Portfolio Shocks and the Dynamics of the Real Economy of Australia (1980-2014): A Structural Vector Autoregressive Model Approach

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17 May 2015

Portfolio Shocks and the Dynamics of the Real Economy of Australia (1980-2014): A Structural Vector Autoregressive Model Approach*

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Abstract

This paper analyses domestic and foreign equity shocks under long-run restrictions on the Australian macro economy using a five-variable SVAR model. Evidence reveals that aggregate supply shocks produce positive wealth effects coming from increasing real value of Australian equity as the goods prices fall. Moreover, the channels of how Australian portfolio shocks affect the Australian economy are through interest rates and prices in the goods market. Australian portfolio also acts as a channel for wealth effect arising from the foreign equity market. There was some reduction in the Australian households wealth following the global financial crises, but shows strong resilience as it quickly rebounded due to the strong aggregate supply shocks. The role of Australian equity to its domestic economy in recent time is getting stronger than in the past since the equity market capitalization has grown enormously in the last decade.

Keywords: equity; shocks; restriction; SVAR

*This paper was prepared for IDEC-8023 (Case Studies in Applied Economics) course at the ANU; Authors are grateful to Professor Robert Breunig, Convenor of the IDEC-8023 (Case Studies in Applied Economics) course at the ANU for his valuable comments and encouragement to understand the issues and perspectives during the presentations and preparation for this paper.

1 Introduction

1.1 Background of the study

Australia, the twelfth largest economy of the world (IMF 2015) was experiencing steady progress in maintaining healthy macroeconomic states over the last two decades. RBA (2011) reveals that economic reforms during this time have fueled towards the continuous drive for economic growth, reduced unemployment, increased productivity and resiliency. Financial market reform also had a positive impact on the real economy, especially after introducing of the *inflation targeting* policy in the early 1990s. Enduring faster economic growths in Asia, particularly in China have significant positive externality in shaping the progress of Australia. Mining sector's turnaround induced big increase in investment along with significant flow-on of employment in these industries. Consequently, the terms of trade have increased, which also resulted in Australian dollar appreciation to a record 30-years high.

Equity market of Australia has also advanced noticeably since 2000 thanks to the prudent financial and capital market regulations and prompt responses to the challenges over this time. Involvement in the stock market has considerably increased in early 2000s as Table-1 depicts that over 50% of adult Australians had an investment in share market till 2006, though slow down a bit afterward owing to the Global Financial Crisis (GFC) and subsequent implications. The declining contribution of the indirect ownership of shares reveals that the investors are being more self-reliant and matured over time. Market Capitalization, as shown in Figure-1 has increased from $A 109 billion to $A 373 billion during 1990-2000 and from $A373 billion to $A1574 billion during 2000-2014. Except the temporary drop during the GFC, the ratio of market capitalization to Nominal GDP has also increased significantly over this period. No of firms enlisted in the Australian Stock Exchange (ASX) has also grown steadily from 1421 to 2073 during 2002-2014. Table-2 refers that participation of foreign firms in ASX has been around 4-5% over this period.

Recent signs of the equity market in Australia are more encouraging from the global perspective. During 2009-2013, ASX was the fourth largest stock exchange after NYSE, NASDAQ and London Stock Exchange to raise equity capital amounting $US 241 billion. It also stepped ASX forward towards the 14th position among global stock exchanges.

All these encouraging signs have, however, posed the importance of analyzing the internal and external shocks on this Australian equity market and to explaining how the shocks are transmitting to and interacting with the real economy of Australia. Fry et al. (2008) have attempted to evaluate the role of portfolio shocks on the Australian Economy using Structural VAR model over the time period of 1980-2005. This study is an extended version of that paper with a broader time horizon to 2014. Original paper considered two external shocks namely the 'Dotcom Crash' during March 2000 to October 2002 and the

Year	Direct only	Indirect only	Direct & indirect	Total number of investors	% of adult population
2000	3111	1709	2563	7405	52.0
2002	2628	1898	2774	7300	50.0
2003	3212	1752	2482	7446	52.0
2004	3358	1606	3066	8030	55.0
2006	3471	1262	2524	7257	43.7
2008	4096	819	1802	6718	40.0
2010	5066	678	1520	7264	43.0
2012	4573	704	1407	6684	38.0

Table 1: Total number of Australians investing in the share market (000s)
Source: Australian Stock Exchange Annual Reports (2000, 2005, 2013). Direct only refers to the investors directly buy and own the share of a firm in stock market. Indirect, on the other hand, refers to those investors invest through the managed/mutual funds or superannuation funds.

Year	Domestic Firms	Foreign Firms	Total
2002	1355	66	1421
2003	1406	66	1471
2004	1515	68	1583
2005	1736	71	1807
2006	1830	78	1908
2007	1992	85	2077
2008	2001	85	2086
2009	1959	84	2043
2010	1986	86	2072
2011	1983	96	2079
2012	1959	97	2056
2013	1951	104	2055
2014	1967	106	2073

Table 2: Number of enlisted firms in the Australian Stock Exchange
Source: Australian Stock Exchange website

'9/11 attacks' in September 2001. Dotcom crash was the outcome of investors' and firms' simultaneous excitement on the speculative rise of the "new untapped economy" driven by the information technology. With a *too much too fast* boom and bust, it primarily affected the NASDAQ and consequently spread over other stock exchanges. The 9/11 attacks in the US had multifaceted impacts in every sector of the super US economy which was then transmitted to other parts of the world. Now for the extension of this study, the effect of the GFC is also examined. Though RBA (2011) states that the effect of the GFC is smaller on the Australian Economy in comparison to most of the developed

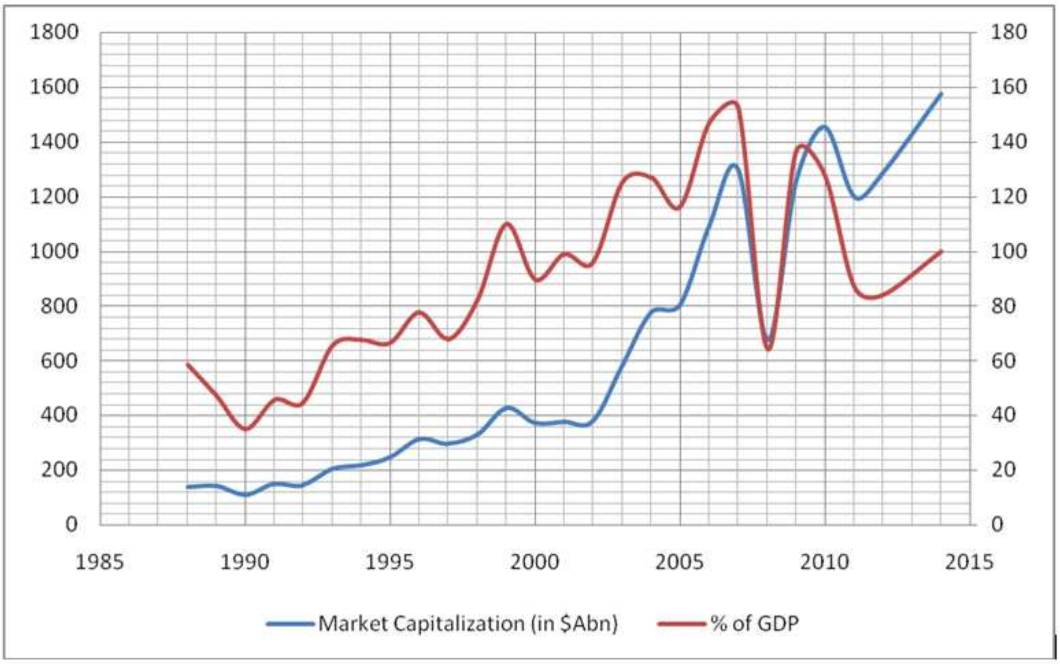

Figure 1: Market Capitalization in ASX
Source: Index Mundi

countries. It mentioned several key factors contributing this resilience: adequate fiscal and monetary stimulus, strong financial regulatory framework, flexible exchange rate, up-surging of the Chinese economy, and recoiling of commodity prices. Figure-2 and 3 also supports the phenomenon that Australian equity market as well as the real economy seems to be less sensitive against the impact of the GFC. However, a comprehensive econometric analysis would reveal the inter-linkages more precisely. So this study is a good step forward in this regard.

Figure 2: Australian and Global share price index

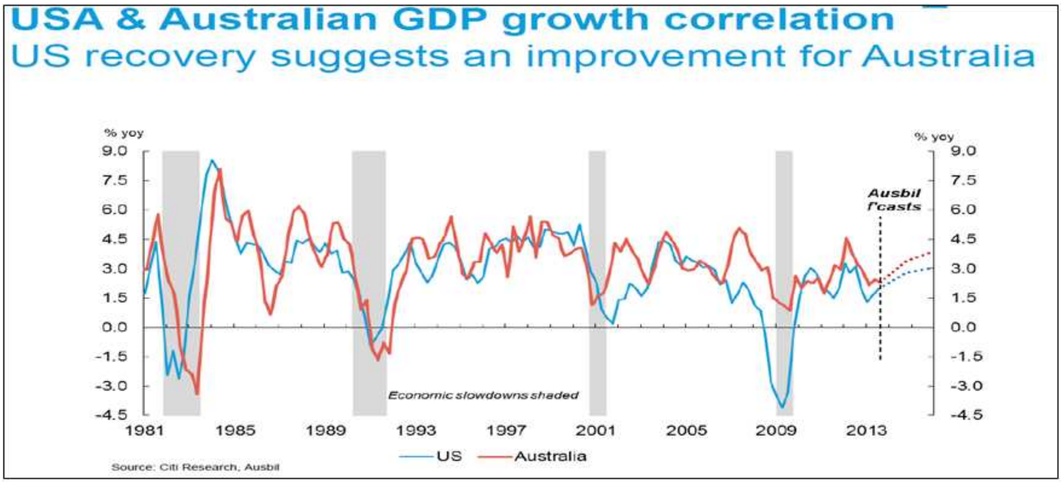

Figure 3: Comparative growth patterns between Australia and the US

1.2 Theoretical aspects of the inter-linkages and dynamics

Shocks in equity market can be transmitted to the real economy through two channels as described in figure-4.

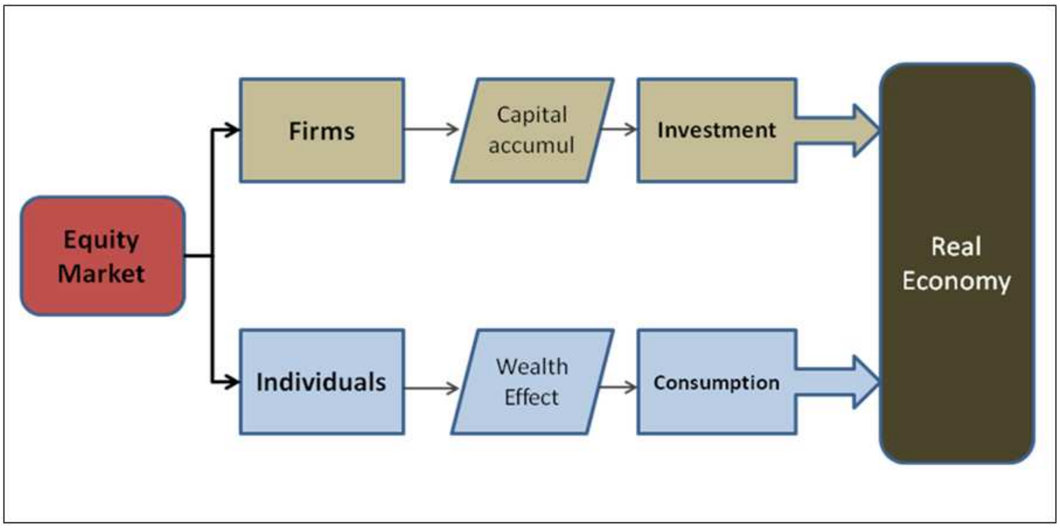

Figure 4: Transmission channels of shocks from Equity market to Real economy

1. **Through Firms:**

   - Tobin's q ratio: Brainard and Tobin (1968) introduced Tobin's q as the ratio between the market price of the firm and its stand-in cost of capital. If the stock price increases, Tobin's q will increase, resulted into relatively cheaper cost for the new plants and equipments. This will encourage the firm to issue more stocks and increase its investment spending, which will lead to increased aggregate demand in the real economy.

