clothing, transport, medical care and education (Akbar, Rolfe et al. 2011, ABS 2017). According to ABS (2017), housing is usually considered affordable if it costs less than 30 percent of gross household income.

Generally residential housing location is determined by several factors include housing cost, transportation cost and location attributes such as the distance to central business district (CBD), social services, and proximity to public transportation and employment centres. A house in a distant location from human and community services cause costs more to the household and also create a range of social disadvantages (Mulliner, Malys et al. 2016). Therfore, cheap housing does not mean housing is affordable (Burke and Hayward 2001).

Australian Metropolitan cities have experienced recent increases in housing prices and rents (Duffy, Kelleher et al. 2017). The median house price increased by 230 percent in Sydney and 214 percent in Melbourne between 1995 and 2003 (Rameli, Salleh et al. 2017). In 1990s, urban consolidation, inner city gentrification and local area development activities in Sydney, Melbourne and Brisbane have increased housing unaffordability to the low income groups. These groups have been changing their dwelling location to the outer suburbs, where there is lower value rental stocks available (Randolph and Tice 2013, Randolph 2017). So there are changes in affordable housing locations in Australian metropolitan cities.

Lovett, Haynes, Sunnenburg and Gale (2016) used spatial statistical analysis to find affordable housing locations by using household income and expenditure for dwelling purpose and its relationship of proximity to the CBD, transport and other service centres. Arafat (2011) did a similar study but added transport costs with rental or mortgage payments. He also built a model to preserve affordable housing location. However, an urban area preservation for affordable housing does not work because both urbanisation and its forces are dynamic in nature. An application of GIS with spatially integrated socio-economic, human services, transport and employment location variables of housing affordability can examine changes in affordable housing locations in Australian metropolitan cities. This paper exmines the changes in affordable housing location in Western Mebourne Metropolitan city through an application of GIS tools with location factors.

This introduction forms Section One of this paper followed by methods depicting spatial variation of affordable housing in Section Two. Section Three provides a brief description of the case study area and Section Four presents the findings of this research. Section Five concludes this paper.

2. METHODS DEPICTING SPATIAL VARIATION OF AFFORDABLE HOUSING

Affordable housing zones with some recently developed facilities are becoming unaffordable zones in many metropolitan cities (Yates, Milligan et al. 2007, Arafat 2011, Bailey 2016, Randolph 2017), entailing trade-offs between housing accessibility and the availability of local jobs and services (Martinez, Navarrete et al. 2004). This paper analysed the median house sale prices in terms of spatial and temporal variations from 2005 to 2016 in western Melbourne of Brimbyank, Maribyrnong and Wyndham city councils. This paper develops a GIS based approach to characterise the spatial accessibility to social services, public transport and employment centres, and its relationship with median housing prices in the suburbs of Western Melbourne Metropolitan City.

GIS based spatial housing analysis includes measuring spatial pattern of median house price over the suburb in Western Melbourne Metropolitan city over three census years as 2005, 2011 and 2016.

Here spatial variation refers to the relationship between the locations of the supply of and the locations of demand for specific services, taking into account existing transportation infrastructure and travel impedance. The spatial variation has been depended mainly on proximity to the bus stops, railway stations and proximity to the service centres (CBD, shopping malls, hospitals, banks etc.) and social cohesion (Arafat, 2011). Spatial variation is a critical consideration in the provision of both public and private services.

To analyse this study, median house price data of 2005 to 2015 were collected from ABS website, RP data base and Land Chanel Victoria. The maps were collected from ABS shapefiles. After collecting these data, data were geocoded in respect to Australian Standard Geographical Classification (ASGC) format. Median house price data were grouped in five different intervals as $250,000, $450,000, $650,000, $850,000 and 12,00,000 and above. Then the data were put in spatial analytical tool (in GIS) to format maps. The excel data sheet was added by using join and relates function in GIS in the map for these three LGAs. Map were graded in different colours to show the median house price for different sub urbs of Maribyrnong, Brimbank and Wyndham City Councils. The details of spatial data presented in the next section.

3. STUDY AREA

This study has chosen Maribyrnong, Brimbank and Wyndham City councils within the Melbourne West region to examine the relative changes in affordable housing location within the last three census period. Median House Price data for Maribyrnong, Brimbank and Wyndham City councils of Melbourne West were collected from CoreLogic RPDatabase, (Figure 1).

Figure 1: Study Area: Maribyrnong, Brimbank and Wyndham City Councils of Melbourne West

These three city councils were chosen because it is anticipated that they are most affordable in terms of median house price in Metropolitan Melbourne. There are 78 suburbs in these city councils, which include the suburbs that are attached or sharing with other city councils. Data were collected from Core logic median house sales price for 10 years and also from ABS census data, ABS ESRI shapefiles along with Victoria spatial database of 'Land Channel'. The different colour graphs for the suburbs show the available data that collected from RP database, Land Channel Victoria and ABS data. All data were geocoded as Australian Standard Geographical Classification (ASGC) and projected with GDA 94 MGA 55 coordinate of Victoria.

Figure 2 shows the median house price data and map of Maribyrnong, Brimbank and Wyndham City Councils from 2005 to 2015. The map also shows the median house price for other suburbs

in Melbourne Metropolitan. In this map the eastern suburbs are expensive then the western suburbs of Melbourne metro. The north eastern Melbourne shows expensive areas same as CBD.

Figure 2: Map of Median House Price from the Data in Appendix Table 1 in 2015

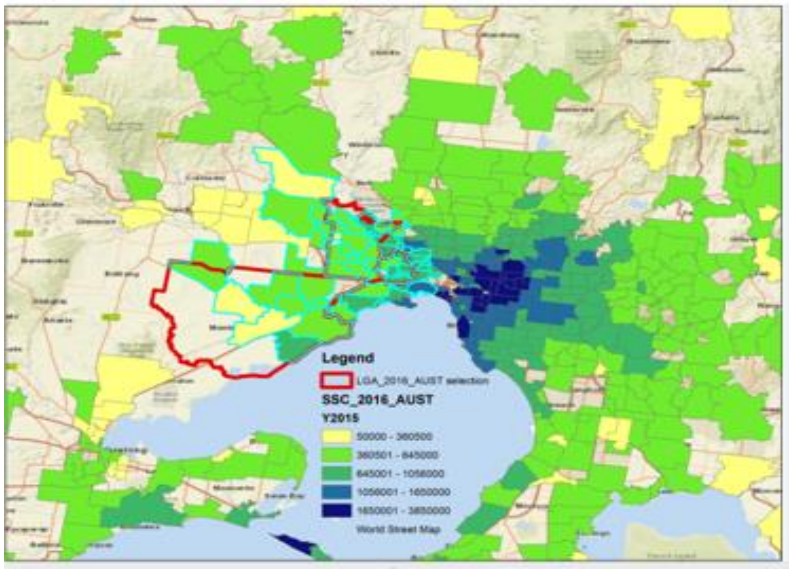
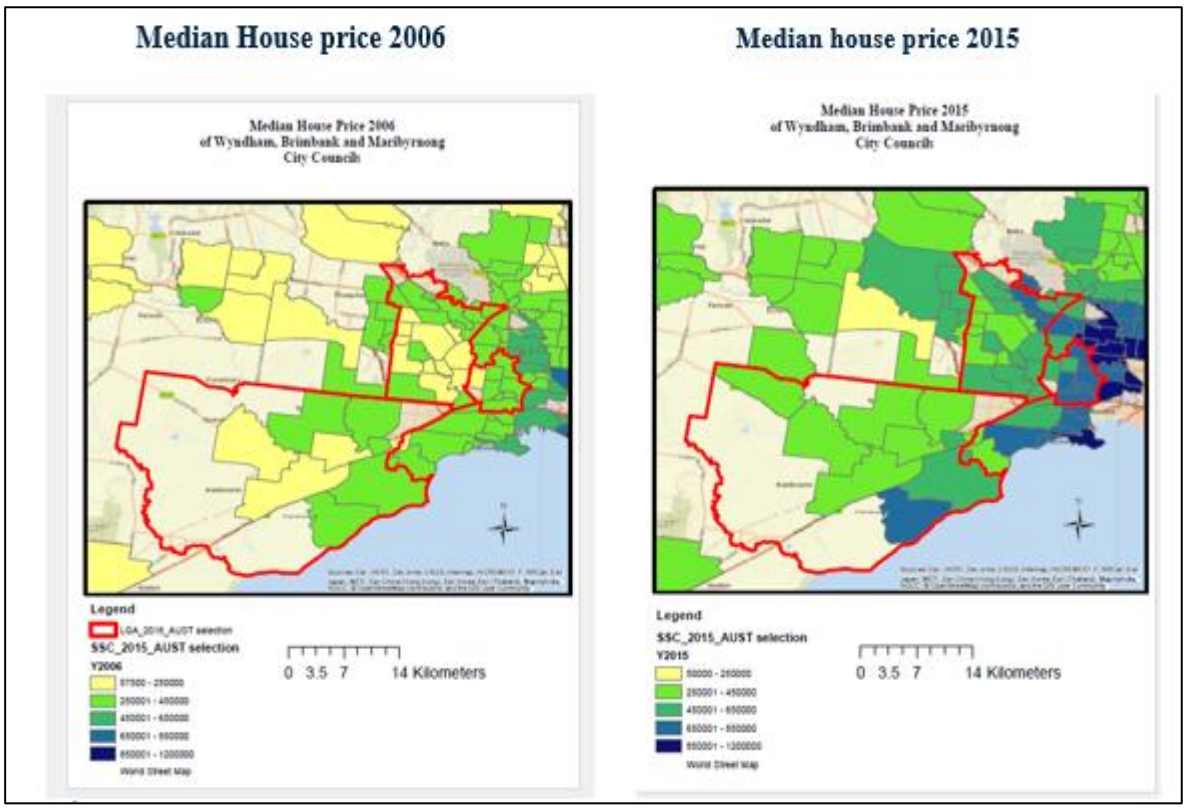


