Bank Lending Behavior and Housing Market Booms: The Australian Evidence

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Abstract

The emerging literature on bank lending during an asset price boom has focused on the U.S. economy before the GFC when the housing market peaked. Following this line of research, this paper studies the Australian economy with its unique banking industry and sustained housing market boom. Results from the single equation and the panel vector autoregression (PVAR) show evidence of crowding out of business loans towards housing loans in response to increased opportunities in strong housing markets, which in turn curtails business investment. In contrast to Chakraborty et al. (2018), such crowding out effect is found to be evident only in the Big Four banks which are dominant and less capital constrained lenders in the credit market. Further examination shows that profit-seeking motives of the Big Four banks might underscore the findings. We do not find a crowding out effect on consumer credit. Our results are robust to the inclusion of business and dwelling investment and the ordering of endogenous variables in the PVAR.

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1. Introduction

It is widely accepted that the collapse of the housing market is central to what the Global Financial Crisis (GFC) unleashed on the world economy. Prior to the GFC, the U.S. housing market had experienced 'boom' conditions but it quickly collapsed when the crisis erupted. The real effects of asset prices 'boom and bust' scenarios have garnered the attention of policy-makers and academics alike, in part due to how the crisis unfolds, the ramifications for the real economy and the lessons learnt to mitigate risks. Much of the literature has focused on the impact of asset price collapse on the real economy with a negative impact documented by Gan (2007a,b) and Peek and Rosengren (2000) through firms' debt capacities and investments as their collateral declines in value.[1] The recent studies by Chakraborty et al. (2018) and Tai (2017) are two exceptions which focus on the real effects of the housing price boom. The former shows that banks which are active in strong housing markets increase mortgage lending and reduce commercial lending, and that firms borrowing from these banks have significantly lower investment. The latter finds that during the last housing boom in the U.S., banks reduced non-mortgage credit supply (i.e. consumer credit) while expanding mortgage lending to homeowners. Both studies identify a crowding out effect in bank lending during the U.S. housing boom prior to the GFC.

This paper contributes to this line of research by focusing on the Australian housing boom, and specifically whether this has led to a similar crowding out effect in the lending behavior of Australian banks. The focus on the Australian housing market and the banking sector is interesting for a number of reasons. Australia has experienced an exceptionally long and massive housing boom since the late 1990s and this boom cycle has yet to end (see Figure 3 for the rapid growth in housing prices). Against this background of a persistent housing boom, Australian banks are known to enjoy handsome profits when compared to banks in other countries. According to one report prepared by the Australian Institute, Australian banks' profit

[1] The literature on asset prices crashes and their impact on the real economy has been the subject of much analysis (see Gan 2007 a,b; Peek and Rosengren, 2000). From the demand perspective, extreme price declines in real estate owned by firms impede borrowing and investment undertaken by such firms due to the collateral channel. The supply side argues that banks' exposure to falling real estate prices constrains the lending channel and severely undermines firms' access to capital and investment.

share as a percentage of GDP amounts to 2.9% and this is ranked the highest in the world.[2] There is reason to believe that Australian banks' profit motives could lead them to engage in strategic lending behavior by leveraging on the housing price boom and shifting bank lending from business loans to housing loans. Further, Australia's household debt is exceptionally high; Australian household debt as of 2017 doubled to 120 percent of GDP relative to its late 1990s figure, making it the highest amongst OECD countries with the bulk of it in residential mortgages (see Figure 1 Panel A for the rapid growth in housing loans). These statistics bear alarming consequences for the Australian economy should housing prices crash. Already there are concerns about the decline in Sydney and Melbourne's housing prices which averaged about 10% from its peak since the middle of 2017. Our research, therefore, has an important bearing in explaining the large household debt; if banks are strategically engaging in lending behavior which promotes housing loans at the cost of reducing business loans, banks through its lending are instrumental in amplifying the real effects of the asset price boom-bust cycle.