- Balance sheet effect: Increase in stock price will raise the net worth of a firm. Higher net worth will act as higher collateral and, in general, will reduce the asymmetric information problem. Owing to reduced adverse selection and moral hazard, it can attract more lending for investment. As a result, aggregate spending in the real economy will rise.

2. **Through Individuals:**

   - Wealth effect: Stock is a financial asset. Increase of its price, therefore, will increase the lifetime resources for its investors through a rise in financial wealth. The feeling of being wealthier will encourage more consumption for the individuals, and hence the aggregate demand of economy will go up.

   - Household liquidity effects: Increase in stock price will reduce the likelihood of financial distress for its investor as the investor will have more liquid assets owing to that price increment. For making a balance, individuals will then start expending on relative illiquid assets like consumer durable or housing. This will encourage real economic output to increase.

1.3 Literature Reviews

Several empirical studies have dealt with the implication of equity market's shocks or changes in portfolio wealth on Australian macroeconomic factors. Dungey and Pagan (2000) use SVAR model to explore the impact of domestic and foreign equity price on the Australian economy. Ross and Russell (2000) only focus on the impact of the US Stock market on the Australian real economy. Beechey *et al.* (2000) use US equity price in their small macroeconomic model to observe the wealth effect of the real economy. Rather than the overall economy, some of the studies only focus on particular areas in the real economy of Australia. Andersen & Subbaraman (1996), using the VAR small macro model, link the equity price with the investment sector. Crosby (2001) explores the link between the return on domestic equities and inflation. Groenewold (2004) evaluates the relationship between the market index and real economic output. Tan and Voss (2003) and Fisher and Voss (2004) work on the impact of shocks in equity price over the consumption sector of the economy.

Few of the literatures depict the complicated inter-linkages between fiscal, monetary and equity policy shocks. Dungey and Fry (2009) using SVAR combining sign restrictions, Traditional and co-integration explains the impact of fiscal and monetary policy shocks on macro variables of Australia. Justiano and Preston (2010) use General Equilibrium (GE) model to investigate the effect of monetary policy shocks on the economies of Australia, New Zealand and Canada. Fernald *et al.* (2014) however, use a new technique called Factor Augmented Vector Autoregression (FAVAR) to establish the relationships between fiscal and monetary policy shocks in the Chinese economy.

For the SVAR or VAR model, one of the key issues is the using of sign restriction. Few of the papers use the short-run restrictions, e.g. Brischetto and Voss (1999), Dungey and Fry (2003), Dungey and Pagan (2000), Suzuki (2004) etc. However, recent trend indicates that long-run identifying restrictions are getting popular. Blanchard and Quah (1989), Moreno (1992), Dungey et al. (2004), Groenewold (2004), and Rapach (2001) use long run restrictions to identify the model. Orden and Fisher (1993) use estimation of vector error correction model to model long-run restrictions. Fisher (1996) entails long-run neutrality assumptions in a trivariate model. Gali (1992) and Huh (1999), however, concurrently use both the long-run and short-run restrictions to construct their models.

1.4 Objectives and organization of the paper

The key objective of this paper is to explain the effects of shocks developed in equity markets on the key macroeconomic factors of Australia. Following the original paper of Fry *et al.* (2008), identification through long-run restrictions methodology is used based on following pertinent economic assumptions: Natural rate Hypothesis; Monetary Neutrality; Purchasing Power Parity; and Long run Portfolio balance through the present value price. As per the requirement of the course IDEC-8023 (Case Studies in Applied Economics), the outcome of the original paper is first replicated and then extension is done as mentioned earlier.

The rest of the paper proceeds as follow: Part-2 depicts the constructing of data, while Part-3 explains the methodology of identifying of the shocks and framing the five-variate macroeconomic SVAR model. Part-4 refers to the results and policy implications for the replication as well as extension portion. This part highlights the impulse responses of the shocks along with the historical decomposition of shocks under different crises mentioned earlier. Concluding remarks are presented in Part-5.

2 Data Construction

Following Fry *et al.*(2008), the purpose of this paper is to test the relationship between Australian goods markets and its equity market as well as foreign equity markets. Therefore, five main variables are included in the model: Australian real GDP (y_t), the real interest rate in Australia (R_t), Australian real equities price (s_t), Australian nominal goods price level (P_t) and real equity price in U.S. converted into Australian dollars (f_t). Sources for the data are described in Appendix-Data Sources. Also following the method used by Fry *et al.* (2008), all variables are firstly transformed into natural logarithms form and then multiplied by 100. Z_t is the assemblage variable which summarizes all transformed variables.

$$Z_t = \{100 \ln(y_t), 100 \ln(R_t), 100 \ln(s_t), 100 \ln(P_t), 100 \ln(f_t)\} \quad (1)$$

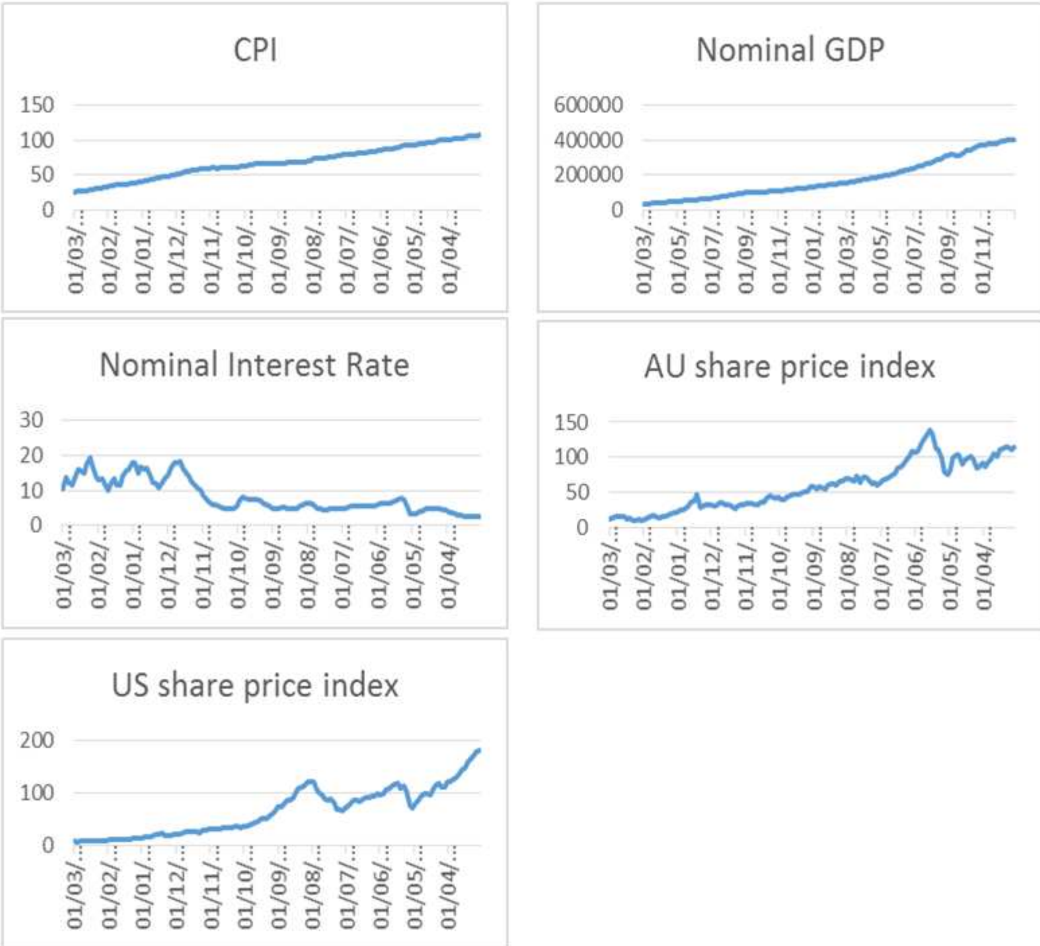

Figure 5: Trends of all variables (raw data)

Figure-5 shows the plot of the value of each raw variable. From it, except the continually decreasing in nominal interest rate, the other four variables clearly show an upward trend with respect to time. It seems that all of the variables are divergent, not stationary. The results of Augmented Dickey-Fuller unit-root test, in Appendix-A, from STATA support the deduction that all transformed variables have a unit root, which means non-stationary. However, since this paper uses Structure Vector Autoregression (SVAR) method to model the impacts of shocks in all five variables on each other, each time series which is applied in SVAR model should be stationary. Therefore, instead of using raw variables or transformed variables, this paper applies ΔZ_t, the first difference of each variable, namely the growth rates, into SVAR model, which is called converted variable in the following parts. The unit-root test shows that every converted variables are stationary (Appendix-B), which also means that all the raw variables are integrated of order 1, i.e. I(1) variables.

3 Methodology

3.1 Structure of SVAR Model

Firstly, a VAR model using ΔZ_t is constructed to show the dynamics of the SVAR model. In the VAR model, each converted variables is expressed as function of itself and other variables in lagged terms as shown below:

$$(I - \Phi_1 L^1 - \Phi_2 L^2 - ... - \Phi_p L^p)\Delta Z_t = \alpha + \kappa D_t + e_t, \tag{2}$$

where$L^k Z_t = Z_{t-k}$ represents the lagged terms and $p$is the lag length, Φ_k are autoregressive parameters which are (5×5) matrices. On the right-hand side, a (5×1) matrix α indicates the intercepts' vector.$D_t = \{D_{1987,t}, D_{GTS,t}, D_{GFS,t}\}$ controls three dummy variables which correspond to the effects of the stock market crash in late 1987, the effects of the GST in the third quarter in 2000 and the effects of the Global Financial Crisis in 2009 respectively, with a (5×3) parameter matrix κ. At last, e_t is a multivariate set which captures five disturbances in the model with several properties, $E[e_t] = 0, E[e_t e_t^{'}] = \Omega, E[e_t e_{t-s}^{'}] = 0 \forall s \neq 0$, which means zero expectation, non-autocorrelation but contemporaneously correlated with itself (the covariance matrix Ω is non-diagonal matrix).
Then rewriting the VAR model into Vector Moving Average (VMA) forms as below:

$$\Delta Z_t = \beta_t + (I + \Theta_1 L + \Theta_2 L^2 + ... + \Theta_p L^p + ...)e_t, \tag{3}$$

where$\beta_t = (I - \Phi_1 L^1 - \Phi_2 L^2 - ... - \Phi_p L^p)^{-1}\alpha + \kappa D_t)$ and Θ_k are moving average parameters in (5×5) matrices. Because the disturbances in the system are contemporaneously correlated, to analyze the effects of each structural shocks separately, e_t need to be decomposed as followed

$$e_t = G v_t, \tag{4}$$

where$v_t = v_{1,t} + v_{2,t} + v_{3,t} + v_{4,t} + v_{5,t})^{'}$represent the independent structural shocks of each converted variables. Unlikee_t, v_t has zero mean, non-autocorrelation but non-contemporaneous autocorrelation ($E[v_t] = 0, E[v_t v_t^{'}] = I, E[v_t v_{t-s}^{'}] = 0 \forall s \neq 0$). One thing to be mentioned is that the matrix G is not the structure parameters, however, it contains the structure parameters H. Substituting the structural shocks into VMA equation shows the equation of SVAR model

$$\Delta Z_t = \beta_t + (I + \Theta_1 L + \Theta_2 L^2 + ... + \Theta_p L^p + ...)G v_t. \tag{5}$$

The crucial factor of estimating this SVAR model is to specify G, or H. There exists three common methods to identify the structural parameters from previous literature. One procedure followed by Sims (1980) is to entail a particular causal ordering based on a Choleski decomposition in the short-run on the variables by specifying G as a lower triangular matrix. The second is to apply economic theory to restrict the ordering of each variable in short-run to identify G (Dungey & Pagan, 2000). Those two methods are called short-run restriction. The third approach is to impose several restrictions on the structure parameters in long-run while leaving the short-run dynamics unrestricted (Quah& Blanchard, 1989; Rapach, 2001; Dungey *et al.*, 2004). Following Fry *et al.* (2008), this paper adopts the third 'long-run restriction' method to analyze the responses of each structural shocks in $v_t$to shocks in aggregate supply, aggregate demand, domestic equity market, domestic goods market and foreign equity market respectively.

