How important are China and US to the Australian economy? – A two block Factor Augmented VAR (FAVAR) approach*

Jasmine Zheng†

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Abstract

This paper investigates the economic impact of shocks in the US and China on Australia, using a two block Factor Augmented VAR (FAVAR) model. The foreign block consists of world commodity prices, the US and China, while the domestic block consists of Australia. The empirical results shed some light on the importance of China and US to the Australian economy. First, this paper finds that China dampens the effects of US activity shock on Australia. In this paper, the US activity shock resembles a supply shock. Second, the impact of a negative financial shock from the US on the Australian economy is not dampened by Australia's increasing trade linkages with China. Third, a shock to Chinese activity affects the US and Australia. Overall, the results suggest that the Chinese economy is potentially a new source of shocks for the US and Australia. It appears that China has the capacity to insulate the Australian economy from a negative US activity shock. However, with US monetary policy and financial shocks, China may not mitigate the impact of these shocks on the Australian economy.

Keywords: International transmission, factor augmented vector autoregression, small open economy, Business cycles

JEL Classification: C32, E32, F41

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†Corresponding author: jasmine.zheng@anu.edu.au

1 Introduction

Over the past four decades, emerging market economies, particularly China, have assumed an increasingly important role in the world economy. The emergence of these economies has been particularly significant for the Australian economy. Between 1990 and 2012, the share of Australia's merchandise exports going to China has increased from 2.5 percent to 29.5 percent. In 2007, China overtook Japan as Australia's largest trading partner. Over the same period, the share of Australia's merchandise exports shipped to the US has declined from 11 percent to 3.8 percent. Similar patterns have occurred with imports. Between 1990 and 2012, Australia's share of merchandise imports sourced from China increased from 2.7 percent to 18.2 percent, while Australia's share of merchandise imports coming from the US declined from 24 percent to 11.6 percent.[1]

The consequences of these changes in trade patterns for Australian business cycles is an open question. On the one hand, Australia's increasing trade engagement with China means that economic developments in China are likely to have an increasing influence on the Australian economy. At the same time, the resilience of the Chinese economy during the period of weak economic growth in advanced economies since 2008 suggests that its emergence may help to insulate Australia from shocks to advanced economies. More broadly, there is a need to better understand the interactions between Chinese and US business cycles, and their implications for Australia. This paper contributes to this understanding.

Empirical studies of the impact of foreign business cycles on the Australian economy have mostly focused on the impact of the US and Japan on the Australian economy. Studies that have examined the impact of the US economy on the Australian economy include Gruen and Shuetrim (1994), Dungey and Pagan (2000), Dungey and Pagan (2009) and Liu (2010). Gruen and Shuetrim (1994) estimate a single equation error correction model and find that the US business cycle has a greater impact on the Australian economy than the business cycles of Australia's other trading partners. Dungey and Pagan (2000) develop a Structural Vector Autoregression (SVAR) model of the Australian economy and find that US variables (US GDP, real interest rates and real share prices) are important explanators of Australian economic activity. Similarly, Liu (2010) estimates a VAR model of the Australian economy using sign restrictions to identify structural shocks. He concludes that developments in the US and G7 economies account for more than 60 percent of the fluctuations in domestic out-

[1]The statistics are calculated based on data from the Direction of Trade Statistics from the International Monetary Fund's website (Source: IMF, http://elibrary-data.imf.org/DataExplorer.aspx (accessed 7 July, 2013)).

put.

Other papers have focused on the impact of the US and Japanese economies on the Australian economy. For example, Lee et al. (2003) estimate VARs including real GDP of the three countries and world average oil price. They find that the US and Japanese business cycles have a significant impact on movements in Australian GDP. Dungey and Fry (2003) investigate the consequences of including Japan in a SVAR. They find that the impact of US shocks on the Australian economy is modified due to the impact of the US shocks on the Japanese variables, which has subsequent indirect effects on the Australian variables. Similarly, Fry (2004) constructs a SVAR model of the Australian economy that allows for international shocks from the US and Japan as well as world commodity prices. The results show that shocks from the US are the dominant source of international shocks on the Australian economy. However, the Japanese economy partially mitigates the negative impact of US shocks on the Australian economy.

Two studies have previously examined the impact of the US and Chinese economies on the Australian business cycles. Laurenceson and Tang (2009) use quarterly GDP data to look at the correlation between Australian, US and Chinese GDP. Using correlation coefficients and a concordance index, the authors find that the Australian economy is now more synchronised with the Chinese economy than it is with the US economy. Leu and Sheen (2011) set up a dynamic factor model to analyse Australia and its links to its trading partners. The results support the hypothesis that the Australian economy is increasingly synchronised with economies in Asia.

The empirical literature on the impact of foreign shocks on Australia has mostly used small-scale VARs. One issue associated with using such models to analyse business cycles is that policy makers routinely monitor a large number of variables and indicators than can be analysed within the VAR framework. Hence, it is possible that the parameters estimated from small-scale VAR models suffer from omitted variable bias, with the effects amplified in an open economy analysis.

This paper estimates a two block FAVAR model for the Australian economy with US and China in the external block, and Australia in the domestic block. In doing so, this paper addresses some of the current gaps in the existing international transmission literature for the Australian economy and makes the following contributions. First, this study is the first to explore the impact of shocks from the US and China on the Australian economy. In

particular, this paper looks at whether the US and China mitigate or magnify the effects of each others' shocks on Australia. Second, the two block FAVAR model is used to study the transmission of shocks not only via the traditional trade transmission channel, but also via the financial transmission channel.

The paper is organized as follows. Section 2 provides the background on the relevant transmission mechanism of shocks. Section 3 introduces the empirical model. Section 4 presents the empirical results. Section 5 provides the results on the forecast error variance decomposition exercise. Section 6 provides results on the robustness checks. Section 7 concludes.

2 The International Transmission of Shocks

Economic theory identifies several channels through which fluctuations in the level of economic activity in one economy can spill over to other economies. These transmission channels include trade and economic integration flows as well as financial flows. These channels suggest that increased economic integration may increase or decrease the synchronisation of business cycles. Hence, economic theory largely fails to provide explicit directions as to how enhanced cross country links will influence business cycle synchronisation.

2.1 Trade transmission channels

From a theoretical point of view, there is no consensus about how an increase in international trade affect the correlations of business cycles across economies.

Frankel and Rose (1998) argue that the removal of trade barriers leads to more correlated business cycles. Increased trade between economies allows demand and policy shocks in one economy to affect others as well as greater knowledge and technology spillovers. Similarly, Kose and Yi (2001) argue that if trade mainly occurs between firms in the same industry, or firms that vertically specialise in stages of production, then greater trade integration is likely to increase the synchronisation of business cycles as a result of demand or other common shocks. On the other hand, Krugman (1993) and Eichengreen and Park (2004) argue that lower barriers to trade will induce countries to specialise in the production of goods in which they have a comparative advantage. These countries are likely to be more sensitive to industry-specific shocks, which will reduce the correlation of business cycles across countries.

2.2 Financial linkage transmission channel

Financial market linkages are widely acknowledged as a mechanism for the international transmission of business cycle shocks. There are also contrasting views on the effects of financial market integration on the synchronisation of business cycles. Financial linkages could increase business cycle synchronisation by generating large demand side effects through financial shocks. For example, a decline in a particular country's stock market could affect the wealth of consumers in other countries who have invested in that stock market. This could then lead to a decline in consumption and investment in these countries. Claessens and Forbes (2001) and Imbs (2006) argue that contagion effects that are propagated via financial linkages could also increase spillovers of macroeconomic fluctuations across countries.

On the other hand, increasing financial links could also reduce the synchronisation of business cycles. This is possible if international financial linkages lead to a greater specialisation of goods through a reallocation of capital that is consistent with the comparative advantages these countries have in different goods. The increase in international financial linkages implies that countries can specialize in the production of goods they have comparative advantage in, while having more diversified portfolios to allow risk to be shared more efficiently in response to country-specific output fluctuations. For example, Kalemli-Ozcan et al. (2001) find that higher capital market integration leads to less symmetric fluctuations, both across and within countries. An increase in financial integration could possibly lead to less correlated business cycles due to an increase in exposure to industry or country specific shocks.

3 Empirical methodology

3.1 The two block Australian FAVAR

This paper analyses the impact of the US and Chinese economies on the Australian economy by extending the general FAVAR approach developed by Bernanke et al. (2005). The FAVAR model allows large amounts of information to be utilised by summarising this information into factors to be used in the estimation. The empirical approach in this paper is closely related to Mumtaz and Surico (2009) and Aastveit et al. (2011). The former extends the general FAVAR framework into a two block structure to include the international economy, while the latter extends the FAVAR framework into a three block structure with separate world, regional and domestic blocks.

The econometric model is made up of two blocks: (i) a foreign block, consisting of com-

modity prices, the US and China; and (ii) a domestic block, representing the Australian economy. The foreign and domestic blocks can be summarized by K factors, (F_t): the World commodity price index (CP_t), the US factors $(F_{US,t})$, the China factors $(F_{CN,t})$ and the Australia factors $(\tilde{F}_t^D)$. Block exogeneity is assumed between the foreign and domestic blocks. That is, Australia is a small open economy that is assumed to have no influence on the rest of the world contemporaneously or at any lags.

Four factors are used to explain the US economy and can be defined as $F_{US,t} = [F_{USACT,t}\ F_{USPRI,t}\ FCI_t\ R_{US,t}]'$. $F_{USACT,t}$ represents movements in US real activity measures and $F_{USPRI,t}$ represents movements in US price measures. These are extracted from data series capturing US real activity and US inflation. FCI_t is the Adjusted National Financial Conditions Index (ANFCI) constructed by the Chicago Federal Reserve. The index summarises financial conditions in US money, debt and equity markets, as well as the traditional and 'shadow' banking systems. The ANFCI takes current economic conditions into account, isolating a component of the index that is uncorrelated with current economic conditions. Hence, the interpretation of the index is relative to the current economic conditions. $R_{US,t}$ is the Federal Funds rate. FCI_t and $R_{US,t}$ are treated as observed factors in the FAVAR.

I use two factors to represent the Chinese economy. These are defined as $F_{CN,t} = [F_{CNACT,t}\ F_{CNPRI,t}]'$. $F_{CNACT,t}$ represents movements in the Chinese real activity measures and $F_{CNPRI,t}$ represents movements in the Chinese price measures, extracted from the Chinese series capturing China's real activity and China's inflation respectively. A financial channel and interest rate channel for China are excluded for several reasons. First, there is a lack of extensive data. Second, the financial sector in China remains fairly closed. Third, financial links between China and Australia remain minimal.