Utilizing Australian individual bank level quarterly data for the period 2003-2017, we focus our analysis on the Big Four banks. The Australian banking industry is characterized by an oligopoly structure and it is dominated by four largest banks - the Big Four banks[3]. The Big Four banks' combined housing and business loans, on average, make up for more than 80% of the banking sector's total private credit for the period and data examined. Different from the bank and firm level data used by Chakraborty et al. (2018) at the loan facility level, we rely on bank level housing and business loans data. The Big Four banks operate nationwide and are the dominant lenders in the credit market. By virtue of their market size (both in terms of assets and market capitalization), they are less financially constrained than other banks in Australia. Our aggregate house price data to a large degree capture the widespread increase in house prices in various states nationwide, so to some degree the lack of facility level and geographic specificity in the data do not inhibit the identification of bank lending behavior associated with house price increases. Further, since the Big Four banks are not localized and they are prevalent nationwide, and the aggregate house price index adequately captures the price movements in

[2]https://www.news.com.au/finance/economy/australian-economy/australian-banks-top-global-list-as-labor-persists-in-demands-for-a-royal-commission/news-story/aefa72c371555ced47804f9604c25c7c

[3] The Big Four banks are Australia and New Zealand Banking Group Limited (ANZ), Commonwealth Bank of Australia (CBA), Westpac Banking Corporation (Westpac), and National Australia Bank Limited (NAB).

the national housing market, the use of aggregate data in this context can permit testing of the crowding out effect of business loans due to an increase in housing loans associated with a housing market boom. We find strong evidence of the crowding out effect but with only tentative evidence of real effects stemming from a reduction in business loans.

Two methods are employed to demonstrate the crowding out of business loans toward housing loans during house price appreciations. The single equation approach follows that of Chakraborty et al. (2018) but suffers from endogeneity concerns. Specifically, does the reduction in business loans result from a decrease in the supply of loans from banks as they increase housing loans, or does this emanate from a fall in demand for loans arising from firms' investment opportunities? Be that as it may, the endogeneity concerns make it harder to demonstrate the crowding out effect; increased housing prices which coincide with strong economic growth are predicted to bring about a positive correlation between housing prices and firm investment opportunities. Consequently, the regressions are prone to underestimate the fall in commercial lending and investment following a positive housing price shock. To circumvent the endogeneity problem, it is common in the literature (Saiz, 2010; Adelino et al., 2015; Chaney et al., 2012; Loutskina and Strahan, 2015) to employ a time-varying instrumental variable comprising the availability of developable land in terms of topographic restrictions, which interacts with the national 30-year fixed mortgage interest rate. The idea is that when mortgage rate decreases this triggers a rise in housing demand, and in the face of limited land for new housing development, the increase in demand should drive higher housing prices relative to areas with more land that can be developed. This instrument therefore captures an increase in housing prices that is independent of firm financing and investment choices. In the absence of such an instrument, we turn to the panel vector autoregressive (PVAR) model which endogenizes all the variables of interest (i.e. house prices, housing loans and business investment) to capture their lead-lag relationships.

The results derived from the single equation framework show that business loans growth declines when housing prices increase, while housing loans growth increases, having controlled for banks' characteristics and macroeconomic variables. In particular, the evidence

points to a negative association between housing price growth and the change in the ratio of business loans to the sum of business and housing loans, thereby supporting our conjecture of a crowding out effect of business loans as banks respond to the opportunities in strong real estate markets. This outcome is further corroborated by the PVAR model which endogenizes changes in the ratio of business loans to the sum of housing and business loans, change in housing prices, and change in business investment which is a proxy for the demand of business loans. The panel Granger causality results point to evidence of predictive power of changes in housing prices over the change in business loan as a proportion of combined housing and business loans, and changes in business investment. The impulse response function further corroborates the negative effect of housing price shocks on changes in business investment in the first quarter and a delayed negative response of changes in business loans as a proportion of combined housing and business loans. In sum, there is overwhelming support for crowding out of business loans resulting from an increase in housing loans in response to positive house price shock. As well, there are tentative negative real effects arising from this crowding out effect. We argue that the real effects are tentative because there are many other channels by which the housing market can affect the real economy apart from bank lending. The PVAR model clearly only captures one of many possible channels.