3.2 Long-run Restrictions

Real Output

The first long-run restriction which is imposed on aggregate supply comes from natural rate hypothesis. The natural rate hypothesis refers to that real output is only affected by the shocks in itself, such as oil prices and technology shocks which could change the potential real output, in the long-run (Rapach, 2001).

$$Z_{1,t} = \lambda_1 v_{1,t}, \tag{6}$$

In equation (6), $Z_{1,t}$represents the first element in Z_t, the real output, and $v_{1,t}$ refers to the shocks in aggregate supply. The parameter $\lambda_1$measures the long-run effects of changes in aggregate supply on real output and it is expected to be positive since and increase in aggregate supply would increase the real output permanently. According to Fry *et al.* (2008), the assumption that the natural rate hypothesis is true for Australia is supported by previous literatures that find relatively stable non-accelerated increased unemployment rate.

Nominal Interest Rate

The second long-run relationship represents the response of nominal interest rate to shocks in itself and other variables. According to Blanchard & Quah (1989), aggregate demand shocks are defined as disturbances which have no long-run effect on either unemployment or output. One interpretation of all disturbances is shocks in nominal interest rate, which is motivated by a traditional Keynesian view of fluctuation. Following the existing literature, this paper also defined aggregate demand shocks, $v_{2,t}$, are shocks in nominal interest rate.

All shocks would influence nominal interest rate in the long-run except the shocks on goods market, namely the nominal shocks $v_{4,t}$, because the monetary neutrality suggests that an increase in money supply would only increase all nominal prices and wages but have no effect on real economic output (aggregate supply and demand), *etc.* Therefore, the equation of nominal interest rate is:

$$Z_{2,t} = \phi_1 v_{1,t} + \phi_2 v_{2,t} + \phi_3 v_{3,t} + \phi_5 v_{5,t}, \tag{7}$$

where$Z_{2,t}$ refers to the second element in Z_t, the nominal interest rate. Without wealth effect, according to IS curve, ϕ_1 is predicted to be negative. However, under real wealth effect, an aggregate supply shock would lead to an increase in stock prices via increasing dividend (how dividends decide the stock price is discussed in next forthcoming section), which will increase aggregate demand. Furthermore, a positive shock in aggregate supply will decrease the price level in goods market, which would directly rise aggregate demand. Comparing the relative magnitudes of both effects, ϕ_1 is anticipated to be positive. According to Rapach (2001), an exogenous positive shock on stock will increase the demand for stock but reduce the demand for bond. To obtain the equilibrium in asset market, a decrease in the price of bonds, an increase in the interest rate is anticipated. Therefore, ϕ_3 and ϕ_5 are expected to be positive. At last, ϕ_2 should be positive, obviously.

Australian Real Equity Prices

The third long-run restriction results from the relationship between real equity prices and their dividends in the future. According to Gordon Dividend Model, equity prices equal to the sum of the present value of all expected dividends in the future

$$s(t) = E_t \int_t^{\infty} d(s) e^{-(R(t)-\pi(t))(s-t)} ds \tag{8}$$

Where E_t refers to the expectation conditional on information at time t, *d(s)* is real dividends at time$s$, *R(t)* is the nominal interest rate which is expected as constant in the future, andπ*(t)* is the inflation rate. If real dividends are predicted to grow at a constant rate η*(t)*.

$$d(s) = d(t) e^{\eta(t)(s-t)} \tag{9}$$

Where η*(t)*<*R(t)* -π*(t),* then the equation (9) becomes

$$s(t) = E_t \int_t^{\infty} d(t) e^{-(R(t)-\pi(t)-\eta(t))(s-t)} ds = \frac{d(t)}{R(t)-\pi(t)-\eta(t)}. \tag{10}$$

Then taking log form for both side

$$\ln(s(t)) = \ln(d(t)) - \ln(R(t) - \pi(t) - \eta(t)),$$

$$\ln(s(t)) = \ln(d(t)) - \ln(R(t) - R(t)\frac{\pi(t)+\eta(t)}{R(t)}),$$

$$\ln(s(t)) = \ln(d(t)) - \ln(R(t)(1 - \frac{\pi(t)+\eta(t)}{R(t)})),$$

$$\ln(s(t)) = \ln(d(t)) - \ln(R(t)) - \ln(1 - \frac{\pi(t) + \eta(t)}{R(t)}) \tag{11}$$

$$\ln(s(t)) = \ln(d(t)) - \ln(R(t)) + \varphi(t), \tag{12}$$

where$\varphi(t) = -\ln(1 - \frac{\pi(t)+\eta(t)}{R(t)})$. Considering that real output , $y(t)$, and foreign real share prices, $f(t)$, determine real dividends, hence

$$\ln(d(t)) = \zeta_1 \ln(y(t)) + \zeta_2 \ln(f(t)) + \zeta_0, \tag{13}$$

equation (7) becomes

$$\ln(s(t)) = \zeta_1 \ln(y(t)) + \zeta_2 \ln(f(t)) - \ln(R(t)) + \varphi(t) + \zeta_0. \tag{14}$$

Based on equation (13), the Australia real equity price ($Z_{3,t}$) has a positive long-run relationship with real output and foreign real equity prices, while has a negative relationship with nominal interest rate

$$Z_{3,t} = \delta_1 v_{1,t} + \delta_2 v_{2,t} + \delta_3 v_{3,t} + \delta_5 v_{5,t}. \tag{15}$$

Goods Market Prices

The forth long-run restriction says that both of the structural shocks have impacts on goods market prices ($Z_{4,t}$)

$$Z_{4,t} = \gamma_1 v_{1,t} + \gamma_2 v_{2,t} + \gamma_3 v_{3,t} + \gamma_4 v_{4,t} + \gamma_5 v_{5,t}. \tag{16}$$

Except that an increase in aggregate supply would cause a decrease in nominal goods prices, which means that$\gamma_1 < 0$, all the other parameters should be positive, $\gamma_2, \gamma_3, \gamma_4, \gamma_5 > 0$.

Foreign Real Equity Prices

The last long-run restrictions imposed on foreign equity prices. Since Australia is assumed to be a small open-economy, in the long-run, the stock price in U.S. is predicted to be affected only by shocks in itself

$$Z_{5,t} = \omega_5 v_{5,t}. \tag{17}$$

Apparently, $\omega_5$should be positive.

Other Restrictions

Except five long-run restrictions discussed above, Fry *et al.* (2008) also impose another two over-identified restrictions on their SVAR model. The first comes from the well-known home-equity puzzle (Lewis, 1999) which implies that domestic investors particularly prefer domestic portfolio than its foreign counterpart although in a fully efficient capital market there should be no deference between, which means shocks in foreign assets would have no effect on Australian nominal interest rate and nominal goods prices

$$\gamma_5 = \phi_5 = 0. \tag{18}$$

The second over-identified long-run restriction is derived from equation (9). That equation shows that real equity prices and nominal interest rate have one-to-one reverse relationship, which means that when an aggregate demand shock $v_{2,t}$ increase the nominal interest rate by ϕ_2, it will also decrease the real equity prices by ϕ_2. Therefore, Fry *et al.* (2008) impose another restriction

$$\delta_2 = -\phi_2. \tag{19}$$

However, from equation (6), it clearly shows that there still exists *R(t)* in $\varphi(t)$ which rejects equation (24). In their paper, the authors do not provide convincible evidence to support their argument. Therefore, this paper will loosen this restriction and only adopts one over-identified restriction, equation (13).

Summary

If only applying five long-run restrictions on structural shocks v_t on the structural parameters H, then the model is called unconstrained model

$$H = \begin{bmatrix} \lambda_1 & 0 & 0 & 0 & 0 \\ \phi_1 & \phi_2 & \phi_3 & 0 & \phi_5 \\ \delta_1 & \delta_2 & \delta_3 & 0 & \delta_5 \\ \gamma_1 & \gamma_2 & \gamma_3 & \gamma_4 & \gamma_5 \\ 0 & 0 & 0 & 0 & \omega_5 \end{bmatrix}. \tag{20}$$

If adopting the over-identified restriction, the SVAR model becomes constrained model with the new structural parameters

$$H = \begin{bmatrix} \lambda_1 & 0 & 0 & 0 & 0 \\ \phi_1 & \phi_2 & \phi_3 & 0 & 0 \\ \delta_1 & \delta_2 & \delta_3 & 0 & \delta_5 \\ \gamma_1 & \gamma_2 & \gamma_3 & \gamma_4 & 0 \\ 0 & 0 & 0 & 0 & \omega_5 \end{bmatrix}. \tag{21}$$

4 Results Policy Implications

4.1 Replication

Replication results of the original paper are presented in Appendix-D to Appendix-H. Whilst Fry et al. (2008) used GAUSS version 6 in estimating the parameters of long run restriction matrices and in running the SVAR model, we used MATLAB version R2014a, Eviews8 and STATA version SE12. In consequence, slight differences are found in our estimation results but they are not substantial. The key features and main story remain the same using the same data period as used in the original paper.

4.2 Extension

This paper extends the data used in the original paper up to 2014. Since the global financial crises hit the US economy during 2008 – 2009, US equity markets collapsed. In turn, Australian equity markets might be affected. A dummy variable capturing the global financial crises period is therefore included within the model as an exogenous variable. It implies that this variable enters all the equations.

Another extension is that it is argued that the magnitude of aggregate demand shock to interest rate () and aggregate demand shock to Australian equity () should not be the same. Fry *et al.* (2008) claim that both have the same level except for the sign at which it is positive for but negative for . Rapach (2001) argues that the difference of both is 25 per cent. From the equation (11) and (13), we find that both are not the same either no evidence that the gap between them is 25 per cent. The consequence of this issue is discussed in section (iv).

4.2.1 Parameter Estimates of Long Run Restrictions

The parameters of matrices in equation (20) and (21) are estimated using maximum likelihood as follows:

$$lnL_t = -\frac{N}{2}ln(2\pi) - \frac{1}{2}ln|\Omega| - \frac{1}{2}e_t'\Omega^{-1}e_t' \tag{22}$$

Where N is the number of endogenous variables, e_t is the estimated residuals and Ω is the variance-covariance matrix of the SVAR.

$$\Omega = GG' \tag{23}$$

Where G is specified by

$$G = (I - \hat{\phi}_1 - \hat{\phi}_2)H \tag{24}$$

With $\hat{\phi}_1$ and $\hat{\phi}_2$ are estimated matrices of autoregressive parameters. Two lags are used in this model. The log likelihood for T observations is

$$lnL = \sum_{t=1}^{T} lnL_t \tag{25}$$

which is maximized with respect to the parameters in H matrices. The parameter estimates are presented in Table-3.

Equation	Shock	Parameter	Estimate of unrestricted model	Estimate of restricted model
Output	Aggregate supply	λ_1	0.957	0.957
Interest	Aggregate supply	ϕ_1	2.794	2.457
	Aggregate demand	ϕ_2	6.185	6.457
	AU portfolio	ϕ_3	8.193	8.505
	US portfolio	ϕ_5	-2.960	
Australian equity	Aggregate supply	δ_1	2.092	2.163
	Aggregate demand	δ_2	-6.239	-6.288
	AU portfolio	δ_3	2.133	2.078
	US portfolio	δ_5	4.531	3.910
CPI	Aggregate supply	γ_1	-0.666	-0.670
	Aggregate demand	γ_2	0.685	0.664
	AU portfolio	γ_3	0.954	0.923
	Nominal	γ_4	1.409	1.439
	US portfolio	γ_5	-0.032	
US equity	US portfolio	ω_5	9.992	9.991
Log-likelihood			-1596.94	-1605.24

Table 3: Maximum Likelihood Estimates of the Long-run Parameters of the SVAR Model in Equation (20) and (21)

4.2.2 Dynamic Inter Relationships: Impulse Responses

The outcomes of how structural shocks affect variables within the model are shown in Figure-6. The solid lines reflect the true response of each variable to each shock, while the dashed lines are the confidence intervals related to each response to each shock. As the variables run in the model are in the form of their growth rates, the drawn impulse responses are accumulated to investigate the effects on the level of each variable. They are reported for 5 years (20 quarters).