The Australian economy consists of three factors, $\tilde{F}_t^D = [\tilde{F}_t^{D1}\ \tilde{F}_t^{D2}\ \tilde{F}_t^{D3}]$, extracted from a panel of Australian economic data series. The domestic factors do not have any economic interpretation and are therefore unidentified. The Australian policy rate, R_t, is included in the estimation of the FAVAR as the monetary policy instrument for the Australian economy. [2]

[2]Bai and Ng (2002) provide a set of information criterion to determine the number of factors in a given dataset when the time period and number of variables in the dataset approach infinity. However, the information criterion do not provide enough information on how many factors should be used in a VAR or FAVAR framework. To ensure parsimony in the Australian economy FAVAR modelling, three Australian factors are obtained and estimated within the FAVAR framework.

I also include the International Financial Statistics (IFS) World commodity price index (CP_t) in the foreign block in the FAVAR. Commodities account for a large share of Australia's exports and so changes in commodity prices affect Australia's terms of trade and the demand for Australian exports. I order CP_t in the foreign block before all other foreign variables. This implies that commodity prices are able to affect the US and Chinese factors contemporaneously.

The unobserved factors are extracted from a large dataset, X_t. The relationship between the variables in the dataset and the factors, F_t, can be summarised in the observation equation:

$$X_t = \Lambda^f F_t + \Lambda^R R_t + v_t, \tag{1}$$

where X_t is a N $\times$ 1 vector of variables, Λ^F and Λ^R are N $\times$ K and N $\times$ 1 matrices of factor loadings and v_t is a N $\times$ 1 vector of idiosyncratic error terms with zero mean and a covariance matrix σ^2.

The two sector FAVAR model can be summarised by the transition equation:

$$\begin{bmatrix} F_t \\ R_t \end{bmatrix} = B(L) \begin{bmatrix} F_t \\ R_t \end{bmatrix} + u_t, \tag{2}$$

where $B(L)$ is a conformable lag polynomial of finite order, and u_t is an error term with mean zero and a covariance matrix Ω.

The FAVAR framework in Equations (1) and (2) are estimated via a two step procedure. In the first step, the unobserved factors are estimated using the principal components method. In the second step, the estimated factors are then included in the FAVAR and estimated with one lag using classical methods. The choice of one lag is based on the Schwarz Criterion (SC).

3.2 Identifying the factors

The estimation of the FAVAR given by Equation (1) requires the unobserved factors within F_t to be estimated first. The unobserved factors are estimated using the principal components method. It is possible for the Chinese and Australian activity and price factors to

span the same space as the US activity and price factors when estimating the unobserved factors. To ensure that the activity and price factors are orthogonal to one another, this paper follows the methodology used in Kose et al. (2003), Karagedikli and Thorsrud (2010) and Aastveit et al. (2011).

To ensure that the Chinese factors do not cover the same space as the US factors, this paper imposes the restriction that the US activity and Chinese activity factors are orthogonal. Similarly, the restriction that the US price and Chinese price factors are orthogonal is imposed. Imposing these restrictions ensures that the Chinese activity and price factors will capture common co-movements in the Chinese activity and price variables that cannot be explained by the US activity and price factor. This orthogonality restriction is also imposed on the Australian factors, assuming these factors are orthogonal to the US and Chinese factors.

To ensure that the Australian policy rate (R_t) is properly identified, this paper follows the methodology in Bernanke et al. (2005) to obtain the Australian factors ($\tilde{F}_t^D$). Appendix A provides detailed information on the estimation procedure.

Once the factors in Equation (1) are properly identified, the relationship between the set of economic time series contained in the X_t matrix and the factors is summarised in Equation (2). The dynamics of each Australian series is a linear combination of the Australian factors as well as the foreign factors. This implies that the foreign factors can affect the Australian economy directly as well as indirectly, as the domestic factors are linked to the foreign factors via the transition Equation (1). Using Equation (2) and the estimated factor loadings, the impulse response of any of the underlying variable in X_t to a shock to the transition Equation (1) can be calculated.

3.3 Identifying the shocks

The structural shocks to the three economies in this paper are identified using a Cholesky identification scheme, implying a recursive ordering of the shocks. Within the foreign block, the US economy is ordered before the Chinese economy. The foreign block is exogenous to the domestic block, consistent with the assumption that Australia is a small open economy. For both the US and China economies, activity factors are ordered before the price, financial conditions and interest rate factors. Hence, standard VAR techniques can be applied to compute impulse responses and variance decompositions.

In this paper, I identify four different shocks: a US activity shock, a US financial conditions shock, a US monetary policy shock and a Chinese activity shock. As the focus of this paper is on the transmission of international economic developments to Australia, I do not identify any Australian shocks.

3.4 Data and estimation

This paper uses quarterly data from 1994Q3 to 2011Q4 for the US, China and Australia, consisting of 70 time series observations. The length of the time series used is constrained by the availability of Chinese data. In addition, as the relationship between the Chinese and Australian economies has only started to deepen in the last two decades, including data prior to the current sample period may not be useful for the analysis in this paper. The data set contains 419 series: 4 observed factors, namely the IFS World commodity price index, the Adjusted national financial conditions index, the Federal Funds rate and the Australian policy rate; 63 series for the US activity factor; 25 series for the US price factor; 72 series for the Chinese activity factor; 29 series for the Chinese price factor; and 188 series for the Australian economy. As the focus of this paper is to examine the responses of the Australian economy following foreign shocks from different aspects, the Australian economy is represented by a wider range of series than the US and Chinese factors. A more detailed description of the dataset can be found in Tables 4-6 in Appendix B.

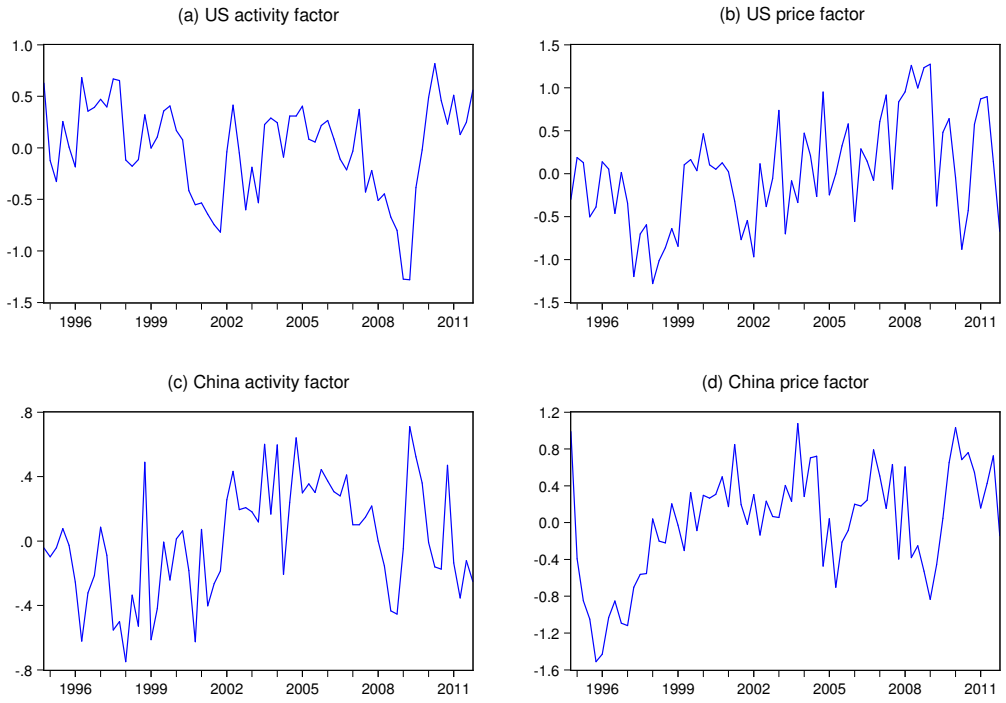
Some monthly series are aggregated into quarterly series by taking the mean of the monthly observations in each quarter and included in the model. Variables that are affected by seasonality are seasonally adjusted using the X12 ARIMA procedure. All data series are also transformed to ensure stationarity prior to the estimation. Following Stock and Watson (2005), the transformed seasonally adjusted series are screened for outliers. Observations with deviations from the median exceeding 1.5 times the interquartile range (in absolute terms) are replaced by the median value of the preceding five observations. Prior to estimation, all data series are also standardised, which enables a comparison of magnitude across shocks.

3.5 Identified factors

Figure 1 presents the estimated US and Chinese activity and price factors. The US activity factor captures the two substantial economic downturns affecting the US economy between

1994 and 2011. The first was the slowdown following the collapse of the dot-com bubble in 2001-2002. The second was the deep recession in the US following the financial crisis of 2007-2008. The US price factor tracks the low inflation period between 1996-1999 that the US economy experienced, as well as the pick-up in inflation between 2007-2008 due to rising energy and food prices.

Figure 1: Identified US and Chinese factors



The Chinese activity factor captures the lower-than-average growth in 2009 that the Chinese economy experienced due to the global recession, as well as the subsequent recovery in the Chinese economy in 2010. The Chinese price factor shows the inflation spike in 1994 due to China's rapid growth as well as the period of lower inflation that the Chinese economy experienced in late 2008-2009.

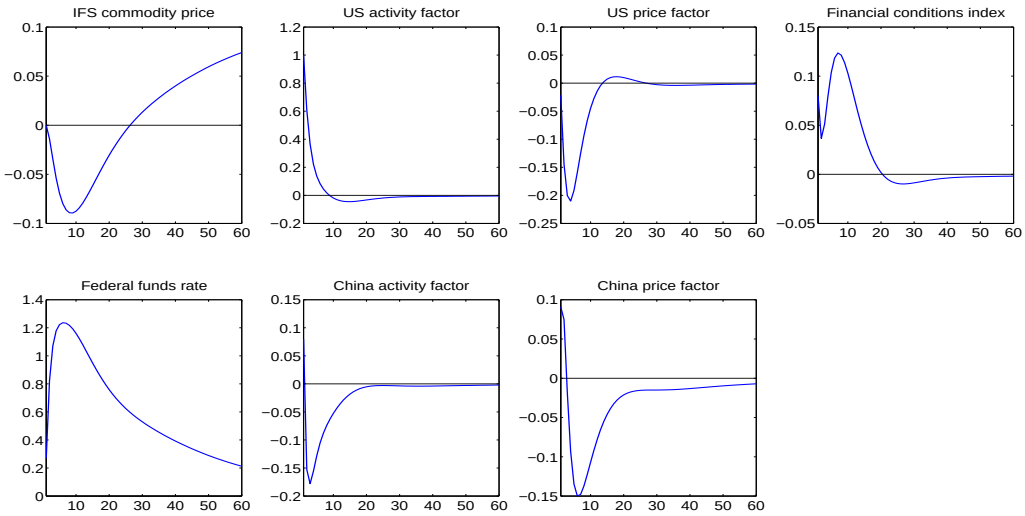
4 Empirical results

This section presents the impulse responses to the following shocks: a US activity shock, a US financial conditions shock, the federal funds rate shock and the Chinese activity shock.