For the other Australian banks (i.e. excluding the Big Four institutions) and the foreign banks, we fail to find any evidence of the crowding out effect. Based on the Big Four banks' weighted quarterly profit margin, we find that the increase in their profit margins is positively (negatively) associated with the increase in the proportion of housing loans (business loans). This profit-seeking strategic lending behavior of banks during the housing price boom is limited to the Big Four banks who are dominant lenders in the credit market. In that regard, our results differ from those of Chakraborty et al. (2018) who find their crowding out results hold much strongly and significantly for capital constrained banks; in other words, banks that are smaller, more levered, and less active in securitization markets. While Australian banks are by and large less active in securitization and loan sales markets, the Big Four banks are less constrained relative to other banks owing to their large market size and the dominant role they play in the credit market. The Big Four banks turn to the highly profitable lending opportunities associated with the housing price boom and pursue lending cuts in business loans. The disparity in

evidence of the crowding out behavior between the Big Four banks and other banks can be rationalized by the oligopolistic behavior of the Big Four Banks. The other smaller banks tend to behave more competitively and their localized access to the market compared to the Big Four banks would imply that they are less able to compete with them. As such, the crowding out behavior observed in the Big Four banks, which is motivated largely by profit-seeking, is not found in the other Australian banks.[4]

Our results contribute to the literature in important ways. Firstly, we document that the observed crowding out effect of business loans arising from housing loans increases during the housing price boom in the U.S. market is also prevalent in other economies that experience a similar housing market boom. A cutback in business loans can have serious implications for investment activities thus advancing the literature on bank lending and the macroeconomy (Peek, Rosengren, and Tootell, 2003; Lown and Morgan, 2006; Faulkender and Petersen, 2006; Sufi, 2009; Leary, 2009; Lemmon and Roberts, 2010; Chava and Purnanandam, 2011; Bassett et al., 2014). Banks play a central role in the economy's functioning because small and medium-sized businesses do not have ready substitutes for bank credit (Bernanke and Gertler, 1995; Peek and Rosengren, 2000; Ashcraft 2005). The crowding out of business loans could pose additional constraints on small and medium-sized businesses. On the flip side, the banking sector is also instrumental in increasing household debt through excessive housing loans, which in turn exposes both households and banks to housing bust risk, and poses a threat to the country's financial stability.

In contrast to the literature which shows that asset price decline can impact negatively on the economy (Gan, 2007 a,b; Peek and Rosengren, 2000), our results demonstrate a similar effect but operating from asset price increase. The mechanism through which this occurs is different from the commonly discussed asset price bust operating through the conventional collateral channel (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997). Here, a positive shock in housing prices is akin to a positive shock to the bank's lending opportunities, which give rise to a substitution effect away from business lending. While there is limited theory to explain

[4] The recent Royal Commission into Australian banking sector malpractices finds that currently much of the misconduct in the banks and other financial institutions can be traced to entities preferring to pursue profit at the expense of all other duties (Royal Commission Final Report, 2019).

banks' allocation of resources to their loan portfolios in the face of external shocks, Chakraborty et al. (2018) argue that the crowding out effect resembles the decision chosen by constrained headquarters in the internal-capital markets which involves reallocating limited resource toward more profitable projects (Stein, 1997; Scharfstein and Stein, 2000). However, this story does not seem applicable to our findings considering the important difference from Chakraborty et al. (2018) – the crowding out effect is evident only in the Big Four banks which are not as capital constrained. Accordingly, the insights that we learn from our results speak to the need for the development of a theory that underpins banks' lending decisions and their allocation of loanable funds.

