Immigration-Unemployment Relationship: Evidence from Five Australian States

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A thesis submitted in partial fulfilment of the requirement for the degree of

Master of Research

Department of Economics

Faculty of Business and Economics

Macquarie University

Australia

October 2016

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Abstract

Immigration to Australia has contributed around 50 per cent of population growth over the last twenty years. The economic consequences of immigration are of great concern not only for policy-makers but also for local workers. Using a system of equations for real gross state product, real wage, immigration rate and unemployment rate for five Australian states (New South Wales, Queensland, Victoria, South Australia and Western Australia), this study suggests that the economic impacts of immigration varies by states and by estimation methods. This study finds that immigrants are not displacing locals' jobs. In the long-run, this study reveals significant negative relationships between immigration and unemployment in New South Wales, Victoria and Western Australia. The short-run error correction models reveal when the unemployment rate of NSW and VIC exceeds the long-run equilibrium level, they would readjust to equilibrium with approximately 12.84 per cent and 27 per cent respectively in the current period. For WA, the long-run decreasing trend of unemployment attracts immigrants. In general, immigration contributes to the permanent expansion of the Australian economy and reduces the unemployment rate.

Statement of Candidate

I certify that the thesis "Immigration-Unemployment Relationship: Evidence from Five Australian States" has not been previously submitted to any other university or organisation as a part of requirement for a degree other than Macquarie University nor submitted for any other degree.

I certify that the thesis is an original work of research and it has been written by me. Any help and assistance that I have received in my research work and the preparation of the thesis have been properly acknowledged.

I certify that all information sources and literature used are indicated in the thesis.

09/10/2016

Acknowledgement

I want to express my gratitude to those who have helped and supported me during this journey of research.

My supervisors, Dr. Michael Dobbie and Associate Professor Roselyne Joyeux have helped me with invaluable advises in all areas of my study. Without their help, I would not possibly produce such a thesis. I want to express my heartfelt gratitude to their patience and their academic supports.

Associate Professor Tony Bryant has shaped an enjoyable research journey that expands my horizons and becomes a remarkable lifetime memory. He has organised the most comfortable and enjoyable seminars.

To my friends and colleagues in the Department of Economics, Faculty of Business and Economics, Macquarie University, thank you for your support and caring.

I would also like to give my gratitude to the Macquarie University for creating the best research environment for my study.

At last, I want to give my heartfelt thanks to my parents and family for their love, support and understanding in this year.

Abbreviations

ABS	Australian Bureau of Statistics
NSW	New South Wales
VIC	Victoria
QLD	Queensland
SA	South Australia
WA	Western Australia
AWE	Average Weekly Earnings
GSP	Gross State Product
VAR	Vector Autoregressive Model
TYVAR	Toda and Yamamoto's Augmented Vector Autoregressive Model
VECM	Vector Error-Correction Model
FMOLS	Fully Modified Ordinary Least Squares

Chapter One: Introduction

Unemployment has always been an important macro-economic phenomenon. Studies on the causes and effects of unemployment were traced in many early economic literatures, for instance, Pigou (1933). New Keynesian economists (Ball and Romer, 1990) argued that wage rigidity in the labour market prevents labour supply and demand converging to equilibria, and geographical immobility was an important factor to explain the long-run effects of historical unemployment (Romer, 2005). For countries with a high level of immigration such as the United States, Australia and Canada, it is reasonable to examine whether the continuous influx of international immigrants has been a major cause of persistent unemployment among local workers.

Economists became interested in the economic impacts of immigration and the links with existing theories in the second half of the twentieth century, when the number of immigrants to the United States increased significantly after a low point during World War II (Simon, 1999, p. 23). For instance, Sjaastad (1962) attempted to measure the effect of immigration on reducing the wage gap between the United States and European countries.

Cobb-Douglas production functions have been used by many economists to examine the influences of immigration on both labour and capital markets (Mishan and Needleman, 1968; Berndt and Christensen, 1974; Rivera-Batiz, 1983; Greenwood and McDowell, 1986). Some economists (such as Piore, 1979; Altonji and Card, 1991) advocated decomposing the labour market into submarkets by the capacities of workers such as skill classes and education levels. They developed many useful suggestions on how the economy could increase its output by adding an amount of a specific class of labour. These results are used for many countries' immigration policies such as the skills based immigration program in Australia.

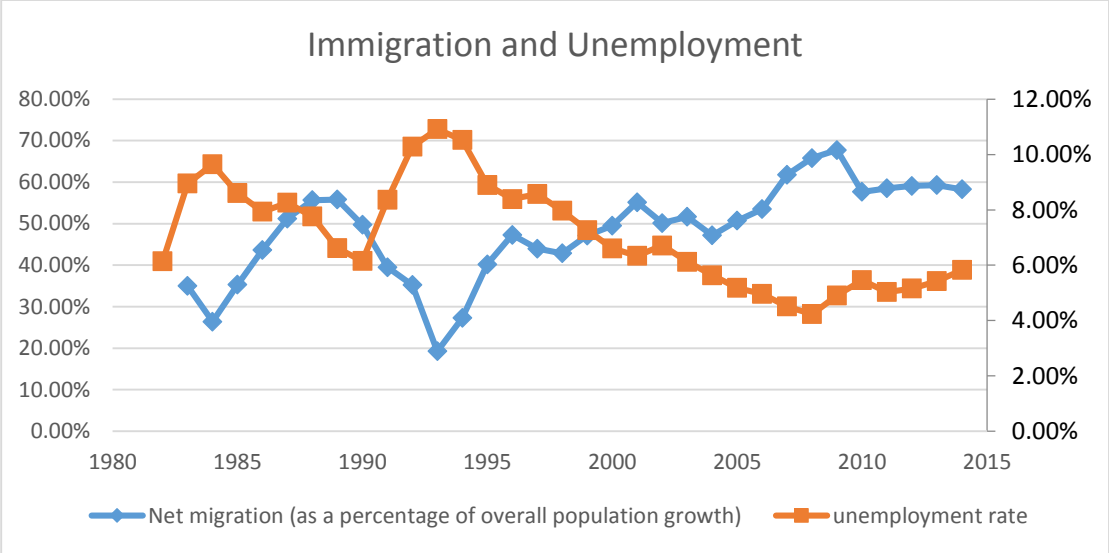
Modern econometric techniques and the availability of data have allowed recent economists (Dustmann et al., 2003; Islam, 2007; Fromentin, 2013; Latif, 2015) to estimate the relationship between immigration and unemployment based on historical observations. They have employed both structural and reduced form models that are built on various economic theories. The models are usually based on a general equilibrium framework that the host country's labour market, starting as isolated and at equilibrium, would respond accordingly to the inflow of

migrants, while the prosperity of the local economy drives the migrants to settle down to maximise their expected utility. The researchers have identified a number of variables to capture the impact of the changing economic environment, and individuals' welfare and labour market status. These econometric techniques could present reliable estimations on the relationships based on the selected sample periods.

Following such methods, this study explores the short-run and long-run unemployment effect of immigration in Australia. The inflow of international immigrants is a major contributor to population growth in Australia. According to the Australian Bureau of Statistics (2014), immigration has contributed 48 per cent to the population growth of Australia between 1982 and 2014. The contribution of immigrants to Australian population growth increased to 56 per cent after the year 2000, as shown in Figure 1. Immigration's share of population growth in Australia is one of the highest among all OECD nations (OECD, 2015).

In addition to increasing population, immigration may have played a significant role in the labour market in Australia. In the sample period, the unemployment rate decreased from 8.31 per cent on average before 2000 to 5.39 per cent on average after 2000, while net overseas migration as a proportion of population growth increased from 41.40 per cent on average before 2000 to 56.40 per cent on average after 2000. Figure 1 illustrates an interesting correlation that the unemployment rate decreased from nearly 11 per cent in 1993 to less than 6 per cent in 2010, while immigration's share of population growth grew from less than 20 per cent to around 60 per cent in the same period. Especially in 2009, the net oversea migration approached to 299,800 (nearly 70 per cent of the Australian population growth in that year), while the unemployment rate dropped to less than 5 per cent (ABS, 2014). It is important to note that the net oversea migration as a proportion of population growth is only used in the Figure 1, while this study has used the time series of net oversea migration in a quarter per 1000 Australians that is given detailed quarterly state data.

FIGURE 1 Net migration rate and unemployment rate in Australia: 1982 – 2014



Note: Left axis/Blue line is net migration's share of population growth; Right axis/Orange line is unemployment rate. The detailed time series graphs for each state are given in the Appendix.
Source: Australian Bureau of Statistics (3101.0; 6202.0)

Most empirical studies based on Australian data suggest no causation from immigration to unemployment, and often reveal that unemployment could have a significant or insignificant negative effect on immigration (Withers and Pope, 1985 and 1993; Tian and Shan, 1999; Konya, 2000). The contemporary relevance of these studies has diminished, since the most up-to-date data sets they examined ended at 1998, before the increase in immigration's share of population growth (Konya, 2000). The research question of how the inflow of international immigrants affects domestic unemployment in contemporary Australia lacks a conclusive answer.

Moreover, apart from Harrison (1983), who analysed immigration impacts on the labour market in the state of South Australia, all Australian studies have used country level data. These studies impose restrictive assumptions that the attractiveness of all Australian states have always been at the same level and the inflow of immigration is evenly distributed into each state by gender, income, and skill classes. However, Australian Bureau of Statistics (2015) data show that international immigrants revealed a preference in migrating to more prosperous and more populous states like New South Wales and Victoria. An important research question is how the different sized labour markets in each state would respond to the different levels of net migration, and if a causal relation between unemployment and immigration can be found in all different labour markets.

This study answers these research questions in the Australian labour market by analysing data from five relatively populous Australian states (New South Wales, Queensland, South Australia, Victoria and Western Australia) from 1988 to 2012. In particular, this study does the following. Firstly, based on the existing theoretical studies and historical empirical literature, a general model is proposed as the foundation to explore the immigration-unemployment relationship. Secondly, whether there is a cointegrating relationship among the time series is individually examined for five states based on the model. Then, Granger causality testing methods are used to identify the directions of causation among the cointegrated time series. The statistical causality tests also provide estimations on the short-run and long-run relationships, which give insight into the immigration effect on each state and whether the effect varies by the size of the labour market.

A contribution of this research is its possible application to the development of Australian immigration policy and unemployment benefit policy. Currently, it is difficult for the Australian government to develop evidence-based policy because Australian studies are out-of-date and foreign studies are not transferable to Australia.

Chapter Two: Literature review

2.1 Overview

This chapter reviews the literature on the immigration and unemployment relationship. Section 2.2 provides a theoretical overview and Section 2.3 reviews empirical evidence, including Australian studies. The various conclusions from historical empirical studies make it explicit that a formal empirical study on the immigration-unemployment relationship in Australia needs to be conducted to assist government decision-making on future immigration and unemployment benefit policies, as well as to inform Australians' opinions on immigration.

2.2 Theoretical review

The following historical literature suggests that immigration could have both direct and indirect effects on the domestic unemployment rate. Theory indicates three key factors which determine the short-run and long-run effects of immigration on unemployment rate include the size of the immigration flow determined by economic inequality between home (origin) and host (destination) regions, the aggregate demand effect of immigration and the labour market responses to immigration.

An important theoretical linkage between immigration and unemployment is the real wage in the labour market. From a classical view, a simple labour supply and demand model can demonstrate the economic effect of immigration. The inflow of immigrants increases the labour supply, which pushes the labour supply curve to the right. By holding the demand curve unchanged, the wage would decrease until the wage gap between immigration origin nations and host nations diminishes. Based on this rationale, Sjaastad (1962) measured how many immigrants were needed to eliminate the income gap based on 1950s American immigration data. The measures of wage gap, defined as the motivation of immigration, allowed Sjaastad to account for an average individual's private cost and return on immigration. Since Sjaastad mainly focused on describing how the aggregate private cost would minimize the geographical wage difference, the potential effect of immigration on unemployment was ignored.

The unemployment issue was first brought to the fore by Harris and Todaro (1970). They described a model of two-sector (agricultural rural and manufacturing urban) economy allowing for a higher than market-clearing level urban minimum wage. Due to the presence of this wage rigidity, unemployment is a long-lasting phenomenon in the urban sector. Migration from rural to urban centres occurs when the urban minimum wage changes. These changes affect the judgement of rural residents on the expected income gap. As the minimum wage starts to increase, agricultural workers are willing to move to the urban sector despite the presence of persistent unemployment. Although the theory assumes that every unemployed individual has the same probability of getting a job, the inflow of immigrants would increase the unemployed population in urban areas. Under such circumstances, Harris and Todaro implied a positive relationship between immigration and urban unemployment (Fromentin, 2013).

Harris and Todaro (1970) highlighted the importance of the difference in economic conditions between the origin and receiving regions. The income gap in the model is an explicit demonstration of the economic inequality between regions. Harris and Todaro (1970) also showed that the size of the immigration flow is a positive function of the expected income gap between home and host regions. It has been found that many empirical studies (such as Marr and Siklos, 1994; Feridun, 2005) support the Harris-Todaro model and use variables such as gross domestic product and the real wage of host nations to reflect the motivation of immigration and how the size of the immigration flow interacts with inequality between origin and host nations. The hypothetical relationship between unemployment and immigration (Harris and Todaro, 1970) could be found as below.

$$N_u = \psi\ (W_m * N_m / N_u - P * q^{'}) \qquad \text{(a)}$$

Where N_u represents the overall urban labor force, N_m represents labor demand of manufacturing, W_m represents the imposed minimum wage, P represents the price of agricultural product putting the manufacturing goods as numeraire and q' is the derivative of agricultural production function with respect to the labor demand of agricultural sector.

However, how immigration affects the local host economy in a way that can create new jobs is given insufficient attention in Harris-Todaro's migration model. The following section reviews researches that explore the role that immigrants play in creating extra demand and hence

additional employment.

Harrison (1983) issued an informal explanation of the demand effect of immigration in his study of the South Australian labour market. By assuming that immigrants and locals will consume goods and services at the same level, Harrison (1983) pointed out that a direct consequence of immigration is an increase in consumption and hence demand for goods and services. The expanding need for goods and services creates more jobs in the labour market. In applying for these positions, local workers appear to be more competitive than immigrants due to the assimilation barriers such as language, skill qualifications, and educational gap. Harrison (1983) concluded that immigration would decrease the unemployment rate of local workers in the short run since the extra jobs created by the immigrants are more likely to be filled by locals than the immigrants; and would subsequently expand the economy permanently. Harrison (1983) did not present whether it is a short-run or long-run effect, but Ng and Simon (1999) formalised Harrison's model and summarised it as a short-run effect.

Based on Harrison's theory, Ng and Simon (1999) constructed an examinable relationship between immigration and change in unemployment rate as the formula below.

$$U' - U = [(a-d)sEM - dMU] / [sE + U + aM] \qquad \text{(b)}$$

U' represents the unemployment rate of natives after immigration, *U* is the pre-immigration unemployment rate, *E* is the number of employed labor force before the entrance, *M* is number of immigrants, *s* is the job turnover rate, *d* is the average immigrant's consumption relative to average native consumption (which actually represent how much proportion of a job could be generated through the consumption of an immigrant), *a* indicates the difference between the chances of an immigrant and an local to apply for the same job, *a*M* is the number of successful job-seekers in overall immigrants.

Nonetheless, this theory understates the positive effect of immigration on the host economy due to its insufficient analysis of the disparate characteristics between immigrants and locals (Simon, 1999). Despite the acknowledgment of immigrants' difficulties in job-seeking, Harrison ignores the impact of the differences in characteristic on the demand side. Simon (1999) explains how it would impact the aggregate demand in the long run. Owing to the continuous inflow of immigrants, the host economy will be characterised by new features such as the increased

demand for foreign goods or services, the supply chain to meet the new needs and even the changes in the preference relation of locals due to multiculturalism. The average job seeking hours of the unemployed are indeed longer in the short-run due to the increased competition, but would be reduced in the long-run once these new features start to create new jobs and even new industries. Meanwhile, instead of regarding the immigrants as a reserve army of unemployed which only drags down wages and increases the unemployment rate, the unemployed immigrants sustain and expand cultural integration industries such as language schools, and bring their foreign knowledge to local production processes.