4.1 US activity shock

Figure 2 displays the responses of the foreign block to a one unit positive shock to real activity in the US. The increase in real activity in the US results in a decline in inflation in the US. This result appears to be consistent with a supply shock that results in an increase in real activity and a decline in inflation. Financial conditions in the US tighten. The federal funds rate increases despite the decline in inflation, suggesting that the Federal Reserve is more concerned about an overheating economy than falling inflation and tightening financial conditions. The shock causes a temporary increase in real activity and inflation in China. However, activity and inflation in China decline soon after, possibly due to negative spillovers from tighter financial conditions in the US. It is also possible that a supply shock that leads to the decline in prices in US has increased the competitiveness of the US relative to China, causing the decline in real activity and inflation in China.

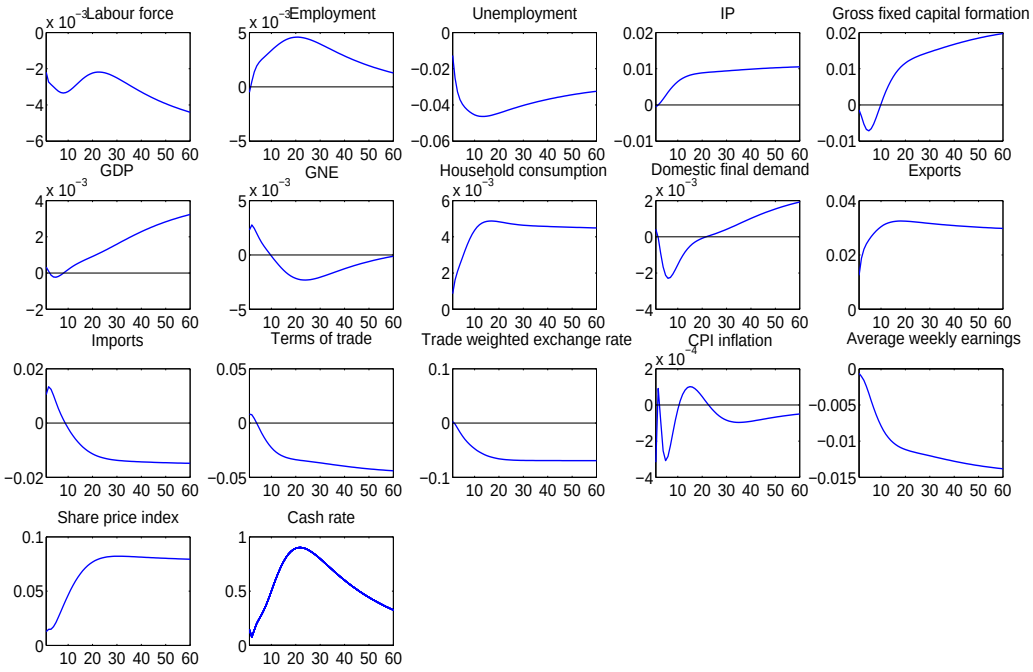
Figure 2: Effects of a shock in US activity on the foreign block



The impact of an increase in US activity is generally positive for the Australian economy, as seen in Figure 3. The Australian labour force expands marginally after a delay. Employment increases from the second quarter, while unemployment falls immediately following the shock.

Following an increase in US activity, industrial production increases and gross fixed capital formation increases after a delay. One important channel where the US activity factor can

Figure 3: Effects of a shock in US activity on the Australian economy



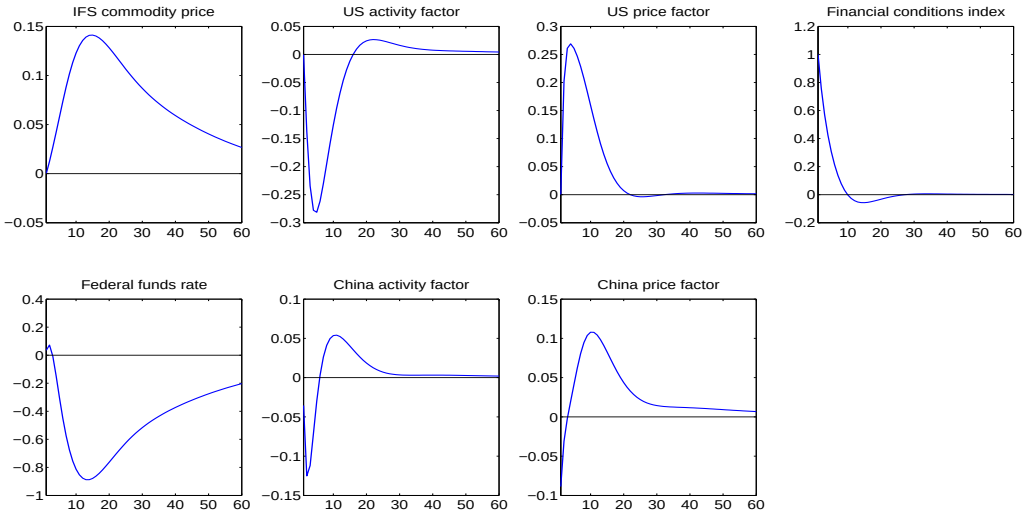
affect the Australian economy is through the trade transmission channel. There is evidence of the trade transmission channel in this study as Australian exports increase with an increase in the US activity factor. This finding is consistent with Lee et al. (2003) who find that fluctuations in output in the US have a large and significant impact on the Australian economy.

Household final consumption increases immediately following the shock, while domestic final demand increases after a delay. Despite the increase in household final consumption, demand for imported goods decline. This is likely to be due to the depreciation in the exchange rate as well as the decrease in investment. The increase in exports and decline in imports is reflected in the delayed increase in Gross Domestic Product (GDP) and decline in Gross National Expenditure (GNE). The increase in GDP is consistent with Dungey and Fry (2003) and Fry (2004), who find that a positive shock to US output has a positive impact on Australian output. Share prices increase following an increase in US activity. However, terms of trade, average weekly earnings and inflation fall. The Australian policy rate increases, following the increase in the federal funds rate.

4.2 US financial conditions shock

In this section, the impact of a shock that results in the tightening of US financial conditions relative to current economic conditions is considered. A tightening of US financial conditions corresponds to a 1 point increase in the Adjusted National Financial Conditions Index (ANFCI). Figure 4 presents the responses of the variables in the foreign block to this shock.

Figure 4: Effects of a tightening in US financial conditions on the foreign block



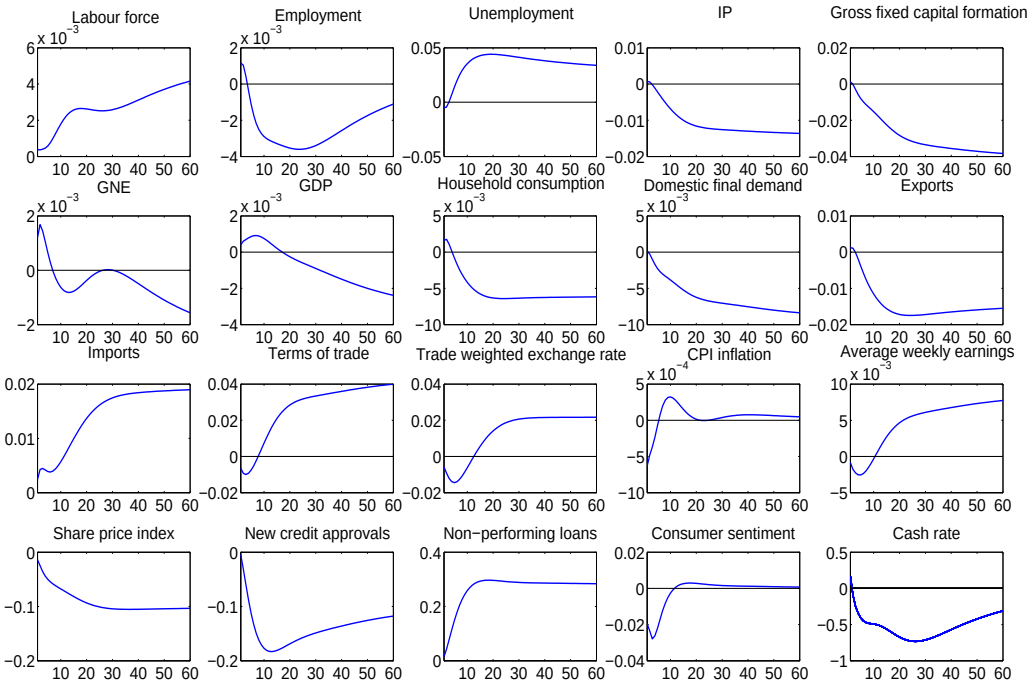
The immediate effects of tighter financial conditions on the US and Chinese economies are negative, although short-lived for the latter. The Federal Reserve cuts the federal funds rate to help to loosen financial conditions in the US economy. Despite the Chinese economy's apparent resilience during the global financial crisis, the model suggests that tighter financial conditions in the US reduce Chinese economic activity, at least initially. After four quarters, however, the Chinese economy starts to expand while inflation rises. This suggests that the Chinese economy does not fully insulate Australia from US financial shocks, although it may help to limit the severity and duration of any contraction. Commodity prices also increase, most likely reflecting higher inflation in the US.

The overall impact of a shock to US financial conditions on the Australian economy is contractionary as seen in Figure 5. That is, the Chinese economy does not fully insulate the Australian economy from a negative US financial shock, despite the increasing economic importance of China to Australia. Conditions in the Australian financial sector deteriorate

immediately following the shock. The quarterly growth of share prices and new credit approvals decline immediately. With deteriorating financial conditions in Australia, the growth of non-performing loans increases as well.

Another important channel through which deteriorating US financial conditions can influence Australian macroeconomic variables is through consumer sentiment, which declines immediately following the shock. The decline in consumer sentiment in Australia appears to have a negative influence on other Australian macroeconomic variables. Similarly, Aastveit et al. (2011) find that consumer expectations is an important transmission channel whereby foreign shocks are directly transmitted to small open economies (Canada, New Zealand, Norway and the UK) through variables such as consumption, investment and house prices.

Figure 5: Effects of a tightening in US financial conditions on the Australian economy



In terms of activity variables, industrial production, gross fixed capital formation and final consumption expenditure starts to decline after one quarter. Household final consumption declines from the third quarter, which can partly be explained by the decline in wealth. With a decline in real activity in the Australian economy, GNE declines in the third quarter following the shock. Australian GDP responds with a delay, declining from the eighth quarter.