Aggregate supply shocks

The first column of Figure-6 shows the responses of each variable to aggregate supply shock signified by a positive shock to Australian real output. In short run, this shock leads real Australian GDP and real Australian equity to increase simultaneously. At the same time, price levels in goods market decrease. The rise in the real Australian equity is due to stimulated real dividends as the economy expands. It then fuels aggregate demand to go up. Furthermore, as the goods prices fall, the real value of Australian equity shoots up which eventually produces positive wealth effects. There is also a capital gain created from the US portfolios. However, as purchasing power parity (PPP) holds, US portfolio effect is denied in the long run.

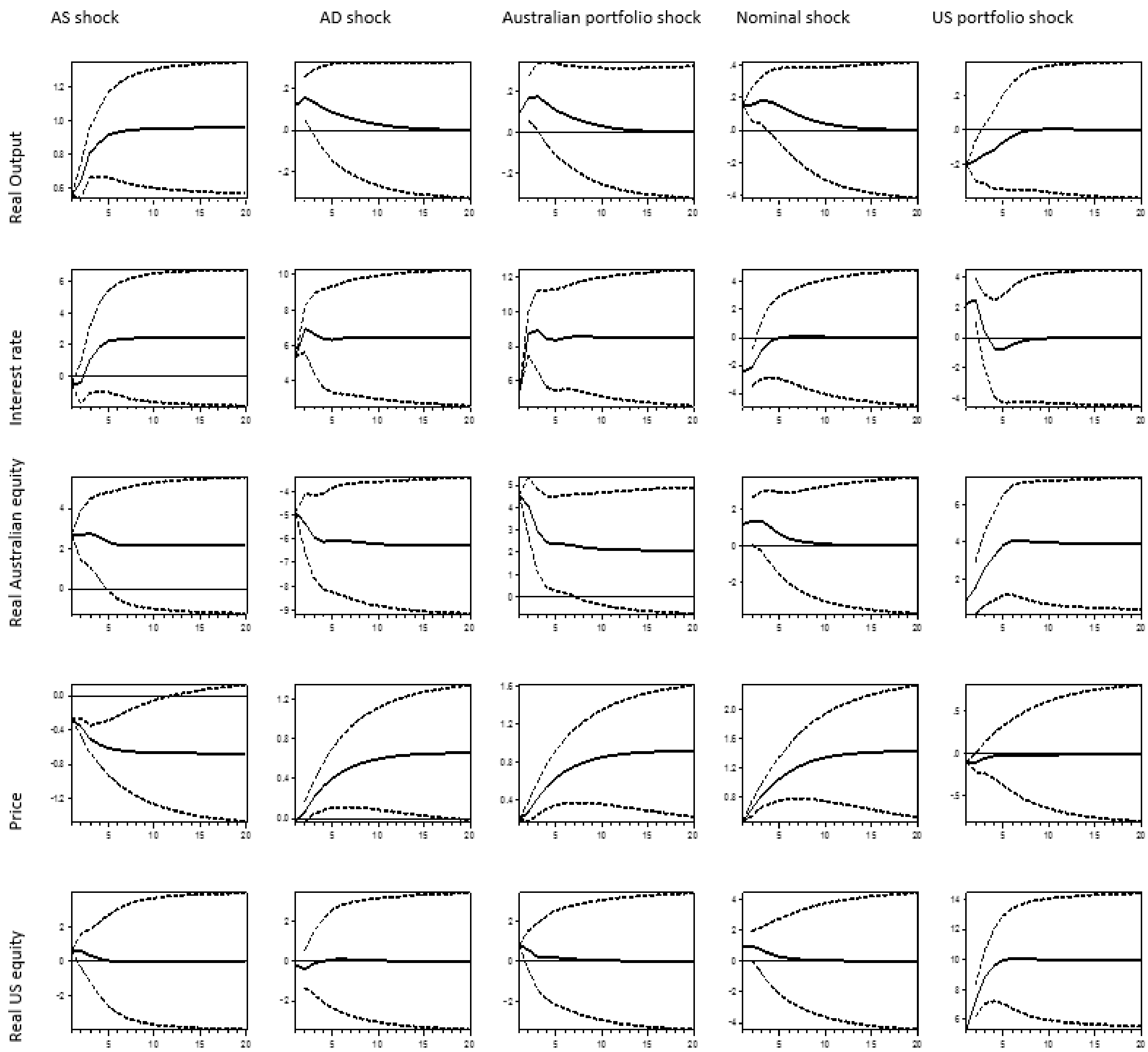

Figure 6: Accumulated Impulse Responses with One Standard Deviation Confidence Intervals Based on 10,000 Monte Carlo Draws (1980q1-2014q4) $\delta_2 \neq -\phi_2$

Aggregate demand shocks

A positive aggregate demand shock is characterized by an increase in the nominal interest rate as shown in column 2 of Figure-6. It initiates Australian real GDP and real Australian equity to escalate instantaneously as well as an increase in the goods prices in the short run. Since long run neutrality of aggregate demand shock holds, its effect on the Australian real GDP vanishes in the long run. The real GDP growth is back to its natural rate. The aggregate demand itself actually produces two opposite effects in the short run. Initially, it drives the economy to expand which consequently delivers a positive effect on the real Australian equity price. On the other hand, the higher interest rate creates higher discounting value of dividends in the future. It then causes the real Australian equity price to decrease. The falling response of real Australian equity price depicted in column 2 of Figure-6 shows that the net effect is dominated by interest rate effect. In addition, there is a negative wealth effect of US equities coming from increasing goods prices in domestic markets. However, this effect dies out since the Australian dollars depreciate headed for its PPP level.

Australian/domestic portfolio shocks

The effect on each variable in response to a domestic portfolio shock is shown in the third column of Figure-6. An unanticipated positive shock to Australian portfolio results in contemporaneous increase in real GDP, nominal interest rate and real Australian equity price. Likewise, prices in the domestic goods market climb up as the economy expands. Since the real GDP growth rate goes back to its natural rate in the long run, the effect of the portfolio shocks is signified by permanent upsurge in the price of goods and nominal interest rates as well as real Australian equity price. Real values of US equity are also positively affected by this domestic portfolio shock as aggregate demand is stimulated. Nevertheless, this effect disappears in the long run as PPP holds. It means that the depreciation of Australian dollars just overall offsets the rises in prices of goods.

Nominal shocks

The column 4 of Figure-6 highlights how each variable responds to an unanticipated nominal shock. This shock is denoted by contracted interest rates in the short run which lead to instantaneous expansion of the economy as well as goods price level. A real wealth effect is positively created through two channels. First is through the expansion of the economy, while the second is through dividends channel. As the interest rate is lower, the discounting value of expected dividends in the future is lower. It then leads to higher prices of real Australian equity. Finally, because nominal shock is neutral in the long run, its effect is only characterized by permanent increase in goods prices. Similarly, it also does not have a permanent effect on real US equity prices due to holding PPP in the long run.

US/foreign portfolio shocks

The role of US portfolio shock to the Australian economy is exhibited in the fifth column of Figure-6. This shock drives the Australian economy to contract and interest rates to climb up in short run. Yet, its effect dissipates in the long run due to natural rate hypotheses. Its effect on the prices of goods market is found statistically insignificant. In contrary, there is significant and permanent effect on the real Australian equity prices. So, the wealth effect onto the Australian economy arising from the foreign portfolio shock clearly comes from the latter channel.

4.2.3 Sensitivity Analysis: Comparison of Impulse Responses over Different Periods

The red lines correspond to the impulse responses using the data from 1980q1-2005q2 as used in Fry et al. (2008), while the black lines represent the extended model as already described in the beginning of section 4.2. The impulse responses are reported for 40 quarters in order to make accurate comparison with the results in Fry et al. (2008).

With the same size of aggregate supply shock, interest rate and real Australian equity price now respond greater than in the past. It shows that both are now more sensitive to the domestic economy. Moreover, with smaller shock of domestic portfolio, the Australian economy now expands more greatly than before (see third column of Figure-7). Equally, the foreign equity price is affected positively in the short run larger than before. Provided that increase in goods prices is greater than before, it implies that the Australian dollars depreciate more so that higher increase in goods prices results in higher US equity prices when they are calculated in Australian dollars.

In addition, the last column of Figure-7 demonstrates that given the same shock magnitude of US equity, the real Australian equity responds less than before and the Australian economy contracts less too. It underlines that the Australian economy is now getting more resilient in response to the international shock. This also implies that the role of Australian equity to its domestic economy is now stronger than in the past since the equity market capitalization has grown enormously in the last decade.

4.2.4 Dynamic Inter Relationships: Variance Decompositions

Forecast error variance decomposition presented in Table-4 provides more dynamic properties information of the model previously estimated. The estimates in each horizon reflect the proportion of total percentage of variance for each variable. For instance, the proportion of variance in real Australian equity because of aggregate demand shock in the long run, is obtained from

$$\frac{100\delta_2^2}{\delta_1^2 + \delta_2^2 + \delta_3^2 + \delta_5^2} \tag{26}$$

These variance decompositions are computed from the parameter estimates of long run restrictions in equation (21).

As shown in Table-4, in the short run, Australian real output is mainly controlled by aggregate supply shocks together with some important portion of foreign portfolio shock. However, the latter shock quickly disappears.

The domestic portfolio shock itself has a very low contribution in determining the real output. It is even overestimated by ± 0.1 per cent if the restriction that $\delta_2 = -\phi_2$ in equation (20) is not released (see Appendix-C for exact value). The Australian real

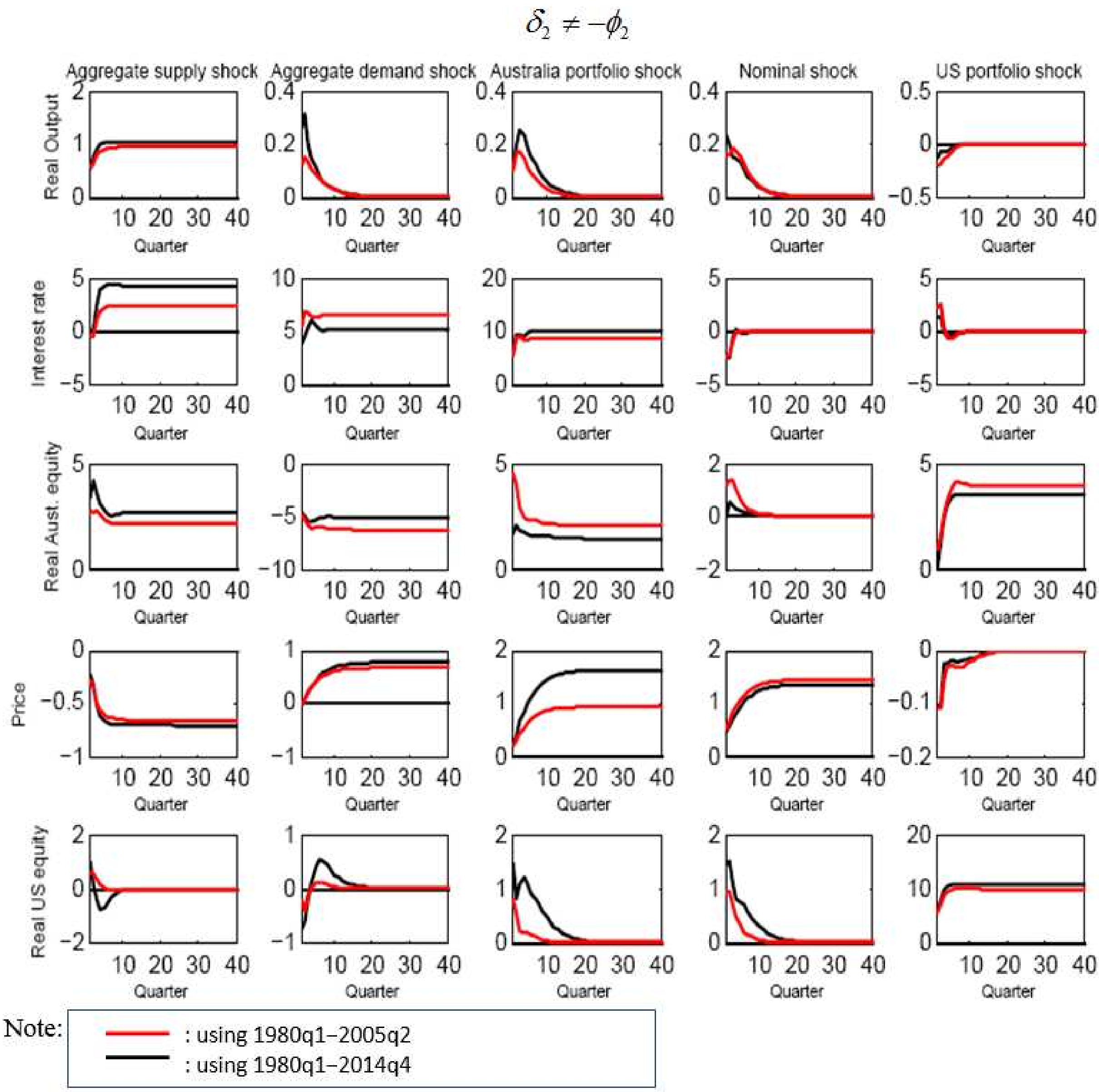

Figure 7: Comparison of Accumulated Impulse Responses (1980q1-2005q2 vs 1980q1-2014q4) $\delta_2 \neq -\phi_2$