The above literature mainly focuses on the indirect effect of immigration on unemployment either through government intervention on minimum wages or through the increased aggregate demand. An important underlying assumption of these theories is the homogeneity between immigrants and locals in the labour market. The consequence of the homogeneity assumption is the direct competition between immigrants and locals that leads to the increase in the short-run unemployment rate. To examine the direct impact of immigration on unemployment, the labour market competition must be modelled to relax the homogeneity assumption.

Piore (1979) challenged the homogenous labour force by observing the real world composition of the labour force of the United States. His study disaggregated the local labour groups by skill classes and separately examined the effect of immigration on each group. Observing the low skill groups in the United States, he found that the group called "secondary workers" (mainly youths and housewives) appear to be more vulnerable to the continuous inflow of immigrants than the others.[1]

Chiswick (1978) challenged the homogeneity assumption from the immigrant's perspective, arguing that it is impossible to perfectly transfer any immigrant's working capacity and endowment from one country to another. Furthermore, the productivity of immigration is positively related to the period of residency in the United States, which mean immigrants would only become competitive with local workers if they reside long enough (Chiswick, 1980, p25). The relaxation of the homogeneity assumption has encouraged a number of studies on the substitution and complementary role of immigrants to local workers (Chiswick, 1982; Borjas and Tienda, 1987; Dolado, Goria and Ichino, 1994)

[1] Altonji and Card (1991) further prove it by showing the job displacement phenomenon in the low-wage and less skilled industries in 120 US major metropolitan statistical areas (SMSA) from 1970 to 1980.

Chiswick (1982) developed a Cobb-Douglas production function with two types of labour (skilled and unskilled) and capital. Under the assumption of constant elasticity of substitution, he states that either complementary or substitutable labour leads to the same positive effect on aggregate income and gross domestic product per capita in the host countries. He also concludes that the only beneficiary local workers would be the complementary group of immigrants, while the substitute group has to confront fiercer competition and lower wages. Friedberg and Hunt (1995) also reached a similar conclusion and further argued that the magnitude of the positive effect of immigration depends upon the contribution of immigrants to the national income and the wage elasticity of labour demand.

In addition to the analysis of the nature of immigrants and locals, economists reveal that immigration has a direct effect on the domestic labour market which can be observed from the local labour market responses to immigration. These responses are determined by the elasticities of the labour supply and demand curve as well as the difference in capability between immigrants and locals.

Greenwood and McDowell (1986) conclude that it is the elasticities of the labour supply and demand curves, as well as the number of annual legal immigrants, which influence the impact of immigration on the wages and overall unemployment of the local labour force. For a given level of immigration, the more inelastic the labour supply and demand curves, the more severe would be the effect on the local wage. In addition, there would be a bigger job displacement effect[2] if the domestic labour supply is more elastic and labour demand was more inelastic.

A demonstration on a typical Cobb-Douglas application on the issue was given by Dolado, Goria and Ichino (1994). In this study, they denoted the human capital to decompose the workers which actually described the interchangeableness of immigrant and natives better than conventional skill or education composition methods. By taking human capital and migration into the Solow Growth model, they studied how the native output and economy growth would react differently to the different human capital content and different size of inflow. Their constant return to scale production function is shown as following.

[2] The decreased wage due to immigration points to a lower position on the original labour supply curve (the local labour supply curve). At the new wage level, the gap between the new labour supply curve and the local labour supply curve is filled by immigrants, but not locals.

$$Y = H^{\alpha} * K^{\beta} * (Le^{gt})^{1-\alpha-\beta},\ 0<\alpha, \beta< 1.$$

$$H' = s_h Y - \delta H + m\varepsilon_h H; \text{ and } K' = s_k Y - \delta K \qquad \text{(c)}$$

Y is the output, H is human capital and H' is next period human capital, K is physical capital and K' is next period physical capital, L is the overall labour force which will grow at g, s_h is the percentage of output which invested in human capital, s_k is the percentage of output which invested in physical capital. We also assumed the depreciation rate of both capital is δ; m is the net migration rate (net migration(M)/overall labor force(L)), ε is the human capital factor and $m\varepsilon_h H$ is the additional human capital brought by immigration.

Dolado et al (1994) suggest using human capital to measure the productivity of workers, by decomposing the labour force by the schooling measures[3]. According to their demonstration, as long as the host nation is a net receiver of immigrants, accepting immigrants who have more human capital would increase both the output and growth rate of the host economy. In addition, the magnitude of this positive effect of immigration depends on the average human capital of immigrants compared to locals' in the host economy that is similar to Friedberg and Hunt's (1995) finding. Gross (2002) conducted a study on the role of skill and origin of immigrants, and suggested that a mixture of skill classes and origins of immigrants would benefit the host economy the most. In France, lopsided immigration policies, such as the skill-oriented immigration program, aggravated the dispersion of the local workforce, which increases the unemployment rate.

In conclusion, existing theories suggest that immigration has a direct influence on aggregate demand and labour supply. In the real world, there are many roles that the government could play to stimulate the positive effects of immigration on local economy, for example government determines how many immigrants will be allowed in a year, which skill groups are more welcome, which level of minimum wage should be set to ensure labour participation and which industries are encouraged to boost the economy. A productive immigration policy requires a continuous understanding of the nature of both the local economy and labour market, as well as the comparability of the human capital of locals and immigrants.

[3] They use three sources of schooling information: the secondary school enrolment data of World Bank; the time series of school attainment (Kyriacou, 1991); and time series of school attainment by Barro and Lee (1992).

2.3 Empirical literature review

Economic theory gives insight into the major factors that determine the immigration-unemployment relationship. However, the development of policies must be informed by up-to-date empirical studies. In fact, economists have contributed many empirical studies on the relationship between immigration and unemployment across the world. Some of these studies use reduced form models that explore the long-run and short-run relationships based on the empirical data. Early researchers tended to estimate the relationship based on time series data, while recent studies use panel data analyses. Other studies start by adding immigration into existing unemployment theory and employ structural form models to test their deduced relationship, for instance, that immigrants take over local jobs (Withers and Pope, 1993). Most of these studies chose to start with a multi-equation system and to use two-stage least squares (2SLS) method to estimate the relationship.

Reduced form framework

An early empirical study is Withers and Pope (1985) who analysed the unemployment effect of post-war (1948-1982) European immigration in Australia. Three estimation methods were used. At first, the F statistics of their Granger bilateral causality tests suggested one-way causality from unemployment to immigration. Then, based on Harper's (1980) and Warren's (1982) work on the role of frictional-structural unemployment in the unemployment-vacancies relationship, Withers and Pope (1985) suggested that immigration has an insignificant negative effect on structural unemployment. Finally, extending the rationing model[4] of Trivedi and Baker (1982) to include immigration, they concluded that unemployment in the period was mainly cyclical due to demand deficiency. The study concludes that the effect of immigration on unemployment is slightly negative indicating that immigrants create more job than they take.

Marr and Siklos (1994, 1995) conducted two empirical studies on the relationship between immigration and unemployment in Canada. Using the non-parametric quarterly time series data of the Canadian unemployment rate, immigration rate[5] and a vector of aggregate supply and

[4] Trivedi and Baker (1982) incorporated the real wage and demand efficiency explanations, which incorporate the classical and Keynesian view of cyclical unemployment.
[5] Defined as the number of immigrants as a percentage of the overall labour force.

demand variables[6] from 1962 to 1990, Marr and Siklos (1994) applied multivariate non-parametric spectral methods and found: 1) the results are sensitive to the chosen sample period; 2) before the structural break in 1978, increases in the current unemployment rate reduced the future immigration rate; and 3) in the sample period of 1978 to 1985, an increase in the immigration rate increased the subsequent unemployment rate. Using annual time series data of unemployment rate, immigration rate and real gross domestic product during the period 1926 to 1992, Marr and Siklos (1995) estimated a Granger causality test between immigration and unemployment based on an unrestricted vector autoregression (VAR) model. They conclude that the unemployment rate has a significant adverse effect on immigration, but not vice versa.

Tian and Shan (1999) applied the Granger no-causality test[7] to explore this issue based on quarterly Australian time series from 1983 to 1995. Based on the disequilibrium model of Withers and Pope (1993), they constructed a six dimensional VAR model. Apart from unemployment rate and immigration rate[8], they used wage, unemployment benefit and the Stoikov index to capture the unemployment effects, and used capacity utilisation rate to reflect the aggregate demand effects. The modified WALD test on their VAR (5) model could not reject the null of no causality between immigration and unemployment.

Two-stage Procedures

A popular estimation strategy in exploring the long-run and short-run relationship between immigration and unemployment is a two-stage procedure developed by Engle and Granger (1987), Johansen and Juselius (1994), and Johansen (1995). This process starts by identifying the stationarity of time series. In the first stage, a cointegration analysis on immigration, unemployment and other long-run endogenous variables[9] is constructed. If the results suggest that the non-stationary time series are cointegrated (residual-based test) or there exists one or several cointegrating relationship (trace statistics and maximum eigenvalue), a vector error correction model (VECM) is used in the second stage to examine the short run relationship using the estimated long-run relationships as error correction terms.

[6] Nominal GDP captures the demand side effect (Lucas, 1973); monetary policy captures aggregate demand effects (Begg, 1983); the energy price captures aggregate supply effects (Gordon, 1982).
[7] Developed by Toda and Yamamoto (1995), and extended by Zapata and Rambaldi (1997).
[8] Defined as the number of net migration per 1000 Australian in a given quarter.
[9] GDP per capita or real GDP, real wage, labour cost and such.

Gross (2002) employed a Johansen two-stage procedure to explore the immigration-unemployment relationship in France based on quarterly data from 1974 to 1994. The variables in her model included immigration rate, unemployment rate, women's participation rate and real labour cost. Three measures were used for the immigration rate: the immigration rate only counting legal workers; and the immigration rate including amnestied workers counted from two estimation scenarios. Both maximum eigenvalue and trace statistics from the first stage cointegration analysis supported the existence of two cointegration vectors. The estimated coefficient's eigenvectors suggested that the immigration rate has an inverse relationship with the French unemployment rate in the long run[10]. Thus, the result is interpreted as being consistent with earlier findings (Simon, 1989; Altonji and Card, 1991) that immigrants create more jobs than they occupy. In the second stage, Gross specified the model as a two-equation structural model in differences to compare the impact of different immigrant groups and concluded that:1) the size of immigration inflow is insignificant; 2) a mixed skill assessment policy decreases the skill dispersion in the local labour force and will decrease the unemployment rate; 3) there is no difference between the impact of legal foreign workers and the impact of amnestied workers on the French labour market; and 4) an increase of immigration rate would slightly increase the unemployment rate in the short run.

Gross (2004) employed a standard two-stage Johansen procedure to estimate a four-equation model of the labour market in British Columbia, Canada, over the sample period of 1980 to 1995. The first stage cointegration analysis revealed two cointegration vectors at lag 4. The conclusion on the short-run and long-run unemployment immigration relationships were consistent with her findings for France.

In Australia, Konya (2000) studied the quarterly series of the unemployment rate and immigration rate[11] over the sample period of 1981-1998. A cointegration analysis based on Engle-Granger approach (residual-based test) was conducted at first. Using both seasonal-adjusted and original data, Konya could not conclude there exists a cointegration relation between two variables. However, he found different results from the Granger bilateral causality test, which suggested that the increase in the immigration rate would reduce the unemployment rate in the long-run.

[10] Note that the adverse effect is larger if we take immigrant's families as the immigration measure instead of immigrants alone.
[11] The percentage of Net permanent and long-run movement in Australian population (ABS 3101).

In Norway, Feridun (2005) studied the annual series of unemployment rate, immigrants' share of population and gross domestic product per capita from 1983 to 2003, following a standard Johansen two-stage model. In the first-stage cointegration analysis, he concluded that no long-run relationship can be established. He also built a VAR model to examine if any Granger causality can be found, and again accepted the null hypothesis of no Granger causation in either direction between immigration and unemployment.

Adding to the wage variable in Feridun's model, Islam (2007) examined the quarterly Canadian time series data over the sample period of 1961 to 2002. He first employed a Granger bilateral causality test between immigration [12] and unemployment rates. It reveals that the unemployment rate Granger causes the immigration rate. In the Johansen cointegration test, Islam (2007) found the existence of a cointegration vector. In the long run, he concluded there is an insignificant negative relationship between the immigration rate and the unemployment rate. Using this relationship as the error correction term into the VECM(5) model, he confirmed the finding of the Granger causality test, which is a unidirectional causality from unemployment to immigration. Later, Fromentin (2013) obtained a similar result for France based on annual data from 1970 to 2008 using a standard Johansen two-stage procedure.

Panel data analysis

Panel data analyses have also been used to estimate the immigration and unemployment relationship. Observing economic and labour markets data over the sample period of 1975 to 2001, Brucker, Fachin and Venturini (2011) explored the job displacement effects in five Italian regions experiencing foreign and domestic migration. Under the assumption of homogeneous long-run effect among regions, they used a bootstrap panel cointegration test to explore the long-run relationship and apply this relationship to the ECM models for each region. The main findings were: 1) the increase in difference in wage and unemployment rate would motivate internal domestic migration; 2) international immigration increases domestic inequality by discouraging internal migration from the poor South to the rich Centre-North of Italy; and 3) using the foreign immigration rate to identify the immigration effect on unemployment is likely to underestimate the impact. The significance of their study is considering the interaction between international immigration and domestic migration and its possible labour supply effect. It is particularly important when studying a host economy with obvious regional disparities.

[12] Islam's immigration rate is measured as number of immigrants' inflow per one thousand Canadian in a given quarter.

Boubtane et al. (2013) explored the relationship between immigration and unemployment based on the annual data of 22 OECD nations for the period of 1980 to 2005. They use the bootstrap panel Granger causality approach, based on the Seemingly Unrelated Regression systems and the WALD test with country/region specific critical values developed by Konya (2006), which test how many and which members in the panel have one-way causality or bidirectional causality. Boubtane et al. (2013) found that immigration has not contributed any negative effect to any of these 22 countries' domestic employment rates. In the opposite causal direction, they only found a negative effect from unemployment to immigration in one country, Portugal.

Following their model of unemployment rate as a function of immigration rate and real GDP per capita, Latif (2015) explored this relationship using annual data for ten Canadian provinces over the period of 1983 to 2010. His estimations strategy can be summarised in three steps. Firstly, he concluded that unemployment, immigration and GDP per capita are cointegrated based on two panel cointegration tests[13]. In a second step, he estimated the long-run relationship using Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) and concluded that the unemployment effect of immigration is insignificantly negative in the long run. Thirdly, he employed the VECM model using an error correction term from the estimation of a Johansen Fisher Panel cointegration test [14]. Based on the estimated unemployment equation in the VECM, the unemployment effect of immigration was significantly positive in the short run. In general, this empirical study showed that the immigration rate has a positive effect on unemployment in the short run but an insignificant negative effect on unemployment in the long run.