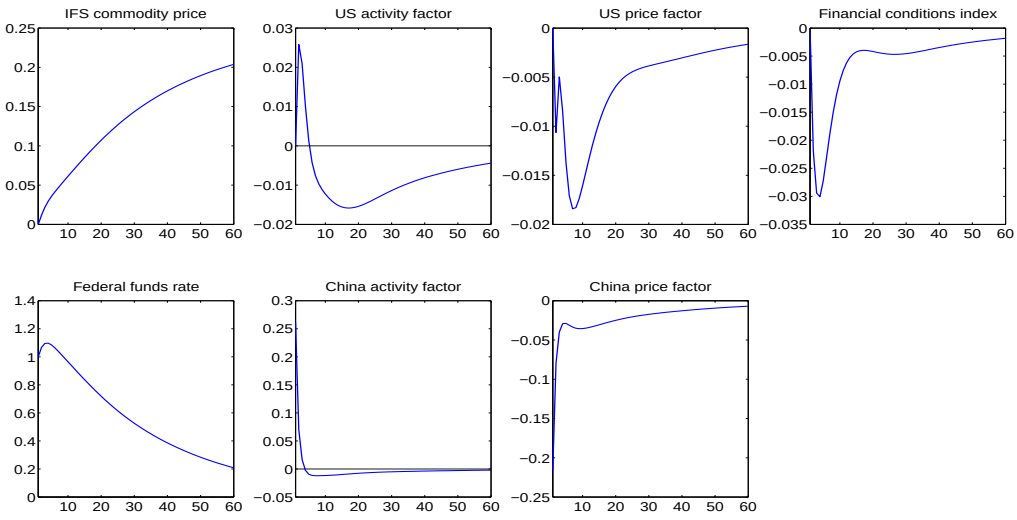
Despite the eventual increase in real activity in China, Australian exports decline from the second quarter. However, imports increase. With the increases in commodity prices, the terms of trade increases as well. Inflation and average weekly earnings decline temporarily with the fall in real activity in the economy. Weak conditions are seen in the Australian labour market after the shock. Employment declines, while unemployment increases. In response to weakening conditions in the Australian economy, the trade weighted exchange rate depreciates and the Australian policy rate declines.

4.3 Federal funds rate shock

Figure 6 shows the responses of the variables in the foreign block to an unanticipated one percentage point increase in the federal funds rate.

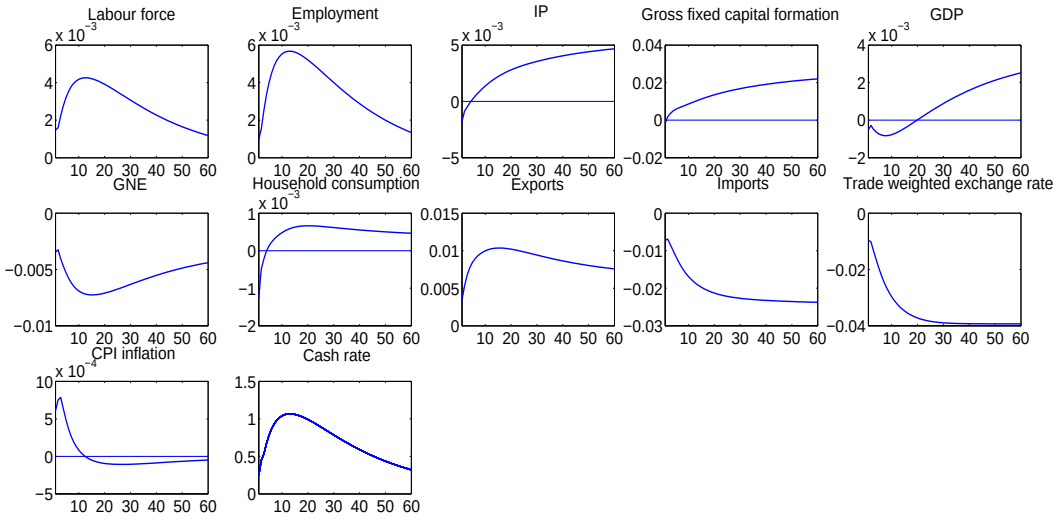
Following an unanticipated increase in the federal funds rate, economic activity in the US falls after a delay. The decrease in economic activity in the US leads to a reduction in inflation. In contrast, economic activity in China increases briefly before declining following this shock, and inflation falls. Despite the increase in the federal funds rate, the financial conditions in the US continues to loosen relative to the current economic conditions. World commodity prices also increase due to growth in China.

Figure 6: Effects of an increase in federal funds rate on the foreign block



The effects of an unanticipated increase in the federal funds rate on the Australian macroeconomic variables are shown in Figure 7. Australian exports, industrial production and gross fixed capital formation increase, assisted by the brief increase in Chinese economic activity. The domestic economy expands, with household final consumption increasing. The improvement in the domestic economy leads to an increase in GDP eventually. The increase in the federal funds rate causes a depreciation of the trade weighted exchange rate as US currency becomes more attractive to investors. The depreciation of the trade weighted exchange rate results in a decline in imports.

Figure 7: Effects of an increase in federal funds rate on the Australian economy

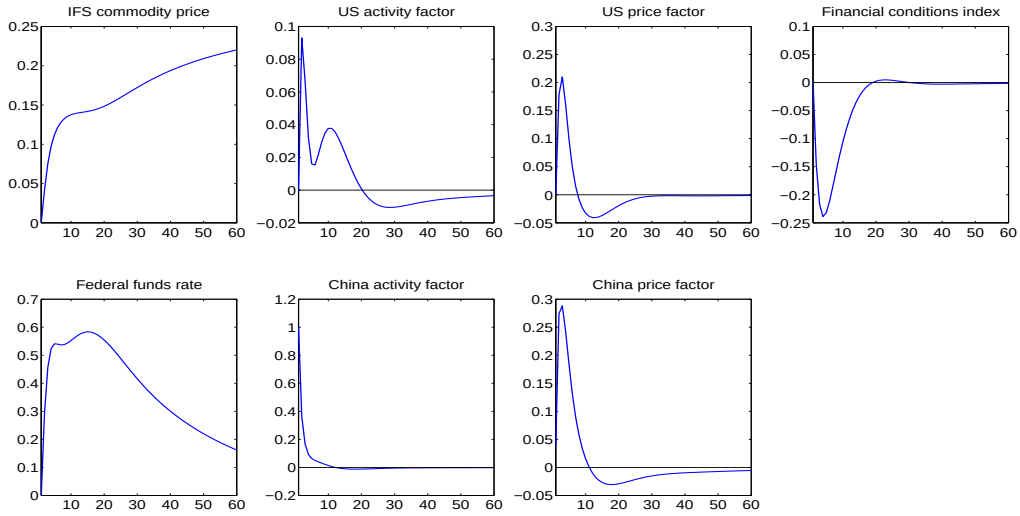


Inflation increases due to stronger economic activity in Australia and the depreciation of the exchange rate. The Reserve Bank responds to this by increasing the cash rate. In contrast, Dungey and Fry (2003) find that Australian GDP and inflation decline following an increase in the US interest rate, putting downward pressure on the cash rate. The difference between these results suggest that the limited negative impact the federal funds rate shock has on the Chinese economy helps to moderate the impact of US monetary policy shocks on the Australian economy.

4.4 Chinese activity shock

Figure 8 shows the responses of the variables in the foreign block to a shock to the Chinese activity factor. The increase in Chinese activity results in an increase in US activity. Financial conditions in the US loosen relative to current economic conditions. The increase in activity in China and the US puts upward pressure on inflation in China and US. The increase in inflation in the US leads to an increase in the federal funds rate.

Figure 8: Effects of an increase in Chinese activity on the foreign block

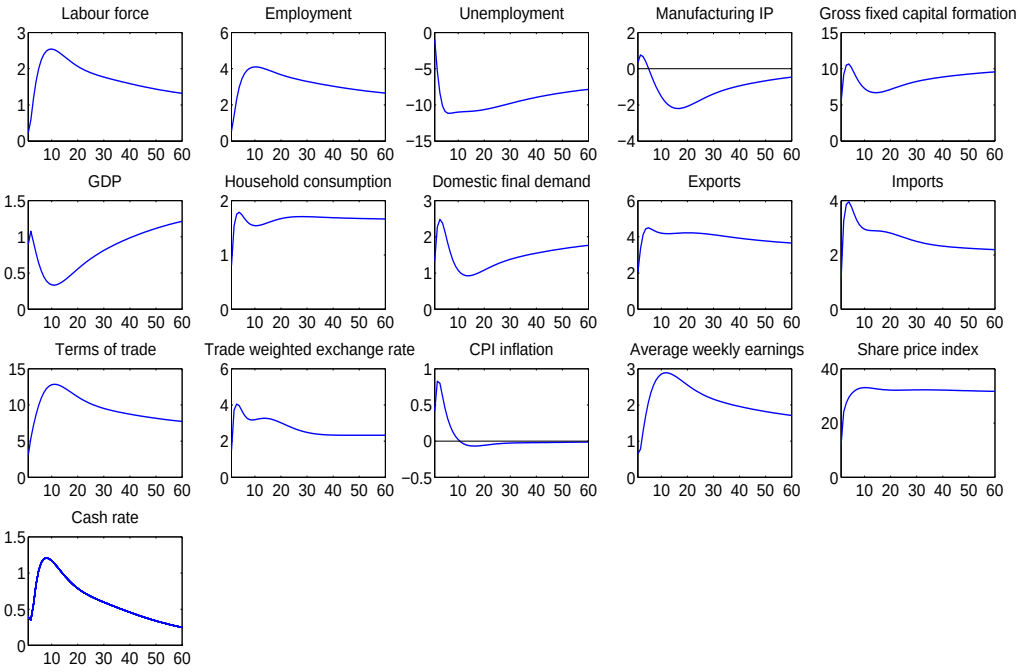


A one unit shock to the Chinese activity factor corresponds to a 0.03 percent increase in the quarterly growth of Chinese industrial production of steel, equivalent to a marginal increase of approximately 7.7 tonnes of the Chinese industrial production of steel.[3] In the following analysis of the impact of the Chinese activity factor on the Australian economy, the impulse responses have been scaled to correspond to a 10 percent increase in the Chinese industrial production of steel.

The impact of a shock to the Chinese activity factor on the Australian economy is mostly positive as shown in Figure 9. The labour market responds positively to the shock to the Chinese activity factor. Quarterly labour force and employment increases, while unemployment decreases.

[3]This is calculated based on the average steel production of China over the sample period of 1994Q3 and 2011Q4, which is equivalent to 24571 tonnes of steel.

Figure 9: Effects of an increase in Chinese activity on the Australian economy



The Australian domestic economy responds positively to the shock to the Chinese activity factor, with investment seeing a substantial increase. Gross fixed capital formation increases immediately following the shock. Households benefit from the booming economy with household final consumption expenditure and domestic final demand increasing.