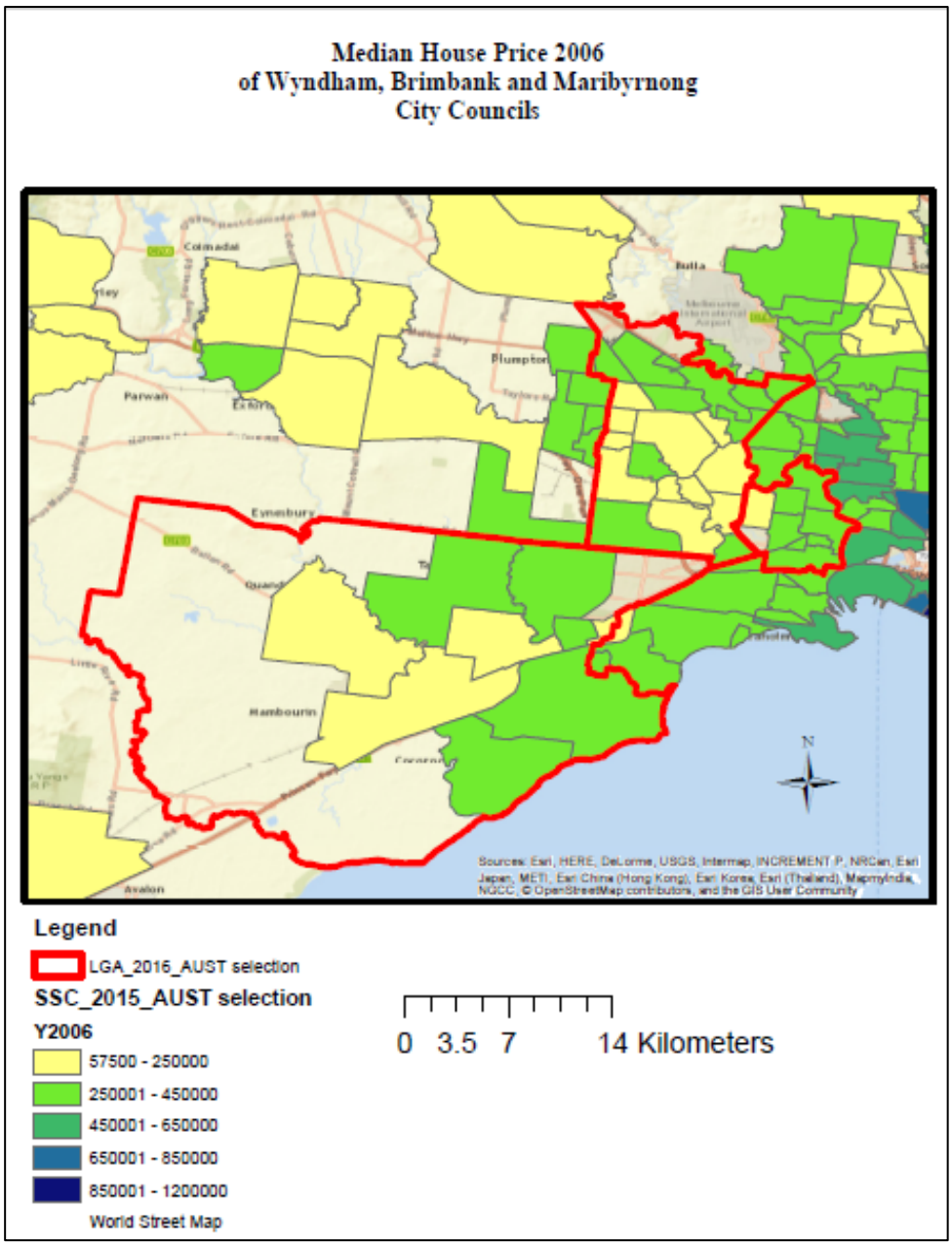
Figure 3: Variation of Median House Price in the Years 2006 and 2015



4. Spatial and Temporal Variations of Median House Sales Price

Using GIS tool, Figure 3 on the previous page shows the variations of median house sales price between 2006, 2011, and 2015. The three maps of the study areas show changes in median house price sales. However in 2016, house price increased at a higher rate that were very close to the Melbourne CBD. Over the last deacde, the median house prices was low in 2005 and its increase was modest till 2011. After 2011, the median house price started to increase in eastern suburbs (Figure 2) and was becoming expensive. People were moving from other part of Melbourne and looking for cheaper place to buy a house. As a result people are coming to western Melbourne metro to buy house and these areas (western suburbs of Melbourne) are becoming expensive in 2015.

Figure 4: Median House Price in 2006



5. SPATIAL VARIATIONS IN MEDIAN HOUSE PRICE

Figure 4 shows the spatial variations of median house sales among the suburbs. It indicates that the median house price were below $250,000 before 2006 in few suburbs of these city councils and median house price were below 450,000 dollars in all suburbs. Specially, the Wyndham' median house price in most suburbs was under $250,000 dollars. Even the close tothe Mebourne CBD, some suburbs in Maribyrnong had median houses price with $250,00 or below. The median house price starting to rise from 2006 and continue rise until now. Figure 5 found that the median house price had been increasing since 2011.

Figure 5: Median House Price 2011 in Brimbank, Maribyrnong and Wyndham City Councils

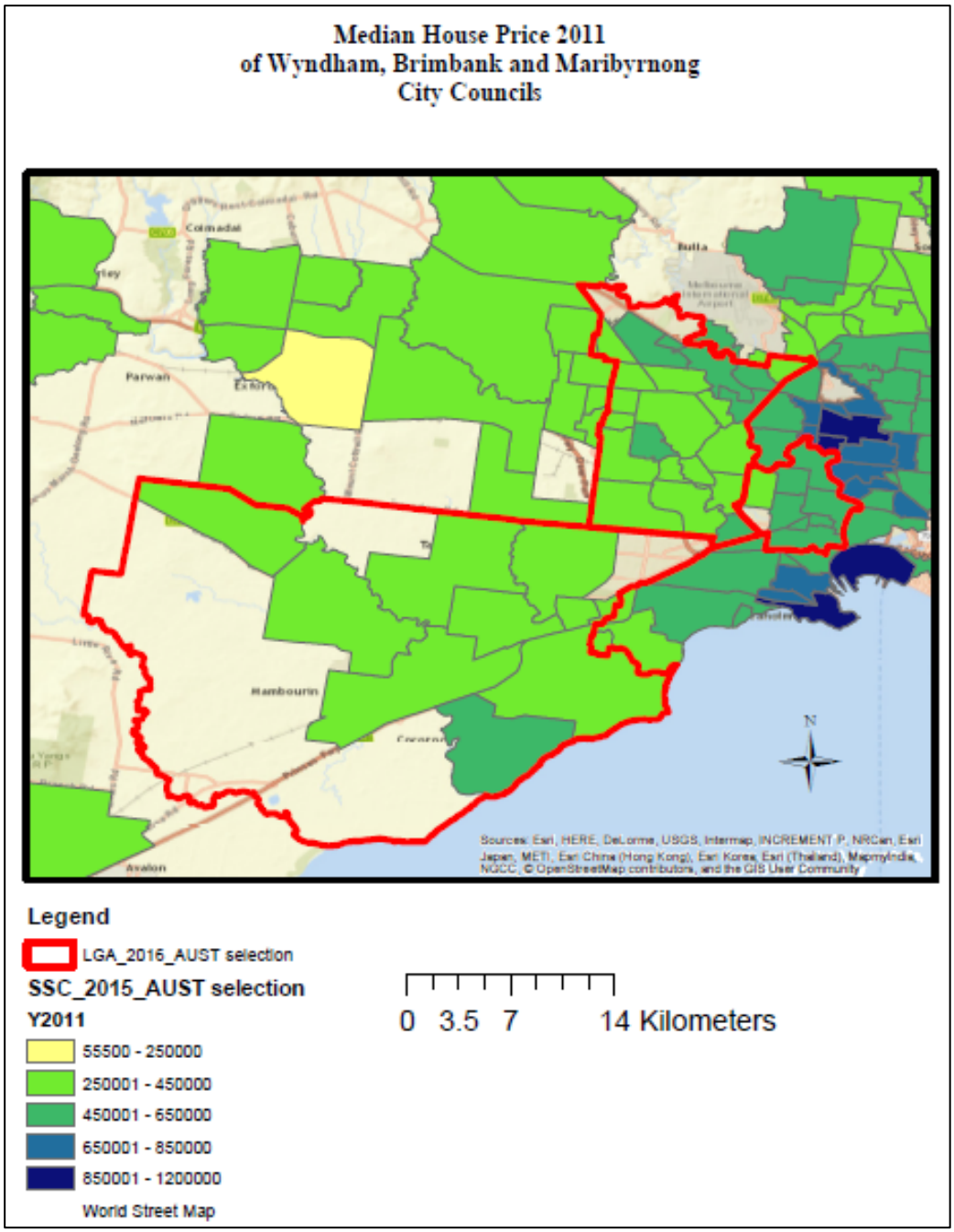
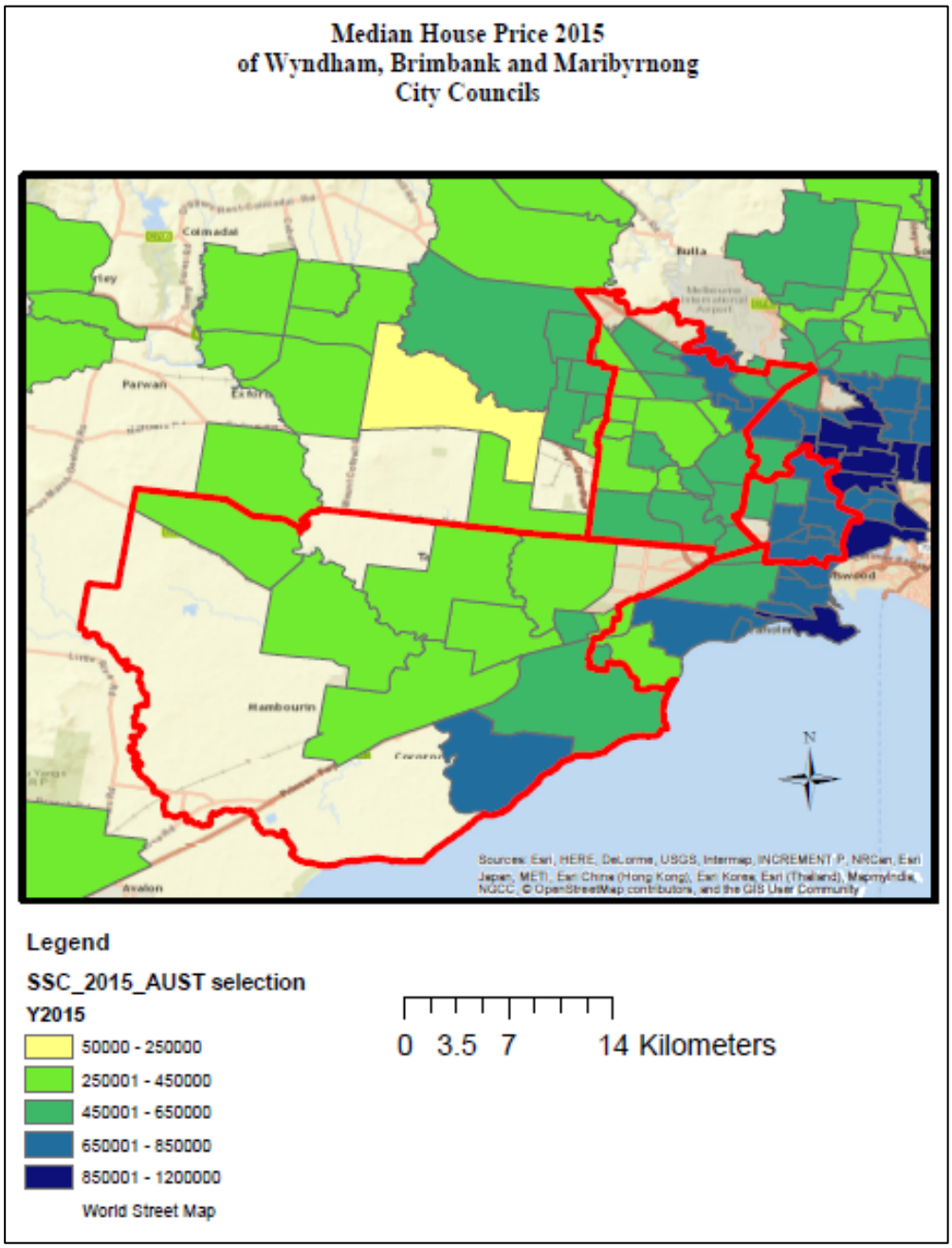


