Journal of Applied Economics

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/recs20

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To cite this article: Mostafa E. AboElsoud , Anas AlQudah & Eman Elish (2020) Does a change in immigration affect the unemployment rate in host countries? Evidence from Australia, Journal of Applied Economics, 23:1, 21-43, DOI: 10.1080/15140326.2019.1684740

To link to this article: https://doi.org/10.1080/15140326.2019.1684740

Published online: 01 Jan 2020.

JOURNAL OF APPLIED ECONOMICS
2019, VOL. 23, NO. 1, 21–43
https://doi.org/10.1080/15140326.2019.1684740

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ARTICLE

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Does a change in immigration affect the unemployment rate in host countries? Evidence from Australia

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ABSTRACT
This study examines and evaluates the dynamic causality relationship between immigration, unemployment, wages and GDP per capita in host countries with a focus on Australia. Previous research has indicated that the economic impact of immigration is significant; nonetheless, its effect on the labour market being positive or negative is inconclusive. This study uses a Vector Error Correction Model (VECM) to examine the dynamic short- and long-run nexus between these variables in Australia over the period 1980–2016. The paper provides clear evidence to policy makers on the positive spillover effect of immigration policies developed by the Australian government.

ARTICLE HISTORY
Received 27 December 2018
Accepted 21 October 2019

KEYWORDS
Immigration; unemployment; wages; economic growth; GDP; Australia; VECM

1. Introduction

The question of the economic impact of immigration has been widely addressed in economics and in political circles. This economic impact of immigration has been identified as significant by previous studies; however, there is no consensus on the immigration effect on the labour market. Even if there is agreement in the economic literature regarding the limited economic impact (Longhi, Nijkamp, & Poot, 2010; Okkerse, 2008), the conclusions diverge according to the context of the geographical, temporal, and methodological analysis (Damette & Fromentin, 2013; Dustmann, Glitz, & Frattini, 2008). Borjas (1995) emphasizes that "the most important lesson is that the economic impact of immigration varies by time and place and can be beneficial or harmful". In this respect, and according to Fromentin (2013), it seems important to raise questions about the connection between immigration and the unemployment rate and to examine their causal relationship, particularly in Australia.

Unemployment in Australia ranged between one and two percent of the labour force in the 25 years following the end of World War II (Khraief, Shahbaz, Heshmati, & Azam, 2018). In the early 1980s and 1990s, however, unemployment levels rose to as high as ten percent before gradually declining in the late 1990s and early 2000s. According to the Australian Bureau of Statistics, current unemployment levels stood at 5.4 percent in June 2018. According to Kerr, Carson, and Goddard (2002) and AlQudah (2009), the

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variation in unemployment levels over the years is attributed to various factors, including but not limited to population increase, the rise in the level of education, the nature of the labour market, economic growth, and government policies.

With respect to immigration history in Australia, its population has increased significantly from the aboriginal population of 400,000 in 1788 during the first European settlement to the present figure of 24.1 million (Malaspinas et al., 2016). The difference in the population is a clear indication of the country's rich immigration history. Roe (2002) observes that like most countries that were under colonization, many of the first immigrants to Australia did not migrate willingly, but this situation has changed considerably over the years. In addition, the increase in immigrants over time in Australia can be associated with the change from the initial White Australia Policy that prevented non-Europeans from immigrating to the country to the current multicultural setting (Jupp, 2002). Subsequently, many of Australia's immigration policies have changed to accommodate a more diverse set of immigrants.

Australia has been recognized as one of the countries that receives a significant number of immigrants each year. According to Bove and Elia (2017) and Kang and Kim (2018), the country receives almost as many immigrants as Canada. Australia's annual permanent migration intake is slightly less than 200,000 people. This is in conjunction with offering temporary visas to as many as 600,000 migrants each year. When these figures are combined, Australia welcomes an average of 800,000 immigrants each year. A majority of the individuals who acquire temporary visas to Australia are international students, temporary skilled workers, and working holidaymakers. Unlike in the United States (US), where family-sponsored immigration is favoured, the policies of Australia and Canada have preferences for incoming skilled immigrants. This has had a profound impact on the region's economy, particularly in regard to employment.

The aim of this study is to produce reliable results that enhance our understanding of the causal relationship and the impact of immigration on the labour market in Australia through an econometric analysis based on a general macroeconomic model framework with a long-term and short-term distinction. For this purpose, we adopt the use of a Vector Error Correction Model (VECM) to examine the dynamic interaction of the short- and long-run relationships among the selected variables used in the study.

The rest of the study is organized as follows. The next section presents the literature on the immigration, the unemployment rate and the economic growth nexus, followed by the methodology used. Section four reports the main empirical results, and section five of the article draws conclusions and provides elements for consideration for the formulation of coherent economic and migratory policies according to the macroeconomic characteristics of Australia.

2. Literature review

Contention regarding the relationship between immigration and the unemployment rate has remained a subject of public and scholarly debate and is a matter of concern in Australia. This is because the high levels of immigration have changed the employment landscape in the country. Some argue that immigration turbo-charges the region's economy, while others postulate that it has adverse impacts on local employment rates. This study seeks to determine whether a change in immigration affects the unemployment rate in host countries, with a focus on Australia.

2.1. Immigration and unemployment

This study explores economic theories in relation to how a change in immigration directly influences the aggregate rate of employment, with Australia as the case study. Many theorists and researchers have explored the link between immigration and the unemployment rate, and their research results and postulations differ with regard to the impact of immigration on the unemployment rate (Damette & Fromentin, 2013; Dustmann et al., 2008; Gross, 2004). For instance, most studies that have been conducted on the US have shown either a neutral or a positive correlation between change in immigration and the unemployment rate, particularly with regard to the employment rates of the native populations. In contrast, many studies on the European continent have indicated negative effects of immigration (Angrist & Kugler, 2003; Fromentin, 2013; Gross, 2002; Jean & Jimenez, 2007). In Australia, the effect of immigration on local wages as well as the prospects of locals in terms of employment are issues that provoke contemporary emotional and heated debates. In Australia, this phenomenon is explored with regard to immigrants, referring to people born outside the country, and how they have impacted the labour market outcomes of the Australian born or natives.