output itself is fully controlled by aggregate supply shocks in the long run, which is consistent with the natural rate hypotheses.

The principal contributors of nominal interest rates in the short run are aggregate demand jointly with the domestic portfolio shock. In the long run, the aggregate demand shock tapers off slowly and the domestic portfolio shock comes as the most dominant factor with contribution accounted for more than 60 per cent. This result highlights the great role of wealth effect originating from Australian portfolio. Again, if the restriction that $\delta_2 = -\phi_2$ in equation (20) is not released, this wealth effect is slightly overestimated by ± 1.5 per cent in the long run (see Appendix-C). Foreign portfolio shock and nominal shock have some short run implications but no long run implication due to the neutrality of nominal shocks.

		Shocks				
Variable	Quarters	Aggregate Supply	Aggregate Demand	Australian portfolio	Nominal	US portfolio
Output	1	77.428	3.680	2.276	6.420	10.196
	4	84.892	2.705	3.529	4.631	4.242
	8	92.057	1.412	1.918	2.765	1.848
	12	94.892	0.914	1.239	1.797	1.158
	∞	99.999	0.000	0.000	0.000	0.000
Interest	1	0.361	41.875	41.413	8.875	7.477
	4	1.126	36.368	57.209	2.605	2.691
	8	2.929	35.456	58.956	1.263	1.396
	12	3.621	35.208	59.425	0.830	0.917
	∞	5.028	34.727	60.245	0.000	0.000
Australian equity	1	13.628	44.360	38.194	2.475	1.343
	4	12.484	53.896	22.350	2.548	8.721
	8	10.008	56.172	15.070	1.350	17.400
	12	9.084	57.768	12.386	0.891	19.871
	∞	7.329	61.946	6.767	0.000	23.959
Prices	1	21.827	0.106	10.917	63.729	3.421
	4	20.857	4.033	15.327	59.032	0.751
	8	17.139	7.844	19.142	55.643	0.231
	12	15.075	9.318	20.466	55.017	0.123
	∞	11.753	11.576	22.356	54.314	0.000
US equity	1	1.294	0.127	2.102	2.829	93.648
	4	0.341	0.085	0.398	0.997	98.178
	8	0.133	0.040	0.166	0.413	99.249
	12	0.083	0.025	0.104	0.258	99.530
	∞	0.000	0.000	0.000	0.000	100.000

Table 4: Variance Decompositions Arising from Alternative Shocks: Percentage of Total $\delta_2 \neq -\phi_2$

The aggregate demand and domestic portfolio shock itself dominate the Australian equity prices in the short run. However, as the domestic portfolio shock evaporates (from 38 per cent to 12 per cent), aggregate demand shock takes place as the most dominant factor determining the Australian equity prices. Surprisingly, the US portfolio shock has very small role in short run (just over 1 per cent), but it then shoots up (over 23 per cent) in the long run. It shows that the Australian equity market is strongly interconnected with the foreign equity markets.

In the prices of goods market, nominal and aggregate supply shocks are the most dominant factor in the short run. Aside from the dominant nominal shock in the long run, aggregate supply shock contribution falls over time and it is replaced by domestic portfolio shock. The wealth effect arising from the Australian equity is getting stronger.

It confirms that the role of domestic portfolio shock onto goods market becomes more valuable in the long run.

Lastly, as expected, the US equity operates solely and truly exogenous to Australian domestic shocks. Australian portfolio and nominal shock influence US equity by just about 2 per cent each in the short run and have no contribution in the long run.

4.2.5 Dynamic Inter Relationships: Historical Decompositions (March 2000 to December 2014)

To analyze the effects of dot-com crises in 2000, 9/11 attack in 2001 and the global financial crises in 2008 – 2009, historical decompositions are now performed. It is obtained by decomposing the structural shocks in each period based on the previous estimated SVAR model. The results are presented both in graphs and bar charts. The three lines in each graph in this section signify the three events mentioned earlier, respectively. The top left of each graph represents the actual data converted into natural logarithms and multiplied by 100. The other figures in each graph denote each structural shock at which AS is for aggregate supply shocks, AD is for aggregate demand shocks, AU is for Australian portfolio shocks, Nominal is for nominal shocks and US is for US equity shocks. The bar charts are shown to study which shock is dominant for each variable.

Australian equity market

Just after the dot-com crises, prices of Australian equity slightly decrease but it then fell more deeply after the 9/11 attack in US (refer Figure-8). This result is consistent with Dungey et al. (2004). The downward slopping trend of the US equity shocks within the same period clearly demonstrates its strong influence onto the Australian equity market. Similarly, as shown in Figure-9, the US equity shocks appeared prominently between 2000 and 2004. Before the global financial crises, the Australian equity prices already fell not only due to negative shocks of the US equity but also a huge negative aggregate demand shock in 2008Q1. The global financial crises just made it worse. As the equity prices fell, the Australian households' wealth was reduced by almost 10 per cent (ABS 2010). However, the Australian equity quickly rebounded as the aggregate supply and aggregate demand shocks became positive. These latter shocks outweighed the negative effects of US equity.

Bond market

Figure 10 and 11 display the strong impacts of Australian equity on the interest rates. As the Australian equity fell after the dot-com crises, interest rates followed. Nevertheless, following the 9/11 attack, they recovered more quickly than the Australian equity because of substantial positive aggregate demand shocks afterwards. This result is consistent with the result in section (iv). During the global financial crises, there was a sharp decline in the interest rates. This signifies one of the central bank policies which

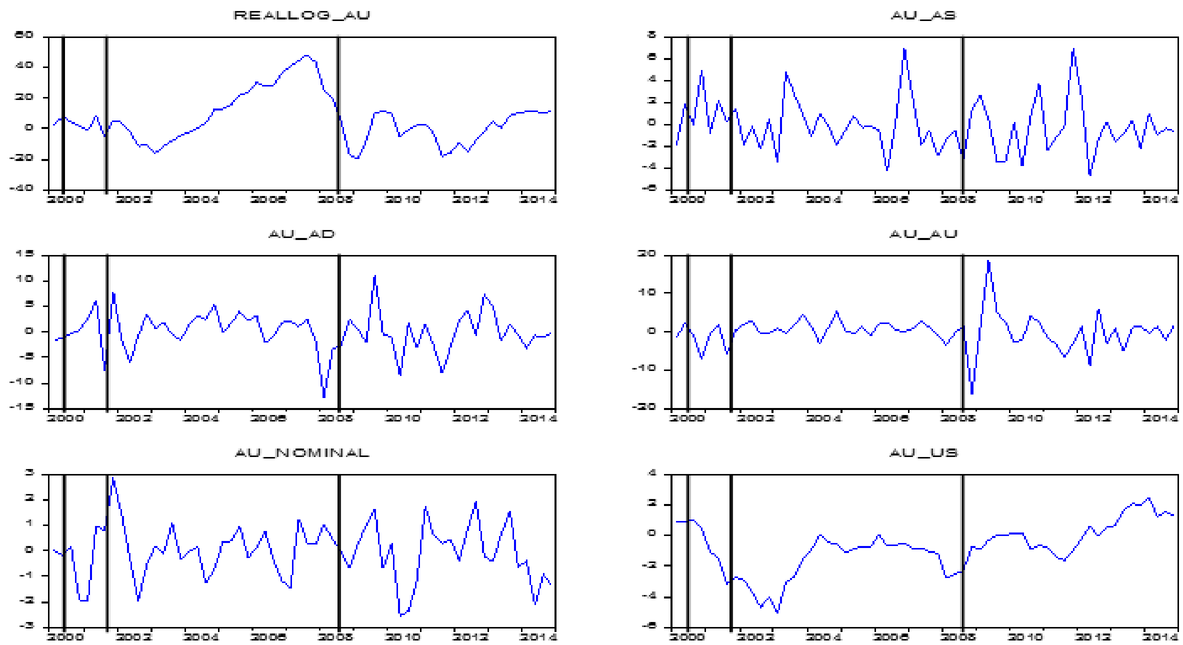

Figure 8: Historical decomposition of Australian real equity prices

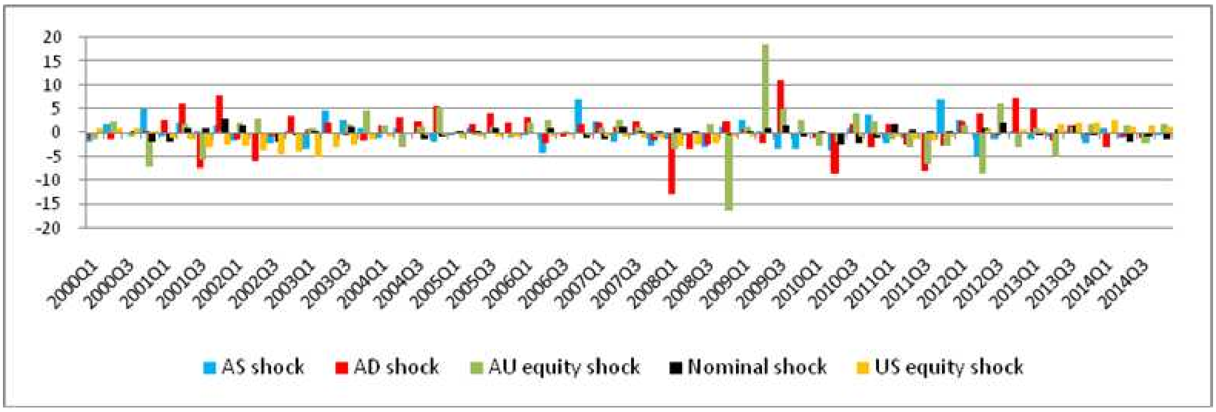

Figure 9: Contribution to real Australian equity prices

in turn it keeps the financial institutions resilient to the crises. As before, the Australian equity shocks played substantial parts for the interest rates around the global financial crises period.

Goods market: output

The Australian economy is found resilient to the external shocks either dot-com crises or 9/11 attack in US. As shown in Figure-13, the aggregate supply shocks are the most dominant factors in driving the economy. Only during the global financial crises the economy experienced a bit stagnant trend, but it then rose up quickly. Policies taken by the government together with central banks are undoubtedly important factors during the period. Consistent with the result in section (ii) and (iv), US portfolio shocks do not have substantial direct impacts to the Australian economy.