Structural modelling

Structural form models are often used to examine deduced relationships between immigration and unemployment based on unemployment-immigration theories. Based on a four-equation[15] disequilibrium model, Withers and Pope (1993) inferred the existence of a relationship between

13 Pedroni (2004)'s test does not resolve the concern of cross-sectional dependence which can be dealt with by using Westerlund (2007) test.
14 Considering Fisher's (1932) suggestion to combine individual tests, Larsson et.al. (2001) test the hypothesis that all of groups in the panel have at most *r* cointergration relationship among the variables.
15 Unemployment, immigration, real wage and capacity utilization rate equations.

immigration and unemployment, which can be either positive or negative. In their econometric analysis for Australia, they analysed annual data from 1861 to 1981 and tested the null hypothesis that "immigrants rob jobs" in their unemployment equation. The results based on 2SLS estimation suggested that the immigration rate has a significant negative effect on the unemployment rate. The results are robust in every sub-period estimation, which is divided by structural breaks like the establishment of the Australian Federation in 1901 and World War II (1939-1945). The estimation on the equation of immigration suggested that an increase in current domestic unemployment would reduce future net migration. They also focused on the 1980s when the Australian government increased the inflow of immigration to fight against the increasing unemployment (Withers and Pope, 1993, p733-735). The results showed that the increasing immigration rate contributed to the reduction of the unemployment rate in the period.

Based on Saint-Paul's (1996), Acemoglu and Angrist's (2001) research on the effects of labour market regulation and employment protection, Angrist and Kugler (2003) developed a model for Western Europe with both immigrants and local workers to forecast the unemployment effect of immigration and how this effect can be influenced by changing labour market institutions. Once immigrants and locals are perfectly substitutable in the labour market, the short-run immigration effect on unemployment would be positive, and this positive effect would diminish in the long-run. The parameter describing substitutability between Western European locals and immigrants is estimated. Based on Ordinary Least Squares (OLS) estimation on 18 Western European OECD countries' data from 1983 to 1999, they find a positive effect of immigration on unemployment. Using an instrumental variable estimation strategy [16], immigration's effect on unemployment was still large and significant. Furthermore, restrictive practices such as high firing cost, wage rigidities, and entry cost in the local labour market will increase the magnitude of the positive effect of immigration on the unemployment rate.

Jean and Jimenez (2007) criticised the Angrist and Kugler (2003) study for misspecification issues and including GDP and government policy factors in the model. They examined the annual Labour Force Survey from 18 OECD countries (including the United States, Australia and New Zealand) over the period of 1984 to 2003. Their findings were consistent with Angrist and Kugler's (2003) finding that the immigration effect on unemployment in OECD countries is diminished in the long run with the presence of a significantly positive and large transitory

[16] The instrument variables are the distances of involuntarily emigration from Sarajevo and Pristina taking Bosnia War and Kosovo War to divide sample periods.

effect in the short-run.

Dustmann et al. (2003) argued that immediate job displacement by immigration may not be captured if there are enough spare positions in the short run. It is possible that immigration will drag down the speed of adjustment toward the long-run equilibrium in the labour market. Using the first lags of immigrant shares of the sample population as instruments, their estimations based on the 1971, 1981 and 1991 UK census suggest that immigration can present a significant positive effect on unemployment. However, due to the limited information on the labour market in the census data, they could not determine whether the cause of such an increase in unemployment is the high unemployment rate among immigrants or the increased unemployment rate of locals due to immigration. They further analyse the annual Labour Force Survey from 1983 to 2000 which provided information to isolate the local unemployment rate from the overall unemployment rate. They observe a high outflow of local workers in the semiskilled sector, which is related to the growth of immigrants.

Furthermore, Dustmann et al. (2003) compare the effect of different labour types[17] of immigrants on unemployment of locals. The results did not reveal strong evidence that immigration from a specific origin or any particular gender would pose a bigger threat to local employment status. In general, the positive effect of immigration on unemployment becomes smaller and insignificant based on continuous annual series. Dustmann et al.'s finding of weak evidence on the positive effect of immigration on the unemployment rate confirms their theory on short-run and long-run effects.

2.4 Summary

The existing empirical literature presents different and even contradictory conclusions on the sign of the immigration-unemployment relationship. It remains an open question for future research. Immigration can have both direct and indirect effects on local unemployment according to existing economic theories. However, whether the aggregate effect of immigration is positive or negative must be determined empirically case-by-case. The most recent Australian evidence is 15 years old, when immigration contributed a lower share of population growth

17 By origins and by gender.

than now. The following empirical study provides new evidence for Australia using more up-to-date data. It contributes to the policy debate on existing Australian immigration policy.

Summarized table for Empirical literature reviews.

Table A: Summary Table of Empirical literature

Time series			
Author	Year	Focus of the study	findings
Withers and Pope	1985	Quarterly time series of immigration and unemployment for the post WWII (1949-1982) European immigration in Australia	1) Unemployment Granger-causes immigration; 2) Immigrants create more jobs than they take.
Marr and Siklos	1994	Non-parametric quarterly time series of immigration, unemployment, nominal GDP, monetary policy and energy price of Canada from 1962 to 1990	1) before 1978, increases in the current unemployment rate reduced the future immigration rate; 2) in the sample period of 1978 to 1985, an increase in the immigration rate increased the subsequent unemployment rate
Marr and Siklos	1995	Annual time series of immigration, unemployment and real GDP of Canada from 1926 to 1992	Unemployment have a negative effect on immigration
Tian and Shan	1999	Quarterly Australian time series of immigration, unemployment, wage, unemployment benefit, Stoikov index and capacity utilization rate from 1983 to 1995	No causal relationship between immigration and unemployment is found
Konya	2000	Quarterly Australian series of immigration and unemployment from 1981 to 1998	The increase in the immigration rate would reduce the unemployment rate in the long-run; no causality is found in the short run.
Gross	2002	Quarterly French series of immigration, unemployment, women participation rate and real labour cost from 1974 to 1994	1) The immigration rate has an inverse relationship with the French unemployment rate in the long run; 2) An increase of immigration rate would slightly increase the unemployment rate in the short run.
Gross	2004	Quarterly time series of immigration, unemployment, real wage and young labour force participation of British Colombia, Canada, from 1980 to 1995	Consistent with Gross (2002)'s findings.
Feridun	2005	Annual Norway time series of unemployment rate, immigrants' share of population and gross domestic product per capita from 1983 to 2003	No cointegration relationship and no causality is found between immigration and unemployment.

Islam	2007	Quarterly series of immigration, unemployment, real wage and real GDP of Canada from 1961 to 2002	1)The unemployment rate Granger causes the immigration rate; 2)An insignificant long-run negative relationship between the immigration rate and the unemployment rate;
Panel Data analysis			
Brucker, Fachin and Venturini	2011	Annual data of five Italian labour markets from 1975 to 2001, variables including wage, unemployment, foreign and internal migration	1) The increase in difference in wage and unemployment rate would motivate internal domestic migration; 2) International immigration increases domestic inequality by discouraging internal migration from the poor South to the rich Centre-North of Italy
Boubtane, Coulibaly and Rault	2013	Annual data of 22 OECD countries from 1980 to 2005, using immigration rate and unemployment rate.	1) Immigration has not contributed any negative effect to any of these 22 countries' domestic employment rates; 2) Only in Portgual, high unemployment could reduce immigration.
Latif	2015	annual data of ten Canadian province from 1983 to 2010, the variables include unemployment, immigration and real GDP per capita	1) In the long run, immigration has an insignificant negative effect on unemployment; 2) In the short run, immigration has a positive effect on unemployment.
Structural modelling			
Author	Year	Data and hypothesis	findings
Withers and Pope	1993	Annual Australian series from 1861 to 1981; Hypothesis: immigrants rob jobs.	Immigration rate has a significant negative effect on the unemployment rate
Angrist and Kugler	2003	Five-year intervals data from 18 Western European OECD countries from 1983 to 1999; Hypothesis: there exists the unemployment effect of immigration and it can be influenced by changing labour market institutions.	1) Immigration could have a positive effect of unemployment; 2) Restrictive practices in labour market could increase the magnitude of the positive effect.
Dustmann et al.	2003	1971, 1981 and 1991 UK census; and UK Labour Force Survey from 1983 to 2000. Hypothesis: 1)immigrants rob jobs; 2) the job displacement effect is different to different labour group; 3)immigration will drag down the speed of adjustment toward the long-run equilibrium in the labour market	1) Immigration can present a significant positive effect on unemployment; 2) The locals from semiskilled sector are leaving related to the high growth of immigration; 3) The positive effect of immigration on unemployment is diminishing in the long run.

Chapter Three: Methodology

3.1 Data and Variable selection

The study uses quarterly Australian state data during the period of March 1988 to June 2012 from the Australian Bureau of Statistics (hereafter ABS). The sample covers five Australian states: New South Wales (NSW), Queensland (QLD), South Australia (SA), Victoria (VIC) and Western Australia (WA).

The study using the state-level data gives insights into the question of how the different sized labour markets respond to different levels of migration. The relationship between immigration and unemployment is revealed by estimating a general model representing a long-run equilibrium relationship among four variables: real wage (*RW*), real gross state product per capita (*PCGSP*), unemployment rate (*UN*), and immigration rate (*IM*).

Five Australian states

This study focuses on the five states (NSW, QLD, VIC, SA and WA) for the following reasons. Firstly, the five states are the most populous states in Australia and the only five states where the estimated resident population has been larger than 1 million throughout the sample period. They provide a large enough domestic labour market to carry out comparable and reliable empirical results.

Secondly, the five states provide a sample of different sized labour markets. In the first quarter of 1988, the smallest labour markets were South Australia and Western Australia which had a labour force of around 0.7 million. Queensland and Victoria had a relative larger labour population, at 1.28 million and 2.06 million respectively. The largest labour market at the beginning of the observation period was New South Wales, which had a labour force of 2.7 million. At the end of the sample period, the labour force of South Australia had increased to 0.85 million, and the labour force of Western Australia had increased to 1.36 million. Queensland's labour force reached 2.41 million and Victoria's labour force reached 3.01

million. The largest labour market was still the New South Wales with 3.7 million in Quarter 2 of 2012 (ABS, 2016).

At last, these five states are long-run net receivers of immigrants. The number of immigrants to more prosperous states is always higher than migrants to less prosperous states. The NSW and VIC have remained as the biggest and second biggest destination states in Australia throughout the period, followed by QLD, WA and SA.

A brief overview of the data for each state is given as the following.

Table B: Descriptive Statistics

		NSW			
Average Quarterly data	1988-1992	1993-1997	1998-2002	2003-2007	2008-end
Labour Force (000)	2806.34	2964.34	3156.35	3374.89	3642.82
unem_rate (%)	0.0787	0.0872	0.0611	0.0521	0.0528
GSP per head per quarter	9675.99	10298.51	11515.19	12892.98	13732.25
immi_rate (per 1000 Australian)	1.91	1.33	1.74	1.75	2.36
Average Weekly Earnings	488.44	577.68	680.98	850.74	983.60
		VIC			
Labour Force (000)	2167.66	2240.62	2364.75	2588.83	2884.87
unem_rate (%)	0.0769	0.0984	0.0667	0.0521	0.0515
GSP per head per quarter	9687.74	10510.98	12848.88	14927.08	16241.39
immi_rate (per 1000 Australian)	1.60	0.98	1.39	2.04	2.84
Average Weekly Earnings	474.79	556.83	628.37	774.485	923.12
		QLD			
Labour Force (000)	1405.91	1612.12	1782.44	2049.39	2349.28
unem_rate (%)	0.0870	0.0942	0.0789	0.0502	0.0505
GSP per head per quarter	8956.32	9790.47	11081.27	13189.27	14525.55
immi_rate (per 1000 Australian)	1.17	0.75	1.42	2.12	2.62
Average Weekly Earnings	441.44	517.42	616.29	757.71	973.62
		SA			
Labour Force (000)	701.49	714.30	725.38	777.66	841.06
unem_rate (%)	0.0904	0.1013	0.0783	0.0540	0.0530
GSP per head per quarter	9132.83	9875.82	11702.88	13892.81	15241.21
immi_rate (per 1000 Australian)	0.84	0.47	0.52	1.43	2.12
Average Weekly Earnings	448.88	515.83	598.60	700.25	870.90
		WA			
Labour Force (000)	801.13	885.93	975.17	1081.09	1261.72
unem_rate (%)	0.0851	0.0799	0.0644	0.0442	0.0416
GSP per head per quarter	11867.11	13751.47	15569.16	20406.78	27929.16
immi_rate (per 1000 Australian)	2.31	1.42	1.91	2.73	4.51
Average Weekly Earnings	468.41	537.90	607.72	785.78	1067.29

Data Source: Australian Bureau of Statistics, 2016 (3101.0, 5206.0, 5368.0, 6202.0, 6302.0, 6401.0)

3.2 Empirical framework

Economic theory and historical empirical literature provide contradictory signs of the effects of immigration on the domestic unemployment rate and local economic growth. This study explores the empirical causal relationship between immigration and unemployment in five Australian states based on a four-variable vector autoregressive model. The stationarity properties of the variables are first examined by the most commonly used unit root tests. Then, the Johansen (1988) cointegration test is used to determine whether the series are cointegrated, and explore the rank of the cointegration vector in each state. If two or more I(1) time series are cointegrated, there must exist a causal relation in at least one-direction (Granger, 1986). To test the direction of causality, the Toda and Yamamoto's augmented vector autoregressive model is applied to the cointegrated time series. Finally, the vector error-correction models are used to determine the direction of long-run causation and the speed of adjustment parameters.

A general model

The aim of this study is to examine the impact of immigration on the Australian labour market. As noted in Chapter 2, immigration could have effects on both aggregate demand and labour supply, which have indirect and direct effects on the unemployment rate. The size of immigration can be influenced by the performance of destination economies, the characteristics of host labour markets and government policy. Thus, in order to estimate the effect of immigration on host labour markets, the study focuses on the aggregate demand effect of immigrants, the responses of domestic real wage and the state labour supply curve. In summary, the major concern of this study is to estimate the interconnection between immigration, economic performance, wages and unemployment.

The study adapts the model suggested and empirically examined by Layard et al (1991), Gross (2002), Islam (2007), Fromentin (2013) and Latif (2015)[18]. Islam (2007) rejected the null hypothesis of weak exogeneity of the four variables, and specifically pointed out that none of

[18] Note that Latif (2015) had to adapt a three variable model. But his definitions of variables and sources of data were exactly as the same as Islam (2007), which did not provide the provincial wage data so that he cannot construct a general model with four variables.

the variables should be excluded from the model. Such a model could be specified as a system of four simultaneous equations as following.

$$UN_{it} = UN_{it}\,[IM_{it}, PCGSP_{it}, RW_{it}, D_{UN}],$$
$$IM_{it} = IM_{it}\,[UN_{it}, PCGSP_{it}, RW_{it}, D_{IM}],$$
$$PCGSP_{it} = PGSP_{it}\,[IM_{it}, UN_{it}, RW_{it}, D_{PCGSP}],$$
$$RW_{it} = RW_{it}\,[UN_{it}, IM_{it}, PCGSP_{it}, D_{RW}], \quad (1)$$

The four variables are in logarithms. *UN* is the quarterly unemployment rate, *IM* is the quarterly immigration rate, *PCGSP* is real GSP per capita in a quarter, and *RW* is the real wage in that quarter. The vectors, D_x, represent sets of dummy variables for each equation. The subscript *i* (*i= 1, 2, 3, 4, 5*) represents five states and *t* (*t= 1….T*) is the time period. The underlying assumption of such a system of four equations is that such a general equilibrium model is stabilised in the long run. As the time trend is not observed in the series, the deterministic trend would be excluded in the model. For every *i* state, the basic theoretical model is a four-variable vector autoregressive model (VAR) of order *n*, shown as the following.

$$Y_t = \alpha_0 + \sum_{j=1}^{n} (\beta_j Y_{t-j}) + \gamma * D + \varepsilon_t \quad (2)$$

Where $Y_t = [UN_t, IM_t, PCGSP_t, RW_t]'$, *D* is a vector of dummy variables and γ are the coefficients of dummy variables, α_0 represents a vector of constant, and ε_{it} is the vector of errors i.e. $\varepsilon_{it} \sim$ i.i.d. N (0,1) . β_j are matrices of coefficients of lagged dependent variables. The four variables in Y_t are assumed to be endogenously determined in the general equilibrium framework describing the supply and demand effects of immigration on unemployment. Estimating the system of equation (2) could provide insight into the long-run and short-run relationship between the four variables.