The theory of economics has not provided a definite conclusion regarding the prediction of the impacts of immigration on the labour market or the growth of the host country's economy. Many studies have argued that immigration's impacts on the host country's employment largely depend on the extent and ways by which immigrants either complement or replace existing local workers. (Borjas & Van Ours, 2010; Greenwood, Hunt, & Kohli, 1996; Grossman, 1982) reiterated this fact by arguing that if immigrants or residents are deemed substitutes, this means that the wage rates will fall due to the increase in competition in the labour market. This translates to a rise in unemployment among residents, which might lead to decline in their work at these extremely low wages. In contrast, if immigrants complement instead of replacing the host country's residents, production will increase, leading to an increase in employment opportunities that, in turn, translates to high wages. Bodvarsson, Van den Berg, and Lewer (2008) stated that immigrants are consumers of local goods and services, which translates to an increase in demand, thus increasing local production and leading to an increase in employment opportunities. A study by Dustmann et al. (2008) analysed the impact of immigration on wages and unemployment using England as a case study. Their study was not conclusive regarding whether immigration has standard effects on aggregate employment or unemployment. It noted some differences in wages, which depend on education and the extent to which immigrants are either complements or substitutes.

Subsequent studies showed an insignificant rise in total unemployment as a result of long-term immigration. In addition, some studies have shown that immigration has a negative effect on unemployment, while it has a smaller or insignificant impact in regard to increases in short-term wages. Research by Peri and Requena-Silvente (2010) estimated the long-, short- and medium-term impacts of immigration on production, employment, and income in the US economy. Their study results indicated that migrants expand the capacity of production due to the enhancement of specialization as well as the investment's stimulation effect. In turn, this enhances the income per worker, yielding some efficiency gains. It should be noted, however, that there is no evidence that migrants reduce employment opportunities for native workers. Another study by Moreno-Galbis and Tritah (2016) explained the effect of shock in labour supply, which is caused by immigrants, on indigenous European workers. The researchers considered the labour market to be of two types: labour suppliers on indigenous people and migrants. From this basic theoretical model, the study concluded that immigrants' influence is externally positive because migrants are more profitable than workers, prompting companies to be able to open more vacancies.

Asadul (2007) discussed the connection between Canada's immigration and its impact on unemployment. The findings showed that in the short run, unemployment can be caused by immigration, but in the long run, it depends on various factors. Liu (2010) raised a controversy over the impact of immigration on social welfare as well as the labour market. Liu concluded that illegal immigration created a considerable gain in indigenous people's well-being.

A recent study by Bond and Gaston (2011) also used the national labour market approach and found positive effects of immigration on native Australian earnings; however, this effect was not evident in all education groups in this study. In addition, while classifying immigrants according to their country of origin, they found that immigrants from non-English speaking countries had greater positive effects on native earnings than immigrants from English-speaking countries. Latif (2015) analysed the effect of global immigration on the rates of employment of host countries and found mixed results in the short run and the long run. In the short run, the results indicated the unidirectional causality that runs from immigration to the unemployment rate; thus, immigration has a positive and significant effect on the rate of unemployment. In the long run, the results indicated that immigration negatively affected the rate of unemployment of the host countries.

Breunig, Deutscher, and To (2017) examined the effect of immigration on the labour market outcomes of Australian workers using the national labour market approach by dividing immigrants into educational groups and experience groups. Their main findings concluded that immigration flows into skill groups where wages and employment are high; however, there was no evidence that labour market outcomes for individuals born in Australia were negatively affected by immigration. For incumbents, a negative relationship between immigration and incumbent wages prevailed and was entirely associated with highly educated female workers with 10 years or less experience entering the Australian market; this effect faded when more precise skill groupings were considered. Generally, the results showed that incumbent labour market outcomes were similarly affected by immigration. Furlanetto and Robstad (2019) used a different technique of isolating immigration as an endogenous model which responds to immigration shocks and other macroeconomic shocks that occurs during business cycles. They have utilized the structural Vector Autoregressive model on Norway from 1990 to 2014 using a quarterly series. They investigated the effects of immigration shocks on unemployment, public finances, house prices, household credit, prices, exchange rates, and productivity. It was found that immigration shocks and labour supply shocks had a significant impact on immigration. The exogenous effect of immigration also showed a reduction of unemployment when immigration shocks existed, however, a minor positive effect on prices and public finance existed. There was no significant effect detected on house prices nor household credit. Nonetheless, a negative effect on productivity existed due to the decline of capital intensiveness in the industry.

2.2. Immigration and economic growth

The debate on immigration policies in Australia has usually focused on a question: is immigration bad for the country's economic performance? Assuming that immigrants have zero or no human capital, they will only increase the host country's population, leading to slow economic growth. This can be said to be due to the local capital dilution. Alternatively, if immigrants transport with them some kind of human capital, then the dilution of local capital may be offset, which accumulates to more economic growth. Because per capita GDP has widely been used as a proxy for the economic performance of host countries, the effect of immigrants on per capita GDP is vital when understanding whether immigration has a positive or negative economic impact on the host country (Boubtane, Coulibaly, & Rault, 2013; Morley, 2006).

On the other hand, the flow of immigration is expected to produce a reduction to the ratio of physical labour/capital in the host country. This, in turn, leads to a decrease in what is called the output per capita. Kemnitz (2001) argued that if immigrants are educated, the human capital that they embody compensates for the reduction in the ratio of physical labour and capital. In addition, research has shown that immigration has positive impacts on both economic growth and productivity (Antecol, Cobb-Clark, & Trejo, 2003; Dolado, Goria, & Ichino, 1994). However, it has been proven that highly educated immigrants contribute more to the aforementioned effects. The economic impact of immigration on the host country in the case of Australia has been an object of extensive theoretical research in economics. Politicians and public opinion makers see inflows of migration as the main cause of difficulties in the domestic economy. However, this argument has not been supported by any economic literature.

d'Albis, Boubtane, and Coulibaly (2019) using a structural Auto Regressive model on 19 OECD countries, argued for the positive economic and fiscal effect of migration on OECD countries that suffered from an aging population. They found a positive significant effect of immigration shocks on per capita GDP during the period 1980–2015. This was a result of the positive impact of these shocks on both the working-age population ratio and employment rate. In addition to the fiscal balance being improved when the per capita transfer payments paid by these governments were reduced.

It should also be noted that migration has been found to boost the working-age population, and migrants contribute to the progress of the host country's productivity. However, this effect may differ from country to country. The education status of immigrants has usually varied in considerable ways, and young immigrants tend to be more educated than those nearing retirement; thus, the former contribute positively to the economy (Arnholtz & Hansen, 2013; Di Giovanni, Levchenko, & Mejean, 2014; Dolado et al., 1994; Peri & Sparber, 2009). Ultimately, the economic effects of immigration on hosting countries have theoretically been approached from different perspectives. The conclusions have depended on the assumptions that have been made when developing the theoretical model. Furthermore, there is no consensus in the literature regarding whether immigration affects the unemployment rate or economic growth in host countries. In addition, there is a paucity of research on the aforementioned nexus in Australia. Accordingly, to the best of our knowledge, this study is the first to contribute to the literature specifically by examining the impact of immigration on the unemployment rate as well as economic growth in Australia at a macroeconomic dynamic level. The data used and the empirical methodology employed are discussed next.