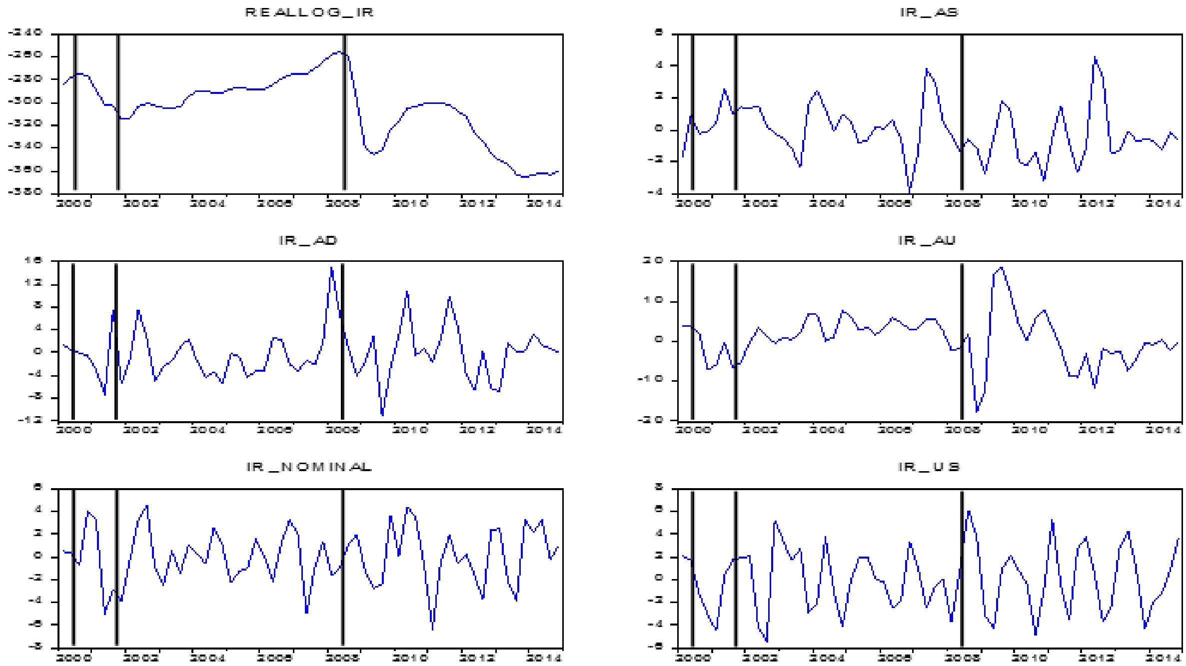

Figure 10: Historical decomposition of nominal interest rate

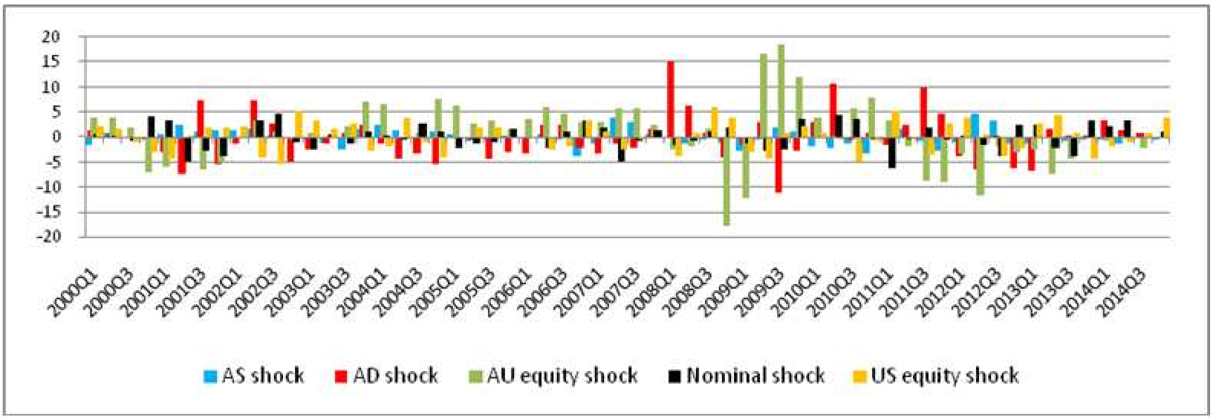

Figure 11: Contribution to nominal interest rate

Goods market: prices

Figure-15 shows that the prices in goods market are mostly determined by the Australian equity shocks and the nominal shocks. Aggregate supply shocks play some role in between. The positive Australian portfolio shocks and the negative nominal shocks compensated each other in most of the periods. However, during the global financial crises positive aggregate supply shocks were the leading shocks among others.

US equity market

Finally, as expected, the US equity market is totally driven by US equity shocks itself as shown in Figure-16. This result again is consistent with the result in section (ii) and (iv). Not surprisingly, all the events, dot-com crises, 9/11 attack and the global financial

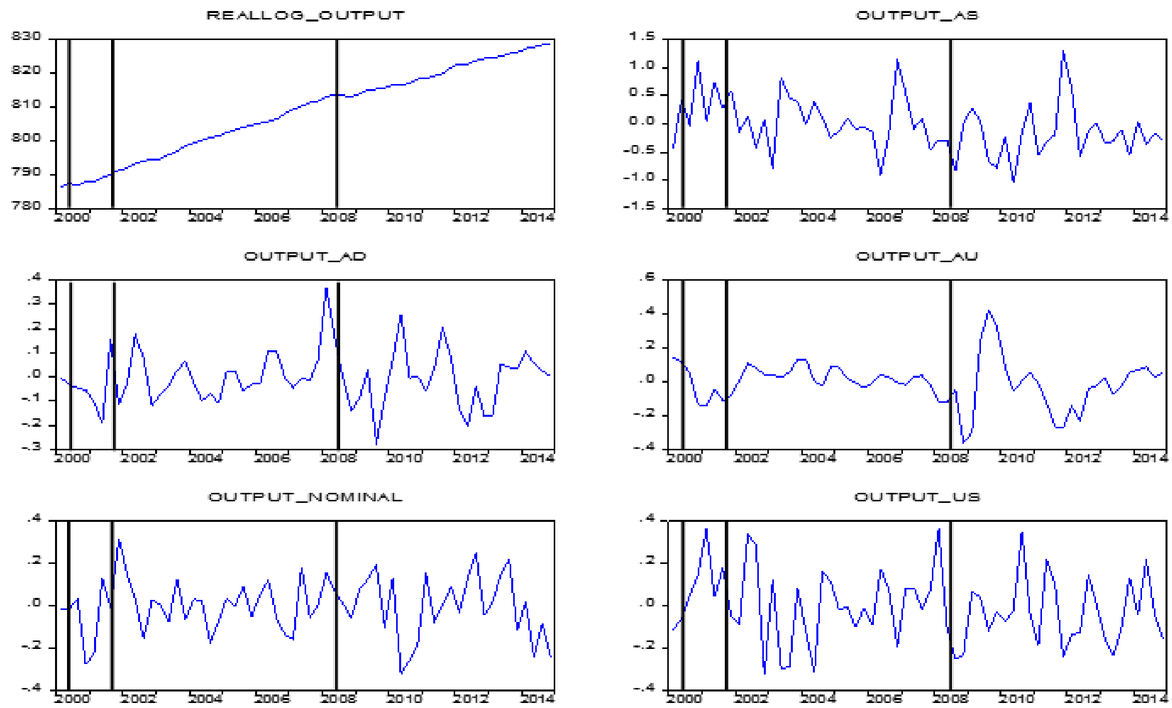

Figure 12: Historical decomposition of Australian real output

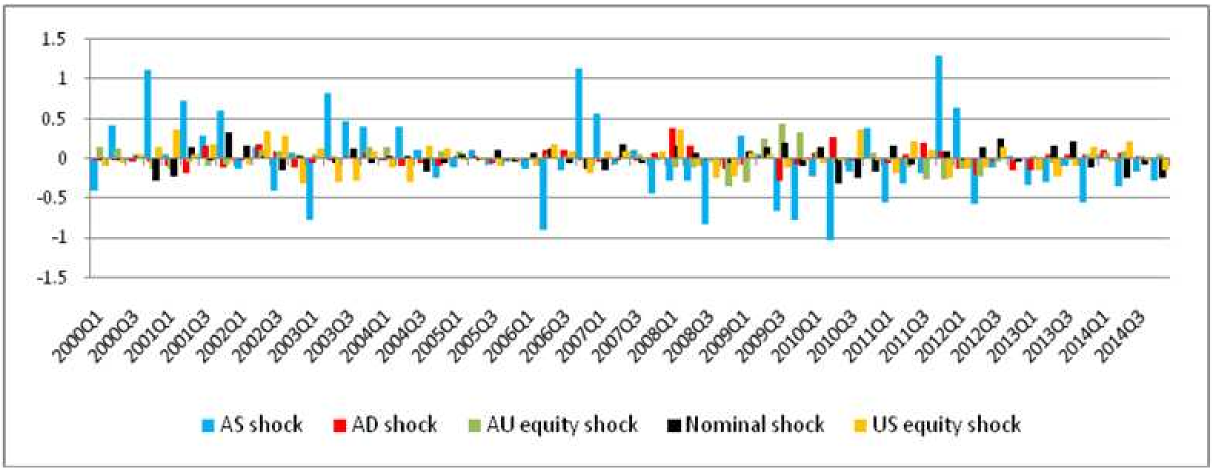

Figure 13: Contribution to real output

crises dampened the US equity market. 9/11 attack had the greatest effect compared with the other two.

5 Conclusions

This paper is motivated by growing equity market size in Australia over time. Its main contributions are through application of long run restrictions for SVAR model for Australia. It also studies the effects of external international shocks including dot-com crises in 2000, 9/11 attack in 2001 and the global financial crises 2008-2009.