Following the increase in demand from China, exports increase while imports decline. The terms of trade also improves while the trade weighted exchange rate appreciates. These results are in line with earlier findings of Laurenceson and Tang (2009) and Leu and Sheen (2011).

The increase in real activity in the Australian economy results in an increase in inflation following the shock. The cash rate increases to help bring down inflation. Labour market and financial market variables also respond positively to the shock, with wages and share prices both increasing.

5 Forecast error variance decomposition

This section constructs forecast error variance decompositions to determine the fraction of the forecasting error of Australian macroeconomic variables that is due to a particular shock at a given horizon.

Table 1: Contribution of shocks to Australian macroeconomic variables (percent).

Shocks	1 quarter ahead	4 quarters ahead	8 quarters ahead	30 quarters ahead
World commodity price	9.3	9.4	9.7	9.8
US activity factor	8.9	9.7	10.3	11.4
US price factor	11.1	12.9	12.0	11.3
ANFCI	4.7	5.9	7.7	8.9
Federal funds rate	3.5	4.6	5.2	5.4
China activity factor	8.8	10.6	10.9	10.6
China price factor	6.7	7.8	8.4	8.8
US factors	28.1	33.1	35.2	37.0
Chinese factors	15.5	18.4	19.3	19.4
Australian factors	41.6	33.2	30.0	28.2
Australian policy rate	5.5	5.9	5.8	5.5

Table 1 reports the average variance decomposition for all Australian variables. Despite Australia's increasing trade linkages with China, the US economy remains important for the Australian economy. US factors explain 28 percent of the variation in all domestic variables on impact, increasing to 37 percent after 30 quarters. However, the contribution of Chinese factors is also non-trivial, explaining 16 percent of the variation in all domestic variables on impact, increasing to 19 percent after 30 quarters. Third, commodity price shocks also matter for the Australian economy. These shocks explain around 10 percent of the variation in all domestic variables at all horizons. Australian shocks explain about half of Australian macroeconomic volatility at short horizons, but are less important at long horizons.

To have a better understanding of the contribution of shocks to Australian macroeconomic variables, it is useful to examine the contribution of shocks to the US and Chinese macroeconomic variables in the foreign block.

Table 2 displays the contribution of shocks to US macroeconomic variables in the foreign block. Variations in US macroeconomic variables are largely explained by US shocks. This result is in line with the US economy as a closed economy.

Table 2: Contribution of shocks to US macroeconomic variables (percent).

Shocks	1 quarter ahead	4 quarters ahead	8 quarters ahead	30 quarters ahead
World commodity price	16.9	16.6	15.4	14.4
US activity factor	38.3	36.9	33.9	33.1
US price factor	28.6	24.2	21.2	20.0
ANFCI	5.1	8.9	14.8	17.0
Federal funds rate	1.2	1.0	1.1	1.7
China activity factor	5.9	6.1	6.1	6.0
China price factor	3.9	6.3	7.6	7.8
US factors	73.3	70.9	70.9	71.8
Chinese factors	9.8	12.4	13.7	13.8

Table 3 presents the variance decomposition of the Chinese macroeconomic variables. While the majority of the variation in the Chinese macroeconomic variables is explained by its own shocks, the US factors explain 35 percent of the variation in the Chinese macroeconomic variables after 30 quarters. This suggests that the Chinese economy continues to be influenced by the US economy.

Table 3: Contribution of shocks to China macroeconomic variables (percent).

Shocks	1 quarter ahead	4 quarters ahead	8 quarters ahead	30 quarters ahead
World commodity price	11.4	11.7	11.9	11.5
US activity factor	6.8	8.5	10.6	11.5
US price factor	11.8	10.5	9.4	9.0
ANFCI	5.6	7.6	8.9	10.7
Federal funds rate	5.1	4.2	3.9	4.1
China activity factor	33.8	31.1	29.6	28.5
China price factor	25.5	26.4	25.8	24.7
US factors	29.3	30.7	32.8	35.3
Chinese factors	59.3	57.6	55.4	53.2

6 Robustness

This section discusses the robustness of my results to alternative model specifications.

First, I consider the impact of using the West Texas Intermediate (WTI) oil price and the Reserve Bank of Australia (RBA) Index of Commodity Prices as alternatives to the IFS commodity price index in the estimations. The use of different commodity indices does not

change the main results, with impulse responses remaining largely the same.

Second, given the increasing importance of China in the world economy, an interesting experiment is to allow the Chinese economy to influence the US economy contemporaneously. In this specification, the US economy can only influence the Chinese economy with a lag. The impulse responses remain mostly unchanged, except for those associated with a federal funds rate shock.

Figure 10 in Appendix C shows the impulse responses of the variables in the foreign block to a shock in the federal funds rate, when the ordering of the US and Chinese economies in the model is reversed. The key differences are in the responses of the US and Chinese activity factors. Following a federal funds rate shock, the US and Chinese economic activity fall. In contrast, in the baseline specification, the US economic activity falls with a delay, while economic activity in China increases marginally before falling. The immediate decline in the US economic activity can be explained by the increase in the federal funds rate and the immediate fall in Chinese activity. As a result of a fall in economic activity in US and China, the impact on the Australian economy is mostly negative as seen in Figure 11 in Appendix C. In this case, the increase in the federal funds rate and the subsequent fall in economic activity in China puts downward pressure on economic activity in Australia.

7 Conclusions

This paper investigates the importance of China and US to the Australian economy using a two block FAVAR model. The foreign block consists of the world commodity price index, China and US, while the domestic block consists of Australia.

The empirical results shed some light on the importance of China and US to the Australian economy. A positive shock to Chinese economic activity affects the US and Australia positively. In contrast, a positive shock to US economic activity has a negative impact on China but a positive effect on Australia. The US economic activity shock identified in this paper is found to resemble a supply shock, with real activity increasing and prices decreasing. Hence, the fall in prices in the US has likely increased the competitiveness of the US relative to China, resulting in a fall in activity and inflation in China. Subsequently, the fall in activity in China possibly offsets some of the positive effects of the US activity shock on Australia, at least initially.

The impact of a negative shock in the US financial conditions on China and Australia is negative. Under such circumstances, China does not dampen the negative impact of the US financial conditions shock has on Australia. In fact, with economic activity in China declining, China may propagate the negative impact of the US financial conditions shock on Australia.

The results in this paper suggest that China is a new source of shocks for the US and Australia, given the positive impact that a Chinese activity shock has on the two countries. However, despite the increasing importance of China in the world economy, the US remains an important source of shocks for China and Australia.

Appendix

Appendix A Estimation of the three block FAVAR

I use the two-step procedure proposed by Bernanke et al. (2005) to estimate the model. It consists of the following steps:

Step 1: Estimating the US, Chinese and Australian factors

All unobserved factors are estimated using principal component methods.

1. I construct the US activity and price factors as the first principal components from the US activity and price data series respectively.

2. To obtain the Chinese activity factor, all Chinese activity data series are regressed on the US activity factor. This produces a sequence of activity residuals. I then estimate the Chinese activity factor as the first principal component of the activity residuals. This ensures that the Chinese activity factor is orthogonal to the US activity factor. I follow a similar procedure to obtain the Chinese price factor.

3. To obtain the three Australian factors, two steps are taken. In the first step, to ensure that the Australian factors are orthogonal to the US and Chinese factors, I regress the Australian data series on the US and Chinese factors to obtain a set of residuals.

In the second step, to ensure the three Australian factors are independent of the effects of R_t, several regressions are estimated. First, I extract three preliminary common factors from the set of Australian data residuals using principal components methods and denote these $F_t^D = [F_t^{D1}\ F_t^{D2}\ F_t^{D3}]$. Within the panel of Australian economic time series, 70 are fast

moving variables. This implies that the estimated factors can respond contemporaneously to R_t. Hence, it would not be appropriate to estimate a VAR with R_t ordered after F_t^D without removing the effects of R_t on F_t^D.

In order to obtain a series of factors with the effects of R_t removed, I follow a a multiple regression approach. First, three slow moving factors, $F_t^{slow} = (F_{1,t}^{slow}, F_{2,t}^{slow}, F_{3,t}^{slow})$ are extracted from the panel of 152 slow moving variables, a subset of X_t. I then estimate the following regression:

$$F_t^D = \beta_1 R_t + \beta_2 F_{1,t}^{slow} + \beta_3 F_{2,t}^{slow} + \beta_4 F_{3,t}^{slow} + e_t, \tag{3}$$

where e_t captures the residual effects of the 70 fast moving variables, with the contemporaneous effects of R_t removed.

Next, the estimated factors $\tilde{F}_t^D$ are calculated as the differences between F_t^D and the product of R_t and its estimated beta coefficient, as outlined in Equation 4:

$$\tilde{F}_t^D = F_t - \beta_1 R_t = \beta_2 F_{1,t}^{slow} + \beta_3 F_{2,t}^{slow} + \beta_4 F_{3,t}^{slow} + e_t, \tag{4}$$

Equation 4 implies that the $\tilde{F}_t^D$ included in the FAVAR model set out in Equation 1 capture the dynamics of the Australian economy, with the possible contemporaneous effects of R_t removed.

The identified factors are then used to estimate the factor loadings and to estimate the transition Equation 1.

Step 2: Estimating the FAVAR

The shocks in the FAVAR are identified using the recursive ordering scheme outlined in the main text. The model is estimated with one lag.

Appendix B Data set

This paper uses almost 400 variables to generate the US, Chinese and Australian factors. Tables 4-6 list the variables used to obtain the US, Chinese and Australian factors respectively. To keep the reporting brief, only the description, transformation and source of each variable are reported.

Table 4: US variables.