3. Methodology

3.1. Data collection and transformation

The monthly data for the period 1980 to 2017 for Australia were retrieved from the World Bank Indicators, Organization for Economic Cooperation and Development (OECD), Federal Reserve Bank of St. Louis' Database (FRED), Australian Bureau of Statistics (ABS) and Australian Department of Home Affairs. Following in particular the research of Marr and Siklos (1994), Gross (2004), Layard, Layard, Nickell, and Jackman (2005), Boubtane et al. (2013), and AboElsoud (2018), a theoretical framework of the general macroeconomic model is proposed that takes into consideration the interdependence among immigration, the unemployment rate, wages and economic growth. The selected variables consist of the endogenous variable "Unemployment rate" and the exogenous variables "Net Overseas Migration", "Hourly Wage Rate" and "Per capita real GDP". All variables used in this study are expressed in the natural logarithmic form.

3.2. Empirical framework

As discussed above, the study uses a general macroeconomic model to determine the dynamic interrelations among the variables under examination. For an empirical application, the variables can be modelled as a function of each other as follows:

$$UN_t = f\left(UN_{t-k,} NOM_{t-k}, PGDP_{t-k}, W_{t-k}\right)$$

$$NOM_t = f(NOM_{t-k}, UN_{t-k}, PGDP_{t-k} W_{t-k})$$

$$PGDP_t = f(PGDP_{t-k}, UN_{t-k}, NOM_{t-k}, W_{t-k})$$

$$W_t = f(W_{t-k}, UN_{t-k}, NOM_{t-k}, PGDP_{t-k}),$$

where *UN* represents the total unemployment rate; *NOM* denotes net overseas migration; *PGDP* is the per capita *GDP; W* indicates the hourly wage rate; and the subscripts t ($t = 1 \ldots .T$) and k ($k = 1 \ldots K$) indicate, respectively, the time period and the lag length.

The conventional vector error correction model (*ECM*) can be written as follows:

$$\Delta Y_t = \beta_0 + \sum_{j=1}^{k} \beta_i \Delta Y_{t-j} + \sum_{i=1}^{k} \delta_i \Delta X_{t-j} + \varphi_i Z_{t-1} + \varepsilon_t,$$

where Z is the error correction term (*ECT*) and is the OLS residuals from the long-run co-integration regression. Consequently, the VECM can be expressed in the following way in equations 1 to 4:

$$\begin{aligned} \Delta lnUN_t = \alpha_1 &+ \sum_{j=1}^{k} \beta_{11j}\ DeltalnUN_{t-j} + \sum_{j=1}^{k} \beta_{12j}\ \Delta lnNOM_{t-j} \\ &+ \sum_{j=1}^{k} \beta_{13j}\ \Delta lnPGDP_{t-j} + \sum_{j=1}^{k} \beta_{14j}\ \Delta lnW_{t-j} + \varphi_1\ ECT_{t-1} + U_{1t} \end{aligned} \tag{1}$$

$$\Delta lnNOM_t = \alpha_2 + \sum_{j=1}^{k} \beta_{21j}\, \Delta lnNOm_{t-j} + \sum_{j=1}^{k} \beta_{22j}\, \Delta lnUN_{t-j} + \sum_{j=1}^{k} \beta_{23j}\, \Delta lnPGDP_{t-j} + \sum_{j=1}^{k} \beta_{24j}\, \Delta lnWt - j + \varphi_2\, ECT_{t-1} + U_{2t} \tag{2}$$

$$\Delta lnPGDP_t = \alpha_3 + \sum_{j=1}^{k} \beta_{31j}\, \Delta lnPGDP_{t-j} + \sum_{j=1}^{k} \beta_{32j}\, t\Delta lnUN_{t-j} + \sum_{j=1}^{k} \beta_{33j}\, \Delta lnNOM_{t-j} + \sum_{j=1}^{k} \beta_{34j}\, \Delta lnW_{t-j} + \varphi_3\, ECT_{t-1} + U_{3t} \tag{3}$$

$$\Delta lnW_{tt} = \alpha_4 + \sum_{j=1}^{k} \beta_{41j}\, \Delta lnW_{t-j} + \sum_{j=1}^{k} \beta_{42j}\, \Delta lnUN_{t-j} + \sum_{j=1}^{k} \beta_{43j}\, \Delta lnNOM_{t-j} + \sum_{j=1}^{k} \beta_{44j}\, \Delta lnPGDP_{t-j} + \varphi_4\, ECT_{t-1} + U_{4t} \tag{4}$$

where α_j is the constant associated with each equation and $ECT_{t\text{-}1}$ is a one-period lagged error correction term. Moreover, K denotes the lag length, while the βs and φs are the coefficients to be estimated; finally, the Us are the disturbance terms, and they are serially uncorrelated. Note that the term error correction relates to the fact that the last-period deviation from the long-run equilibrium influences the short-run dynamics of the target variable. Thus, the coefficient of ECT, φ, is the speed adjustment because it measures the speed at which the target variable returns to the equilibrium after a change in the explanatory variable.

To assess the stationarity properties of the variables, this study used the Augmented Dickey and Fuller (1979) test along with Phillips and Perron (1988). Furthermore, to examine whether the variables are co-integrated, that is, whether there exists a long-run relationship between the variables under discussion, the study applied the Johansen (1988) and Stock and Watson (1988) tests. In addition, the short-run dynamics between the unemployment rate and net overseas migration flows were evaluated using the Wald and Granger causality tests to examine the direction of causation among the variables. Finally, a diagnostic test was conducted to test for serial correlation and heteroscedasticity in the residuals.

4. Empirical analysis

4.1. Summary statistics and correlations

Table 1 presents a brief descriptive analysis and the correlations. The descriptive analysis shows the distribution properties of the individual variables, while the correlation matrix shows the relationship between these variables in our proposed model.