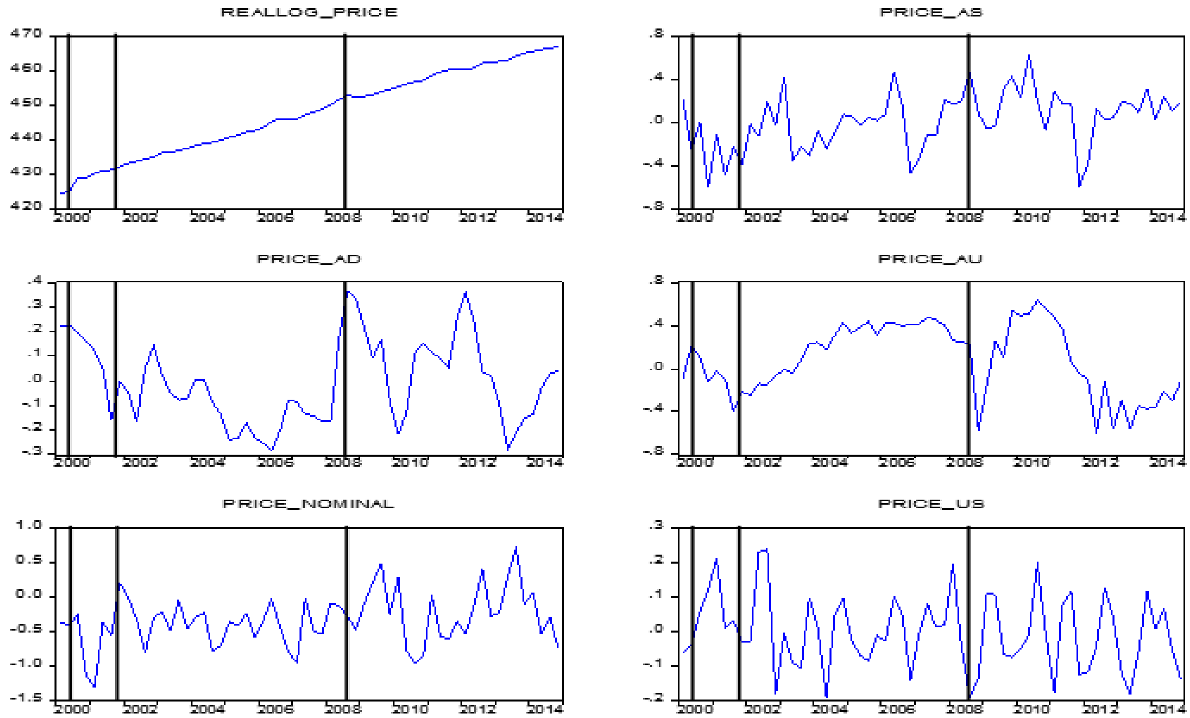

Figure 14: Historical decomposition of goods prices

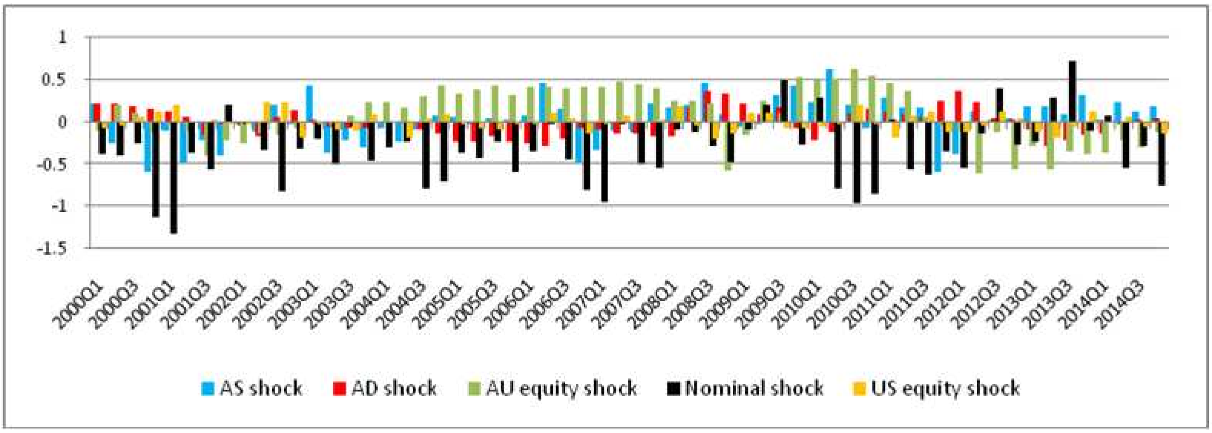

Figure 15: Contribution to prices in goods market

A number of important findings are as follows. Aggregate supply shocks produce positive wealth effects coming from increasing real value of Australian equity as the goods prices fall. Moreover, the channels of how Australian portfolio shocks affect the Australian economy are through interest rates and prices in the goods market. Australian portfolio also acts as a channel for wealth effect arising from the foreign equity market.

The Australian economy is now more resilient in response to the international shock. Although there was some reduction in the Australian households' wealth following the global financial crises, it quickly rebounded due to the strong aggregate supply shocks as the Australian economy is more attached to the emerging Asian economies. The role of Australian equity to its domestic economy is now stronger than in the past since

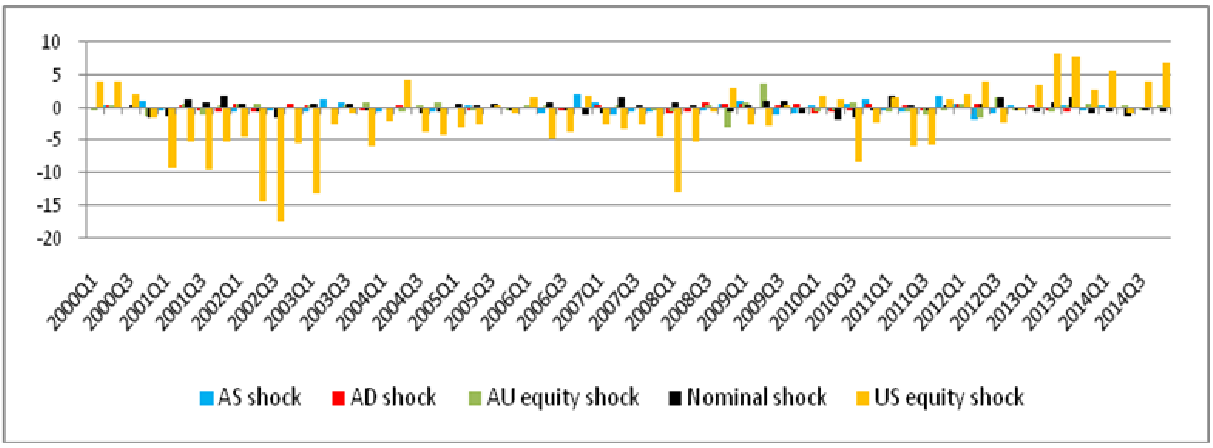

Figure 16: Contribution to real US equity prices

the equity market capitalization has grown enormously in the last decade. In addition, imposing restriction of the same magnitude of aggregate demand shock to interest rate (ϕ_2) and aggregate demand shock to Australian equity (δ_2) has caused the contribution of Australian portfolio shock to output and interest rate to be overestimated.

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Appendix: Data source

Data from 1980q1 to 2014q4, from various sources

CEIC Database:

- Australian share price index
- CPI, all groups, 2011-2012=100
- US Share price index, S&P Industrials
- USD/AUD spot exchange rate, average over the quarter

Australian Bureau of Statistics:

- Australia Implicit Price Deflator
- Australia Nominal GDP, expenditure, total AUD million

Reserve Bank of Australia:

- 90 day bank accepted bill interest rate, average over the quarter

Appendix: A

```
. dfuller ngdp

Dickey-Fuller test for unit root                   Number of obs   =       139

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             7.329            -3.497            -2.887            -2.577
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 1.0000

.
. dfuller ausp

Dickey-Fuller test for unit root                   Number of obs   =       139

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)            -0.663            -3.497            -2.887            -2.577
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.8562

.
. dfuller ir

Dickey-Fuller test for unit root                   Number of obs   =       139

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)            -1.061            -3.497            -2.887            -2.577
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.7306

.
. dfuller cpi

Dickey-Fuller test for unit root                   Number of obs   =       139

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)            -1.076            -3.497            -2.887            -2.577
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.7246

.
. dfuller ussp

Dickey-Fuller test for unit root                   Number of obs   =       139

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             1.408            -3.497            -2.887            -2.577
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.9971
```

Appendix: B

. dfuller crgdp

Dickey-Fuller test for unit root   Number of obs = 138

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-9.184	-3.497	-2.887	-2.577

MacKinnon approximate p-value for Z(t) = 0.0000

.

. dfuller causp

Dickey-Fuller test for unit root   Number of obs = 138

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-11.771	-3.497	-2.887	-2.577

MacKinnon approximate p-value for Z(t) = 0.0000

.

. dfuller cir

Dickey-Fuller test for unit root   Number of obs = 138

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-7.773	-3.497	-2.887	-2.577

MacKinnon approximate p-value for Z(t) = 0.0000

.

. dfuller ccpi

Dickey-Fuller test for unit root   Number of obs = 138

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-6.321	-3.497	-2.887	-2.577

MacKinnon approximate p-value for Z(t) = 0.0000

. dfuller cussp

Dickey-Fuller test for unit root   Number of obs = 138

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-8.022	-3.497	-2.887	-2.577

MacKinnon approximate p-value for Z(t) = 0.0000

Appendix: C

Variable	Quarters	Shocks: Aggregate Supply	Aggregate Demand	Australian portfolio	Nominal	US portfolio
Output	1	77.428	3.587	2.369	6.420	10.196
	4	84.892	2.608	3.626	4.631	4.242
	8	92.057	1.360	1.970	2.765	1.848
	12	94.892	0.881	1.272	1.797	1.158
	∞	99.999	0.000	0.000	0.000	0.000
Interest	1	0.361	40.540	42.747	8.874	7.477
	4	1.126	34.919	58.659	2.605	2.691
	8	2.929	34.001	60.411	1.263	1.396
	12	3.621	33.751	60.882	0.830	0.917
	∞	5.028	33.268	61.704	0.000	0.000
Australian equity	1	13.628	45.677	36.878	2.475	1.343
	4	12.484	54.943	21.303	2.548	8.722
	8	10.007	57.036	14.206	1.350	17.400
	12	9.084	58.561	11.592	0.891	19.871
	∞	7.328	62.587	6.125	0.000	23.959
Prices	1	21.827	0.143	10.880	63.729	3.421
	4	20.857	3.802	15.559	59.031	0.751
	8	17.139	7.462	19.525	55.643	0.231
	12	15.075	8.883	20.902	55.017	0.123
	∞	11.753	11.064	22.869	54.314	0.000
US equity	1	1.294	0.144	2.085	2.829	93.648
	4	0.341	0.090	0.393	0.997	98.178
	8	0.133	0.041	0.164	0.413	99.249
	12	0.083	0.026	0.103	0.258	99.530
	∞	0.000	0.000	0.000	0.000	100.000

Appendix: D

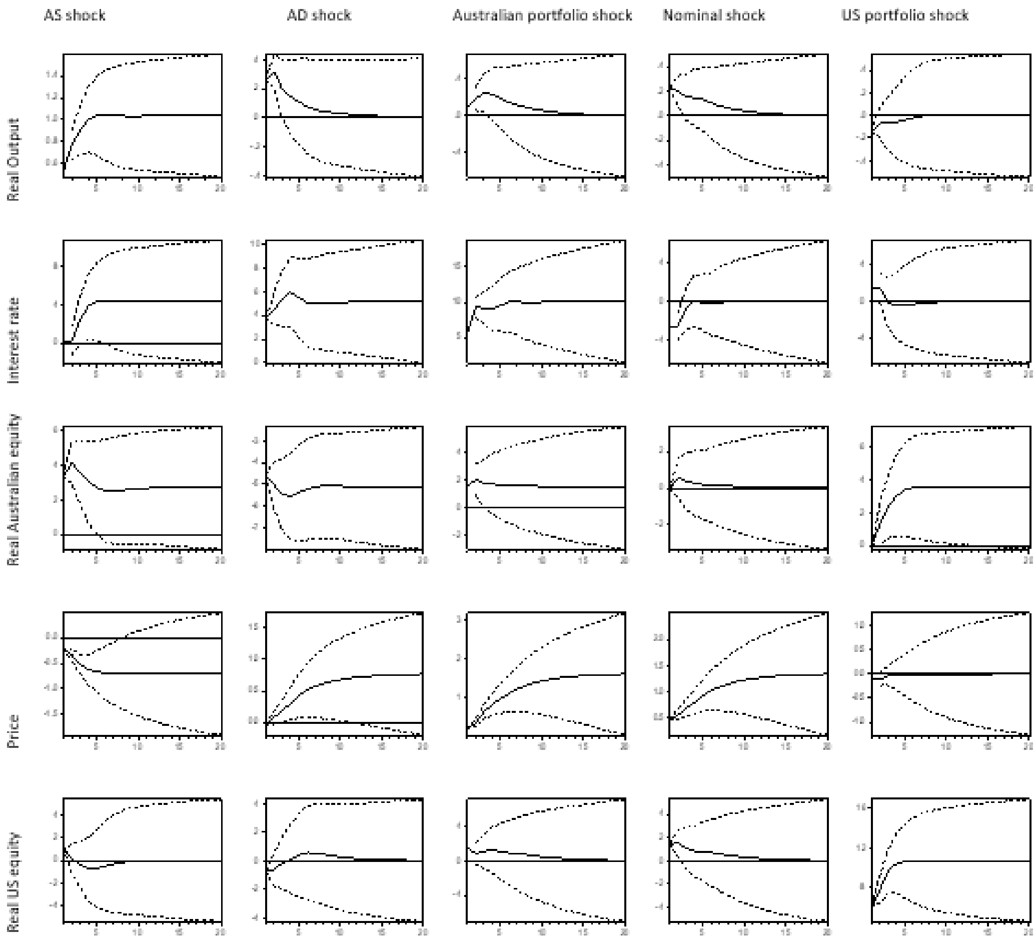
Replication of Table 3 MLE estimates

			Unrestricted model			Restricted model		
Equation	Shock	Parameter	Estimate	SE	p-value	Estimate	SE	p-value
Output	Aggregate supply	λ_1	1.039			1.039		
Interest	Aggregate supply	φ_1	4.317			4.300		
	Aggregate demand	φ_2	5.100			5.181		
	AU portfolio	φ_3	9.928			10.109		
	US portfolio	φ_5	-2.111					
Australian equity	Aggregate supply	δ_1	2.706			2.708		
	Aggregate demand	δ_2	-5.170			-5.181		
	AU portfolio	δ_3	1.452			1.429		
	US portfolio	δ_5	3.725			3.514		
CPI	Aggregate supply	γ_1	-0.710			-0.712		
	Aggregate demand	γ_2	0.765			0.773		
	AU portfolio	γ_3	1.601			1.621		
	Nominal	γ_4	1.348			1.349		
	US portfolio	γ_5	-0.279					
US equity	US portfolio	ω_5	10.752			10.752		
Log-likelihood			-1153.63			-1155.45		

LR = -2(-1155.46+1153.63) = 3.649

Based on the Likelihood Ratio test above, the restricted model is note rejected. It gives the same results as in the original paper.