Variable specification

Real wage: The original wage data is the "average weekly earnings (AWE)", published by the ABS in various before 2012 Q2[19] issues of *6302.0 Average Weekly Earnings States and Australia*. Specifically, the AWE is the average income of employees in a week from all employee categories that include both male and female, and full-time as well as part-time employed. Considering the potential impacts of inflation, average weekly earnings are deflated by the consumer price index[20] (hereafter CPI) to estimate "real wage". In the general model of immigration-unemployment relationship (see Section 3.2.1), the real wage is vital to capture one of the major cause of immigration, the expected income gap of immigrants (Harris and Todaro, 1970). The real wage gives information on the real labour cost of destination states. The dynamics of series capture the natural characteristics of local labour markets including the elasticities of labour supply and demand curves, the market responses to the various levels of immigration, and the changes of local employees' welfare before-and-after immigration (Withers and Pope, 1993; Gross, 2002; Islam, 2007; Fromentin, 2013).

Real gross state product (GSP) per capita: The GSP is not available as a quarterly time series in ABS datasets during the sample period. This study uses the sum of quarterly State Final Demand (SFD) and Net Export in various issues of 5206.0[21] and 5368.0[22] from ABS as a proxy for the quarterly GSP series. According to ABS, the SFD estimates the level of spending in the state economy by the private and public sector. It excludes sales made to buyers who need inputs to produce, export sales and sales that lead to accumulation of inventories. The quarterly proxy (SFD + Net Export) is divided by the state population to proxy "GSP per capita per quarter". To eliminate the concern of inflation, GSP per capita is deflated by the CPI index. The variable which captures the aggregate economic impact of immigration in this study is "the real GSP per capita". As mentioned in Section 2.2, economic inequality is the most important cause of immigration. Including the real GSP per capita in the model allows to capture how the domestic economic conditions affect immigration and labour market status.

[19] After June of 2012, the AWE data is collected biannually.
[20] Note that the quarterly state-level CPI index is not available from the ABS. The most relevant and comparable substitute is the Capital cities' quarterly CPI index from 6401.0 Consumer Price Index, Australia: table 1 and 2. CPI: All Groups, index Numbers and Percentage Changes.
[21] Australia National Accounts: National Income, Expenditure and Product: Table 25. State Final Demand, Summary Components by State: Chain Volume Measures.
[22] International Trade in Goods and Services, Australia. Table 36a-36e. Merchandise Exports; and Table 37a-37e. Merchandise Imports.

Unemployment rate: Monthly total unemployment rate is sourced from the ABS *6202.0 Labour Force, Australia*: *Labour force status by Sex* (various issues). The quarterly data are derived by averaging three-month unemployment rates for each quarter during the observation period. Immigration has direct impacts on the domestic economy through enlarging local labour supply and by increasing demand for goods and services. Both aspects cause the unemployment rate to change. The current unemployment rate is also a key factor influencing the destination selections of potential immigrants (Chiswick, 1982; Harrison, 1983; Greenwood and McDowell, 1986; Ng and Simon, 1999; Islam, 2007).

Immigration rate: Definitions of immigration vary in different studies. This study examines the aggregate effect of immigration, instead of decomposing it into different categories by education levels, skill classes or willingness to migrate. The estimated net overseas migration is based on the measures of the net permanent and long-term overseas movement to Australia, which captures the difference between the number of permanent and long-term arrivals and the number of permanent and long-term departures. The quarterly estimation of net overseas migration to each state is sourced from the ABS *3101.0 Australian Demographic Statistic: Table 2. Population Change, Components – States and Territories (Number)*.

According to the ABS (2016), the movement of individuals is recorded in two components – a long-term residential component and a short-term visitor component. The distinction between the two components changed during the sample period. Before June 2006, an incoming traveller must stay in Australia for 12 months or more after international arrival to be a long-term arrival, and an outgoing traveller must leave Australia for 12 months or more to be a long-term departure. It is strictly required that this 12-month period is continous in both cases. After September 2006, the ABS implemented a new estimation method called the "12/16 rule" which allows a discontinued 12-month residence out of 16 months for an incoming traveller to be recorded as a long-term resident. The change in the definition could give rise to a potential concern about the appearance of a structural break in June 2006. However, the subsequent empirical analysis does not observe a notable fluctuation before and after that date. A possible explanation is that both methods are acceptable during their operating periods as international travel has become more frequent and affordable over time. In this study, the immigration rate is defined as the total number of estimated net overseas migration in a quarter per 1000 Australians in that quarter.

The series in the study are in seasonally adjusted form. The wage, unemployment rate and CPI indices are provided as seasonally adjusted data by the ABS, while the net export component in the proxy "GSP per capita" and "immigration rate" are given as original data. In this study, the latter two series are seasonally adjusted using the additive seasonal adjustment method to ensure the reliability and consistency of the study. The series are taken in logarithmic form in estimations.

Stationarity properties of the variables

In this study, the augmented VAR model and vector error-correction models (hereafter VECM) are used to estimate the causal relations. An important pre-requisite is a thorough understanding of the stationarity properties of the Y_t variables.

This study uses the most commonly used unit root tests: the Augmented Dickey-Fuller (ADF) tests (1979). The ADF tests can be set out as three equations with differently assumed deterministic components: 1) test with constant and trend; 2) test with constant; and 3) test without constant. The null hypothesis is the presence of a unit root, suggesting that the series is non-stationary. The series is integrated of order 0 (stationary I(0)) if the null hypothesis is rejected. The series is integrated of order 1 (non-stationary I(1)) if and only if the null hypothesis of a unit root is rejected for first-differenced series.

This study also performs two additional unit-root tests on the series, ADF-GLS and Kwiatkowski, Phillips, Schmidt and Shin (KPSS, 1992) tests. The ADF-GLS test is a modification of the ADF tests, developed by Elliott, Rothenberg and Stock (1996). The ADF-GLS test is an asymptotically point optimal test to identify the unit root. It also examines the null hypothesis of a unit root of time series, but is more efficient for series with deterministic components (trends and/or constants) as the ADF-GLS tests locally de-trends the original series to perform the ADF tests. The KPSS test differs from the two alternatives as it tests the null hypothesis of stationarity of time series. Rejecting the null hypothesis of KPSS test suggests the series are non-stationary I(1).

Estimation strategies

The focus of this study is to see if there exists empirical causation between immigration and unemployment in five Australian states. In doing so, this study will first examine the existence of a cointegrating relationship among four variables.

As the time series of five states are all I(1) (see Section 4.1), this study has used the Johansen contegration test (1988) to estimate for the number of cointegration vectors. For each state, the cointegration test is based on the four-variable VAR model of order n as set out below.

$$\Delta Y_t = \alpha_0 + \sum_{j=1}^{n-1} \left(\Gamma_j \Delta Y_{t-j}\right) + \Pi Y_{t-1} + \varepsilon_t,\ \varepsilon_t \sim \text{i.i.d.N}\ (0,\ \Omega) \qquad (3)$$

Where $Y_t = [UN_t, IM_t, PGSP_t, RW_t]'$, the notations ($\Gamma$ and Π) are coefficient matrices of the lagged terms of ΔYt and Yt, respectively. The Π estimates gives information on the long-run adjustments. The rank of Π is the number of stationary linear independent combinations of the four variables. It is the number of cointegration vectors among the four variables.

To test for the rank of Π matrix (hereafter r), the Johansen trace statistics is used. For trace statistics in this four-variable study, the null hypothesis is "$r \leq 4\text{-}i,\ i=1,\ldots,4$" and the alternative is "$r > 4\text{-}i$". In this study, it starts by testing if the null hypothesis is rejected at $r \leq 3$, and then approaches to $r \leq 0$ until the null hypothesis is rejected.

At the second stage, this study first applies the Toda and Yamamoto's augmented VAR ($n+d_{max}$) model (hereafter, TYVAR) to generate a general understanding on the causation toward immigration and unemployment. For TYVAR, not only is the optimal lag order of VAR in levels (n) included, but the model is also augmented by including the optimum order of integration of the four-variable system (d_{max}). For each state, the model is referred to as a system of four equations as following.

$$Y_t = \alpha_0 + \sum_{j=1}^{n+dmax} \left(\Gamma_j Y_{t-j}\right) + \varepsilon_t,\ \varepsilon_t \sim \text{i.i.d.N}\ (0,\ \Omega) \qquad (4)$$

Where $Y_t = [UN_t, IM_t, PGSP_t, RW_t]'$, and Γ_j are a 4×4 coefficient matrix for the lagged terms of Y_t. This study uses the WALD tests to examine the restrictions such that the lagged immigration terms are jointly zero in the equation of unemployment. Such a restriction can be interpreted as whether the immigration Granger causes unemployment or not.

As the time series in study are non-stationary (see Section 4.1), this study uses the Modified WALD tests (hereafter MWALD). The extra d_{max} lags of variables are added in the equation so that the WALD statistics follows an asymptotic χ^2 distribution. In testing the null hypothesis of immigration Granger cause unemployment, the extra d_{max} lags of immigration term shall be excluded. According to Zapata and Rambaldi (1997), the MWALD test is as powerful as the Likelihood Ratio (LR) and WALD tests. Moreover, when there is no cointegration among variables or the stability and rank conditions cannot be matched, the MWALD test can still be applied as long as the order of the VAR model is bigger than the order of integration of the process (Toda and Yamamoto, 1995).

However, the TYVAR test does not differentiate between the long-run or short run causal relationships. When the time series are non-stationary I(1) and cointegrated, the error-correction models can be used to test for the long-run causation.

If the Johansen cointegration tests present evidence that the time series are cointegrated, the cointegrating relationships are estimated by the Fully Modified Ordinary Least Squares (FMOLS) method. Developed by Phillips and Hansen (1990), the FMOLS regression gives the optimal estimates for the cointegrating relationships. It augments least squares to correct serial correlation in the residuals and endogeneity among the variables.

As this study first uses FMOLS to estimate the cointegrating relationships, the error-correction terms ($FMOLSECT_t$) in the VECM must be withdrawn from FMOLS estimates. The lagged ECT ($FMOLSECT_{t-1}$) are the lagged estimated errors from FMOLS regressions. For each *i* state, the VECM is specified as a system of four simultaneous equations in differences as equation (5), and individually estimated by Ordinary Least Squares (OLS) method.

$$\Delta Y_t = A_1 + \sum_{j=1}^{n-1}\left(B_{1j}\Delta UN_{t-j}\right) + \sum_{j=1}^{n-1}\left(B_{2j}\Delta IM_{t-j}\right) + \sum_{j=1}^{n-1}\left(B_{3j}\Delta PCGSP_{t-j}\right) + \sum_{j=1}^{n-1}\left(B_{4j}\Delta RW_{t-j}\right) + \lambda_k FMOLSECT_{t-1} + \gamma D + e_t \quad (5)$$

ΔY_t = [ΔUN_t, ΔIM_t, $\Delta PGSP_t$, ΔRW_t]'. A_1 is the vector of constant; $FMOLSECT_{t-1}$ denotes the first lag of the error correction terms resulting from the FMOLS estimates, λ_k is [λ_1, λ_2, λ_3, λ_4]'denoting the coefficients of $FMOLSECT_{t-1}$ in four equations of VECM , e_t denotes the vector of error terms. The notation (B) denotes the vector of coefficients of four variables in four equations, e.g. B_{1j} refers to the vector of four coefficients of ΔUN_{t-j} in four equations. D refers to the dummy variables of each state and γ denotes the coefficients of dummies.

The long-run causality is determined by the coefficients of $FMOLSECT_{t-1}$. Based on the t-statistic tests, the null hypotheses: H_0: $\lambda_1=0$, H_0: $\lambda_2=0$, H_0: $\lambda_3=0$ and H_0: $\lambda_4=0$ are tested individually. If the null hypothesis H_0: $\lambda_1=0$ for the ΔUN_t equation is rejected, there confirms the existence of the cointegration relationship. When the unemployment rate exceeds the long-run equilibrium level, it will readjust. The magnitude of coefficients (λ_k) estimates the speed of this readjustment process.

Chapter Four: Results

This chapter presents the empirical findings. The results of the stationarity of variables is presented first, followed by the cointegration tests on whether there exists a cointegrating relationship among the series of each state. The major results on the relationships between immigration and unemployment and their disparities in each state are given at the end.

4.1 Stationarity of variables in model

The stationarity of the time series decides the number of additional lags (d_{max}) for the Toda and Yamamoto tests. And only if the I(1) series are cointegrated, there exists causation in at least one direction (Granger, 1986). Tables 1 to 5 give detailed information on the outcomes of unit root tests for each state.

TABLE 1: Stationarity tests in levels and first differences (NSW)

	ADF t-statistics		ADF-GLS test		KPSS test	
Variables	With C & T	With C	With C	With C& T	With C	With C & T
Log(UN)	-2.91	-1.54	-1.40	-2.50	0.91***	0.11
Log(IM)	-3.00	-2.66	-1.98	-2.30	0.26	0.10
Log(PCGSP)	-3.13	-2.25	0.57	-1.81	1.09***	0.10
Log(RW)	-3.78**	-0.61	0.45	-2.92	1.28***	0.14**
In first difference	With C	Without C	With C	With C & T	With C	With C & T
ΔLog(UN)	-7.58***	-7.57***	3.04***	-4.15***	0.08	0.07
ΔLog(IM)	-15.07***	-15.15***	-14.73***	-15.01***	0.08	0.04
ΔLog(PCGSP)	-10.37***	-10.00***	-9.86***	-10.42***	0.15	0.10
ΔLog(RW)	-8.98***	-8.79***	-8.94***	-9.02***	0.10	0.09

Note: C is the constant and T denotes the deterministic trend assumption. Based on MacKinnon's (1991) Critical Value, *** and ** represents the null hypothesis of non-stationary is rejected at 1 per cent, and 5 per cent level respectively.
For ADF and ADF-GLS, Null hypothesis: a unit root. For KPSS, Null hypothesis: stationary. The number of lags is determined by Schwarz Information Criterion for ADF and ADF-GLS, as well as Bartlett Kernel for KPSS.

Table 1 shows the outcomes of the three unit root tests of the four NSW variables. Based on the ADF tests, the variables in levels for *log(UN)*, *log(IM)* and *log(PCGSP)* are non-stationary I(1) as the null hypothesis of a unit root cannot be rejected at 1 per cent significance level. And the variables in first difference are stationary since null hypotheses for *Δlog(UN)*, *Δlog(IM)* and *Δlog(PCGSP)* are rejected at the 1 per cent significance level.

Nonetheless, the ADF tests could not give convincing results on the stationarity property of *log (RW).* The ADF test statistics of equation with constant and trend (With C & T) reject the null of a unit root at the 5 per cent level. Nonetheless, the τ-statistics of *log (RW)* in the ADF-GLS tests cannot reject the null hypothesis of a unit root at the 5 per cent level, while the null hypothesis is rejected at the 1 per cent level after first differencing. The KPSS tests examine the null hypothesis of stationarity, which presents the same conclusion as the ADF-GLS tests. We conclude that the four dependent variables for NSW are I (1).

TABLE 2: Stationarity tests in levels and first differences (QLD)

	ADF t-statistics		ADF-GLS test		KPSS test	
Variables	With C & T	With C	With C	With C& T	With C	With C & T
Log(UN)	-2.70	-1.07	-0.68	-2.47	0.95***	0.15**
Log(IM)	-3.20	-1.53	-1.40	-1.75	0.79***	0.14
Log(PCGSP)	-3.51**	-3.76***	-0.53	-1.63	0.35**	0.11
Log(RW)	-2.48	0.10	-0.79	-1.70	1.19***	0.20**
In first difference	With C	Without C	With C	With C & T	With C	With C & T
ΔLog(UN)	-7.05***	-7.05***	-2.36**	-3.52**	0.08	0.08
ΔLog(IM)	-11.40***	-11.46***	-11.26***	-11.42***	0.10	0.07
ΔLog(PCGSP)	-9.58***	-9.56***	-3.22***	-8.03***	0.21	0.10
ΔLog(RW)	- 9.31***	- 9.09***	-9.11***	-9.35***	0.13	0.04

Note: C is the constant and T denotes the deterministic trend assumption. Based on MacKinnon's (1991) Critical Value, *** and ** represents the null hypothesis of non-stationary is rejected at 1 per cent, and 5 per cent level respectively.
For ADF and ADF-GLS, Null hypothesis: a unit root. For KPSS, Null hypothesis: stationary. The number of lags is determined by Schwarz Information Criterion for ADF and ADF-GLS, as well as Bartlett Kernel for KPSS.