Table 1 presents the descriptive statistics as well as the correlation matrix of the data used in the study after logarithmic transformations. As seen in Table 1, the measures of the mean, median, measures of dispersion around the mean, skewness, kurtosis and the probabilities of the Jarque-

Table 1. Summary statistics and correlations.

	lnUN	lnNOM	lnPGDP	lnW
Mean	1.916	9.299	8.152	4.205
Median	1.853	9.273	8.169	4.195
Maximum	2.416	10.154	8.447	4.802
Minimum	1.416	8.252	7.813	3.288
Std.Dev	0.246	0.467	0.209	0.388
Skewness	0.243	−0.061	−0.104	−0.349
Kurtosis	2.192	2.100	1.564	2.363
Jarque-Bera	16.899	15.660	40.004	16.967
Probability	0.0002	0.0004	0.0000	0.0002
Obs.	456	456	456	456
lnUN	1.000			
lnNOM	−0.838	1.000		
lnPGDP	−0.676	0.834	1.000	
lnW	−0.524	0.765	0.972	1.000

Variable definitions: *lnUN, lnNOM, lnW* and *lnGDP* are the logarithmic forms of the unemployment rate, net overseas migration, hourly wage rate, and the real per capita gross domestic product of Australia, respectively.
Source: Authors' calculations.

Berra test statistic indicate that the process follows a normal distribution. Additionally, we can conclude that there is a strong positive and statistically significant relationship between *lnNOM, lnPGDP* and *lnW*. However, there is a strong negative and statistically significant relationship between *lnUN* and all other variables used in the study. Clearly, all of the correlation signs are consistent with the economic theory. The next section tests whether the variables have long-run and short-run relationships.

4.2. The long-run and short-run relationship

As mentioned earlier, our aim is to identify the long-run and short-run dynamics of the unemployment rate to changes in the net overseas migration in Australia. For this purpose, the study concentrates on co-integration analysis to determine the long-run nexus because it can be interpreted as the long-run response between the aforementioned variables. However, the co-integration test requires a previous test to answer the question of whether the variables under discussion are stationary because their degree of integration defines the estimation method. The study constructs a vector error correction model (VECM) to identify both the short-run and the long-run dynamics of the series.

4.2.1. Unit root tests

The unit root tests form one of the essential requirements in time series econometrics because working with non-stationary time series would produce spurious results in empirical studies due to an unstable representation of data. Consequently, the time-series data under consideration are tested for stationarity using the *ADF* (1979) test. Furthermore, to compensate for the fact that no unit root test is currently truly satisfactory, we also run the *PP* (1988) test. The graphical representation of the respective variables (not reported) by level indicates that we are dealing with a random walk with drift. The results of using the *ADF* and the *PP* tests appear in Table 2.

As seen in Table 2, the result of the *ADF* and *PP* tests affirms that all variables, *lnUN, lnNOM, lnPGDP* and *lnW*, contain unit roots. Thus, all of these variables are integrated *I*

Table 2. Augmented Dickey-Fuller and Phillips Perron tests.

	In Levels				1st differences			
Variable	Lag	Test Statistic ADF	Band-width	Test Statistic PP	Lag	Test Statistic ADF	Band-width	Test Statistic PP
lnUN	9	−2.007	14	−1.655	12	−4.399***	8	−8.487***
lnNOM	12	−1.060	15	−1.737	12	−5.655***	13	−14.095***
lnPGDP	12	−1.064	15	−0.905	12	−5.856***	13	−15.922***
lnW	10	−2.560	12	7.864	9	−3.875***	13	−8.957***

MacKinnon (1996) critical value at 1% = −3.444, at 5% = −2.868, and at 10% = −2.570.
***, ** and * denote significance at the 99%, 95%, and 90% confidence levels, respectively.
Lag orders used in tests are selected automatically according to the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC).
Source: Authors' calculations.

(1) when a constant is included. That is, all the variables used in the study become stationary at one percent significance level after the first-difference *I(1)*. In Figure 1, we present the log-differences of the respective variables. As shown, while the *lnUN* and *lnNOM* variables are highly variant over the study period, *lnPGDP* exhibits fluctuation, especially between 1980 and 1992. Correspondingly, for *lnPGDP, lnW* is highly variant in the same time period. These fluctuations are associated with the new labour accord and economic liberalisation orientation that started under the umbrella of economic reforms during this period.

The aforementioned results indicate that the series are integrated in the same order; hence, there might be a long-run relationship between the variables under discussion. The next step is to proceed with the co-integration test to check the existence of such a relationship.

4.2.2. The long-run relationship

The co-integration analysis enables the long-run economic nexus between the variables to be identified and the hazard of spurious regression to be avoided. For this objective, the study applied the Johansen and Stock-Watson (1988) co-integration test. However, prior to performing this test, we need to first determine the optimal numbers of lags. To implement this process, the most objective and effective method for determining the lag length is the unrestricted vector autoregressive (VAR) lag-order selection criteria, as shown in Table 3.

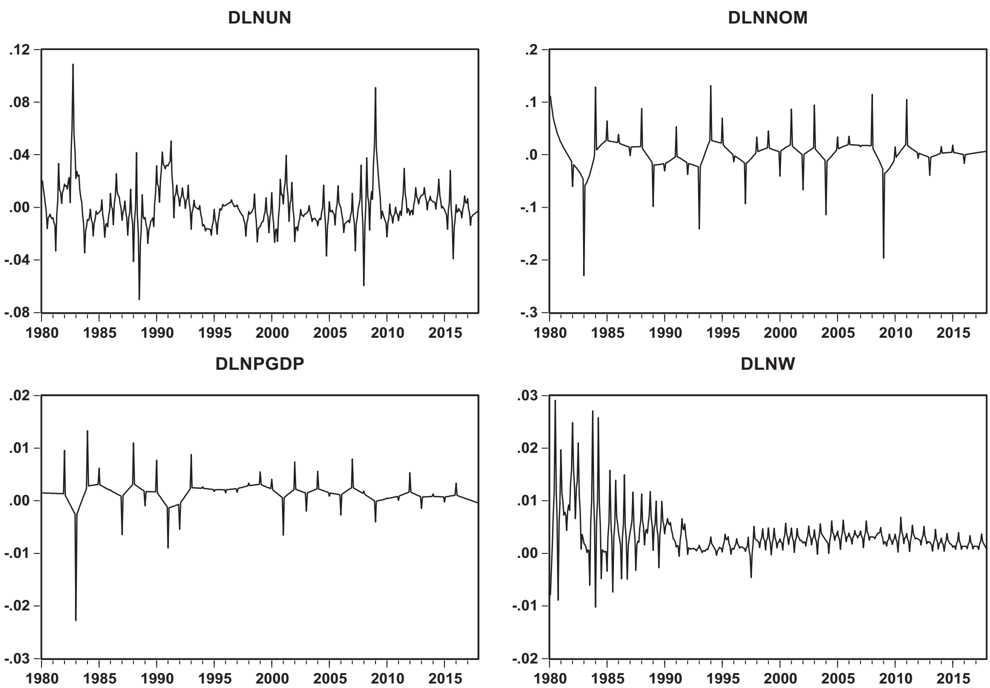

Figure 1. Log-differences of the variables.
Source: Authors' results.