Figure 6: Median House Price in Brimbank, Maribyrnong and Wyndham City Councils in 2015 Census Year



It appears that there is suburbs with house price 450,000 dollars in all three LGAs, if the houses are close to the main road or train station the median house price is even higher. The median house prices also have increased in closer to the CBD (Melbourne).

Some of the suburbs became more expensive in 2016 census year, especially in Brimbank and Maribyrnong. Even few suburbs in Maribyrnong has a median house price around $850,000 dollars, which is even beyond the affordability of middle-income families.

6. GROWTH OF MEDIAN HOUSE PRICE

Figure 7 shows the comparison of growth rate in median price among the suburbs of three LGAs. Growth rate of median house price increases in 2006 to 2011 than 2006 to 2015. However, median house price of some of the suburbs in these three LGAs increases more in 2006 to 2015 census year.

Growth of median house prices increased at least by 18 percent and up to 100%. Some suburbs in Maribyrnong, Brimbank and Wyndham became really expensive. Figure 8 shows that growth rate of suburbs of Brimbank and Maribyrnong increased more than the growth of Wyndham.

There were some suburbs in Wyndham city council had moderate growth rate. High growth were observed in Brimbank city council. It might be cause of increasing of housing prices in other suburbs in Melbourne and many resident migrated in Brimbank from other local government areas and hence increase the housing demand. Figure 9 show the rate of increase of median house price between 2011 and 2015.

Three suburbs in Wyndham and four suburbs in Maribyrnong shows growth rate between 30% and 60% but outside the study area, there is one suburb show same increase rate (30%-60%). Figure 10 shows higher house price growth rate in two suburbs in Brimbank while three suburbs in Maribyrnong have higher growth rate.

The median house sales price are continue to increase in all suburbs within the study area. The rate of growth in median house sales reached more than double in last 10 years. Some of the suburbs among these three city councils rose nearly about 160%.

Figure 7: Growth in Variations of Median House Price among the Suburbs of Brimbank, Maribyrnong and Wyndham City Councils from 2006 to 2015.

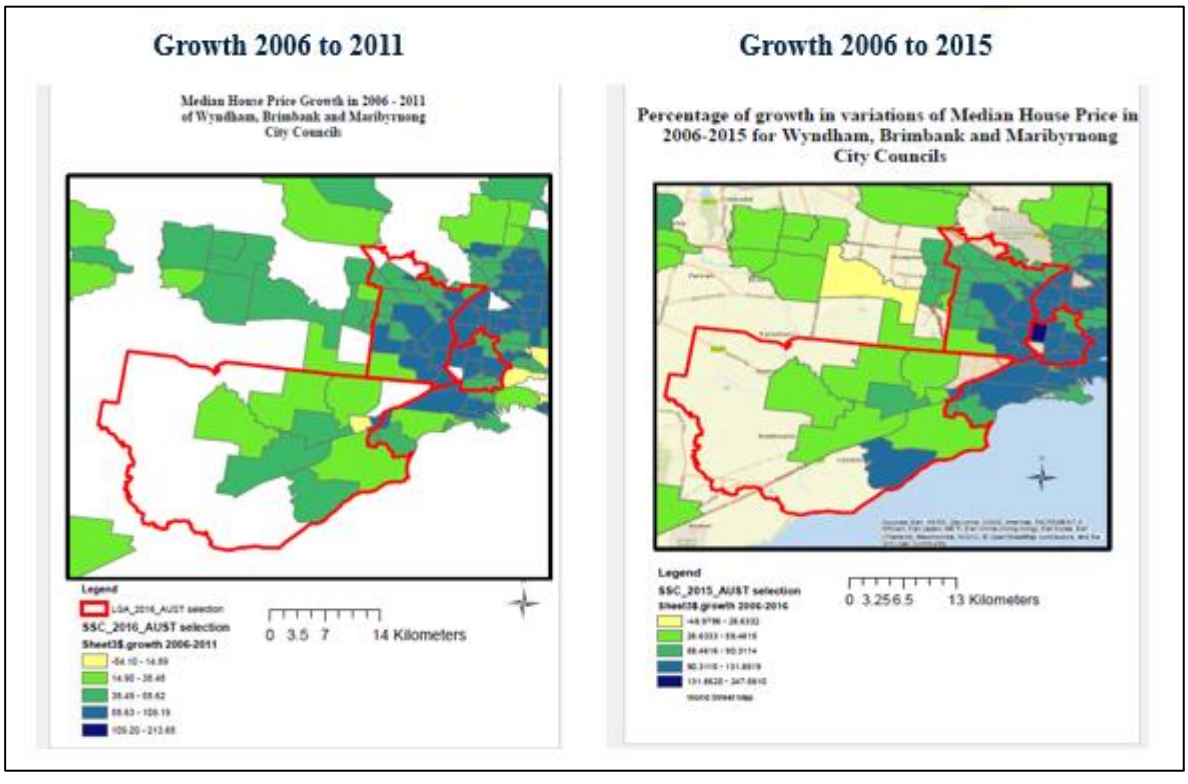


Figure 8: Growth of Median House Price among the Suburbs of Brimbank, Maribyrnong and Wyndham City Councils from 2006 to 2011

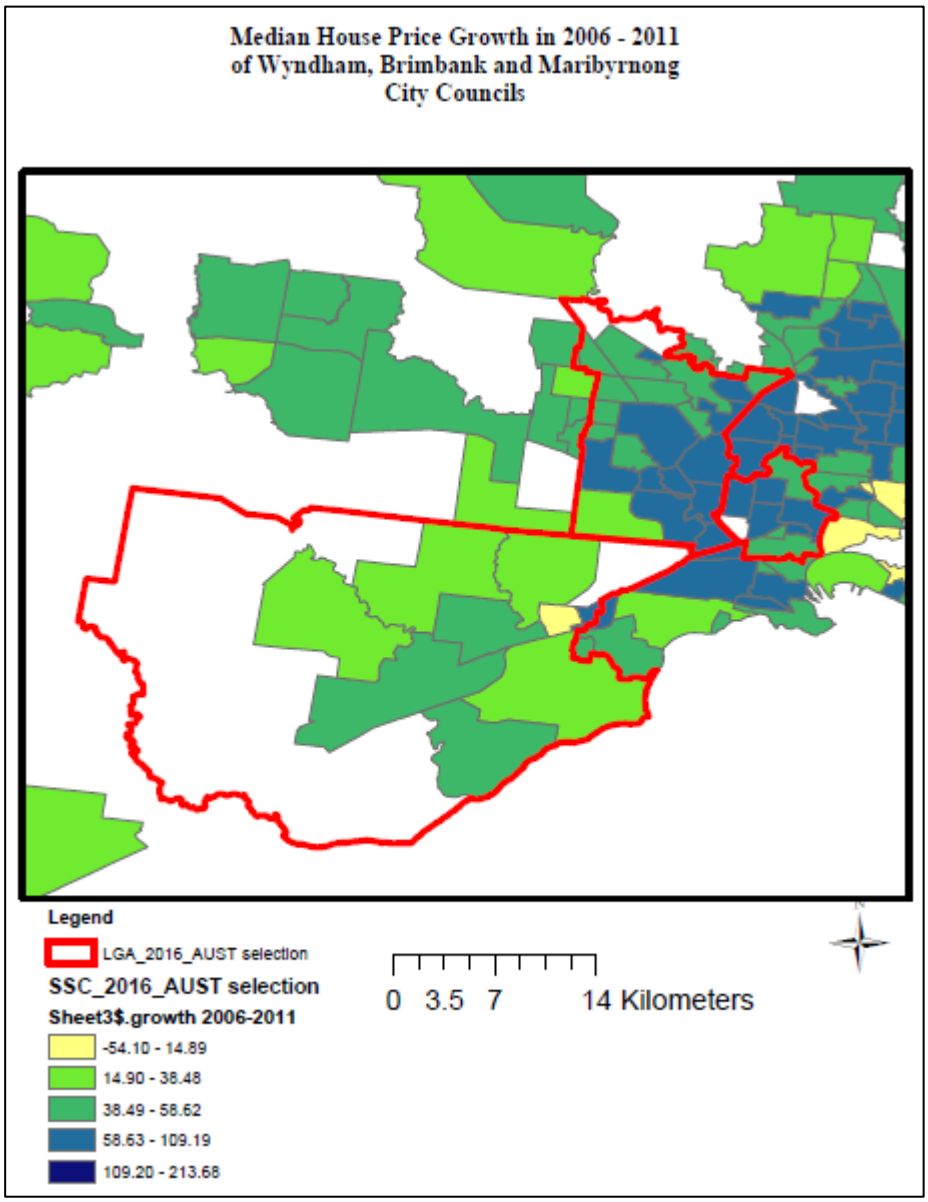


Figure 9: Growth of Median House Price among the Suburbs of Brimbank, Maribyrnong and Wyndham City Councils from 2011 to 2015