Table 2 shows that *log(UN), log(IM)* and *log(RW)* are I(1).The case of *log(PCGSP)* is arguable in ADF tests as the outcomes of the test with constant and trend and the test with constant failed to reject the null hypothesis of a unit root at the 5 per cent and the 1 per cent respectively. The KPSS tests also give inconclusive results.

However, according to the ADF-GLS test, *log (PCGSP)* is I(1) because the τ-statistics from the two tests on the levels cannot reject the null hypothesis of non-stationary process even at the 10 per cent level, while they are rejected at the 1 per cent level for variables in first difference. In general, all four series from QLD are non-stationary I(1).

TABLE 3: Stationarity tests in levels and first differences (SA)

	ADF t-statistics		ADF-GLS test		KPSS test	
Variables	With C & T	With C	With C	With C& T	With C	With C & T
Log(UN)	-1.61	-0.72	-0.35	-1.36	1.03***	0.17**
Log(IM)	-2.58	-1.42	-1.39	-1.71	0.66**	0.22***
Log(PCGSP)	-2.82	-2.75	-0.44	-1.33	0.15	0.15**
Log(RW)	-2.53	-0.82	-0.58	-2.35	0.94***	0.21**
In first difference	With C	Without C	With C	With C & T	With C	With C & T
ΔLog(UN)	-9.67***	-9.62***	-3.54***	-9.43***	0.12	0.11
ΔLog(IM)	-11.79***	-11.85***	-11.83***	-11.94***	0.17	0.09
ΔLog(PCGSP)	-12.73***	-12.64***	-4.71***	-11.05***	0.24	0.20**
ΔLog(RW)	-10.86***	-10.81***	-10.76***	-10.74***	0.22	0.05

TABLE 4: Stationarity tests in levels and first differences (VIC)

	ADF t-statistics		ADF-GLS test		KPSS test	
Variables	With C & T	With C	With C	With C& T	With C	With C & T
Log(UN)	-2.60	-1.39	-1.41	-1.62	0.68**	0.14**
Log(IM)	-2.70	-1.84	-1.69	-1.93	0.59**	0.15**
Log(PCGSP)	-2.12	-1.98	-0.22	-1.13	0.20	0.13
Log(RW)	-3.07	-0.31	0.16	-2.30	1.19***	0.21**
In first difference	With C	Without C	With C	With C & T	With C	With C & T
ΔLog(UN)	-6.60***	-6.63***	-3.93***	-6.37***	0.13	0.10
ΔLog(IM)	-14.35***	-14.43***	-14.42***	-14.45***	0.10	0.04
ΔLog(PCGSP)	-8.47***	-8.42***	-3.76***	-4.73***	0.21	0.20**
ΔLog(RW)	-11.43***	-11.23***	-4.76***	-10.66***	0.17	0.03

TABLE 5: Stationarity tests in levels and first differences (WA)

	ADF t-statistics		ADF-GLS test		KPSS test	
Variables	With C & T	With C	With C	With C& T	With C	With C & T
Log(UN)	-2.53	-1.13	-0.79	-2.25	1.02***	0.11
Log(IM)	-2.82	-1.32	-1.20	-1.49	0.66**	0.18**
Log(PCGSP)	-2.33	-0.04	-0.03	-1.38	1.02***	0.26***
Log(RW)	-0.83	2.27	1.97	-0.47	1.10***	0.33***
In first difference	With C	Without C	With C	With C & T	With C	With C & T
ΔLog(UN)	-7.70***	-7.67***	-7.17***	-7.57***	0.08	0.05
ΔLog(IM)	-15.27***	-15.35***	-14.84***	-15.22***	0.26	0.06
ΔLog(PCGSP)	-9.93***	-9.83***	-3.79***	-9.14***	0.28	0.03
ΔLog(RW)	-11.44***	-10.81***	-2.47**	-11.11***	0.88***	0.05

Note: C is the constant and T denotes the deterministic trend assumption. Based on MacKinnon's (1991) Critical Value, *** and** represents the null hypothesis of non-stationary is rejected at 1 per cent, and 5 per cent level respectively.
For ADF and ADF-GLS, Null hypothesis: a unit root. For KPSS, Null hypothesis: stationary. The number of lags is determined by Schwarz Information Criterion for ADF and ADF-GLS, as well as Bartlett Kernel for KPSS.

Tables 3, 4 and 5 present the results of ADF tests on the four variables for SA, VIC and WA. In general, the series are found to be non-stationary I(1). The KPSS tests show that some variables are arguably I(1) such as *log(PCGSP)* of SA and VIC, and *log(UN)* of WA. However, the ADF and ADF-GLS present consistent outcomes about these variables. The null hypotheses of a unit root cannot be rejected at the 5 per cent level for all three variables in levels, and the null are rejected at the 1 per cent level for variables in first difference.

In conclusion, the series of five states are non-stationary I(1). As they are all integrated of order 1, a VAR(n+1)[23] model can be used to test the existence of causality in general. And the Johansen two-stage model can be applied to explore the long-run and short-run causal relationship.

4.2 VAR lag length selection

This section shows how the optimum lag length (*n*) is chosen for the VAR model. This study determines *n* based on the VAR lag length selection procedures using variables in levels. This study uses three commonly used lag order selection criteria: sequential modified LR test statistics (LR), Final prediction error (FPE), and Akaike information criterion (AIC). The FPE and AIC are found to have higher probability to reveal the true lag length for VAR model than Schwarz information criterion (SC) and Hannan-Quinn information criterion in the studies with smaller than 100 observations (Liew, 2004; Gutierrez, Souza and Guillen, 2009). Moreover, including LR tests could largely increase the success rate of lag length selection criteria (Hatemi-j and Hacker, 2009).

Maximum lag length selection

In this study, five is chosen as the maximum lag taking into consideration the sample size of observations and the Australian immigration policies.

First of all, the choice is due to the small sample size of the study. The quarterly series from March 1988 to June 2012 have only 98 observations for each state. Increasing maximum lag order could result in a bigger lag length selection for the VAR model and VECM model, which carries more variables in a single equation. Under such circumstances, the degree of freedom and the power of the outcomes would be decreased substantially. It is preferred to choose a relatively small optimal lag order for the model.

[23] This study uses *n* to denote the optimum lag of the system, and *n* is determined in Section 4.2.

Secondly, the Australian Department of Immigration and Border Protection (DIBP) have been revising the quota and skill selection lists for the immigration program on a yearly basis. The ABS records a permanent immigrant by the noted "12/16" rules. Such a definition method is based on an implicit assumption that the arrived foreigners would make the decision to migrating in a particular Australian state within average sixteen months when they start to seek jobs and participate in the local economy. As this study is using quarterly series, selecting five as the maximum lag order is reasonable based on the immigration definition and policies of Australia.

Lag order selection criterion

Choosing five as the maximum lag order, the Appendix Table I gives the detailed outcomes of LR, AIC and FPE for each state.

For NSW, the LR test selects five lags, while the FPE and AIC both select two lags. In order to maximise the power of estimation in the following procedures, a small lag length is preferred to minimize the number of lost degrees of freedom in VAR and VECM equations. However, the VECM (1) model presents serial correlation. Thus, one more lag is added, that is three lags for the model, and hence a VECM(2) model.

For SA, AIC and FPE choose one lag for the VAR model. However, selecting the one lag for the VAR model in levels would enforce a VECM(0) model. Thus, a VAR(2) model is estimated instead.

For QLD, VIC and WA, three lag length selection criteria are consistent to select two lags as the optimum lag length for the system. Thus, the optimum lag length for the NSW four-variable system is three, while *n* for other four systems is two.

4.3 Cointegration analysis

If the time series are cointegrated, the series shall move together over time. Although the movement could be disturbed by temporary shocks, the variables would readjust to the long run

equilibrium level. For the Johansen cointegration tests specification, this study uses the deterministic assumption as unrestricted constant, which means the four variables can have linear trends but there is no trend in the cointegrating relationships.

In general, the cointegration tests show that the time series of VIC and WA are cointegrated at the 5 per cent significance level. The existence of a cointegration vector for NSW series is revealed at the 10 per cent significance level. For QLD and SA, the series are not cointegrated.

TABLE 6: Unrestricted Cointegration Rank Tests (Trace statistics)

	NSW			QLD			SA		
H_0	Trace Statistic	CV (5%)	P-value	Trace Statistic	CV (5%)	P-value	Trace Statistic	CV (5%)	P-value
r=0	46.33966	47.85613	0.0689*	43.81121	47.85613	0.1140	43.26660	47.85613	0.1262
r≤1	25.47252	29.79707	0.1452	22.55613	29.79707	0.2686	23.14541	29.79707	0.2390
r≤2	10.21151	15.49471	0.2648	8.199166	15.49471	0.4443	5.729008	15.49471	0.7273
r≤3	0.296017	3.841466	0.5864	0.006278	3.841466	0.9363	0.490750	3.841466	0.4846
	VIC			WA					
H_0	Trace Statistic	CV (5%)	P-value	Trace Statistic	CV (5%)	P-value			
r=0	65.73014	47.85613	0.0005**	54.51268	47.85613	0.0104**			
r≤1	27.24963	29.79707	0.0957	26.58146	29.79707	0.1123			
r≤2	11.44026	15.49471	0.1858	8.501609	15.49471	0.4134			
r≤3	0.334201	3.841466	0.5632	2.598673	3.841466	0.1070			

Note: Null hypothesis, at most x (0 to 3) cointegration relationships;
Adjusted sample: Quarter 3/1988 to Quarter 2/2012. Variables: Unemployment rate, immigration rate, real wage and real GSP.
** and * denotes that the null hypothesis (H0) is rejected at the 5 and 10 per cent significance level, respectively.
CV represents the critical value.

The results of the Johansen cointegration tests on the five states are shown in Table 6. For NSW, the p-value is 0.0689 on the first row "r=0", suggesting the null hypothesis of no cointegrating relationship can be rejected at the 10 per cent level. On its second row of "r≤1", the null hypothesis "there is one cointegration vector instead of two" cannot be rejected. At the 10 per cent significance level, there is an independent linear combination of the NSW time series that will be stationary.

For VIC and WA, on the first row, the p-values are 0.0005 and 0.0104, respectively. At the 5 per cent significance level, the null hypotheses of no cointegration vector are rejected. Then on the second row, the null hypotheses of "r≤1" are all accepted at the 5 per cent level. There exists one cointegration vector for VIC and WA series individually.

For SA and QLD, the null hypothesis of no cointegrating relationship cannot be rejected even at the 10 per cent significance level. This study concludes that the series of these two states are not cointegrated, and thus no cointegration relationship can be estimated.

4.4 Toda and Yamamoto's (1995) VAR model

In the following procedure, the Toda and Yamamoto's (1995) augmented VAR model (hereafter, TYVAR) is specified as a VAR ($3+d_{max}$) model for NSW and a VAR ($2+d_{max}$) model for the other four states. Based on the outcomes of Tables 1 to 5, all the time series in levels are non-stationary, I(1). The maximum order of integration for the five groups of variables is 1. Thus, a VAR(4) model shall be estimated for NSW and a VAR(3) model is individually estimated for each of the other states.

Nonetheless, Section 4.3 shows that there exists no cointegration relationship among the variables in levels for QLD and SA so that this study will conduct the augmented VAR in first difference for the two states. The VAR(3) model is transformed as VAR(2) in first difference for these two states.

In general, the MWALD tests on TYVAR estimates reveal a unidirectional Granger causation from the unemployment rate of WA to its immigration rate, while no causation has been revealed in other four states: NSW, QLD, SA and VIC.

In each state, this study concentrates on the following equations, which give information on the directions of causation between immigration and unemployment.

$$UN_t = \alpha_1 + \sum_{j=1}^{n+dmax} \left(\beta_{1j} UN_{t-j}\right) + \sum_{j=1}^{n+dmax} \left(\gamma_{1j} IM_{t-j}\right) + \sum_{j=1}^{n+dmax} \left(\delta_{1j} RW_{t-j}\right) + \sum_{j=1}^{n+dmax} \left(\eta_{1j} PCGSP_{t-j}\right) + \varepsilon_{1t} \quad (6)$$

$$IM_t = \alpha_2 + \sum_{j=1}^{n+dmax} \left(\beta_{2j} UN_{t-j}\right) + \sum_{j=1}^{n+dmax} \left(\gamma_{2j} IM_{t-j}\right) + \sum_{j=1}^{n+dmax} \left(\delta_{2j} RW_{t-j}\right) + \sum_{j=1}^{n+dmax} \left(\eta_{2j} PCGSP_{t-j}\right) + \varepsilon_{2t} \quad (7)$$

Note: all variables are in logarithms.

In this study, the Seemingly Unrelated Regression (SUR) is used to estimate the four dimensional VAR model. For a TYVAR(3) model, the null hypothesis of "$\gamma_{11} = \gamma_{12} = 0$" is tested to determine whether immigration Granger causes unemployment based on the estimates of equation (6). In equation (7), this study focuses on the null hypothesis of "$\beta_{21} = \beta_{22} = 0$" to see if unemployment Granger causes immigration.

In the following part, the outcomes of MWALD tests for two equations of QLD and SA are presented at first. Then, the outcomes for VIC and WA are followed. Note in QLD and SA, the MWALD statistics follows the χ^2 distribution with one degree of freedom. And in VIC and WA, the MWALD statistics follows the χ^2 distribution with two degrees of freedom.

VAR in first difference, QLD and SA

TABLE 7: TYVAR MWALD test results, QLD

Dependent variable: Δ(Unemployment rate)			Dependent variable: Δ(Immigration rate)		
Excluded	Chi-square	Probability	Excluded	Chi-square	Probability
ΔImmi_rate	0.627097	0.4284	ΔUnem_rate	0.329020	0.5662
ΔReal AWE	1.241100	0.2653	ΔReal AWE	1.224305	0.2685
ΔReal GSP	1.108270	0.2925	ΔReal GSP	2.161762	0.1415

Note: Null hypothesis: the lagged terms of a certain variable are jointly insignificant to describe the dependent variable. ***, ** and * indicates that the null hypothesis is rejected at 1 per cent, 5per cent and 10 per cent significance level.

Table 7 provides that the null hypotheses of "immigration does not Granger cause unemployment" and "unemployment does not Granger cause immigration" are all accepted, suggesting that there is no causality between immigration and unemployment in QLD. The statement "immigrants rob jobs" has not been supported. No causation has been revealed among the four series in first differences for QLD.

TABLE 8: TYVAR MWALD test results, SA

Dependent variable: Δ(Unemployment rate)			Dependent variable: Δ(Immigration rate)		
Excluded	Chi-square	Probability	Excluded	Chi-square	Probability
ΔImmi_rate	1.197289	0.2739	ΔUnem_rate	1.115101	0.2910
ΔReal AWE	0.541048	0.4620	ΔReal AWE	1.116202	0.2907
ΔReal GSP	0.322354	0.5702	ΔReal GSP	1.742071	0.1869

Note: Null hypothesis: the lagged terms of a certain variable are jointly insignificant to describe the dependent variable. ***, ** and * indicates that the null hypothesis is rejected at 1 per cent, 5per cent and 10 per cent significance level.