No.	Description	Transformation	Source
US activity			
1	Value of Manufacturers' New Orders for Nondurable Goods Industries	5	FRED
2	Value of Manufacturers' New Orders for All Manufacturing Industries	5	FRED
3	Value of Manufacturers' New Orders for All Manufacturing Industries With Unfilled Orders	5	FRED
4	Average Weekly Hours of Production and Nonsupervisory Employees: Manufacturing	5	FRED
5	Average Weekly Hours Of Production And Nonsupervisory Employees: Total Private	5	FRED
6	Average Weekly Overtime Hours of Production and Nonsupervisory Employees: Manufacturing	5	FRED
7	Average Weekly Hours of Production and Nonsupervisory Employees: Goods-Producing	5	FRED
8	Average Weekly Hours of Production and Nonsupervisory Employees: Private Service-Producing	5	FRED
9	Average Weekly Hours of Production and Nonsupervisory Employees: Mining and Logging	5	FRED
10	Average Weekly Hours of Production and Nonsupervisory Employees: Construction	5	FRED
11	Average Weekly Hours of Production and Nonsupervisory Employees: Durable Goods	5	FRED
12	Average Weekly Overtime Hours of Production and Nonsupervisory Employees: Durable Goods	5	FRED
13	Average Weekly Hours of Production and Nonsupervisory Employees: Nondurable Goods	5	FRED
14	Average Weekly Overtime Hours of Production and Nonsupervisory Employees: Nondurable Goods	5	FRED
15	Average Weekly Hours of Production and Nonsupervisory Employees: Trade, Transportation and Utilities	5	FRED
16	Average Weekly Hours of Production and Nonsupervisory Employees: Wholesale Trade	5	FRED
17	Average Weekly Hours of Production and Nonsupervisory Employees: Retail trade	5	FRED
18	Average Weekly Hours of Production and Nonsupervisory Employees: Transportation and Warehousing	5	FRED
19	Average Weekly Hours of Production and Nonsupervisory Employees: Utilities	5	FRED
20	Average Weekly Hours of Production and Nonsupervisory Employees: Information	5	FRED
21	Average Weekly Hours of Production and Nonsupervisory Employees: Financial Activities	5	FRED
22	Average Weekly Hours of Production and Nonsupervisory Employees: Professional and Business Services	5	FRED
23	Average Weekly Hours of Production and Nonsupervisory Employees: Education and Health Services	5	FRED
24	Average Weekly Hours of Production and Nonsupervisory Employees: Leisure and Hospitality	5	FRED
25	Average Weekly Hours of Production and Nonsupervisory Employees: Other Services	5	FRED

No.	Description	Transformation	Source
26	Civilian Labor Force Participation Rate	1	FRED
27	Civilian Labor Force	5	FRED
28	Personal Consumption Expenditure: Goods	5	FRED
29	Manufacturers' New Orders: Durable Goods	5	FRED
30	Real Disposable Personal Income	5	FRED
31	Civilian Employment-Population Ratio	1	FRED
32	Housing Starts: Total: New Privately Owned Housing Units Started	5	FRED
33	Housing Starts in Midwest Census Region	5	FRED
34	Housing Starts in Northeast Census Region	5	FRED
35	Housing Starts in South Census Region	5	FRED
36	Housing Starts in West Census Region	5	FRED
37	Industrial Production Index	5	FRED
38	Industrial Production: Business Equipment	5	FRED
39	Industrial Production: Consumer Goods	5	FRED
40	Industrial Production: Durable Consumer Goods	5	FRED
41	Industrial Production: Durable Manufacturing (NAICS)	5	FRED
42	Industrial Production: Manufacturing (NAICS)	5	FRED
43	Industrial Production: Materials	5	FRED
44	Industrial Production: Mining	5	FRED
45	Industrial Production: Nondurable Consumer Goods	5	FRED
46	Industrial Production: Nondurable Manufacturing (NAICS)	5	FRED
47	Industrial Production: nondurable Materials	5	FRED
48	Industrial Production: Electric and Gas Utilities	5	FRED
49	Capacity Utilization: Manufacturing (NAICS)	1	FRED
50	Personal Consumption Expenditures	5	FRED

No.	Description	Transformation	Source
US activity (continued)			
51	Personal Consumption Expenditures: Durable Goods	5	FRED
52	Personal Consumption Expenditures: Nondurable Goods	5	FRED
53	Personal Consumption Expenditures: Services	5	FRED
54	Retail Sales: Total (Excluding Food Services)	5	FRED
55	Inventories: Total Business	5	FRED
56	United States, Exports, Goods, total, census basis, SA, USD	5	FRED
57	United States, Imports, Goods, total, census basis, SA, USD	5	FRED
58	Average (Mean) Duration of Unemployment	5	FRED
59	Unemployed	5	FRED
60	Civilian Unemployment Rate	1	FRED
61	Fixed Private Investment	5	FRED
62	Real Gross Domestic Product, 3 Decimal	5	FRED
63	Private Residential Fixed Investment	5	FRED
US prices			
64	Average Hourly Earnings of Production and Nonsupervisory Employees: Construction	5	FRED
65	Average Hourly Earnings of Production and Nonsupervisory Employees: Manufacturing	5	FRED
66	Consumer Price Index for All Urban Consumers: Apparel	5	FRED
67	Consumer Price Index for All Urban Consumers: All Items	5	FRED
68	Consumer Price Index for All Urban Consumers: All Items Less Food & Energy	5	FRED
69	Consumer Price Index for All Urban Consumers: Medical Care	5	FRED
70	Consumer Price Index for All Urban Consumers: Transportation	5	FRED
71	Consumer Price Index for All Urban Consumers: All Items Less Food	5	FRED
72	Consumer Price Index for All Urban Consumers: All Items Less Shelter	5	FRED
73	Consumer Price Index for All Urban Consumers: All Items Less Medical	5	FRED
74	Consumer Price Index for All Urban Consumers: Durables	5	FRED

No.	Description	Transformation	Source
US prices (continued)			
75	Consumer Price Index for All Urban Consumers: Services	5	FRED
76	Producer Price Index: Finished Consumer Goods Excluding Foods	5	FRED
77	Producer Price Index: Finished Goods: Capital Equipment	5	FRED
78	Producer Price Index: Crude Materials for Further Processing	5	FRED
79	Producer Price Index: Finished Consumer Foods	5	FRED
80	Producer Price Index: Finished Consumer Goods	5	FRED
81	Producer Price Index: Finished Goods	5	FRED
82	Producer Price Index: Intermediate Materials: Supplies & Components	5	FRED
83	United States, Bea End Use Export Indexes, Export Prices, All commodities, Index, 2000=100	5	FRED
84	United States, Bea End Use Import Indexes, Import Prices, All commodities, Index, 2000=100	5	FRED
85	Nonfarm Business Sector: Real Compensation Per Hour	5	FRED
86	Business Sector: Real Compensation Per Hour	5	FRED
87	Business Sector: Unit Labor Cost	5	FRED
88	Nonfarm Business Sector: Unit Labor Cost	5	FRED

Table 5: Chinese variables.

No.	Description	Transformation	Source
Chinese activity			
1	Retail Sales of Consumer Goods: Total	5	CEIC
2	Industrial Production: Bicycles	5	CEIC
3	Industrial Production: Camera	5	CEIC
4	Industrial Production: Television Sets: Colour	5	CEIC
5	Industrial Production: Hi Fi	5	CEIC
6	Industrial Production: Household Washing Machines	5	CEIC
7	Industrial Production: Oily Gas Ventilator	5	CEIC
8	Industrial Production: Household Refrigerator	5	CEIC
9	Industrial Production: Air Conditioner	5	CEIC
10	Industrial Production: Chemical Fibre	5	CEIC
11	Industrial Production: Chemical Fibre: Synthetic	5	CEIC
12	Industrial Production: Yarn	5	CEIC
13	Industrial Production: Cloth	5	CEIC
14	Industrial Production: Cloth: Chemical Fibre (CF)	5	CEIC
15	Industrial Production: Cloth: CF, Pure Chemical	5	CEIC
16	Industrial Production: Cloth: Pure Cotton	5	CEIC
17	Industrial Production: Woolen Goods	5	CEIC
18	Industrial Production: Garments	5	CEIC
19	Industrial Production: Salt	5	CEIC
20	Industrial Production: Canned Food	5	CEIC
21	Industrial Production: Dairy Products	5	CEIC
22	Industrial Production: Synthetic Feed Stuffs	5	CEIC
23	Industrial Production: Plastic Products (PP)	5	CEIC
24	Industrial Production: PP: Membrane for Agricultural Use	5	CEIC
25	Industrial Production: Processed Crude Oil	5	CEIC

No.	Description	Transformation	Source
Chinese activity (continued)			
26	Industrial Production: Gasoline	5	CEIC
27	Industrial Production: Kerosene	5	CEIC
28	Industrial Production: Diesel Oil	5	CEIC
29	Industrial Production: Lubricant Oil	5	CEIC
30	Industrial Production: Power Generated	5	CEIC
31	Industrial Production: Power Generated: Thermal Power	5	CEIC
32	Industrial Production: Coke	5	CEIC
33	Industrial Production: Pig Iron	5	CEIC
34	Industrial Production: Steel	5	CEIC
35	Industrial Production: Steel Products	5	CEIC
36	Industrial Production: Iron Alloy	5	CEIC
37	Industrial Production: Sulphuric Acid	5	CEIC
38	Industrial Production: Concentrated Nitric Acid	5	CEIC
39	Industrial Production: Soda Ash	5	CEIC
40	Industrial Production: Caustic Soda	5	CEIC
41	Industrial Production: Ethylene	5	CEIC
42	Industrial Production: Pure Benzene	5	CEIC
43	Industrial Production: Synthetic Ammonia	5	CEIC
44	Industrial Production: Chemical Fertilizer(100% purity)	5	CEIC
45	Industrial Production: Pharmaceutical and Medicine	5	CEIC
46	Industrial Production: Paints	5	CEIC
47	Industrial Production: Rubber Tyre	5	CEIC
48	Industrial Production: Synthetic Rubber	5	CEIC
49	Industrial Production: Cement	5	CEIC
50	Industrial Production: Plated Glass	5	CEIC

No.	Description	Transformation	Source
Chinese activity (continued)			
51	Industrial Production: Power Generating Equipment	5	CEIC
52	Industrial Production: Alternating Current Generator	5	CEIC
53	Industrial Production: Metal Cutting Machines	5	CEIC
54	Industrial Production: Automobiles	5	CEIC
55	Industrial Production: Automobiles: Buses and Coaches	5	CEIC
56	Industrial Production: Automobiles: Cars	5	CEIC
57	Industrial Production: Automobiles: Loading Vehicles	5	CEIC
58	Industrial Production: Motor Cycles	5	CEIC
59	Industrial Production: Tractors	5	CEIC
60	Industrial Production: Small Tractors	5	CEIC
61	Industrial Production: Passenger Coaches	5	CEIC
62	Industrial Production: Freight Wagons	5	CEIC
63	Industrial Production: Civil Steel Ships	5	CEIC
64	Industrial Production: Computer: Micro Computer	5	CEIC
65	CN: Industrial Production Index: % Change	1	CEIC
66	Industrial Sales	5	CEIC
67	Industrial Sales: Light Industry	5	CEIC
68	Industrial Sales: Heavy Industry	5	CEIC
69	Industrial Sales: State Owned	5	CEIC
70	Exports fob	5	CEIC
71	Imports cif	5	CEIC
72	Fixed Assets Investment: ytd	5	CEIC
Chinese prices			
73	Consumer Price Index	5	CEIC
74	Consumer Price Index: Food	5	CEIC
75	Consumer Price Index: Food: Grain	5	CEIC
76	Consumer Price Index: Food: Fresh Vegetables	5	CEIC

No.	Description	Transformation	Source
Chinese prices			
77	Consumer Price Index: Rural	5	CEIC
78	Consumer Price Index: Rural: Food	5	CEIC
79	Consumer Price Index: Rural: Food: Grain	5	CEIC
80	Consumer Price Index: Rural: Food: Meat and Poultry	5	CEIC
81	Consumer Price Index: Rural: Food: Eggs	5	CEIC
82	Consumer Price Index: Rural: Food: Aquatic Products	5	CEIC
83	Consumer Price Index: Rural: Food: Fresh Vegetables	5	CEIC
84	Retail Price Index	5	CEIC
85	Retail Price Index: Food	5	CEIC
86	Retail Price Index: Beverage, Tobacco and Liquors	5	CEIC
87	Retail Price Index: Garments, Footwear and Headgear	5	CEIC
88	Retail Price Index: Textiles	5	CEIC
89	Retail Price Index: Cosmetics	5	CEIC
90	Retail Price Index: Daily Use Articles	5	CEIC
91	Retail Price Index: Urban	5	CEIC
92	Retail Price Index: Urban: Food	5	CEIC
93	Retail Price Index: Urban: Beverage, Tobacco and Liquors	5	CEIC
94	Retail Price Index: Urban: Garments, Footwear and Headgear	5	CEIC
95	Retail Price Index: Urban: Textiles	5	CEIC
96	Retail Price Index: Rural	5	CEIC
97	Retail Price Index: Rural: Food	5	CEIC
98	Retail Price Index: Rural: Beverage, Tobacco and Liquors	5	CEIC
99	Retail Price Index: Rural: Garments, Footwear and Headgear	5	CEIC
100	Retail Price Index: Rural: Textiles	5	CEIC
101	Corporate Goods Price Index: Overall	5	CEIC

Table 6: Australian variables.