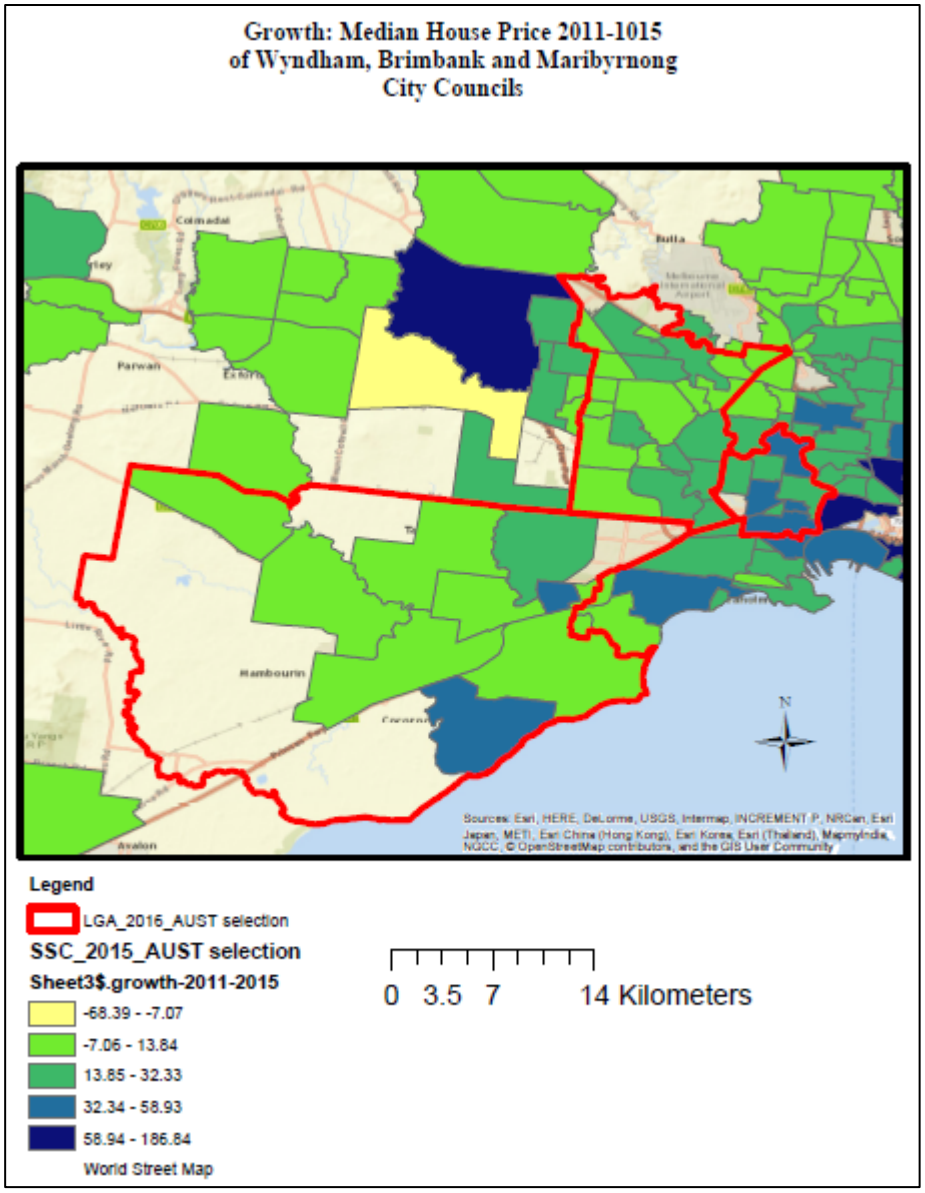
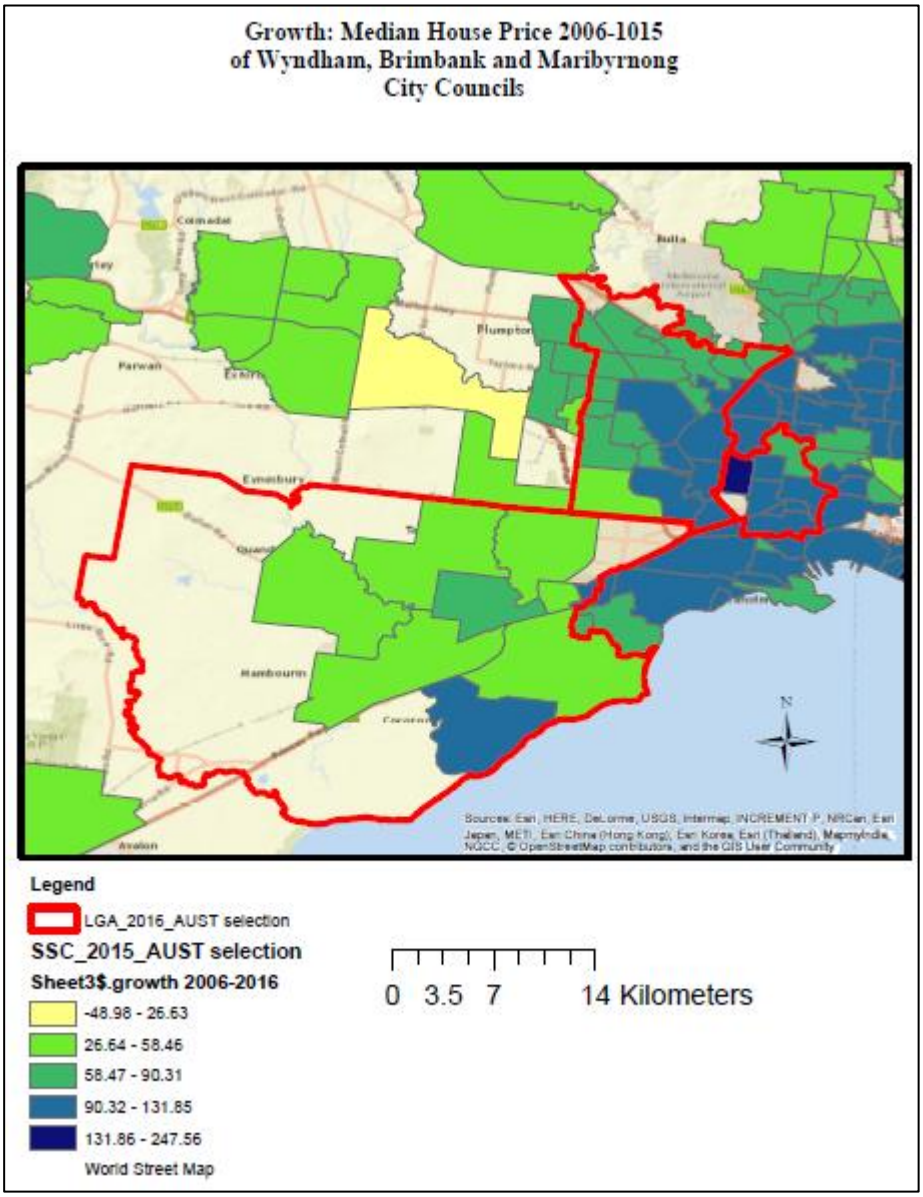


Figure 10: Growth of Median House Price among the Suburbs of Brimbank, Maribyrnong and Wyndham City Councils from 2006 to 2015



7. CONCLUSION

This paper identified the variations of median houses price and rate of growth within the three local government areas in Melbourne Metropolitan City over the last three census period. An important finding of this analysis is that prices of housing rose much faster in 2011 to 2016 than 2006 to 2011. Over the last 10 years, growth of median house price across these three LGAs' increased substantially i.e., upto 160%. The suburbs with low priced houses in 2006 were becoming expensive in 2011 and even becoming more expensive in 2015 (census year 2016).

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APPENDIX:

Table 1: Median House Price 2005 -2015

Locality	SSCcode	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2014_2015	2005_2015	2005_20151
ABERFELDIE	20003	455,000	325,000	483,500	330,000	515,000	500,000	575,000	511,500	550,000	490,000	555,000	13.00	22.00	2.00
AIRPORT WEST	20014	285,000	310,000	327,500	358,000	390,000	422,500	440,000	442,500	474,000	465,000	470,500	1.00	65.00	5.10
ALBION	20020	147,500	145,000	148,000	162,500	214,000	253,000	237,500	232,000	229,000	298,000	205,000	-31.00	39.00	3.30
ALTONA	20034	276,000	278,500	295,500	330,000	365,000	420,000	430,000	400,000	480,000	464,000	526,000	13.00	91.00	6.70
ALTONA MEADOWS	20035	194,000	209,000	234,000	260,000	294,500	323,500	341,500	306,500	335,000	315,000	353,500	12.00	82.00	6.20
ALTONA NORTH	20036	200,000	257,000	325,000	305,000	345,000	449,500	465,000	453,500	446,000	469,500	540,000	15.00	170.00	10.40
ARDEER	20061	153,000	215,000	163,000	265,000	303,500	320,000	310,000	340,000	295,000	317,500	358,500	13.00	134.00	8.90
ASCOT VALE	20074	255,000	300,500	360,000	365,000	425,000	495,500	492,500	435,000	464,000	490,000	531,500	8.00	108.00	7.60
AVONDALE HEIGHTS	20088	270,000	297,500	328,500	358,000	382,000	420,000	495,000	420,000	466,000	465,500	445,000	-4.00	65.00	5.10
BRAYBROOK	20322	230,500	230,000	286,500	280,000	325,000	361,000	355,000	350,000	350,000	411,500	420,000	2.00	82.00	6.20
BROOKLYN	20350	259,500	282,500	280,500	248,000	328,000	372,000	372,000	379,000	397,000	423,000	450,000	6.00	74.00	5.70
BURNSIDE HEIGHTS	20418	216,000	295,500	300,000	318,000	332,500	352,000	352,000	175,000	202,500	380,000	392,500	3.00	82.00	6.20
DEER PARK	20723	212,500	205,000	217,000	245,000	274,500	305,000	320,000	304,000	304,500	318,500	310,000	-3.00	46.00	3.80
DELAHEY	20725	210,000	196,500	226,500	233,000	273,000	312,500	316,500	305,000	306,500	325,000	343,000	6.00	63.00	5.00
DERRIMUT	20737	407,000	320,000	225,000	298,500	312,500	326,500	303,500	275,000	300,000	368,500	370,000	0.00	-9.00	-0.90
ESSENDON WEST	20882	365,000	334,500	425,000	432,000	486,000	398,000	330,000	500,000	557,500	510,000	455,000	-11.00	25.00	2.20
FLEMINGTON	20923	224,000	224,000	279,000	301,500	308,500	385,000	375,000	387,500	359,000	345,000	417,000	21.00	86.00	6.40
FOOTSCRAY	20929	197,000	183,000	287,000	245,000	360,000	375,000	337,500	379,000	395,000	410,000	377,500	-8.00	92.00	6.70
HILLSIDE (MELTON)	21184	235,000	234,000	236,500	265,000	284,000	325,000	325,000	338,000	320,000	314,000	345,000	10.00	47.00	3.90
HOPPERS CROSSING	21194	196,000	197,000	198,500	215,000	239,000	270,000	272,500	257,500	251,000	279,500	285,000	2.00	45.00	3.80
KEILOR	21306	307,000	280,000	460,000	430,000	360,000	418,500	412,500	391,500	410,000	391,500	629,000	61.00	105.00	7.40
KEILOR DOWNS	21307	239,000	220,000	240,000	267,500	300,000	295,000	375,000	329,000	318,000	340,000	373,000	10.00	56.00	4.60
KEILOR EAST	21308	290,500	270,000	352,000	350,000	399,500	438,500	450,000	507,000	540,000	485,000	509,000	5.00	75.00	5.80
KEILOR PARK	21311	227,500	304,000	275,000	478,500	507,000	440,000	447,000	351,000	367,000	382,500	495,000	29.00	118.00	8.10
KENSINGTON	21319	305,000	315,000	364,000	371,000	388,000	460,000	428,000	418,000	439,000	425,000	460,000	8.00	51.00	4.20
KINGS PARK	21354	192,500	167,500	200,000	222,000	255,000	270,000	294,500	260,000	262,500	280,000	300,000	7.00	56.00	4.50
KINGSVILLE	21357	200,000	189,000	230,500	316,500	310,000	350,000	330,500	386,500	320,000	322,500	380,000	18.00	90.00	6.60
LAVERTON	21467	150,000	160,000	121,000	235,000	255,000	279,000	298,500	340,000	290,000	315,000	363,000	15.00	142.00	9.20
MAIDSTONE	21565	288,500	280,000	350,000	355,000	370,000	425,000	395,000	432,500	420,000	435,000	482,500	11.00	67.00	5.30
MARIBYRNONG	21593	256,000	281,000	308,000	363,500	435,000	494,000	433,000	429,500	476,000	447,000	448,500	0.00	75.00	5.80
MOONEE PONDS	21730	302,500	310,000	342,500	376,000	410,000	466,000	462,500	436,000	478,000	467,500	434,000	-7.00	43.00	3.70
POINT COOK	22074	289,500	250,000	295,000	298,000	285,000	320,500	319,000	318,000	321,500	305,000	350,000	15.00	21.00	1.90
PORT MELBOURNE	22095	480,000	465,000	465,000	524,000	580,000	605,000	600,000	627,000	662,500	660,500	665,500	1.00	39.00	3.30
RAVENHALL	22129	615,000	365,000	317,500	280,000	368,500	395,000	281,500	440,000	335,500	313,500	467,500	49.00	-24.00	-2.70
SEDDON	22245	313,500	272,500	330,000	310,000	332,000	377,500	419,500	430,000	400,000	425,500	483,000	14.00	54.00	4.40
SOUTH KINGSVILLE	22298	216,000	262,500	310,000	337,500	441,000	370,000	431,000	404,000	479,000	435,500	377,000	-13.00	75.00	5.70
SPOTSWOOD	22308	235,000	338,500	395,000	352,000	417,000	489,000	480,000	331,000	498,000	560,000	440,000	-21.00	87.00	6.50
ST ALBANS	22319	185,000	190,000	198,500	220,000	256,000	307,000	310,000	295,000	295,000	294,000	325,500	11.00	76.00	5.80
SUNSHINE	22383	185,000	197,500	175,500	222,500	260,000	268,000	305,000	337,500	330,000	365,000	380,000	4.00	106.00	7.50
SUNSHINE NORTH	22384	219,500	203,500	236,000	240,000	250,000	312,000	340,000	285,000	327,500	340,000	355,000	4.00	62.00	4.90
SUNSHINE WEST	22385	232,500	206,500	245,000	295,000	298,000	360,000	345,000	343,500	340,500	345,000	350,000	1.00	51.00	4.20
SYDENHAM	22402	220,000	216,500	232,500	246,000	270,000	295,000	305,000	312,000	300,000	295,000	307,000	4.00	40.00	3.40
TARNEIT	22439	228,000	230,000	233,000	245,000	244,500	275,000	273,000	286,500	290,000	290,000	301,000	4.00	32.00	2.80
TAYLORS HILL	22461	229,000	228,500	264,000	314,000	300,500	341,000	367,500	320,000	251,000	326,000	367,000	13.00	60.00	4.80
TAYLORS LAKES	22462	313,000	235,000	231,000	304,500	263,500	372,000	364,500	350,000	385,000	357,500	359,000	0.00	15.00	1.40
TRUGANINA	22569	138,000	240,000	242,000	242,500	265,000	296,000	310,500	283,500	250,000	290,000	320,500	11.00	133.00	8.80
TULLAMARINE	22573	225,000	240,000	227,500	286,000	300,000	352,500	322,000	340,000	330,000	338,000	360,000	7.00	60.00	4.80
WERRIBEE	22736	205,000	209,000	210,000	214,000	237,500	255,000	272,000	250,000	246,500	260,000	274,000	5.00	34.00	2.90
WERRIBEE SOUTH	22737	300,000	720,000	320,000	407,500	350,000	467,000	467,000	425,000	461,000	539,000	576,500	7.00	92.00	6.70
WEST FOOTSCRAY	22742	170,000	202,500	223,500	275,000	320,000	300,000	361,500	369,000	382,000	401,500	397,500	-1.00	134.00	8.90
WEST MELBOURNE	22743	384,500	397,500	443,500	449,000	480,000	518,000	488,000	440,000	505,000	520,000	575,000	11.00	50.00	4.10
WYNDHAM VALE	22868	177,000	210,000	203,000	237,500	242,000	260,000	275,000	275,000	250,000	255,000	278,000	9.00	57.00	4.60
YARRAVILLE	22902	310,000	336,000	366,500	385,000	410,000	496,000	455,000	517,500	471,000	525,000	535,000	2.00	73.00	5.60

Source: RP data Base, 2017, Land Chanel Victoris, 2017 and ABS 2017.

Regional and Socio-economic Factors of Digital Literacy

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ABSTRACT

The digital prosperity of society is believed to be achieved through learning and improvements of the individual digital literacy. The research has found out socio-demographics factors having the most significant impact on a variety of digital skills and which of them retain their effect over time. The existing digital divide has a negative impact on the social groups with specific socio-demographic profiles such as elderly people, households without young people and inhabitants of smaller settlements. Widely assumed factors of regional affiliation, lower education and low income confirm additional negative impact, but their influence is decreasing over the years due to the better availability and affordability of digital services and internet. A study of time-series dependencies has shown that despite the overall digital literacy is increasing, but the digital divide remains similar in the course of time.

Three research questions are studied, using regression models for cross-sectional data - Pooling model, Random effects model and Fixed-effects model and the Item Cluster Analysis method. The paper has identified the most relevant digital skills for general digital literacy as working with a computer, the internet and digital communication skills. Two other groups skill categories - working with hardware and software represent less necessary skills for a general digital literacy, having only an additional positive influence and representing skills which remain indispensable to selected groups of IT professionals.

1. INTRODUCTION

The advancement of Information Technology (IT) into all fields of the economy and society has brought dramatic changes and defined the entry into the 21st century as a digital age. The development of information and communication technologies has caused profound structural changes having a positive impact on economic growth, the rise in labour productivity, cost reduction and improvement of living standards. There are many arguments on the benefits of IT technology for humanity. However the achievements of the digital economy go together with concerns about future prosperity, the ongoing divide of the world and society on the background of the unequal digital capabilities, and threats to prosperity due to the loss of typical jobs.

The growth economics hypothetically anticipates that investment in ICT drives economic growth. Curiously, several empirical studies on the impact of ICT have produced ambiguous results, being partly influenced by differing research methodologies and focusing on different countries. In reality, the exploration of the ICT effects has recognised paradoxically stunning

little effect on productivity in the early decades of the computer revolution. This phenomenon is often denoted as productivity paradox (or Solow computer paradox) related to the rapid expansion of the information technology in the United States but accompanied by the deceleration in productivity growth in the 1970s and 80s (Solow, 1987; Baily, 1986; Dewan and Kraemer, 1998; Oliner and Sichel 2000). The expenditures on ICT have risen in almost all of the world economies while productivity growth has slowed (David, 1990; Rei, 2004).

The computer paradox could be explained in various ways, e.g. as a result of imprecise traditional productivity measurement of the input-output relationship failing to take into consideration new sources of value. Another presumed important factor of the paradox is dealing with time lags in productivity rise associated with slow technology diffusion, learning requirements or insufficient use of technologies.