Table 3. VAR lag-order selection criteria.

Lag	LR	FPE	AIC	SC	HQ
0	NA	9.52e-18	−27.84167	−27.80496	−27.82720
1	701.4211	2.09e-18	−29.35701	−29.17345	−29.28464
2	69.33853	1.92e-18	−29.44373	−29.11332	−29.31346
3	220.2527	1.24e-18	−29.87963	−29.40238	−29.69148
4	423.0945	4.98e-19	−30.79198	**−30.16788***	−30.54593
5	11.55803	5.21e-19	−30.74753	−29.97658	−30.44358
6	75.23335	4.68e-19	−30.85422	−29.93642	−30.49238
7	**184.6770***	**3.23e-19***	**−3 1.22444***	−30.15979	**−30.80471***
8	13.97759	3.36e-19	−31.18661	−29.97512	−30.70899

* Indicates the lag order selected by the criterion. Each test is at the 95% confidence level.
Notes: Definitions: LR – sequential modified likelihood ratio; FPE – final prediction error; AIC – Akaike information criterion; SIC – Schwarz information criterion; and HQ – Hannan-Quinn information criterion.
Source: Authors' calculations.

The results in Table 3 indicate that the LR, FPE, AIC, and HQ test statistics selected the optimum lag length of 7 at the 5 percent level of significance. Hence, the lag length of 7 was used to run the Johansen and Stock-Watson co-integration test. The results of this test appear in Table 4 and are reported in Table A1.

The results in Table 4 provide two types of tests. The first is the Unrestricted Co-integration Rank Test (Trace), which measures the co-integration between the variables by using the T-statistic. In addition, the null hypothesis states that there is no co-integration between the series. The Trace test confirms that the null hypothesis cannot be accepted at any significance level. Hence, the variables under examination are co-integrated. Consistently, in the second test, which is the maximum eigenvalue, the null hypothesis cannot be accepted at any significance level. The maximum eigenvalue indicates that there is a long-run association between the variables. Subsequently, the stationarity tests confirmed that the residuals are $I(0)$ at the one percent significance level (in levels: ADF = −8.657***; PP = −19.290***). Given these outcomes, the study can proceed to run the VECM to examine the short-run and long-run dynamics, which are reported in Table A2.

4.2.2.1. Overview on the estimated VECM equations.

It should be noted that the speed of adjustment towards the long-run equilibrium, φ_i, must be negative and statistically significant to retain its economic interpretation. By being negative, it tells us that if there

Table 4. Johansen and Stock-Watson Co-integration Test.

Unrestricted Co-Integration Rank Test								
Hypothesized	Eigenvalue		Statistic		Critical Value 5%		Prob.**	
No. of CE(S)	Trace	Maximum Eigenvalue	Trace	Maximum Eigenvalue	Trace	Maximum Eigenvalue	Trace	Maximum Eigenvalue
None*	0.098	0.098	85.99	46.54	47.856	27.584	0.000	0.000
At most 1*	0.043	0.043	39.46	19.77	29.797	21.132	0.003	0.077
At most 2*	0.034	0.034	19.69	15.53	15.495	14.265	0.011	0.031
At most 3*	0.009	0.009	4.158	4.158	3.8415	3.842	0.041	0.041

Both the Trace and max-eigenvalue test indicate 4 co-integrating eqn(s) at the 0.05 level.
*denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon-Haug-Michelis p-values.
Source: Authors' calculations.

Table 5. The speed of adjustment φ_i.

	Coefficient	Std. Error	t-Statistic	Prob.
φ_1	−0.134901**	0.052188	−2.584884	0.0101
φ_2	−0.579328***	0.139398	−4.155929	0.0000
φ_3	−0.030547***	0.010288	−2.969175	0.0032
φ_4	−0.003017	0.010394	−0.290256	0.7718

φ_1 : *lnUN* positioned as the target variable. φ_2 : *lnNOM* positioned as the target variable. φ_3 : *lnPGDP* positioned as the target variable. φ_4 : *lnW* positioned as the target variable.
•***, **and *denote significance at the 99%, 95%, and 90% confidence levels, respectively.
•Source: Authors' calculations.

is a deviation in one direction, the correction would have to pull back to the other direction to ensure that the equilibrium is retained. In addition, the negative and statistically significantφ_i states that there is a long-run causality between the variables under study. Table 5 shows φs, the *ECT* coefficients, as well as the *p*-values associated with these coefficients.

As demonstrated in Table 5, the speed of adjustments towards the long-run equilibrium, $\varphi_i s$, does satisfy both conditions; they are negative and statistically significant at five percent, except φ_4; equation 4 of the VECM. In conclusion, the Johansen and Stock-Watson co-integration test confirms that there exists a long-run equilibrium relationship among the unemployment rate, net overseas migration and per capita GDP in Australia. Furthermore, net overseas migration allows long-run unemployment rate to be reduced.

4.2.2.2. Evaluating the impact of immigration on unemployment. Since the aim of this study is to produce reliable results that enhance our understanding of the causal relationship and the impact of immigration on the labour market in Australia. We focus on the interpretation of the *ECT* equation (1) in section 3.2, which shows how the *LnUN* response to net overseas migration. By normalizing the coefficient of the *lnUN* series, estimation of the long-run co-integration relationship of equation (1) can be obtained as follows:

$$\begin{aligned} ECT_{t-1} = {} & lnUN_{t-1} + 0.3112\ lnNOM_{t-1} \\ & + 3.8186\ lnPGDP_{t-1} + -\ 0.1705\, lnW_{t-1} -\ 0.005 \end{aligned}$$

(0.06659)	(1.00329)	(0.54844)
[4.67286]	[3.80611]	[−0.31096]

In the abovementioned long-run model, there is a significant negative statistical relationship between the unemployment rate and net overseas migration as well as between the unemployment rate and per capita GDP at the one percent significance level, which seems to be consistent with the economic theory. In contrast, the positive relationship between the wage level and the unemployment rate is insignificant in the long-run. For more information on the VECM equations, see Table A2.