Table 8 shows that there exists no causal relationship between the unemployment rate and the immigration rate in SA. The statement "immigrants rob jobs" is also not supported by the SA data. Again, the chi-square based tests on the TYVAR in first difference cannot reveal the significance of any variables to immigration and unemployment. No causation is revealed for SA.

TYVAR in levels, VIC and WA

TABLE 9: TYVAR MWALD test results, VIC

Dependent variable: Unemployment rate			Dependent variable: Immigration rate		
Excluded	Chi-square	Probability	Excluded	Chi-square	Probability
Immi_rate	2.608018	0.2714	Unem_rate	2.484036	0.2888
Real AWE	8.476390	0.0144**	Real AWE	7.230810	0.0269**
Real GSP	3.897579	0.1424	Real GSP	1.353279	0.5083

Note: Null hypothesis: the lagged terms of a certain variable are jointly insignificant to describe the dependent variable. ***, ** and * indicates that the null hypothesis is rejected at 1 per cent, 5per cent and 10 per cent significance level.

Table 9 reports that there exists no causality between the immigration rate and the unemployment rate in VIC. The null hypotheses are accepted in both causation directions at the 10 per cent level, from immigration to unemployment and the other way around.

Unlike the foregoing two states, the unidirectional causation from real wage to the unemployment rate and the immigration rate is found at the 5 per cent level in VIC. Real wage is found to be an important variable to explain the fluctuations of the unemployment rate and the immigration rate in VIC.

TABLE 10: TYVAR MWALD test results, WA

Dependent variable: Unemployment rate			Dependent variable: Immigration rate		
Excluded	Chi-square	Probability	Excluded	Chi-square	Probability
Immi_rate	0.700849	0.7044	Unem_rate	7.874116	0.0195**
Real AWE	2.561292	0.2779	Real AWE	1.656072	0.4369
Real GSP	7.719641	0.0211**	Real GSP	0.667966	0.7161

Note: Null hypothesis: the lagged terms of a certain variable are jointly insignificant to describe the dependent variable. ***, ** and * indicates that the null hypothesis is rejected at 1 per cent, 5per cent and 10 per cent significance level.

Table 10 shows that the unemployment rate Granger causes the immigration rate at the 5 per cent significance level in WA. It is the only state where there exists a causal relation between immigration and unemployment, although the unidirectional causation actually runs from the unemployment rate to the immigration rate.

The null hypothesis of "immigration does not Granger cause unemployment" is accepted with a p-value of 0.7044. Again, immigration in WA is not an important source of unemployment. Moreover, a unidirectional causality from the real GSP to the unemployment rate is shown at

the 5 per cent significance level. The unemployment rate of WA depends on the economic growth.

New South Wales

As mentioned, the augmented model for NSW time series will be VAR(3+1) model. The equations are similar to equation (6) and (7) with one additional lag variable on the right-hand side equation. In the TYVAR(4) model for NSW, the null hypothesis of the MWALD tests is "$\gamma_{11} = \gamma_{12} = \gamma_{13} = 0$" to see if immigration Granger causes unemployment, while the null hypothesis to examine the opposite causation is "$\beta_{21} = \beta_{22} = \beta_{23} = 0$". In NSW, the MWALD statistics would follow the χ^2 distribution with three degrees of freedom.

TABLE 11: TYVAR MWALD test results, NSW

Dependent variable: Unemployment rate			Dependent variable: Immigration rate		
Excluded	Chi-square	Probability	Excluded	Chi-square	Probability
Immi_rate	0.379299	0.9445	Unem_rate	6.154388	0.1043
Real AWE	5.144285	0.1615	Real AWE	3.193334	0.3628
Real GSP	15.73291	0.0013***	Real GSP	0.533243	0.9115

Note: Null hypothesis: the lagged terms of a certain variable are jointly insignificant to describe the dependent variable. ***, ** and * indicates that the null hypothesis is rejected at 1 per cent, 5per cent and 10 per cent significance level.

For NSW data, no evidence of a causal relationship between immigration and unemployment is revealed by Table 11. Nonetheless, the real GSP per capita is an essential factor of the unemployment rate in NSW.

In summary, the augmented VAR model presents no causality from immigration to unemployment in all five states. For the immigration-unemployment relationship, only the estimates of WA series have revealed a unidirectional causation from unemployment to immigration. Apart from that, the significance of the real wage to immigration and unemployment is only found in VIC. Furthermore, the real GSP per capita Granger causes the unemployment rate in NSW and WA.

4.5 The long-run relationship

As the TYVAR estimates do not differentiate between the long-run and short-run causality, the following sections will apply a modified Johansen two-step procedure to estimate the long-run relationships, as well as the directions of long-run causation.

Section 4.3 shows that the series of NSW, VIC and WA are cointegrated. In this stage, the Fully Modified OLS (FMOLS) is used to estimate the long-run relationships of three states. The coefficients are the long-run elasticities of the unemployment rate with respect to the other three variables. The estimated residuals of FMOLS equations are used as the error-correction terms (ECT) into the subsequent error-correction models.

In general, a significant and negative long-run relationship between unemployment and immigration is found in all three states, at different magnitudes. The long-run relationships among the four variables vary by states.

TABLE 12: FMOLS regression outcomes, NSW

Independent variables	Coefficients	Standard Error	t-statistics	P-value
Immi_rate	-0.237404	0.074568	-3.183739	0.0020
Real AWE	-3.127755	0.785189	-3.983441	0.0001
Real GSP per capita	-0.712377	0.725014	-0.982569	0.3284
C	8.050116	5.146893	1.564073	0.1212

Note: FMOLS: R^2 = 0.746609, adjusted R^2 = 0.738435; Dependent variable: Unemployment rate. Deterministic assumption: with constant. AWE is average weekly earnings. All variables are in logarithm. Adjusted sample: Q2 1988 to Q2 2012.

Table 12 reports the FMOLS estimation results of NSW. Setting the maximum lag length at five, this study use Akaike information criterion (AIC) to choose the lag for FMOLS. The FMOLS (1) is used for NSW data.

The t-statistics on the FMOLS estimates of coefficients reveal two significant relationships among the series, which are between immigration and unemployment, and between unemployment and real wage. For the former relationship, the long-run elasticity of the unemployment rate is -0.24 with respect to immigration, suggesting that a 1 per cent increase in the immigration rate may decrease the unemployment rate by nearly 0.24 per cent, *ceteris paribus*. Meanwhile, the unemployment rate could fall by 3.13 per cent for a 1 per cent increase in real wage.

TABLE 13: FMOLS regression outcomes, VIC

Independent variables	Coefficients	Standard Error	t-statistics	P-value
Immi_rate	-0.211258	0.047123	-4.483155	0.0000
Real AWE	-1.761678	0.413344	-4.262016	0.0000
Real GSP per capita	-2.207035	0.362808	-6.083202	0.0000
C	12.58988	2.078479	6.057253	0.0000

Note: FMOLS: R^2 = 0.825822, adjusted R^2 = 0.820203; Dependent variable: Unemployment rate. Deterministic assumption: with constant. AWE is average weekly earnings. All variables are in logarithm. Adjusted sample: Q2 1988 to Q2 2012.

Table 13 shows FMOLS results of VIC. Setting the maximum lag length at five, the AIC criterion selects two lags for the FMOLS model of VIC.

In VIC, the coefficients of immigration, real wage and real GSP are all significant at the 1 per cent significance level. At first, the long-run elasticity of unemployment with respect to immigration is slightly smaller than NSW's, but significant at 1 per cent significance level. An increase of 1 per cent net migration rate in VIC may results in a 0.21 per cent decrease in the unemployment rate. Second, the unemployment rate falls by 1.76 per cent after a 1 per cent increase in real wage, *ceteris paribus*. A 1 per cent increase in real GSP per capita could leads to an estimated decrease in the unemployment rate of 2.21 per cent.

TABLE 14: FMOLS regression outcomes, WA

Independent variables	Coefficients	Standard Error	t-statistics	P-value
Immi_rate	-0.533489	0.138423	-3.854047	0.0002
Real AWE	0.229182	1.429589	0.160313	0.8730
Real GSP per capita	-0.329968	1.309392	-0.252001	0.8016
C	-1.086286	4.519921	-0.240333	0.8106

Note: FMOLS: R^2 = 0.645980, adjusted R^2 = 0.634560; Dependent variable: Unemployment rate. Deterministic assumption: with constant. AWE is average weekly earnings. All variables are in logarithm. Adjusted sample: Q2 1988 to Q2 2012.

Table 14 shows the regression results of FMOLS for WA. Setting the maximum lag length at five, the AIC selects one lag for the model. The long-run elasticity of unemployment with respect to immigration in WA is the largest among three states. The long-run elasticity of unemployment with respect to immigration is -0.53, suggesting that a 1 per cent increase of the net migration rate would decrease unemployment by 0.53 per cent, *ceteris paribus*. Then, the real wage of WA has an insignificant and positive effect on the unemployment rate unlike NSW and VIC results.

In general, the FMOLS estimates do not reveal any positive relation between immigration and unemployment, suggesting that immigrants to these three states have not taken over locals' jobs.

To the contrary, the statistical negative relationships indicate that the presence of immigrants could possibly expand the job market through aggregate demand effects (Harrison, 1983; Simon, 1999). The estimates also show a significant and negative relationship between real wage and unemployment in NSW and VIC, while the relationship is insignificant and positive in WA. A negative long-run relationship between the real GSP per capita and unemployment is only significant in VIC.

4.6 Vector error-correction models

As these I(1) series are cointegrated (shown in Table 6), this study could use the VECM model to reveal the direction of long-run causation and the short-run dynamics of four variables. The error correction terms ($FMOLSECT_t$) in the following tables are the obtained residuals from Section 4.5 representing the cointegrating relationships.

By performing the causality tests, the diagnostic tests on residuals are made to ensure the adequacy of the vector error-correction models. This study uses OLS methods to estimate the VECM. The Breusch-Godfrey tests and Jarque-Bera tests for each equation in each state show no autocorrelation and individually normal distributed residuals. Then, the Ljung-Box Q statistics also show no autocorrelation up to order 4 and order 8 in any of the equations. Based on the outcomes of Doornik-Hansen tests, the VECM residuals of NSW and VIC are jointly normal distributed. Although the residuals of WA estimates are not jointly normal distributed, it may result from the small sample size of this study. After all, the diagnostic tests on the residuals give little concern on the reliability of the error-correction models.

Long-run causality analysis

Overall, the long-run causation goes from immigration to unemployment in NSW and VIC, while it goes on the opposite direction in WA. The coefficients of error correction terms give information on the speed of adjustment of the variable to readjust to the long-run equilibrium level after one period. According to the VECM estimates, the unemployment rate of VIC will readjust at a faster speed than NSW. The immigration rate of WA has the largest speed of

adjustment parameter among three states. Tables 15 to 17 present the estimates of three vector error-correction models.

It is important to note that some dummy variables have to be added into the model in order to minimize the autocorrelation and normal distribution concerns. These dummies are generated by observing the trends of residuals in the trials of the VECM model. Some of them, such as Dummy2000Q3, might be influenced by renowned event like introducing Good and Services Tax in Australia. However, they are not found to be influential in all three states.

TABLE 15: Causality results, NSW

	D(Unem_rate)	D(Immi_rate)	D(Real AWE)	D(Real GSP)
$FMOLSECT_{t-1}$	-0.128445 (0.039870)***	-0.182057 (0.282320)	-0.015909 (0.012350)	-0.004743 (0.014542)
$D(Unem\_rate)_{t-1}$	0.163104 (0.082377)*	-0.321500 (0.419181)	0.020508 (0.019754)	-0.001099 (0.033854)
$D(Unem\_rate)_{t-2}$	0.321478 (0.105138)***	-1.152975 (0.585098)*	0.033667 (0.027163)	0.017452(0.033782)
$D(Immi\_rate)_{t-1}$	0.022307 (0.013449)	-0.525309 (0.141730)***	0.006678 (0.002906)**	0.005804 (0.006125)
$D(Immi\_rate)_{t-2}$	0.020345 (0.013779)	-0.219263 (0.122851)*	0.005905 (0.003063)*	0.005932 (0.004389)
$D(Real\ AWE)_{t-1}$	0.725402 (0.447619)*	-2.806677 (2.566374)	0.008167 (0.118936)	-0.251906 (0.214448)
$D(Real\ AWE)_{t-2}$	-0.112733 (0.412539)	-2.701431 (2.622131)	-0.145238 (0.113923)	0.026772 (0.163782)
$D(Real\ GSP)_{t-1}$	-0.591900 (0.269840)**	0.070217 (1.433475)	0.168670 (0.072596)***	-0.018831 (0.094992)
$D(Real\ GSP)_{t-2}$	-0.394775 (0.218635)	0.422648 (1.853799)	0.116591 (0.058543)**	0.096544 (0.084715)
C	-0.010986 (0.005441)**	0.005465 (0.042045)	0.003003 (0.001095)***	-0.001699 (0.001972)
Dummy1993Q2	-0.022442 (0.010910)**	-1.331704 (0.049343)***	0.001098 (0.003077)	-0.009673(0.003610)***
Dummy2000Q3	-0.075381 (0.010448)***	0.152076 (0.073728)**	-0.012431 (0.003402)***	-0.076727 (0.004542)***
Dummy2009Q1	0.159438 (0.009394)***	-0.110974 (0.059369)*	-0.007769 (0.002293)***	-0.001373 (0.004526)
R^2	0.419871	0.469593	0.164967	0.281061
Adjusted R^2	0.334974	0.391972	0.042767	0.175850

Note: Assumptions: Intercept (no trend) in Cointegration and VAR; Lag interval in first differences: 1 to 2;
Sample: Q3 1988 to Q2 2012; *, ** and *** denotes the variable is significant at 10 per cent, 5 per cent, and 1per cent, respectively.
The figures in parenthesis are HAC Robust standard errors.

TABLE 16: Causality results, VIC

	D(Unem_rate)	D(Immi_rate)	D(Real AWE)	D(Real GSP)
$FMOLSECT_{t-1}$	-0.270963 (0.055006)***	-0.235204 (0.228476)	-0.004264 (0.012246)	0.041922 (0.017258)**
$D(Unem\_rate)_{t-1}$	0.338687 (0.106653)***	-0.563348 (0.272566)**	0.030245 (0.022265)	-0.033946 (0.030394)
$D(Immi\_rate)_{t-1}$	0.018217 (0.018429)	-0.296546 (0.125824)**	-0.008071 (0.003320)**	-0.000194 (0.006667)
$D(Real\ AWE)_{t-1}$	-0.245882 (0.412398)	-2.900564 (1.398326)**	-0.248803 (0.099658)**	-0.449956(0.146741)***
$D(Real\ GSP)_{t-1}$	0.409143 (0.321424)	0.651914 (1.363716)	0.246741 (0.069273)***	0.045494 (0.115744)
C	-0.006649 (0.005361)	0.023778 (0.024731)	0.002866 (0.001279)**	-0.000390 (0.001881)
Dummy2001Q3	-0.010328 (0.051234)	-1.018260 (0.058197)***	-0.005332 (0.002034)**	-0.003292 (0.017664)
Dummy1993Q2	0.056991 (0.050432)***	-1.088998 (0.039608)***	0.000309 (0.001710)	-0.005973 (0.017387)
Dummy1993Q3	-0.010668 (0.053698)	0.790909 (0.126552)***	-0.014238 (0.003804)***	0.026160 (0.018513)
Dummy1996Q1	0.008701 (0.050990)	-0.744611 (0.063278)***	0.005723 (0.002108)***	0.002656 (0.017579)
R^2	0.395905	0.567845	0.156441	0.178017
Adjusted R^2	0.332686	0.522620	0.068161	0.091995

Note: Assumptions: Intercept (no trend) in Cointegration and VAR; Lag interval in first differences: 1 to 1;
Sample: Q3 1988 to Q2 2012; *, ** and *** denotes the variable is significant at 10 per cent, 5 per cent, and 1 per cent, respectively.
The figures in parenthesis are HAC Robust standard errors.