Recent statistical approaches have allowed more accurate new data to be compiled, and to quantify the hardly measurable IT impacts to date. Credible explanations could have been documented only over time showing a significant increase in productivity in companies that invested heavily in IT. Ultimately, however, the productivity increased in the period 1995- 2000 from average 1.4 to 2.6 percent and it increased even more to about 3.6 percent even further in 2001–2003 (Brynjolfsson and Saunders, 2010). Today, there is already a consensus on the tangible productivity acceleration based on IT revolution as well as on the implication of the time lag caused by the very new demands of learning and using new IT technologies denoted as digital literacy.

2. DIGITAL LITERACY AND DIGITAL PROSPERITY

The ICT innovations and expected boost of productivity are impossible without the investments into worker ICT knowledge and skills. Digital organisations have to afford more learning and training than in the other industries. It comes, employees need right IT skills and have to be trained to operate new digital processes, to search and find information effectively, but also to cope with exceptions and to make quick decisions.

Futurelab follows the traditional concept of literacy as the ability to read and write in a common language of culture (digital participation, digital literacy and school subjects, 2009). What essentially means that a similar approach can also be applied to digital literacy. Digital literacy is focused on reading and writing digital texts, the ability to read web pages through hyperlinks or the ability to publish by uploading digital photos or videos to social networks. Accordingly, digital literacy could be defined as the ability to functionally exploit the skills needed to operate and communicate with technology and the media. Getting such knowledge and skills evolves is now quite different from the recent past. Knowledge is no longer nicely stored in textbooks and encyclopedias but is often available free of charge on the Internet by keyword search. Different sources may offer different interpretations of the same data or simply offer conflicting data about the same subject. So digital literacy also means understanding how technology and media influence the way we search our information (Hague, Williamson, 2009).

Digital literacy implies acting in new ways on information in digital form and through new organisational forms (Aral, Brynjolfsson, and Van Alstyne, 2006; Brynjolfsson & Brown, 2005). New technology always plays a key role in discovering and determining new skills considered necessary for its enforcement in the economy. Growth driven by IT revolution is of course not possible without encouraging digital literacy and adoption of digital technologies. The deployment of ICT technologies in all the sectors is resulting in a new situation demanding for broad new skills.

Computers have long been regarded as a sole concern of hardware and programming specialists, requiring advanced new skills, what has evoked defensive reactions from the workers and hindered in their massive placement. Later, the Internet diffusion added significant pressure on the use of further Internet literacies. Digital literacy as a term has been first introduced rather generally, as an "ability to understand and to use information from a variety of digital sources", as required by new digital age (Gilster, 1997). Also, some other authors (Eshet, 2002) argue and consider digital literacy as a special kind of mindset or thinking and not only a practical ability to use digital sources effectively.

Over the past three decades, several approaches have emerged to classify old and new literacy skills that are needed in the 21st century in workplaces and have been gradually introduced into education. Already before, computer and information literacy terms have been in use (Bawden, 2001; Behrens 1994). The computer literacy is related to traditional computers, emphasising practical skills in using computer and software application packages. In comparison, information literacy is focused on the ways, in which information is accessed and evaluated (Martin, 2006), accentuating the location and identification, further evaluation, and use of media.

Also, a skill set can be assigned to digital literacy and one of the esteemed skill designs is named 21st-century skills (Warschauer and Matuchniak, 2010). Today, after many confusing attempts and critical discussions, digital literacy can be considered as an integrating framework of several forms of literacy and skill-sets (Martin, 2006).

Developed countries have therefore introduced digital literacy into general education as the prevalent majority of their citizens become an active element of the digital economy. Lack of digital literacy is a key factor of the low prosperity. The positive aspects of the impact of IT on productivity and growth also cause adverse effects of increasing economic and social disparities and creating a digital divide (Hoffman, 2008). ICT and the Internet have considerable power to strengthen traditional forms of inequality on the basis of uneven access to computer devices and internet and level of digital literacy.

The previous reasoning enables to understand in a better way the impact of ICT on productivity and to emphasise the role of digital literacy in achieving national or regional prosperity. Digital prosperity requires identification and understanding the factors behind the spatial distribution of digital prosperity and literacy, which have a capacity to even deepen poverty in less developed, rural or peripheral regions. At the same time, there are more vulnerable groups of the population due to worse Internet access and computer technologies, disadvantaged by age, gender, income or family situation. This gives a motivation to formulate research questions to explore the vulnerability of social groups and regions in their relationship to maturity in digital literacy and its development over time. In addition to evaluation of digital literacy factors and prosperity, it is possible to conclude which types of digital literacy are essential for developing digital literacy as a whole. These results have clear implications for school education, the training of employees and working with disadvantaged social groups.

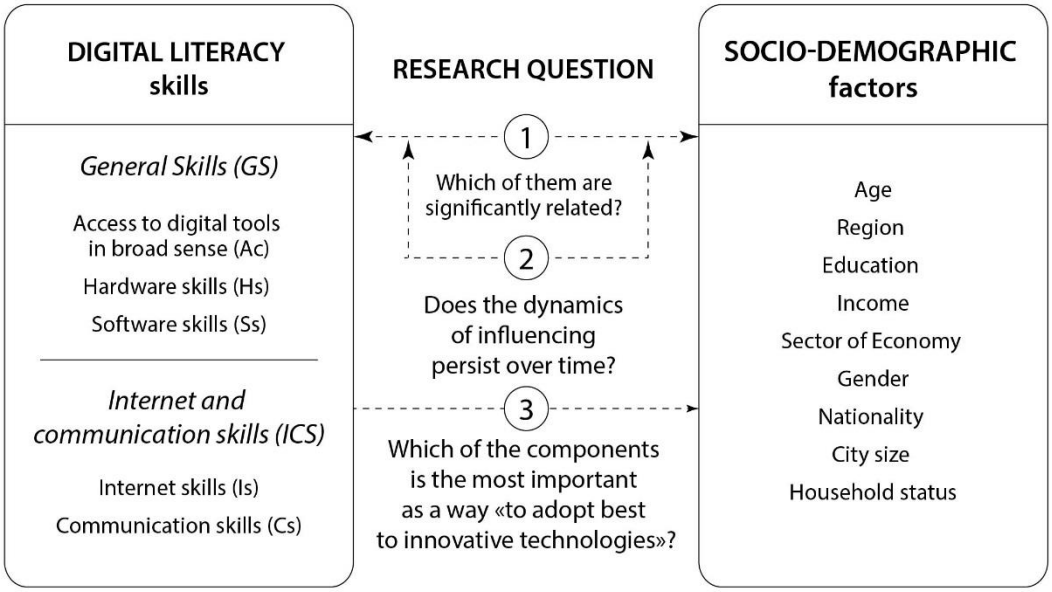
3. RESEARCH QUESTIONS AND METHODOLOGY

Research and analysis are based on the representative surveys carried out by the Institute for Public Affairs (Inštitút pre verejné otázky, IVO), Bratislava. Data were collected within the long-term project the Digital Slovakia during the period 2005-2015 and provide an all-embracing picture of the digital skills of the citizens of Slovakia in time and space, following several economic, social and demographic parameters. The publicly available dataset has a form of contingency tables displaying statistical panel data in three dimensions: categories of digital skills and related social phenomena, demographic characteristics and years of

observations. The surveys were realised on the representative samples among the population of Slovakia on the sample of 1,000+ inhabitants older than 14 years biannually (2005-2015). The quota sampling took into account the parameters of gender, age, education, nationality, settlement size and region. The results are published in a form of tables and charts, comparing a set of digital literacy indicators, and values of the composite Digital Literacy Index (Velšic, 2011) according to above quota parameters.

In this article, digital literacy skills are classified into two categories of General Skills (GS) and Internet and communication skills (ICS). The GS category consists of three general components: Access to digital tools in broad sense (Ac), Hardware skills (Hs) and Software skills (Ss). The ICS category is divided into two components of Internet skills (Is) and Communication skills (Cs).

Figure 1: Research Framework



In general, lower digital skills could be expected due to old age, lower education, smaller city size or lower income families. Hence, the first research question is formulated as follows:

Research Question 1: Which of the socio-demographic factors are significantly related to the value of the aggregated components of digital literacy?

Altogether ten socio-demographic indicators are subject to correlation analysis with five groups of aggregated items of digital skills. The list of variables, categories and coding is shown in the following Table1.

Of course, it is notable to study how digital skills change over the period of 10 years and what the nature and pattern of the digital skills dynamics are. It might be expected that some factors of digital divide will lose their influence over time. Hence, a special class of regression models for cross-sectional data can be applied to study time effect including fixed effects, random effects and independently pooled time series effects as the second research question:

Research question 2. Does the influence of socio-demographic factors on digital skills level persist over time?

Table 1: Factors, Categories and Coding of the Digital Literacy Surveys

Factor	Code	Category
Age	1	14-17
	2	18-24
	3	25-34
	4	35-44
	5	45-54
	6	55-59
	7	60-
Region	1	Bratislavský
	2	Trnavský
	3	Trenčiansky
	4	Nitriansky
	5	Žilinský
	6	Banskobystrický
	7	Prešovský
	8	Košický
Education	1	Elementary
	2	Vocational
	3	Secondary
	4	Higher
Income	1	Very well-off
	2	Relatively well-off
	3	Average level well-off
	4	Inadequately well-off
	5	Poor

Factor	Code	Category
Sector of Economy	1	State-owned
	2	Public
	3	Cooperative
	4	Private
Gender	1	Male
	2	Female
Nationality	1	Slovak
	2	Hungarian
	3	Other
City size	1	Less than 2 thousand
	2	2 - 5 thousand
	3	5 - 20 thousand
	4	20 - 50 thousand
	5	50 - 100 thousand
	6	Above 100 thousand
Household status	1	Young persons
	2	Young children household
	3	Average age children household
	4	Adult children household
	5	Three-generation household
	6	Elderly household (no children)
	7	Senior citizens
	8	Other household

Given the proposed structure of skills, the third research questions is dealing with possible improvements in the individual digital literacy and the ways how to set up the education and training effectively. The hierarchical clustering algorithm is used to study the structural relationship between the five components of digital literacy:

Research question 3. Which of the components of digital literacy under study are the most important to focus on to improve universal individual digital literacy as a way to adopt best to innovative technologies?

The original dataset had to be significantly modified, scaled, normalised and aggregated into categories subject to three models. The final dataset consisted of three dimensions represented by the variables and corresponding data:

1. Digital skills, aggregated into 5 components: Access to digital tools in broad sense (Ac), Hardware skills (Hs), Software skills (Ss), Internet skills (Is) and Communication skills (Cs).