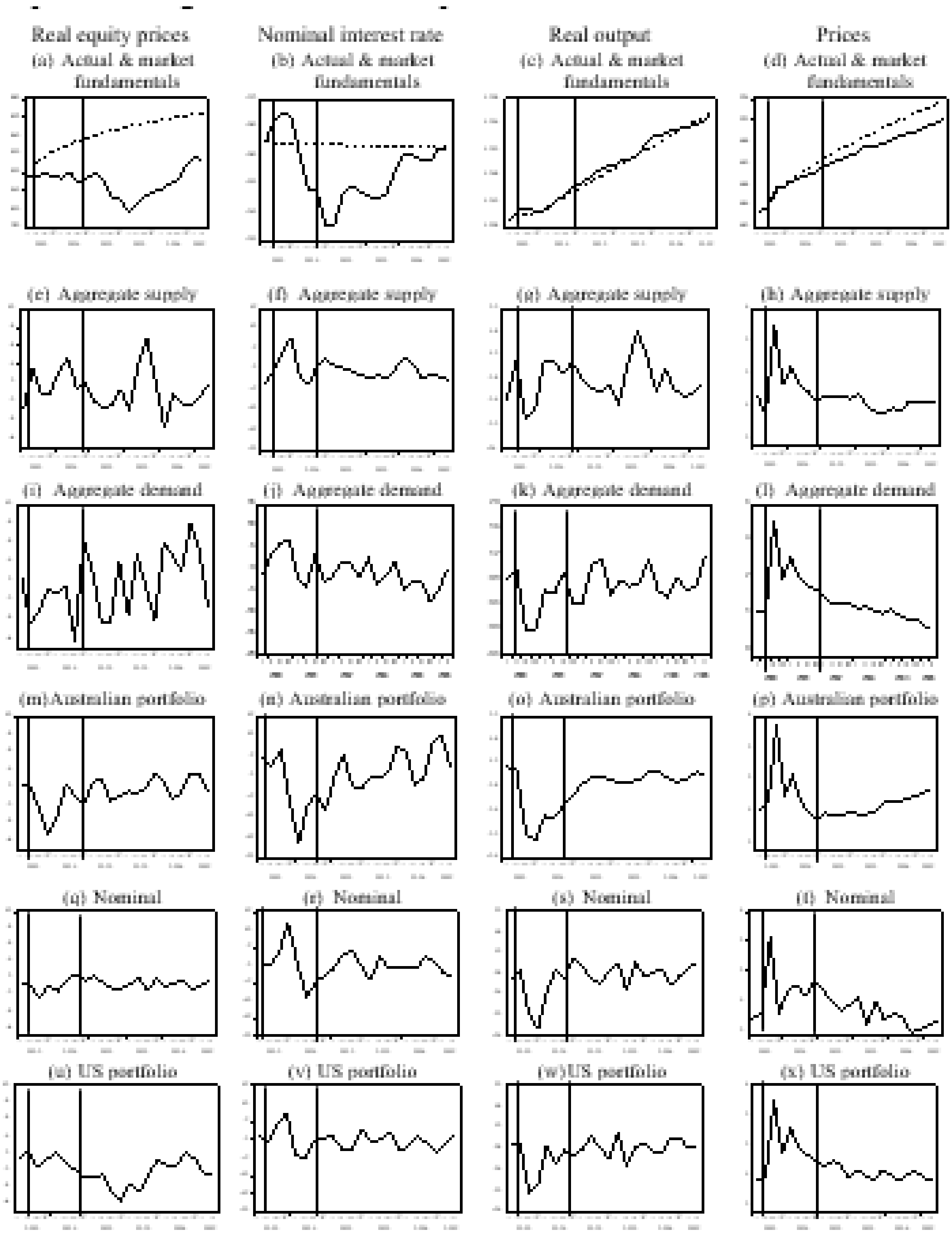
Appendix: E


AS shock
AD shock
Australian portfolio shock
Nominal shock
US portfolio shock
Real Output
Interest rate
Real Australian equity
Price
Real US equity

Appendix: F

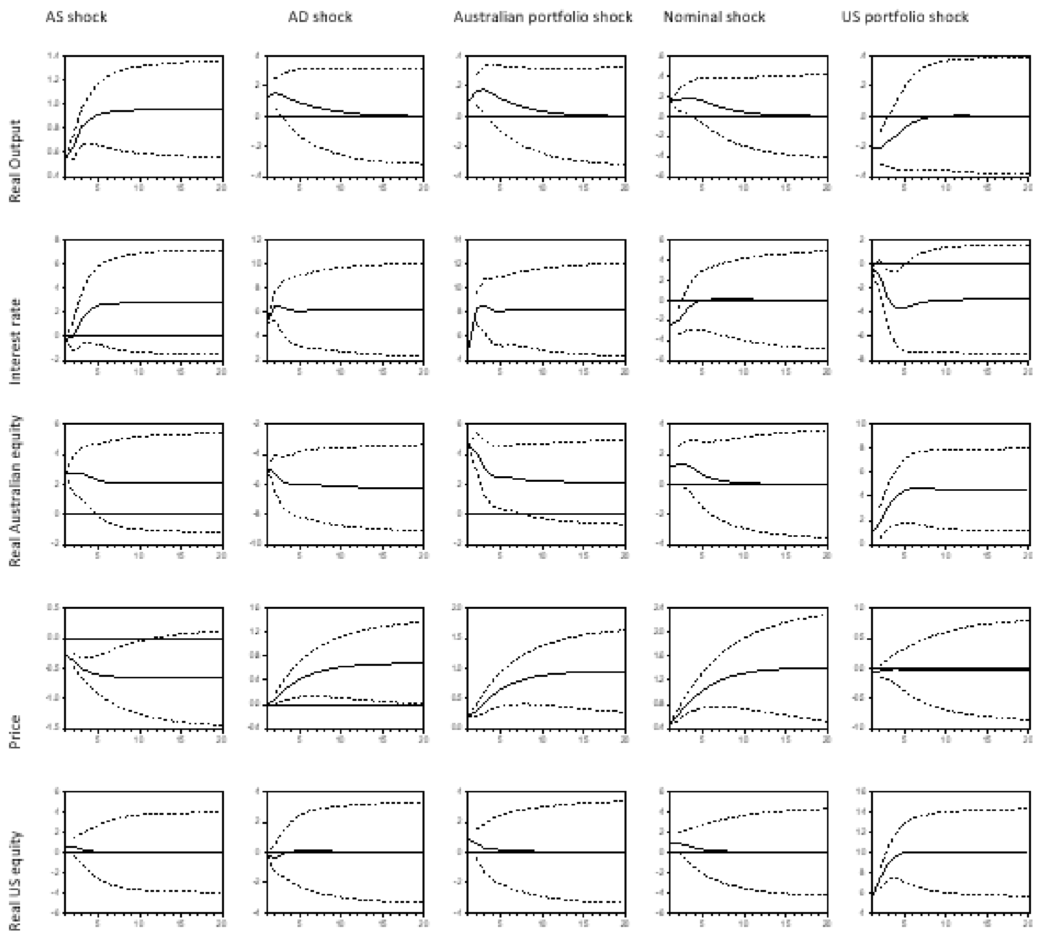
		Shocks				
Variable	Quarters	Aggregate Supply	Aggregate Demand	Australian portfolio	Nominal	US portfolio
Output	1	64.006	16.039	2.694	12.697	4.564
	4	82.420	7.105	5.171	4.302	1.002
	8	90.649	3.304	3.260	2.338	0.448
	12	93.814	2.148	2.202	1.548	0.288
	∞	99.999	0.000	0.000	0.000	0.000
Interest	1	0.002	24.507	60.719	11.617	3.155
	4	4.786	23.227	67.836	3.193	0.958
	8	9.678	20.544	67.987	1.360	0.431
	12	10.802	19.621	68.443	0.861	0.273
	∞	12.535	18.192	69.273	0.000	0.000
Australian equity	1	32.605	59.827	7.558	0.009	0.001
	4	27.048	56.999	6.871	0.285	8.797
	8	20.316	56.311	6.054	0.159	17.160
	12	18.508	55.663	5.676	0.110	20.044
	∞	15.099	55.270	4.205	0.000	25.427
Prices	1	15.179	0.128	16.613	64.927	3.153
	4	20.796	3.348	32.815	42.448	0.593
	8	16.132	7.567	39.871	36.281	0.149
	12	13.325	8.944	42.896	34.761	0.074
	∞	9.136	10.751	47.311	32.802	0.000
US equity	1	2.605	1.309	5.149	4.949	85.988
	4	0.585	0.307	1.751	1.979	95.378
	8	0.352	0.245	1.110	1.002	97.290
	12	0.222	0.174	0.762	0.657	98.185
	∞	0.000	0.000	0.000	0.000	100.000

Appendix: G



Real equity prices
(a) Actual & market fundamentals
Nominal interest rate
(b) Actual & market fundamentals
Real output
(c) Actual & market fundamentals
Prices
(d) Actual & market fundamentals
(e) Aggregate supply
(f) Aggregate supply
(g) Aggregate supply
(h) Aggregate supply
(i) Aggregate demand
(j) Aggregate demand
(k) Aggregate demand
(l) Aggregate demand
(m)Australian portfolio
(n) Australian portfolio
(o) Australian portfolio
(p) Australian portfolio
(q) Nominal
(r) Nominal
(s) Nominal
(t) Nominal
(u) US portfolio
(v) US portfolio
(w)US portfolio
(x) US portfolio

Appendix: H


AS shock
AD shock
Australian portfolio shock
Nominal shock
US portfolio shock
Real Output
Interest rate
Real Australian equity
Price
Real US equity

Appendix: I

I. Converted Real GDP

LAG	AC	PAC	Q	Prob>Q
1	0.2309	0.2321	7.5739	0.0059
2	0.2648	0.2245	17.605	0.0002
3	-0.0236	-0.1368	17.686	0.0005
4	-0.0438	-0.0837	17.964	0.0013
5	-0.0526	0.0172	18.369	0.0025
6	-0.0893	-0.0543	19.545	0.0033
7	-0.0930	-0.0730	20.829	0.0040
8	-0.0818	-0.0233	21.83	0.0052
9	-0.0953	-0.0521	23.2	0.0058
10	-0.0637	-0.0378	23.817	0.0081
11	-0.0548	-0.0248	24.277	0.0116
12	-0.1207	-0.1411	26.526	0.0090
13	0.0156	0.0523	26.564	0.0143
14	0.0375	0.1054	26.784	0.0205
15	0.1156	0.0646	28.895	0.0166
16	-0.0085	-0.1035	28.906	0.0246
17	0.0491	0.0186	29.294	0.0319
18	-0.0476	-0.0305	29.661	0.0409
19	-0.0567	-0.0952	30.186	0.0495
20	-0.0237	-0.0071	30.279	0.0655
21	0.0180	0.0657	30.332	0.0855
22	0.0021	0.0009	30.333	0.1106
23	-0.0399	-0.0937	30.602	0.1329
24	-0.0461	-0.0658	30.964	0.1548
25	-0.1711	-0.1839	35.998	0.0716
26	-0.1103	-0.0725	38.108	0.0592
27	-0.1185	-0.0026	40.564	0.0453
28	-0.1116	-0.1566	42.765	0.0367