TABLE 17: Causality results, WA

	D(Unem_rate)	D(Immi_rate)	D(Real AWE)	D(Real GSP)
$FMOLSECT_{t-1}$	0.006004 (0.040855)	-0.495498 (0.108628)***	-0.007837 (0.008837)	-0.006609 (0.013220)
$D(Unem\_rate)_{t-1}$	0.144229 (0.107017)	-0.113796 (0.300263)	0.013160 (0.023543)	-0.010812 (0.037552)
$D(Immi\_rate)_{t-1}$	0.002157 (0.013450)	-0.323589 (0.076778)***	0.011012 (0.006843)	-0.000311 (0.010790)
$D(Real\ AWE)_{t-1}$	0.417714 (0.553175)	-0.955536 (1.488986)	-0.205508 (0.107215)*	0.142082 (0.207448)
$D(Real\ GSP)_{t-1}$	-0.775265 (0.270355)***	-0.223282 (0.822005)	0.092320 (0.074436)	-0.057874 (0.163309)
C	-0.010678 (0.008088)	0.013767 (0.021535)	0.003819 (0.001441)***	0.002981 (0.003326)
Dummy1993Q2	0.031273 (0.016836)*	-0.912241(0.204948)***	1.13e-05 (0.003786)	0.002793 (0.007653)
Dummy2009Q1	0.412486 (0.012887)***	-0.259052 (0.202989)	0.012475 (0.003118)***	-0.064574 (0.004902)***
Dummy1999Q4	0.057070 (0.012797)***	-0.815367 (0.202079)***	-0.001451 (0.002944)	0.036940 (0.005299)***
Dummy1995Q2	0.004488 (0.025688)	0.615146 (0.211406)***	-0.017886 (0.005550)***	0.007493 (0.009275)
R^2	0.420766	0.563014	0.104743	0.081444
Adjusted R^2	0.360148	0.517283	0.011053	-0.014684

Note: Assumptions: Intercept (no trend) in Cointegration and VAR; Lag interval in first differences: 1 to 1;
Sample: Q3 1988 to Q2 2012; *, ** and *** denotes the variable is significant at 10 per cent, 5 per cent, and 1 per cent, respectively.
The figures in parenthesis are HAC Robust standard errors.

As noted, the cointegrated I(1) series could readjust to the long-run equilibrium level after the deviation caused by the temporary shocks. The coefficients of lagged error correction terms ($FMOLSECT_{t-1}$) report estimations on the speed of such adjustment processes. Tables 15, 16 and 17 report the estimation outcomes of the VECM (as shown in equation 5) for each state, which gives insight into the directions of long-run causation among four variables and the estimates of the speed of adjustment parameters. Whether the coefficients of $FMOLSECT_{t-1}$ are significant is determined based on a standard χ^2 test.

For the unemployment equation of NSW, the speed of adjustment parameter is negative and significant at the 1 per cent level, suggesting the unemployment rate adjusts to long-run equilibrium. We conclude that if a temporary exogenous shock such as an increase of income tax or a new unemployment benefit scheme takes place, the unemployment rate would adjust back to equilibrium level with about 12.84 per cent of the adjustment for each quarter. Such a negative and significant coefficient also indicates that the long-run causation goes from immigration to unemployment. As the FMOLS regression of Table 12 gives that there exists a significant and negative relationship (-0.24) between immigration and unemployment, we conclude that the continuous inflow of immigrants would reduce the local unemployment rate of NSW in the long run. As noted, an increase of 1 per cent in the immigration rate would reduce the unemployment rate of NSW by 0.24 per cent.

For VIC, a negative and significant speed of adjustment parameter is also found in the equation for the unemployment rate. Nonetheless, the unemployment rate of VIC takes a much shorter period to readjust to the equilibrium level. The speed of adjustment is equal to -0.27 implying that a temporary shock caused deviation of the unemployment rate would be adjusted by 27% after one period. The speed of adjustment parameter is approximately as twice as the NSW's. Taking into consideration the negative coefficient of immigration in Table 13, the assumption that a 1 per cent increase in immigration rate would lead to a fall in the VIC's unemployment rate of 0.21 per cent is confirmed.

Table 17 demonstrates the causality test outcomes of the WA data. From the equation for the immigration rate, the speed of adjustment parameter is significant and negative, suggesting the long-run causation runs from immigration to unemployment, unlike the foregoing two states. If a temporary shock such as the mining boom boosts the immigration rate, 49.55 per cent of the previous period's disequilibrium error is adjusted in the current period. As Table 14 reveals a

negative correlation between two variables, Table 17 further reveals that the variations in the unemployment rate have negative effects on the WA immigration rate in the long run.

All in all, the short-run error correction models point out the direction of long-run causation. None of the long-run FMOLS estimates and short-run VECM estimates show a positive relationship between immigration and unemployment.

Chapter Five: Discussion and Conclusion

This chapter discusses the findings obtained from estimates of the Toda and Yamamoto augmented VAR model (hereafter TYVAR) and the modified Johansen two-step procedure. Next I address the research questions and discuss some additional interesting findings. Furthermore, some questions are raised for future research, and some limitations of the study are discussed.

In general, the empirical relationships among the four variables in the model varies by states and by estimation methods. The research questions focus on the relationships between immigration and unemployment in five states of Australia from Quarter 1 1988 to Quarter 2 2012. In general, both estimates (TYVAR and VECM) contribute to the view that the continuous inflow of immigrants would not increase unemployment in the five states in both the short run and the long run.

Immigration-unemployment relationships in five states

In SA and QLD, the outcomes of the Johansen cointegration tests and TYVAR estimates do not reveal any causation and/or cointegrating relationships between immigration and unemployment. There is no significant effect of immigration on unemployment, real wage and economic growth in the two states.

The historical literature offers two mainstream explanations. Firstly, the inflow of immigrants to SA and QLD could be an irrelevant or insignificant variable to their regional labour supply and demand (Tian and Shan, 1999; Boubtane et al., 2013). Secondly, it is also possible that the negative aggregate demand effects and positive labour supply effects of immigration on domestic unemployment are mitigated by each other, that is the high substitutability between immigrants and locals could largely compensate for the labour demand caused by the increasing needs for good and services (Dolado et al, 1994).

Based on the TYVAR estimates, no causation from immigration to unemployment has been revealed, while a unidirectional causality from unemployment to immigration is only found in

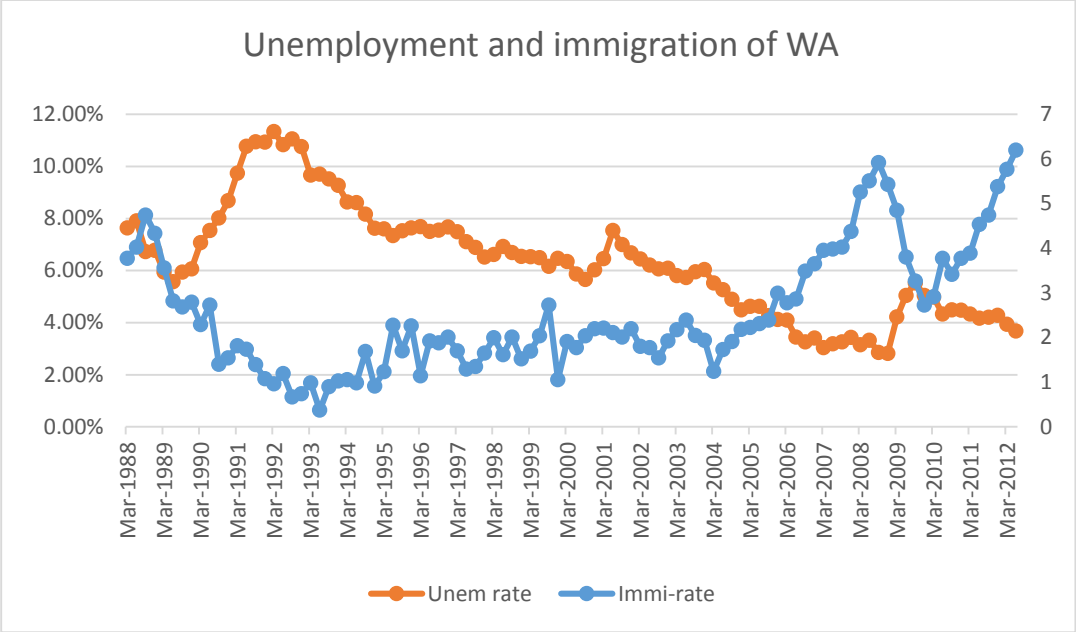
WA. A general overview on the historical series (Figure 2 in next page) suggests that a decreasing trend of unemployment rates in the state triggers the immigrants' interest in WA. Such a finding is confirmed by the VECM estimates that there exists a negative long-run causation from unemployment to immigration in WA.

According to the Johansen cointegration tests, the existence of one cointegrating relationship is found among the time series of NSW, VIC and WA. Based on the estimates from the modified two-step procedure, the immigration rates of NSW and VIC have long-run significant and negative effects on their unemployment rates.

In the long run, the major driver of the immigration effects in the two states could be the aggregate demand effect resulting from the increased consumer population, which significantly increases the demand for the overall labour force. Considering the high substitutability between immigrants and locals due to the skills-based Australian immigration program, both labour groups would benefit from the long-run negative effect. The results show that for every 1 per cent of increase in the immigration rate, the unemployment rate will be decreased by around 0.24 per cent and 0.21 per cent respectively in NSW and VIC, *ceteris paribus*. The inflow of immigrants appears to create more jobs in the long run instead of creating competition in the labour market. Moreover, future research could focus on the comparative analysis of the effects on more decomposed groups in the two labour forces, or examine whether there is an industrial dispersion where some industries are more favoured by immigrants and/or are likely to employ those bringing foreign knowledge (Harrison, 1983; Simon, 1999).

By estimating the VECM model, we found the speed of adjustment parameter of the VIC unemployment rate is approximately 27 per cent, which is 50 per cent larger than the NSW's (at 12.84 per cent). If a temporary external shock like a change of income tax or local's unemployment benefit throw the variables out of equilibrium, VIC has a much faster readjustment process than the NSW. It is worthwhile to examine what actually causes the difference in the speed of adjustment parameters and if the labour and immigration policies of NSW should follow VIC's.

FIGURE 2 Unemployment and immigration in WA, Q1 1988 to Q2 2012.



Left axis/orange line is the unemployment rate (per cent); right axis/blue line is the immigration rate (per 1000 Australians).
Source: Australian Bureau of Statistics (3101.0; 6202.0)

In WA, the VECM estimates present that the negative causality runs from the unemployment rate to the immigration rate in the long run. The tests on the direction of causation confirms the TYVAR estimates. This finding implies that immigrants moving to WA seems to be severely influenced by the perceived labour market status. Together with the demonstration in Figure 2, the long-run decreasing trend in the unemployment rate, from nearly 12 per cent in the early 1990s to 3.98 per cent in Quarter 2 of 2012, attracts an inflow of immigrants which drives the immigration rate of WA up from nearly 0 per 1000 inhabitants in 1993 to 6.2 per 1000 inhabitants in Quarter 2 of 2012. The VECM estimates also suggest that once the immigration rate surges due to the exogenous shocks such as the mining boom in 2008-2009, it shall decrease to the long-run equilibrium level.

The findings might indicate that immigration is a Pareto improvement process for WA in the long run. For the immigrants, they are motivated to reside in WA for better job opportunities, higher wage rate and living standard. For the locals, the unemployment rate is decreased with the inflow of immigrants. The long-run negative relationship between unemployment and real GSP further suggests that the inflow of immigrant could have a positive effect on the economic growth. The better off of economic conditions and labour market performance, in turn, could

attract more immigrants. Every participant is better off under such circumstances. The study in WA might reveal an interesting benign circle or a long-run adjustment process to Pareto optimal.

All in all, the two estimates (TYVAR in fist difference and cointegration tests) confirm that there exists no cointegrating relationship between immigration and unemployment in QLD and SA, while the relationships varies in the other states. The empirical evidence shows that immigration has not increased the unemployment rate in major Australian residential areas in the long run, although it has contributed to about half of the population growth. To the contrary, immigration has made a significant contribution to lowering the unemployment rate in NSW and VIC. Moreover, the long-run downward shift of the unemployment rate of WA attracts more immigrants to reside.

Apart from the relationship between immigration and unemployment, this study also reveals how immigration effects vary in different labour markets, and how the two other variables (real GSP and real wage) would impact immigration and unemployment.

Immigration effects in different sized labour markets

This study finds an interesting relationship between the immigration rate, the sizes of labour markets and the magnitude of the immigration-unemployment relationship.

First of all, the cointegrating relationships are only found among the series of the three states with higher immigration rate. Among five states, WA has the highest average immigration rate at 2.5367 immigrants per thousand inhabitants throughout the sample period, followed by NSW (1.8079), VIC (1.7462), QLD (1.5944) and SA (1.0549). The Johansen cointegration tests reveal the existence of a cointegrating relationship in the three most popular destinations of WA, NSW and VIC. Moreover, the TYVAR estimates only reveal a causation from unemployment to immigration for WA that is the state with the highest immigration rate.

Secondly, the immigration rate could have a positive relationship with the magnitude of the immigration-unemployment relationship. Based on estimates of long-run relationships in Section 4.5, immigration has a universal significant and negative relationship with unemployment in the NSW, VIC and WA. The largest long-run elasticity of the unemployment

rate with respect to the immigration rate (in absolute value) is found in WA (0.5335), followed by NSW (0.2374) and VIC (0.2112). It seems that the higher average immigration level the state has in the sample period, the larger the magnitude of the relationship.

The size of the labour market also has a significant role in the foregoing relationships. According to the Labour Force statistics (ABS, 2016), the labour market of WA experienced the highest growth rate in the study period of the three states by 79.87 per cent from 0.755 million in Quarter 1 of 1988 to 1.358 million labour force in Quarter 2 of 2012, while the other states grew by less than 50 per cent (37.66 per cent for NSW, 46.11 per cent for VIC).

Combining labour force growth data with the average immigration rates of the three states, the largest long-run elasticity of unemployment with respect to immigration (WA) might result from the significant continuous involvement of immigrants in a notable labour market expansion, but not a big change in the labour market size or a high immigration rate alone. Such an inference is supported by the evidence from other states. Although the VIC labour market had a slightly bigger expansion than NSW's, the higher average migration rate of NSW is shown with the presence of a larger coefficient on the empirical immigration-unemployment relationship. Moreover, QLD actually experienced the largest labour market expansion of the five states, at 88.91 per cent (from 1.28 million to 2.41 million). Such a rapid expansion might partially be caused by the high inter-state migration due to the mining boom. As the time series of net oversea migration does not include the inter-state migration data, this study only focuses on the aggregate effects of oversea migration on the labour market (ABS, 2016). However, the cointegrating relationship is not shown possibly due to its low immigration rate.

In summary, the causal relationship between immigration and unemployment is more likely to be found for the states which have higher average immigration rates. The magnitude of the effect is determined by the immigrant share of labour force growth in the sample period.

The effects of the real GSP on unemployment and immigration

In general, there exists a negative relationship between the real GSP and the unemployment rate. In the long-run, FMOLS estimates reveal the negative relationship is significant in VIC, while they are negative but insignificant in NSW and WA (Tables 12 to 14). The estimates of

short-run VECM models suggests that the increase of real GSP would contribute to lower unemployment. Such a result confirms the conventional observations that the unemployment rate would normally peak during a recession, and decrease when the economy grows.

Combining this finding with the long-run negative relationships between unemployment and immigration in the states, it is reasonable to infer that there could exist a positive relationship between immigration and real GSP. An increasingly prosperous state with a low unemployment rate would inevitably increase its own attractiveness to immigrants, and a continuous inflow of immigrants could contribute to the long-run expansion of the state's economy.