2. Socio-demographic factors, aggregated into 9 categories of factors (Gender, Age, Education, Income, Nationality, Household status, Sector, Region, City size).
3. G1 as the dependent output variable is based on the answers in the surveys 2005, 2011, 2013, 2015: "How do you adapt and learn to master modern information and communication technologies (computers, the internet, electronic mail, electronic banking, etc.)?" It is supposed, the level of adaptation depends on the individual current computer skills, and directly describes the subjective ability to improve individual digital literacy.

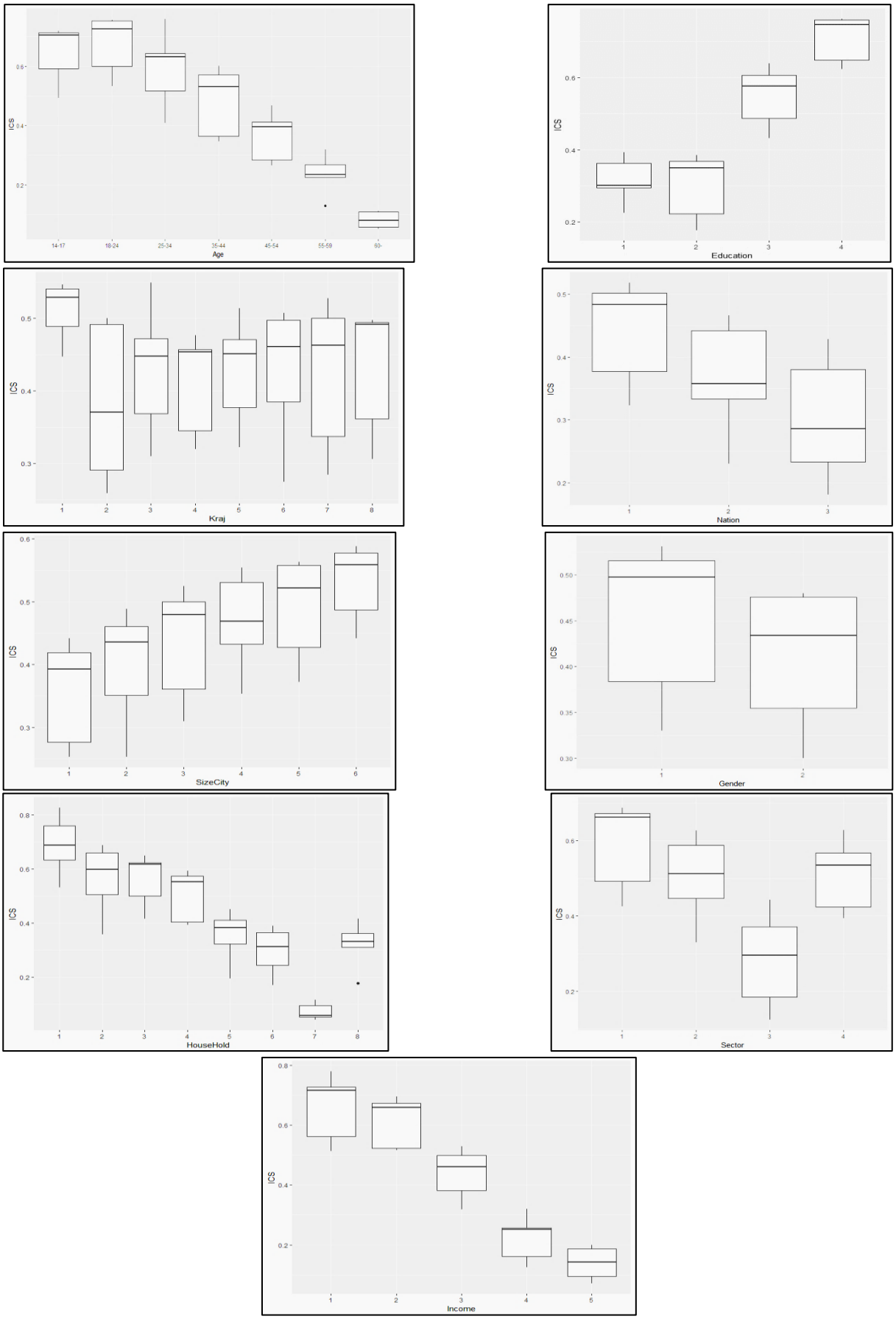
4. DATA AND DESCRIPTIVE STATISTICS

In accordance with the concept and the framework outlined above, digital skills indicators were selected and grouped into 5 components:

Table 2: Groups, Components and Variables of Digital Literacy

Group	Component	Var	Skills
GS: General Skills	Ac: Access to digital tools (in wide sense)	Hw1	Working with PC (desktop)
		Hw2	Working with a laptop/smartphone
	Hw: Hardware skills	Hw3	Printing documents on a PC printer
		Hw4	Work with the scanner
		Hw5	Write data to portable media
		Hw6	Install hardware to PC
		Hw7	Carrying / Copying Data on LAN
	Sw: Software skills	Sw1	Working with a word processor
		Sw2	Work with a spreadsheet
		Sw3	Working with a database program
		Sw4	Working with a graphic editor
		Sw5	Working with a multimedia program
		Sw6	Working with an Internet browser
		Sw7	Install software and set up PC features
ICS: Internet and communication skills	IS: Internet skills	IS1	Search for information and services on the Internet
		IS2	Registration of access to information and services on the Internet
		IS3	Using Internet Banking
		IS4	Purchasing goods or services over the Internet
		IS5	Search for different information in LAN
		IS6	Download/upload files, data over the Internet
	CS: Communication skills	CT1	Send and receive emails
		CT2	Chat / video chat communication
		CT3	Sending messages from mobile phone/smartphone (SMS, MMS)
		CT4	Internet telephony (VoIP)
		CT5	Communicating in newsgroups, forums, fanclubs

Figure 2: Boxplots of the relationships between the ICS aggregated skills and socio-demographic factors.



The general components of digital literacy describe basic skills, including elementary ability to work on a computer, stationary or portable (AC), work with various kinds of software (Sw), and particular skills that enable solving simple hardware issues (Hw). The most important for the concept of digital literacy as a tool for achieving digital prosperity are the skills assigned to the ICS group. Namely, two components of the ICS group (Internet and communication skills) are vital for direct provision of goods and services and communicating with people and institutions.

Alfa Cronbach values were calculated showing high internal consistency in all variables (alpha values always greater than 0.90). The relation between aggregated ICS group skills and 9 socio-demographic factors are visualised in Figure 2 on the previous page:

The visual difference between the average values of individual socio-demographic factors is suggesting confirmation of the influence of the relevant factors on internet and communication skills such as age, education, income or city size. Digital divide and its borderlines can be seen immediately as a positive or negative correlation. Because of different type of variables (binary, nominal, ordinal), different measures of correlation or association testing have to be applied. A more detailed exploration of dependencies and dynamics following the research questions is presented in the following section.

5. Statistical Analysis and Results

Correlations between the socio-demographic variables (ordinal, nominal or binary scale) and the five components of digital literacy (interval scale) (Research question 1) require the use of different methods. The Spearman coefficient is obviously appropriate for measuring correlations between the ordinal and interval scales.To calculate the correlation between the nominal and the interval scale, the Etha coefficient is recommended (Levine and Hullet, 2002). The association between the dichotomous and interval variables (Gender) can be tested by the rank-biserial correlation coefficient (Kerby, 2014). All results on correlation or association are presented in Table 3.

Table 3: Association between the Socio-Demographic Variables and Components of Digital Literacy

Factor	Scale	Coefficient	Ac	Hw	Sw	Is	Cs	Association
Age	ordinal	Spearman	-0,86	-0,91	-0,94	-0,85	-0,9	strong negative
Region	nominal	etha squared	0,08	0,25	0,28	0,15	0,14	weak positive
Education	ordinal	Spearman	0,86	0,83	0,82	0,87	0,85	strong positive
Income	ordinal	Spearman	-0,91	-0,94	-0,95	-0,91	-0,92	strong negative
Household	nominal	etha squared	0,81	0,88	0,9	0,79	0,81	strong positive
City size	ordinal	Spearman	0,48	0,71	0,75	0,56	0,61	Positive
Sector of Economy	nominal	etha squared	0,53	0,71	0,75	0,49	0,53	Positive
Gender	binary	biserial	-0,3	-0,47	-0,45	-0,36	-0,25	weak negative
Nationality	nominal	etha squared	0,29	0,49	0,51	0,31	0,29	weak positive

The values of the coefficients estimate the strength of the association between socio-demographic factors and the components of digital literacy. The four of 9 socio-demographic factors considered have a significant effect on digital skills levels – age, education, income and household type. The city size and the sector of the economy also show an influence on digital skills. However, only a weak influence relates to factors of region, gender and nationality, which are therefore detached from the further consideration.

In the second research question, the dynamics of the socio-demographic factors influence is tested. Three most-known regression models are selected for the analysis: Pooling model, Random effects model and Fixed-effects model. All three models can be written in the form:

$$y_{it}=\alpha+x'_{it}\beta+z'_i\gamma+c_i+u_{it},$$

where: i refers to a cross-sectional unit such a household;

t refers to a unit of time such as a year from 2005 till 2013;

x'_{it} is a time-varying explanatory variable such a category of digital skills;

z'_I is a time-invariant explanatory variable such a socio-demographic factor;

β and γ are coefficients related to type explanatory variables above;

c_i is within cross-sectional unit error, that is time-invariant but varies across cross-sections; and

u_{it} is between cross-sectional unit error, that varies over time and households (our cross-sectional units), and is a truly stochastic error term.

Pooling model (P) assumes that the groups or objects under consideration do not have individual differences, that is, the data can be viewed as a general time series, without a panel structure, so it is assumed c_i.=0. In the fixed-effect model (FE), each unit is considered "unique" and cannot be regarded as a result of a random choice from a certain general population, so it is assumed c_i. depends on x_i. This approach is often confirmed when the cross-sectional units under study have important time-invariant differences that persist over time. If the objects are in the panel "accidentally" as a result of sampling from a large population (so c_i and u_{it} depends on x_i), then the model with a random effect (RE) is acceptable.