4.2.3. The short-run relationship

As discussed in section 3.2, this study uses a VECM. The main characteristic of the VECM is its strength to correct any instability that could influence the system from one period to another. In addition, we can evaluate the short-run dynamic interrelations of the unemployment rate, net overseas migration flows, per capita GDP and real wage level (Fromentin, 2013).

Focusing on the short-run dynamics, we need to test the short-run coefficients jointly; these are reported in Table A2. In particular, we are interested in answering the question of whether in the short run, net overseas migration in Australia Granger causes the unemployment rate and economic growth. To do so, the study focuses on the VECM equations (1 and 3), where $lnUN$ and $lnPGDP$ are the target variables. Using Wald and Granger causality tests, Table 6 depicts the results of these tests. The null hypotheses are that $lnNOM$ does not Granger cause $lnUN$ or $lnPGDP$.

As demonstrated in Table 6, the outcomes of the Wald test show that all *p*-values of the F-statistic and χ^2 are below five percent. Hence, we can conclude that the null hypotheses cannot be accepted. As a result, there is short-run causality running from *lnNOM* to *lnUN*, and as stated before in the long-run analysis, the effect is in opposite direction. Conversely, all lags of *lnNOM* Granger cause *lnPGDP*. Overseas immigrants who acquire higher wages actually contribute to the aggregate increase in national income and hence the increase in per capita GDP in Australia. Additionally, the Granger causality test in Table 6 confirms that the null hypotheses cannot be accepted. Therefore, there is a unidirectional causality running from *lnNOM* to *lnUN*. Furthermore, there is a causal relationship in both directions between *lnNOM* and *lnPGDP* at all significance levels.

For more robustness, Figure 2 depicts the stability diagnostic test, which is applied to confirm that the VECM is dynamically stable. The outcome of the CUSUM test indicates that the model is well specified and dynamically stable.

5. Conclusion and policy implications

This study attempted to investigate the existence of a dynamic causal relationship among immigration, unemployment, per capita GDP and wage levels in the Australian labour market. A macroeconomic framework was adopted by applying a Vector Error Correction Model (VECM) to examine the dynamic interaction for the short- and long-run relationships among the selected variables used in this study. Unemployment and immigration exhibited high variation over the study period, as did income per capita between 1980 and 1992. This variation is associated

Table 6. Wald & Granger Causality Tests.

Variable	Test Statistic	Value	df	Probability
lnUN	F-statistic	2.298948	(7, 417)	0.0262
	Chi-square	16.09264	7	0.0243
lnPGDP	F-statistic	13.47602	(7, 417)	0.0000
	Chi-square	94.33214	7	0.0000
Null Hypothesis			**F-statistic**	**Prob.**
LNNOM does not Granger cause LNUN			0.82154	0.5697
LNUN does not Granger cause LNNOM			3.82785	0.0005
LNPGDP does not Granger cause LNNOM			0.34201	0.9343
LNNOM does not Granger cause LNPGDP			0.02396	1.0000

Note: See Table A3 for more information about the Granger causality test.
Source: Authors' calculations.

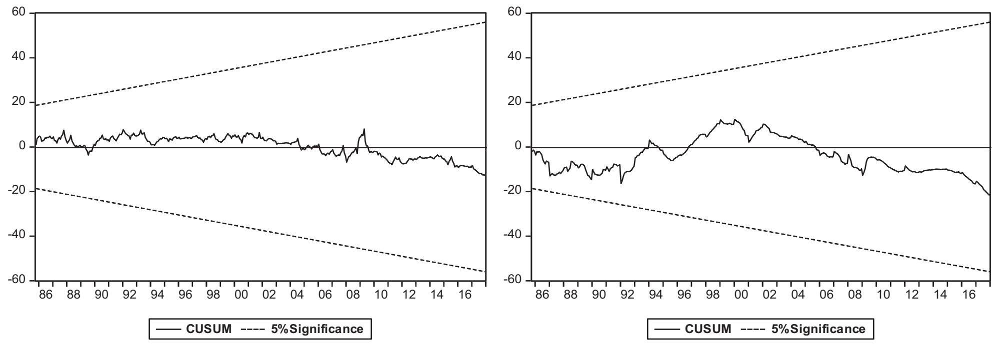

Figure 2. Recursive estimates – CUSUM test.
Source: Authors' results.

with the new labour accord and economic liberalization orientation that started under the umbrella of economic reforms during this period of time. Correspondingly, the per capita GDP and wage levels were also highly variant in the same time period. Additionally, there was a strong negative and statistically significant relationship between unemployment and all other variables in the study. The VECM and all tests revealed a long-run equilibrium relationship among the unemployment rate, net overseas migration and per capita GDP in Australia. A negative and significant statistical relationship between the unemployment rate and net overseas migration was found as well as between the unemployment rate and per capita GDP. On the other hand, a positive relationship between the wage level and the unemployment rate was found to be insignificant in the long run. For the short run, a negative causality relationship was found from overseas migration to unemployment. Conversely, all lags of overseas migration Granger cause variation in per capita GDP jointly, though in a positive way. Finally, there is a causal relationship in both directions between overseas migration and per capita GDP at all significance levels.

The main findings provide insight into the policy developments that have occurred in the structure and pattern of immigration in Australia (after the development of the immigration programme in 1996) and how these have contributed to the positive impact of immigration on the above-mentioned variables. Among these developments are a remarkable increase in Australia's annual permanent migration intake, as mentioned; the diverse profile of immigrants; the policy orientation towards encouraging the immigration of individual skilled labour and moving away from family immigration; and, finally, the rise of temporary migration and two-step migration, which allows for better selection of candidates and international students who have acquired high skills from their education.

Further studies should address the impact of overseas migration with different skill levels and how each category of skills affect this model. A sectoral analysis would also allow us to see which sectors can be most affected by overseas migration. Our results showing no negative effects of immigration were found in a time where good economic conditions prevailed; however, it is unclear whether the same conditions would prevail in times of recession and economic downturns.

Disclosure statement

No potential conflict of interest was reported by the authors.

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APPENDICES

Table A1. Johansen and Stock-Watson co-integration test.