No.	Description	Transformation	Source
Australian activity			
1	Labour Force: sa	5	CEIC
2	Labour Force: sa: Males	5	CEIC
3	Labour Force: sa: Females	5	CEIC
4	Employment: sa	5	CEIC
5	Employment: sa: Males	5	CEIC
6	Employment: sa: Females	5	CEIC
7	Employment: sa: Full Time	5	CEIC
8	Employment: sa: Full Time: Males	5	CEIC
9	Employment: sa: Full Time: Females	5	CEIC
10	Employment: sa: Part Time	5	CEIC
11	Employment: sa: Part Time: Males	5	CEIC
12	Employment: sa: Part Time: Females	5	CEIC
13	Employment: Actual Hours Worked	5	CEIC
14	Unemployment: sa	5	CEIC
15	Unemployment: sa: Males	5	CEIC
16	Unemployment: sa: Females	5	CEIC
17	Unemployment: sa: Looking for Full Time Work	5	CEIC
18	Unemployment: sa: Looking for Full Time Work: Males	5	CEIC
19	Unemployment: sa: Looking for Full Time Work: Females	5	CEIC
20	Unemployment: sa: Looking for Part Time Work	5	CEIC
21	Unemployment: sa: Looking for Part Time Work: Males	5	CEIC
22	Unemployment: sa: Looking for Part Time Work: Females	5	CEIC
23	Unemployment Rate: sa	1	CEIC
24	Unemployment Rate: sa: Males	1	CEIC
25	Unemployment Rate: sa: Females	1	CEIC

No.	Description	Transformation	Source
Australian activity (continued)			
26	Participation Rate: sa	1	CEIC
27	Participation Rate: sa: Males	1	CEIC
28	Participation Rate: sa: Females	1	CEIC
29	Employment to Population Ratio: sa	1	CEIC
30	Employment to Population Ratio: sa: Males	1	CEIC
31	Employment to Population Ratio: sa: Females	1	CEIC
32	Retail Sales: sa	5	CEIC
33	Retail Sales: sa: Food Retailing	5	CEIC
34	Retail Sales: sa: Food Retailing: Supermarkets and Grocery Stores	5	CEIC
35	Retail Sales: sa: Food Retailing: Liquor Retailing	5	CEIC
36	Retail Sales: sa: Food Retailing: Other Specialised Food Retailing	5	CEIC
37	Retail Sales: sa: Household Good Retailing (HGR)	5	CEIC
38	Retail Sales: sa: HGR: Furniture, Floor Coverings, Houseware and Textile Goods Retailing	5	CEIC
39	Retail Sales: sa: HGR: Electrical and Electronic Goods Retailing	5	CEIC
40	Retail Sales: sa: HGR: Hardware, Building and Garden Supplies Retailing	5	CEIC
41	Retail Sales: sa: Clothing, Footwear and Personal Accessory (CFPA) Retailing	5	CEIC
42	Retail Sales: sa: CFPA: Clothing Retailing	5	CEIC
43	Retail Sales: sa: CFPA: Footwear and Other Personal Accessory Retailing	5	CEIC
44	Retail Sales: sa: Department Stores	5	CEIC
45	Retail Sales: sa: Other Retailing (OR)	5	CEIC
46	Retail Sales: sa: OR: News and Book Retailing	5	CEIC
47	Retail Sales: sa: OR: Recreational Goods Retailing	5	CEIC
48	Retail Sales: sa: OR: Pharmaceutical, Cosmetic and Toiletry Goods Retailing	5	CEIC
49	Retail Sales: sa: OR: nec	5	CEIC
50	Retail Sales: sa: Cafes, Restaurants and Takeaway Food Services (CRTFS)	5	CEIC

No.	Description	Transformation	Source
Australian activity (continued)			
51	Retail Sales: sa: CRTFS: Cafes, Restaurants and Catering Services	5	CEIC
52	Retail Sales: sa: CRTFS: Takeaway Food Retailing	5	CEIC
53	New Motor Vehicle Sales: sa: Total Vehicles: Australia	5	CEIC
54	New Motor Vehicle Sales: sa: Sports Utility Vehicles: Australia	5	CEIC
55	New Motor Vehicle Sales: sa: Other Vehicles: Australia	5	CEIC
56	GDP: 2009-10p: sa	5	CEIC
57	GDP: 2009-10p: sa: Gross Fixed capital Formation (GFCF)	5	CEIC
58	GDP: 2009-10p: sa: GFCF: Public	5	CEIC
59	GDP: 2009-10p: sa: GFCF: General Government	5	CEIC
60	GDP: 2009-10p: sa: GFCF: General Government: State & Local	5	CEIC
61	GDP: 2009-10p: sa: GFCF: General Government: National	5	CEIC
62	GDP: 2009-10p: sa: GFCF: Private	5	CEIC
63	GDP: 2009-10p: sa: GFCF: Private: Total Private Business Investment	5	CEIC
64	GDP: 2009-10p: sa: GFCF: Private: Non Dwelling Construction: Total	5	CEIC
65	GDP: 2009-10p: sa: GFCF: Private: Dwellings: Total	5	CEIC
66	GDP: 2009-10p: sa: GFCF: Private: Dwellings: New	5	CEIC
67	GDP: 2009-10p: sa: Final Consumption Expenditure (FCE)	5	CEIC
68	GDP: 2009-10p: sa: FCE: General Government	5	CEIC
69	GDP: 2009-10p: sa: FCE: General Government: State & Local	5	CEIC
70	GDP: 2009-10p: sa: FCE: General Government: National	5	CEIC
71	GDP: 2009-10p: sa: FCE: General Government: National: Non Defence	5	CEIC
72	GDP: 2009-10p: sa: FCE: General Government: National: Defence	5	CEIC
73	GDP: 2009-10p: sa: Domestic Final Demand	5	CEIC
74	GDP: 2009-10p: sa: Imports of Goods & Services	5	CEIC
75	GDP: 2009-10p: sa: Exports of Goods & Services	5	CEIC

No.	Description	Transformation	Source
Australian activity (continued)			
76	GDP: 2009-10p: sa: Gross National Expenditure	5	CEIC
77	Real Gross Domestic Income: 2009-10p: sa	5	CEIC
78	Real Gross National Income: 2009-10p: sa	5	CEIC
79	Household Final Consumption Expenditure (HFCE): sa: 2009-10p	5	CEIC
80	HFCE: sa: 2009-10p: Food	5	CEIC
81	HFCE: sa: 2009-10p: Cigarettes & Tobacco	5	CEIC
82	HFCE: sa: 2009-10p: Alcoholic Beverages	5	CEIC
83	HFCE: sa: 2009-10p: Clothing & Footwear	5	CEIC
84	HFCE: sa: 2009-10p: Rent & Other Dwelling Services	5	CEIC
85	HFCE: sa: 2009-10p: Electricity, Gas & Other Fuel	5	CEIC
86	HFCE: sa: 2009-10p: Furnishings & Household Equipment	5	CEIC
87	HFCE: sa: 2009-10p: Health	5	CEIC
88	HFCE: sa: 2009-10p: Transport Services	5	CEIC
89	HFCE: sa: 2009-10p: Communications	5	CEIC
90	HFCE: sa: 2009-10p: Recreation & Culture	5	CEIC
91	HFCE: sa: 2009-10p: Education Services	5	CEIC
92	HFCE: sa: 2009-10p: Hotels, Cafes & Restaurants	5	CEIC
93	HFCE: sa: 2009-10p: Insurance & Other Financial Services	5	CEIC
94	HFCE: sa: 2009-10p: Other Goods & Services	5	CEIC
95	AU Terms of Trade NADJ	5	Datastream
96	AU Industrial Production – Manufacturing VOLA	5	Datastream
97	AU Industrial Production VOLA	5	Datastream
98	AU Gross Disposable Income – Households CURA	5	Datastream
99	AU Melbourne/Westpac Consumer Sentiment Index SADJ	1	Datastream
100	Insolvency: Bankruptcies	5	CEIC

No.	Description	Transformation	Source
Australian activity (continued)			
101	Private New Capital Expenditure (PNCE): Chain Volume: 2009-2010: Actual: sa	5	CEIC
102	PNCE: 2009-2010: Actual: sa: Assets: Buildings & Structures	5	CEIC
103	PNCE: Chain Volume: 2009-2010: Actual: sa: Assets: Equipment, Plant & Machinery	5	CEIC
104	PNCE: Chain Volume: 2009-2010: Actual: sa: Industry: Mining	5	CEIC
105	PNCE: Chain Volume: 2009-2010: Actual: sa: Industry: Manufacturing	5	CEIC
106	Building Construction Started: Value: sa: Total	5	CEIC
107	Building Construction Started: Value: sa: Total: Private Sector	5	CEIC
108	Building Construction Started: Value: sa: Residential: Total	5	CEIC
Australian prices			
109	Consumer Price Index: sa	5	CEIC
110	CPI: Goods	5	CEIC
111	CPI: Services	5	CEIC
112	CPI: All excl Food	5	CEIC
113	CPI: All excl Volatile Items	5	CEIC
114	Import Price Index (ImPI): SITC: All Groups	5	CEIC
115	Export Price Index: SITC: All Groups	5	CEIC
116	Average Weekly Earning	5	CEIC
117	Average Weekly Earning: Mining	5	CEIC
118	Average Weekly Earning: Manufacturing	5	CEIC
119	Average Weekly Earning: Electricity, Gas, Water & Waste Services	5	CEIC
120	Average Weekly Earning: Construction	5	CEIC
121	Average Weekly Earning: Wholesale Trade	5	CEIC
122	Average Weekly Earning: Retail Trade	5	CEIC
123	Average Weekly Earning: Accommodation & Food Services	5	CEIC
124	Average Weekly Earning: Transport, Postal & Warehousing	5	CEIC
125	Average Weekly Earning: Information Media & Telecommunications	5	CEIC