Standard hypothesis testing techniques make possible to choose a model taking into consideration hierarchy among them. The pooling model P is a special case of both models FE and RE. Also, the model with random effects RE can be regarded as a special case of the model with fixed effects FE.

When testing the statistical hypotheses for the choice of the model, the null hypothesis is stated as validity of a narrower model, and the alternative hypothesis relates to a more general model. Thus, the model and its coefficients are tested to determine their significance. The Table 4 displays the coefficients of the three models for significant social-demographic factors: age, education, income, household type, employment sector and city size.

Comparison of the models exploits three different tests.

1. The standard F-test: fixed effects model against pooling regression. Null hypothesis: the pooling model is correct/fixed effects model is incorrect.
2. The Hausman test: fixed effects model against random effects model. Null hypothesis assumes consistency of the coefficients in both models. If rejected, the coefficients are untenable in the RE model.
3. The Breusch-Pagan test: random effects model against pooling regression. Null hypothesis assumes the pooling regression is correct.

Table 4: Regression Coefficients for Social-Demographic Factors

Factor	Model	Coefficients				Estimation of model	
		Intercept	AC	Hw	Sw	p-value	R2
Age	pooling	0,004	0,461	0,420	0,139	< 2,22e-16	0,991
		0,648	0,00022***	0,113	0,486		
	random effects	0,004	0,457	0,435	0,128	< 2,22e-16	0,992
		0,617	0,00024 ***	0,098	0,522		
	fixed effects		0,343	0,159	0,771	< 2,22e-16	0,963
			0,019*	0,573	0,0065**		
Education	pooling	-0,007	0,879	-0,632	0,779	4,93E-14	0,981
		0,795	0,00114**	0,364	0,201		
	random effects	-0,007	0,879	-0,632	0,779	4,93E-14	0,981
		0,795	0,00114**	0,364	0,201		
	fixed effects		0,592	-0,163	0,793	2,98E-06	0,880
			0,240	0,876	0,233		
Income	pooling	0,024	0,535	-0,019	0,475	< 2,22e-16	0,983
		0,104	0,005625**	0,968	0,258		
	random effects	0,028	0,562	0,213	0,185	< 2,22e-16	1,000
		1,84e-06 ***	2,647e-05***	0,180	0,344		
	fixed effects		0,382	0,306	0,526	4,81E-08	0,880
			0,09491	0,607	0,263		
Household	pooling	-0,013	0,796	-0,704	0,973	< 2,22e-16	0,985
		0,247	1,34e-07***	0,073	0,0067**		
	random effects	-0,011	0,783	-0,655	0,934	< 2,22e-16	0,987
		0,283	1,52e-07***	0,09019	0,0084**		
	fixed effects		0,853	-1,328	1,764	< 2,22e-16	0,948
			1,393e-06***	0,00479**	0,00011***		
Sector	pooling	-0,044	0,980	-0,702	0,812	8,10E-13	0,973
		0,08993	9,652e-05***	0,08902	0,022*		
	random effects	-0,044	0,980	-0,702	0,812	8,10E-13	0,973
		0,08993	9,65e-05***	0,0890	0,022*		
	fixed effects		0,748	-0,683	1,246	2,95E-09	0,959
			0,016460*	0,154	0,0041**		
City size	pooled	-0,082	0,434	-0,070	0,949	< 2,22e-16	0,947
		0,00738**	0,0019**	0,831	0,0073**		
	random effects	-0,056	0,386	0,146	0,710	< 2,22e-16	0,970
		0,015539*	0,001787**	0,625	0,0274*		
	fixed effects		0,302	-0,017	1,216	3,32E-12	0,929
			0,131	0,966	0,0041**		

Table 5: Testing of the Dynamics of the Socio-Demographic Factors over Time

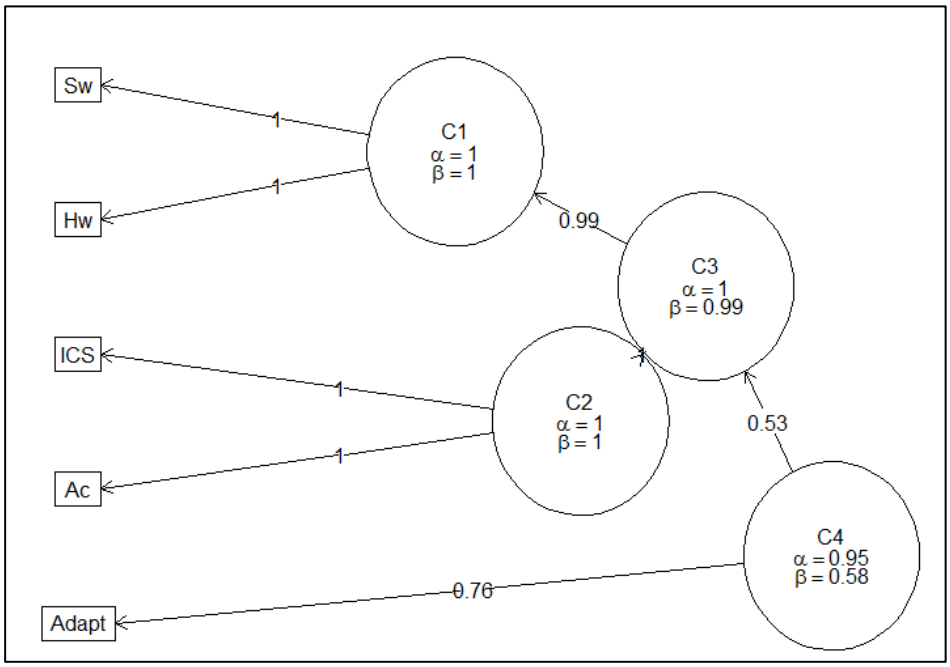
Test	F-test	H-test	BP-test	Conclusion
H0:	Pooling	RE	Pooling	
H1:	FE	FE	RE	
Age	0,059	0,001	0,663	fixed effect model is significant
	H0	H1	H0	
Education	0,867	0,924	0,155	random effect model is significant
	H0	H0	H0	
Income	0,6615	0,2931	0,09201	random effect model is significant
	H0	H0	H0	
Household	0,0811	0,002716	0,6645	fixed effect model is significant
	H0	H1	H0	
Sector	0,2183	0,05028	0,6674	random effect model is significant
	H0	H0	H0	
SizeCity	0,6262	0,02398	0,2791	fixed effect model is significant
	H0	H1	H0	

The model with fixed effects well represents three factors of Age, Household type and City size showing individual group differences. In other words, the differences of the digital skills in groups divided by Age, City Size, and Household Type are significant and time invariant. By contrast, Education, Sector of economy and Income are well described by the random effects model indicating the differences in the groups are not confirmed. Progressing Internet accessibility and affordability have brought lower dependence of Digital skills on higher education, income or special skills related to the sector of employment.

At last, the Research Question 3 is studied, namely which of the components of digital literacy is the most important for increasing individual digital literacy as a way to adapt to innovative technologies. In other words, to figure out, which digital skills have a potential to serve as means to overcome the societal digital divide and to increase individual digital literacy. To understand the role of the single digital skills in improving digital literacy, the indicator of adaptation to digital tools (denoted below as Adapt) is employed.

The structural model is proposed to test associations between the components of digital literacy using the Item Cluster Analysis method (ICLUST). The items used in correlations are variables, and similarly to factor analysis, the aim is to reduce the data complexity and to identify homogeneous clusters – subgroupings (Revelle, 1979). Hence, the result of the ICLUST method is the tree diagram showing the nesting structure of the clusters of items - variables. Also, this method is employed to analyse the adequacy of scales in use and to decide whether the assumed constructs are measured properly. Indeed, the indicators are consistent with the components, as pointed by the high Cronbach alpha value 0.95 and the average value of the factor saturation (Betta Revelle) equal to 0.58.

Figure 3: Hierarchical Clustering of the Digital Literacy Components



The linear model, residuals and coefficients are as follows:

ModelAdapt <- lm(Adapt~ Ac+Sw+Hw+ICS, data=DL)

Residuals:

Min	1Q	Median	3Q	Max
-0.030500	-0.010688	-0.003643	0.009144	0.030970

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.025610	0.008981	2.852	0.01154 *
Ac	0.489713	0.138074	3.547	0.00268 **
Sw	-0.311235	0.221357	-1.406	0.17884
Hw	0.358001	0.338263	1.058	0.30561
ICS	0.555943	0.229376	2.424	0.02758 *

Residual standard error: 0.01749 on 16 degrees of freedom.

Multiple R-squared: 0.7613, Adjusted R-squared: 0.7016.

F-statistic: 12.76 on 4 and 16 DF, p-value: 7.48e-05.

The regression table shows significance of the built model with a p-value 0.017<0.05 and fairly high R-squared is 0.76. So, the assumption about dependency between the Adaptation to new digital tools and existing digital skills is confirmed. Besides, the significant variables are AC (basic ability to work with PC) and ICS (Internet and Communication skills). The software skills and Hardware skills are not essential.

6. CONCLUSIONS

The digital prosperity of society is believed to be achieved through learning and improvements of the individual digital literacy. The research has determined socio-demographics factors having the greatest impact on a variety of digital skills and which of them retain their effect over time. The existing digital divide has a negative impact on the social groups with specific socio-demographic profiles such as elderly people, households without young people and inhabitants of smaller settlements. Widely assumed factors of lower education, low income and regional affiliation confirm additional negative impact, but their influence is decreasing due to the better availability and affordability of digital services and internet. A study of time-series dependencies has shown that despite the overall digital literacy is increasing, the digital divide remains similar in the course of time.

The study has identified the most relevant digital skills for general digital literacy as working with a computer, the Internet and digital communication skills. Two other groups skill categories - working with hardware and software represent less necessary skills for a general digital literacy, having only additional positive influence and representing skills which remain indispensable to selected groups of IT professionals.

The digital economy and society development requires higher digital literacy, and several social-demographics factors represent typical factors of exclusion. To ensure democratic principles towards to digital prosperity, it is supposed to provide equal opportunities to all demographic groups. This is the role of the government and regional stakeholders, to shape the education, learning and trainings having capacity in reducing the divide. The study gives several hints on sensitive socio-demographic factors of digital divide, as well as about the key areas of intervention.

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