Date: 08/10/18 Time: 08:03
Sample (adjusted): 1980M09 2017M12

Included observations: 448 after adjustments

Trend assumption: Linear deterministic trend
Series: LNUN LNNOM LNPGDP LNW

Lags interval (in first differences): 1 to 7

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.098660	85.99340	47.85613	0.0000
At most 1 *	0.043167	39.45831	29.79707	0.0029
At most 2 *	0.034076	19.68964	15.49471	0.0110
At most 3 *	0.009237	4.157567	3.841466	0.0414

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.098660	46.53509	27.58434	0.0001
At most 1	0.043167	19.76867	21.13162	0.0767
At most 2 *	0.034076	15.53207	14.26460	0.0314
At most 3 *	0.009237	4.157567	3.841466	0.0414

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b = I):

LNUN	LNNOM	LNPGDP	LNW
−1.535950	−4.091056	−11.36788	12.25873
−11.24476	−5.005749	−14.22949	6.588302
−6.952279	0.981184	−24.47032	10.81539
−1.523988	1.364079	−26.59357	10.91956

Unrestricted Adjustment Coefficients (alpha):

D(LNUN)	0.000550	0.000342	0.001337	0.000265
D(LNNOM)	0.002490	0.003485	−0.001433	−0.000819
D(LNPGDP)	−9.81E-05	0.000142	−0.000165	0.000104
D(LNW)	−0.000463	0.000119	5.08E-05	−3.75E-05

1 Cointegrating Equation(s): Log likelihood 7135.570

Normalized cointegrating coefficients (standard error in parentheses)

LNUN	LNNOM	LNPGDP	LNW
1.000000	2.663535	7.401204	−7.981204
	(0.51444)	(2.71957)	(1.49021)

Adjustment coefficients (standard error in parentheses)

D(LNUN)	−0.000845
	(0.00061)
D(LNNOM)	−0.003824
	(0.00163)
D(LNPGDP)	0.000151
	(0.00012)
D(LNW)	0.000711
	(0.00012)

(*Continued*)

Table A1. (Continued).

2 Cointegrating Equation(s):	Log likelihood	7145.454	
Normalized cointegrating coefficients (standard error in parentheses)			
LNUN	LNNOM	LNPGDP	LNW
1.000000	0.000000	0.034162	0.898123
		(0.81416)	(0.48390)
0.000000	1.000000	2.765889	−3.333662
		(1.15506)	(0.68651)
Adjustment coefficients (standard error in parentheses)			
D(LNUN)	−0.004695	−0.003964	
	(0.00449)	(0.00256)	
D(LNNOM)	−0.043010	−0.027629	
	(0.01189)	(0.00677)	
D(LNPGDP)	−0.001447	−0.000310	
	(0.00088)	(0.00050)	
D(LNW)	−0.000628	0.001297	
	(0.00088)	(0.00050)	

3 Cointegrating Equation(s):	Log likelihood	7153.220	
Normalized cointegrating coefficients (standard error in parentheses)			
LNUN	LNNOM	LNPGDP	LNW
1.000000	0.000000	0.000000	0.923897
			(0.10558)
0.000000	1.000000	0.000000	−1.246894
			(0.12669)
0.000000	0.000000	1.000000	−0.754465
			(0.04498)
Adjustment coefficients (standard error in parentheses)			
D(LNUN)	−0.013989	−0.002652	−0.043837
	(0.00519)	(0.00255)	(0.01190)
D(LNNOM)	−0.033046	−0.029036	−0.042819
	(0.01391)	(0.00683)	(0.03188)
D(LNPGDP)	−0.000302	−0.000471	0.003122
	(0.00103)	(0.00050)	(0.00235)
D(LNW)	−0.000981	0.001347	0.002324
	(0.00103)	(0.00051)	(0.00236)

Table A2. Vector error correction estimates.

Vector Error Correction Estimates
Date: 08/11/18 Time: 10:38
Sample (adjusted): 1980M10 2017M12
Included observations: 447 after adjustments
Standard errors in () & t-statistics in []

Cointegrating Eq:	CointEq1			
LNUN(−1)	1.000000			
LNNOM(−1)	0.311154			
	(0.06659)			
	[4.67286]			
LNPGDP(−1)	3.818623			
	(1.00329)			
	[3.80611]			
LNW(−1)	−0.170540			
	(0.54844)			
	[−0.31096]			
C	−0.005223			
Error Correction:	**D(LNUN)**	**D(LNNOM)**	**D(LNPGDP)**	**D(LNW)**
CointEq1	−0.134901	−0.579328	−0.030547	−0.003017
	(0.05219)	(0.13940)	(0.01029)	(0.01039)
	[−2.58488]	[−4.15593]	[−2.96918]	[−0.29026]
D(LNUN(−1))	0.170524	0.228856	0.009537	0.001403
	(0.06624)	(0.17692)	(0.01306)	(0.01319)
	[2.57441]	[1.29352]	[0.73036]	[0.10634]
D(LNUN(−2))	0.269000	0.214560	0.023434	0.001267
	(0.05977)	(0.15966)	(0.01178)	(0.01190)
	[4.50041]	[1.34390]	[1.98880]	[0.10641]
D(LNUN(−3))	−0.769679	0.424633	−0.012905	−0.010599
	(0.06161)	(0.16456)	(0.01214)	(0.01227)
	[−12.4933]	[2.58048]	[−1.06263]	[−0.86379]
D(LNUN(−4))	0.231597	−0.012090	−0.020426	−0.003681
	(0.07293)	(0.19479)	(0.01438)	(0.01452)
	[3.17574]	[−0.06206]	[−1.42079]	[−0.25347]
D(LNUN(−5))	0.201164	−0.119398	−0.003788	0.000734
	(0.05103)	(0.13629)	(0.01006)	(0.01016)
	[3.94235]	[−0.87603]	[−0.37661]	[0.07228]
D(LNUN(−6))	−0.341459	0.420955	−2.69E-06	0.021611
	(0.05168)	(0.13804)	(0.01019)	(0.01029)
	[−6.60727]	[3.04956]	[−0.00026]	[2.09966]
D(LNUN(−7))	0.111923	0.093529	−0.009026	−0.002534
	(0.05448)	(0.14552)	(0.01074)	(0.01085)
	[2.05443]	[0.64274]	[−0.84042]	[−0.23359]
D(LNNOM(−1))	0.069519	−0.571029	0.005122	0.003113
	(0.02231)	(0.05960)	(0.00440)	(0.00444)
	[3.11542]	[−9.58047]	[1.16431]	[0.70036]
D(LNNOM(−2))	0.065741	−0.372573	0.002891	0.003438
	(0.02455)	(0.06556)	(0.00484)	(0.00489)
	[2.67829]	[−5.68266]	[0.59748]	[0.70338]
D(LNNOM(−3))	0.044988	−0.203023	−4.72E-05	0.006728
	(0.02521)	(0.06734)	(0.00497)	(0.00502)
	[1.78445]	[−3.01489]	[−0.00951]	[1.33987]
D(LNNOM(−4))	0.040439	−0.113900	−0.000806	0.003634
	(0.02497)	(0.06669)	(0.00492)	(0.00497)
	[1.61953]	[−1.70778]	[−0.16377]	[0.73079]
D(LNNOM(−5))	0.022495	−0.054723	−0.000693	0.003973
	(0.02388)	(0.06380)	(0.00471)	(0.00476)
	[0.94185]	[−0.85778]	[−0.14711]	[0.83530]
D(LNNOM(−6))	0.014106	−0.001600	0.000963	0.011561
	(0.02222)	(0.05936)	(0.00438)	(0.00443)
	[0.63476]	[−0.02695]	[0.21977]	[2.61199]
D(LNNOM(−7))	0.004961	0.010360	0.000189	0.002129

(*Continued*)

Table A2. (Continued).