Questions, limitations and future research

One question that arises is the inconsistent outcomes between the TYVAR estimates and the estimates of the Johansen cointegration tests. Based on the TYVAR estimates, the causal relationship is only found in the state with the largest immigration rate(WA), while the Johansen cointegration tests suggests there also exists a causal relationship among the time series of NSW, and VIC. The VECM estimates present a long-run unidirectional causality from the immigration rate to the unemployment rate in these two states. It is important to explore why the TYVAR and the Johansen cointegration tests often present different outcomes (such as Alimi and Ofonyelu, 2013)

Another question arises is that the significant and negative relationship between real wage and unemployment. Based on the FMOLS estimates, a 1 per cent increase of real wage could result in approximately 3.13 per cent and 1.76 per cent decrease of the unemployment rate in NSW and VIC, respectively. Such empirical findings actually disapprove the theoretical inference that the increase in the wage should normally increase the unemployment rate, as Harris-Todaro (1970) implied. A possible explanation to the significant long-run negative relationship between the real wage and the unemployment is the hypothesis of "wage curve", presented by Blanchflower and Oswald (1994). In fact, such findings is not unheard of in the existing empirical literature (Withers and Pope, 1993, p.729). It can be inferred that the NSW and VIC has been through fast economic expansion in the observation period so that even the continuous inflow of skilled immigrants cannot meet the demand for labour, while another study on NSW and VIC economic conditions have to be conducted to examine such inference.

A limitation of this study relates to the deflation measures used. Due to the data limitations, include the quarterly CPI index of each capital city is used to represent the quarterly CPI index of each state. It is likely that the inflation rates in the capital cities are more unstable and higher on average than the state indices. However, the dispersion should not be significant as the residents in the capital cities of the five states account for nearly 70 per cent of the states' population. It is expected that only the capital cities of Australia could provide a consistent measure of CPI index due to the feasibility of data collection approaches in cities and their complete sets of industries.

Another limitation of the study is the concern on the stationarity properties of the series. The KPSS series in Tables 1 to 5 occasionally provide uncertain results. However, the ADF and ADF-DLS gives the robust results that the series are all non-stationary I(1).

A more advanced and reliable study could include not only variables from the general model, but also state-specific variables such as different immigration quotas per year, different unemployment benefit schemes, a unique industry structure or the workplace environment favouring the immigrants. In each state, the exogenous variables to explain the immigration rate may be many and diverse. For example, Harrison (1983) compared the industry participation between locals and immigrants, and revealed that immigrants to South Australia had a higher participation rate in trading industry. Although his study is now out-of-date, it is worthwhile to examine whether any particular industry is preferred by immigrants in the long term. The future study may focus on a more thorough understanding of the immigration environment in each state, and thus contribute to a more comprehensive analysis.

Apart from that, another direction of future study is examining the economic impacts of immigration on the origin countries. The loss of workforce for the origin countries could also cause severe socio-economic issues such as loss of wealth, wisdom and productivity. It is necessary to identify the origin countries which keep losing their workforce, and study whether the high mobility of population could have detrimental effects on the origin countries.

Appendix

Data Sources

Australian Average Weekly Earnings ($): Australian Bureau of Statistics 2016. *6302.2 Average Weekly Earnings, Australia*: *Table 12a to 12e*. Average Weekly Earnings – Seasonally adjusted, varies issues. Available online: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/second+level+view?ReadForm&prodno=6302.0&viewtitle=Average%20Weekly%20Earnings,%20Australia~May%202012~Previous~16/08/2012&&tabname=Past%20Future%20Issues&prodno=6302.0&issue=May%202012&num=&view=&>

Australian consumer price index: Australian Bureau of Statistics 2016. *6401.0 Consumer Price Index, Australia*: *Tables 1 and 2*. CPI: All Groups, Index Numbers and Percentage Changes. Available online: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6401.0Jun%202016?OpenDocument>

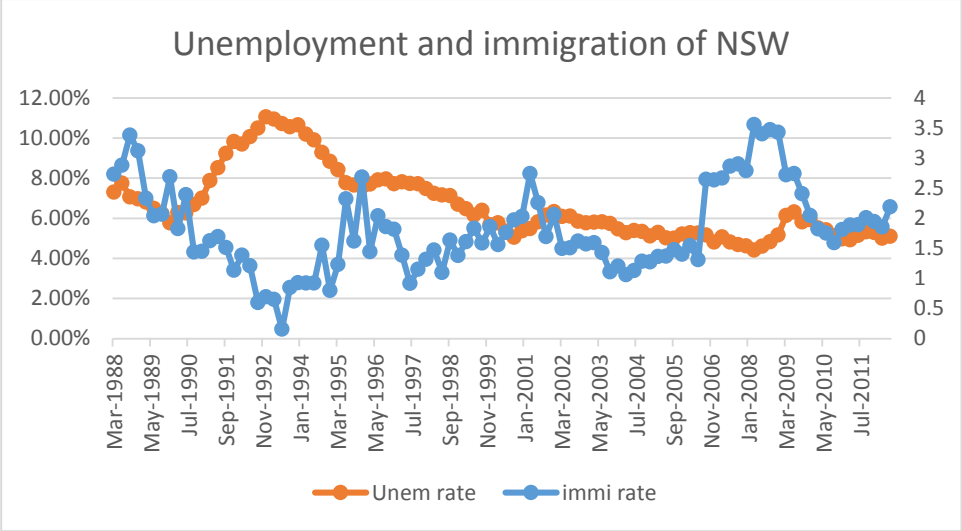
*Australian Net Migration Rat*e and *Australian Population*: Australian Bureau of Statistics various issues. *3101.0 Australian Demographic Statistic: Table 2. Population Change, Components – States and Territories (Number)*. Available online: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/second+level+view?ReadForm&prodno=3101.0&viewtitle=Australian%20Demographic%20Statistics~Sep%202015~Latest~24/03/2016&&tabname=Past%20Future%20Issues&prodno=3101.0&issue=Sep%202015&num=&view=&>

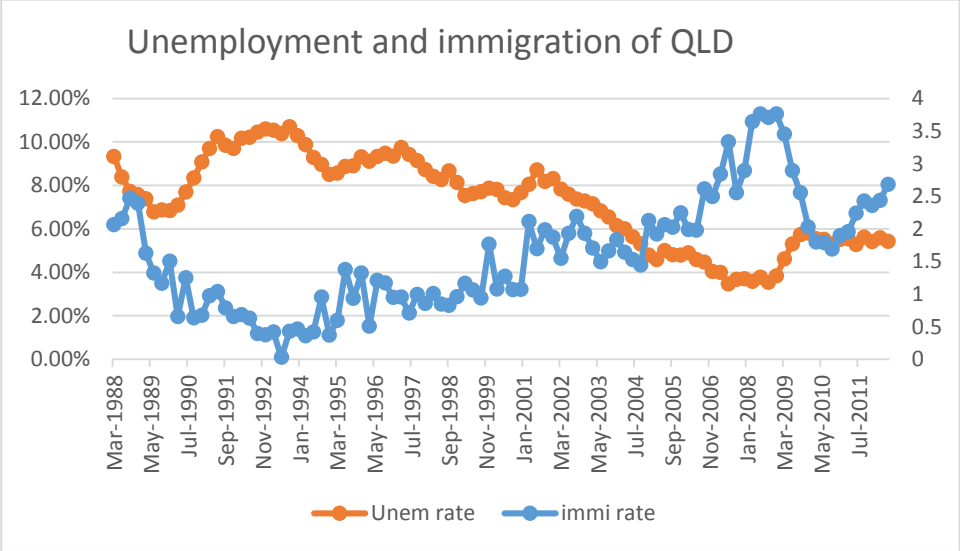
Australian unemployment rate (%): Australian Bureau of Statistics 2016. *6202.0 Labour Force, Australia*: *Tables 4 to 8*. Available online: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6202.0Apr%202016?OpenDocument>

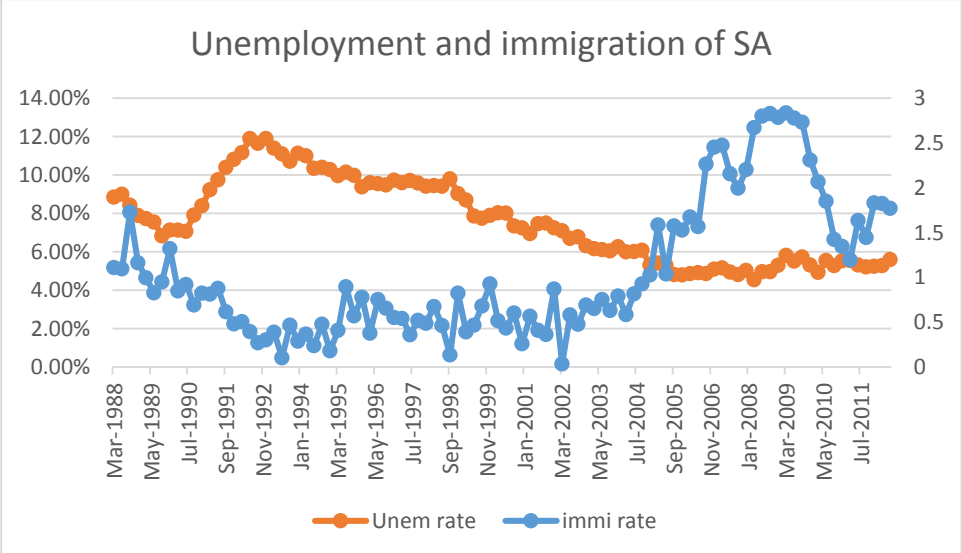
Net Export ($ Millions): Australian Bureau of Statistics 2016. *5368.0 International Trade in Goods and Services, Australia*: *Table 36a-36e & 37a-37e*. Merchandise Exports and Imports. Available Online: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5368.0Jul%202016?OpenDocument>

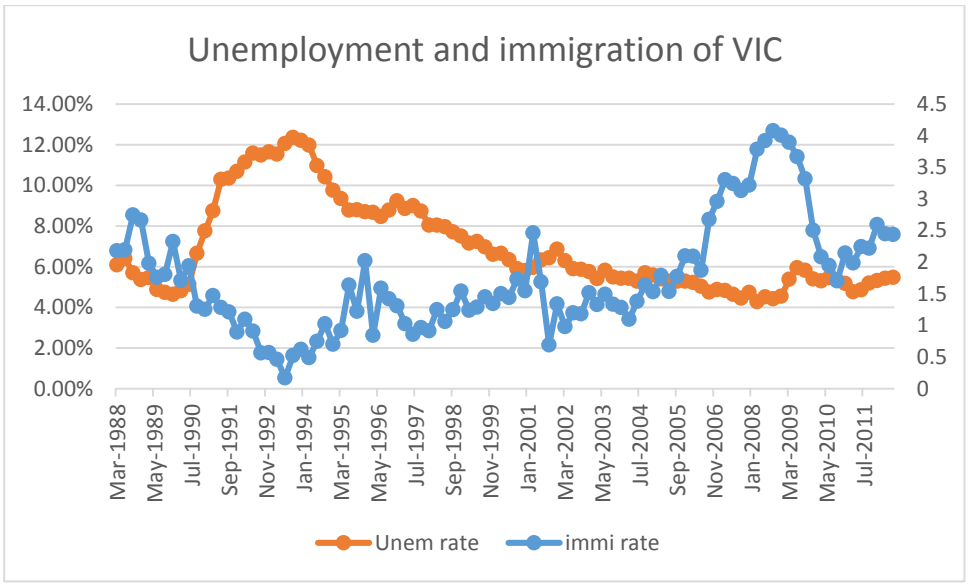
State Final Demand ($ Millions): Australian Bureau of Statistics 2016. *5206.0 Australian National Accounts: National Income, Expenditure and Product*: *Table 25*. State Final Demand, Summary Components by States: Chain volume measures. Available online: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5206.0Jun%202016?OpenDocument>

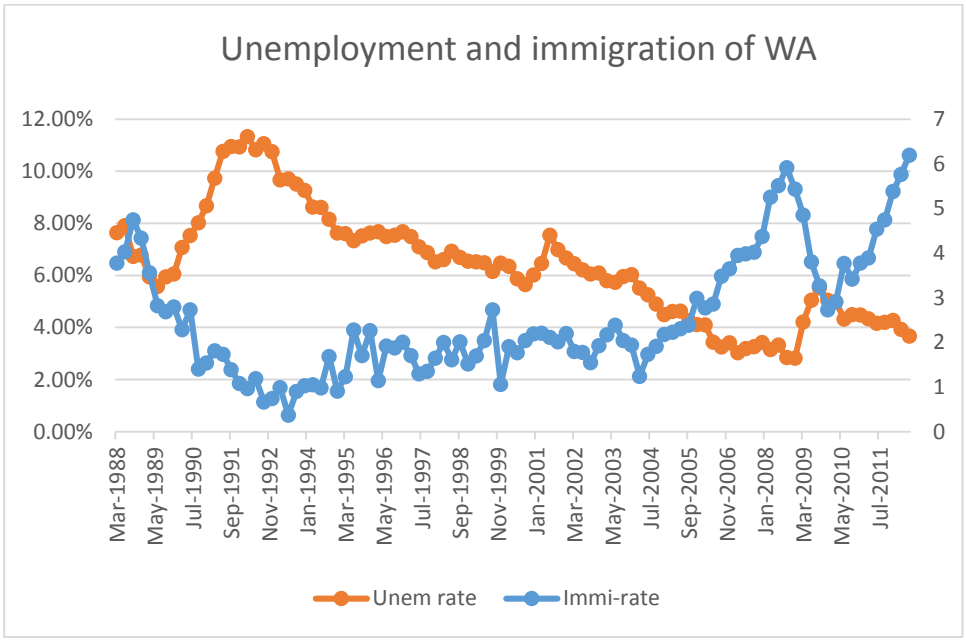
Time series graphs for each state











Left axis/orange line is the unemployment rate (per cent); right axis/blue line is the immigration rate (per 1000 Australians).
Source: Australian Bureau of Statistics (3101.0; 6202.0)

Table I: VAR LAG ORDER SELECTION CRITERIA FOR FIVE STATES

	NSW			QLD			SA		
Lag	LR	FPE	AIC	LR	FPE	AIC	LR	FPE	AIC
0	NA	1.44e-08	-6.701353	NA	6.17e-08	-5.249253	NA	2.97e-08	-5.981236
1	722.4051	5.55e-12	-14.56642	679.5107	3.86e-11	-12.62688	569.3449	6.49e-11*	-12.10698*
2	31.64021	5.38e-12*	-14.59900*	29.89459*	3.82e-11*	-12.63868*	26.42489*	6.70e-11	-12.07747
3	23.84407	5.66e-12	-14.55296	15.99007	4.44e-11	-12.49447	20.36109	7.36e-11	-11.98790
4	17.21544	6.43e-12	-14.43540	22.27479	4.71e-11	-12.44347	15.10026	8.59e-11	-11.84250
5	27.78198*	6.26e-12	-14.47717	23.15248	4.89e-11	-12.42095	20.58267	9.25e-11	-11.78429

	VIC			WA		
Lag	LR	FPE	AIC	LR	FPE	AIC
0	NA	2.42e-08	-6.185630	NA	6.24e-08	-5.237959
1	717.2688	9.85e-12	-13.99233	674.9827	4.11e-11	-12.56413
2	36.70019*	9.00e-12*	-14.08515*	32.57457*	3.94e-11*	-12.60784*
3	25.92842	9.22e-12	-14.06517	12.54145	4.78e-11	-12.42052
4	15.94328	1.06e-11	-13.93086	20.68636	5.18e-11	-12.34862
5	21.81640	1.13e-11	-13.88978	16.32410	5.91e-11	-12.23126

Note: * indicates lag order selected by the criteria; Endogenous variables: Unemployment rate, immigration rate, real wage and real GSP. Exogenous variable: Constant. Sample: Quarter 1 1988 to Quarter 2 2012. Included observations: 93.

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