No.	Description	Transformation	Source
Australian prices (continued)			
126	Average Weekly Earning: Financial & Insurance Services	5	CEIC
127	Average Weekly Earning: Rental, Hiring & Real Estate Services	5	CEIC
128	Average Weekly Earning: Professional, Scientific & Technical Services	5	CEIC
129	Average Weekly Earning: Administrative & Support Services	5	CEIC
130	Average Weekly Earning: Public Administration & Safety	5	CEIC
131	Average Weekly Earning: Education & Training	5	CEIC
132	Average Weekly Earning: Health Care & Social Assistance	5	CEIC
133	Average Weekly Earning: Arts & Recreation Services	5	CEIC
134	Average Weekly Earning: Other Services	5	CEIC
135	AU Unit Labour Cost Index (Nominal) SADJ	5	Datastream
Australian money			
136	AU: Money Supply: Base Money	5	CEIC
137	AU: Money Supply: M1: Seasonally Adjusted	5	CEIC
138	AU: Money Supply: M3: Seasonally Adjusted	5	CEIC
139	AU: Money Supply: Broad Money: Seasonally Adjusted	5	CEIC
140	AU: International Liquidity: International Reserves	5	CEIC
Australian assets, credit, share prices, exchange rate			
141	Bank Lending to Businesses: New Credit Approvals: Total	5	CEIC
142	Household Finance: Ratio: sa: Debt to Assets	5	CEIC
143	Household Finance: Ratio: sa: Housing Debt to Housing Assets	5	CEIC
144	Household Finance: Ratio: sa: Debt to Disposable Income	5	CEIC
145	Household Finance: Ratio: sa: Debt to Disposable Income: Housing	5	CEIC
146	Household Finance: Ratio: sa: Debt to Disposable Income: Housing: ow Owner Occupier	5	CEIC
147	Household Finance: Ratio: sa: Assets to Disposable Income	5	CEIC
148	Household Finance: Ratio: sa: Assets to Disposable Income: Financial Assets	5	CEIC

No.	Description	Transformation	Source
Australian assets, credit, share prices, exchange rate (continued)			
149	Household Finance: Ratio: sa: Interest Payments to Disposable Income	5	CEIC
150	Household Finance: Ratio: sa: Interest Payments to Disposable Income: Housing	5	CEIC
151	Non Performing Loans	5	CEIC
152	Total Impaired Assets	5	CEIC
153	Total Assets	5	CEIC
154	Equity Market Index: Month End: ASX: S&P/ASX 200	5	CEIC
155	ASX Index: All Ordinaries	5	CEIC
156	ASX Index: S&P/ASX 50	5	CEIC
157	ASX Index: S&P/ASX 20	5	CEIC
158	ASX Index: S&P/ASX 300	5	CEIC
159	ASX Market Capitalization: Domestic	5	CEIC
160	Building Approved: Value: sa	5	CEIC
161	Building Approved: Value: sa: Residential	5	CEIC
162	Building Approved: Value: sa: Residential: New	5	CEIC
163	Building Approved: Value: sa: Residential: Others	5	CEIC
164	Building Approved: Value: sa: Non Residential	5	CEIC
165	Dwelling Units Approved: sa: Building	5	CEIC
166	Dwelling Units Approved: sa: Building: Private Sector	5	CEIC
167	Dwelling Units Approved: sa: Building: Public Sector	5	CEIC
168	Dwelling Units Approved: sa: Building: Houses	5	CEIC
169	Dwelling Units Approved: sa: Building: Non House: Private Sector	5	CEIC
170	Dwelling Units Approved: sa: Building: Houses: Private Sector	5	CEIC
171	Dwelling Units Approved: sa: Building: Non House	5	CEIC
172	Exchange Rate: RBA: Trade Weighted Index	5	CEIC

No.	Description	Transformation	Source
Australian assets, credit, share prices, exchange rate (continued)			
173	WM Reuters exchange rate (US/AUD)	5	CEIC
174	Bank Accepted Bills Rates: Monthly Average: 30 Days	1	CEIC
175	Bank Accepted Bills Rates: Monthly Average: 90 Days	1	CEIC
176	Bank Accepted Bills Rates: Monthly Average: 180 Days	1	CEIC
177	Government Bond Yield (GBY): Australian Government: 3 Years	1	CEIC
178	GBY: Australian Government: 5 Years	1	CEIC
179	GBY: Australian Government: 10 Years	1	CEIC
180	GBY: Australian Government: Indexed	1	CEIC
181	GBY: National Mutual Royal Savings Bank Treasury Corporation: 3 Years	1	CEIC
182	GBY: National Mutual Royal Savings Bank Treasury Corporation: 5 Years	1	CEIC
183	GBY: National Mutual Royal Savings Bank Treasury Corporation: 10 Years	1	CEIC
184	AU All Ordinaries Share Price Index (EP) NADJ	5	Datastream
185	AU Financial Intermediaries: Narrow Credit - Private Sector CURN	5	Datastream
186	AU Fin. Intermediaries: Lending - Loan & Adv, Priv. Sector, Banks CURN	5	Datastream
187	AU House Fin: All Lenders - Investment Housing CURA	5	Datastream
188	AU Housing Finance: All Lenders - Owner Occupied Housing (Number)	5	Datastream

Appendix C Variance decomposition

This section provides details of how the variance decompositions in Section 5 are calculated.

The fraction of the variance of $X_{t+k} - \hat{X}_{t+k}$ due to a particular shock, say ϵ_t, can be expressed as:

$$\frac{var(X_{t+k} - \hat{X}_{t+k|t}|\epsilon_t)}{var(X_{t+k} - \hat{X}_{t+k|t})} \quad . \tag{5}$$

However, as shown in Equation 2, part of the variance of the macroeconomic variables comes from their idiosyncratic component which might partly be due to measurement error. As pointed out in Bernanke et al. (2005), it is unclear that the standard VAR variance decomposition gives an accurate measure of the relative importance of a structural shock. The variance decomposition exercise performed within the FAVAR framework is more appropriate, where the relative importance of a structural shock is assessed only to the portion of the variable explained by the common factors. This variance decomposition for X_{it} is denoted as:

$$\frac{\Lambda_i var(X_{t+k} - \hat{X}_{t+k|t}|\epsilon_t)\Lambda_i'}{\Lambda_i var(X_{t+k} - \hat{X}_{t+k|t})\Lambda_i'} \quad , \tag{6}$$

where Λ_i is the i^{th} line of Λ and $\frac{var(X_{t+k} - \hat{X}_{t+k|t}|\epsilon_t)}{var(X_{t+k} - \hat{X}_{t+k|t})}$ is the standard VAR variance decomposition based on equation 1.

Appendix D Robustness

Figure 10: Effects of an increase in the federal funds rate on the foreign block

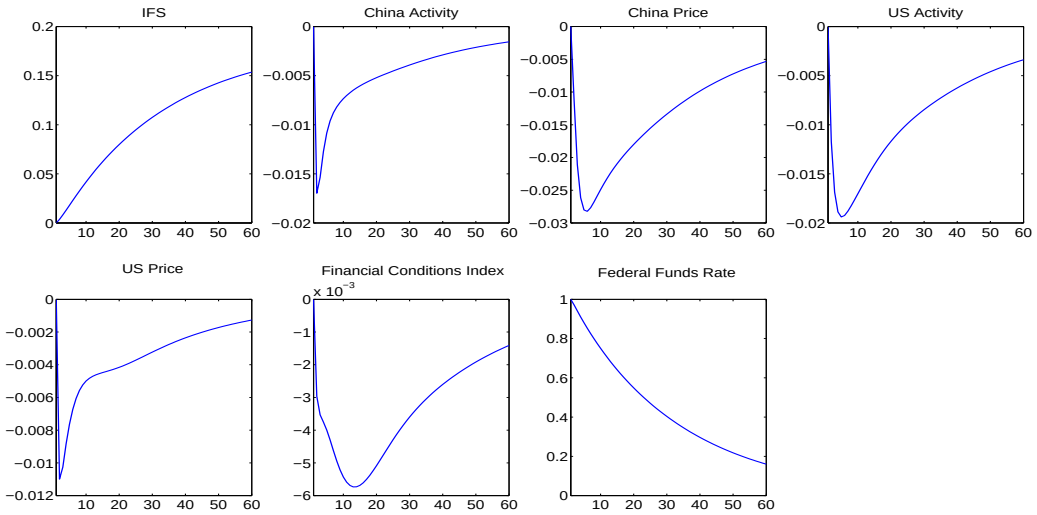
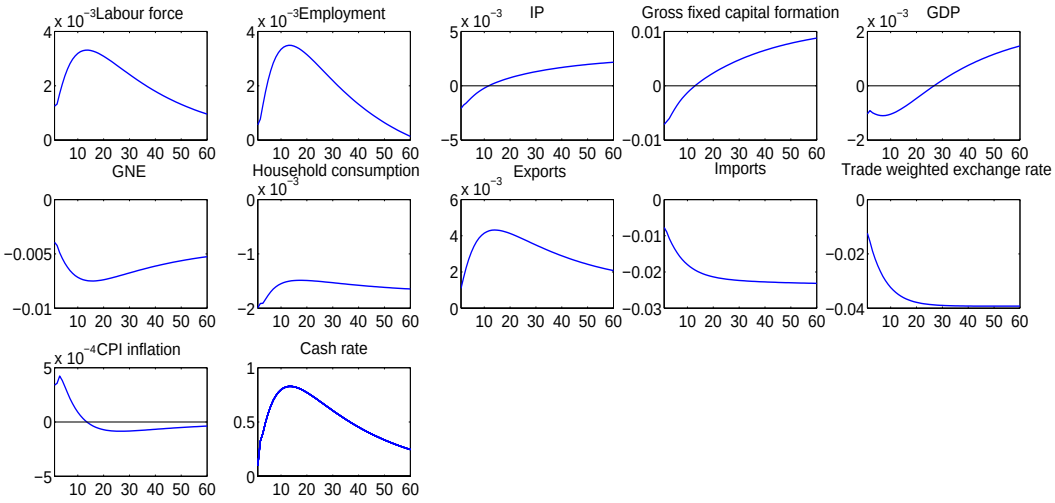


Figure 11: Effects of an increase in the federal funds rate on the Australian economy



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