	(0.01846)	(0.04930)	(0.00364)	(0.00368)
	[0.26875]	[0.21012]	[0.05206]	[0.57925]
D(LNPGDP(−1))	0.629631	1.478999	−0.647764	0.057157
	(0.30058)	(0.80286)	(0.05925)	(0.05986)
	[2.09473]	[1.84216]	[−10.9321]	[0.95480]
D(LNPGDP(−2))	0.214945	1.091751	−0.456526	0.116318
	(0.33140)	(0.88519)	(0.06533)	(0.06600)
	[0.64859]	[1.23335]	[−6.98801]	[1.76232]
D(LNPGDP(−3))	−0.813185	1.626178	−0.258560	0.336322
	(0.34397)	(0.91877)	(0.06781)	(0.06851)
	[−2.36409]	[1.76995]	[−3.81310]	[4.90937]
D(LNPGDP(−4))	−0.271842	0.934113	−0.198406	0.191532
	(0.35035)	(0.93579)	(0.06906)	(0.06978)
	[−0.77592]	[0.99820]	[−2.87276]	[2.74497]
D(LNPGDP(−5))	−0.318439	0.513560	−0.125776	0.191703
	(0.31534)	(0.84230)	(0.06216)	(0.06280)
	[−1.00982]	[0.60971]	[−2.02329]	[3.05241]
D(LNPGDP(−6))	−0.644070	0.235272	−0.091940	0.367598
	(0.29090)	(0.77702)	(0.05735)	(0.05794)
	[−2.21403]	[0.30279]	[−1.60323]	[6.34482]
D(LNPGDP(−7))	−0.170857	0.032537	−0.057389	0.108610
	(0.24800)	(0.66243)	(0.04889)	(0.04939)
	[−0.68892]	[0.04912]	[−1.17384]	[2.19890]
D(LNW(−1))	0.054673	−0.141112	0.041051	−0.030670
	(0.24528)	(0.65516)	(0.04835)	(0.04885)
	[0.22290]	[−0.21539]	[0.84899]	[−0.62783]
D(LNW(−2))	0.089466	0.059631	0.037521	0.076190
	(0.19667)	(0.52531)	(0.03877)	(0.03917)
	[0.45491]	[0.11352]	[0.96780]	[1.94517]
D(LNW(−3))	0.118594	0.170897	−0.026899	−1.049450
	(0.18003)	(0.48087)	(0.03549)	(0.03586)
	[0.65874]	[0.35539]	[−0.75793]	[−29.2693]
D(LNW(−4))	0.187371	0.105434	0.056768	0.000540
	(0.30893)	(0.82516)	(0.06090)	(0.06153)
	[0.60652]	[0.12777]	[0.93216]	[0.00878]
D(LNW(−5))	0.036525	0.554094	0.094108	0.071255
	(0.19238)	(0.51385)	(0.03792)	(0.03831)
	[0.18986]	[1.07832]	[2.48151]	[1.85976]
D(LNW(−6))	0.111131	−0.493199	−0.123275	−0.420330
	(0.18077)	(0.48284)	(0.03564)	(0.03600)
	[0.61477]	[−1.02145]	[−3.45936]	[−11.6752]
D(LNW(−7))	0.202501	−0.296083	−0.032825	0.008034
	(0.20412)	(0.54523)	(0.04024)	(0.04065)
	[0.99205]	[−0.54304]	[−0.81575]	[0.19761]
C	3.33E-05	−0.000169	−7.22E-06	−1.65E-05
	(0.00041)	(0.00109)	(8.1E-05)	(8.1E-05)
	[0.08140]	[−0.15508]	[−0.08948]	[−0.20301]
R-squared	0.526981	0.385163	0.449959	0.759710
Adj. R-squared	0.494085	0.342405	0.411707	0.742999
Sum sq. resids	0.031091	0.221818	0.001208	0.001233
S.E. equation	0.008635	0.023064	0.001702	0.001720
F-statistic	16.01970	9.007888	11.76295	45.46211
Log likelihood	1505.390	1066.225	2231.265	2226.688
Akaike AIC	−6.601297	−4.636352	−9.849062	−9.828581
Schwarz SC	−6.325958	−4.361013	−9.573722	−9.553241
Mean dependent	1.02E-05	−7.93E-05	−4.16E-06	−1.31E-05
S.D. dependent	0.012140	0.028441	0.002219	0.003392
Determinant resid covariance (dof adj.)		2.92E-19		
Determinant resid covariance		2.21E-19		
Log likelihood		7063.482		
Akaike information criterion		−31.04914		
Schwarz criterion		−29.91107		

Table A3. Granger causality tests.

Pairwise Granger Causality Tests

Date: 08/14/18 Time: 21:06

Sample: 1980M01 2017M12
Lags: 7

Null Hypothesis:	Obs	F-Statistic	Prob.
LNNOM does not Granger Cause LNUN	448	0.82154	0.5697
LNUN does not Granger Cause LNNOM		3.82785	0.0005
LNPGDP does not Granger Cause LNUN	448	3.88472	0.0004
LNUN does not Granger Cause LNPGDP		7.28864	3.E-08
LNW does not Granger Cause LNUN	448	2.22591	0.0313
LNUN does not Granger Cause LNW		2.18789	0.0343
LNPGDP does not Granger Cause LNNOM	448	0.34201	0.9343
LNNOM does not Granger Cause LNPGDP		0.02396	1.0000
LNW does not Granger Cause LNNOM	448	2.30180	0.0259
LNNOM does not Granger Cause LNW		2.75940	0.0082
LNW does not Granger Cause LNPGDP	448	7.73136	8.E-09
LNPGDP does not Granger Cause LNW		10.5488	3.E-12