Finally, whilst our results are consistent with that of Chakraborty et al. (2018) in terms of the crowding out effect in bank lending behavior due to house price appreciation, the ensuing effect of business loans reduction is likely to translate into a greater negative real impact on the economy, because the Big Four banks are dominant lenders in the credit market. The macroeconomic models devised by Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) point to the amplification of positive asset price shock on real investments stemming from firms' ability to borrow and invest more; our findings indicate that this effect on business investment can be dampened owing to the reduction in business loans. More importantly, if banks which play a dominant role in the credit market are actively crowding out business loans, the effect of positive asset price shock may generate a negative net real effect on the economy through a reduction in real investment. The distortionary effect of loans allocation arising from asset price boom can be more disconcerting if the real estate price appreciation leads to a housing price bubble that is fueled by agents' expectations of future price increases and supported by banks' lending behavior.

The rest of the paper is structured as follows. Section 2 describes the data and variables construction. Section 3 describes the empirical models. Section 4 explains the results and discusses results of certain robustness analyses. Section 5 concludes this study and provides policy implications.

2. Data

2.1 Bank Data

The panel data comprise quarterly balance sheet entries across banks which operate in Australia from 2003Q4 to 2017Q4. The Australian Prudential Regulatory Authority (APRA) collects Monthly Banking Statistics series from all banks operating in Australia since June 2002. We select balance sheet items from this data set over the sample period and convert the monthly series to quarterly figures to be consistent with the availability of quarterly macroeconomic data. This information relates to the operations of licensed banks in Australia (including international banks) with the domestic market and residents. The data neither include offshore branches of domestically owned banks nor any offshore controlled entities. Given our focus is to determine the presence of a substitution effect between business and housing loans, we consider the Big Four banks who are the major lenders to businesses and households in the presence of housing price boom. Small banks are excluded since they primarily provide credit only to specific sectors. Newer banks which have not been operating in Australia for the whole sample period are also excluded. Subsidiaries of other banks are not included as individual entities in the dataset.[5] The list of banks in our samples of the Big Four banks, other Australian banks and foreign banks is presented in Table A1 in the Appendix.

The lending focus of Australian banks has traditionally been dedicated to retail banking, specifically to the household and the business sector. Credit growth across all areas has followed a positive trend, which is unsurprising given the Australian economy has experienced over 25 years without a technical recession. Figure 1 Panel A presents aggregate credit levels from 1990 to 2017, which shows the strongest growth in housing related loans followed by business lending. Since the onset of the GFC, housing loans growth rate is faster than business loans growth rate. Figure 1 Panel B illustrates the increasing share of housing loans as a proportion of total private credit in the economy and the declining share of business lending.

[5] For example, the Bank of Melbourne, which is a subsidiary of the Westpac Group, does not have its own balance sheet entries in the data. The balance sheet information of all domestic operating subsidiaries is included in the entries of the major banks.

– Figure 1 about here –

We focus on two types of loans, housing loans and business loans, which make up most of banks' private loan portfolio. The former is made up of the sum of loans to households for owner-occupied housing and housing investment, while the latter is the loans to non-financial private corporations. There are other loan classifications, namely, consumer credit, loans to financial corporation, loans to community service organization and non-profit institutions, and loans to government. Figure 2 Panel A displays the housing loans, business loans and consumer credit as a proportion of total private sector loan value for all banks in our sample for the period 2003Q4-2017Q4. It can be seen that on average housing loans dominate banks' private sector loans and they make up approximately 66% of the total loan value. This is followed by business loans which comprise nearly 28% of the total loan value. The business loan ratio falls during the GFC and it increases to a level below the pre-GFC level. This trend mirrors the slow growth rate of business loans post-GFC displayed in Panel A of Figure 1. The proportion of housing loans starts to increase post-GFC and has remained at around 68% in recent years; this is also consistent with the steeper growth in housing loans post-GFC. The negative association between housing loan and business loan ratios is apparent and their correlation is about -0.64. In Panel B, the trends of housing loan and business loan ratio for the Big Four banks are similar to those of the total sample of banks. The similarity reflects the fact that the Big Four banks are the dominant players in the credit market and they exert determinative influence on credit market trends. For the other Australian banks (Panel C), the trend is different; the proportion of housing loan gradually increases post-2008, which is accompanied by a persistent decline in the business loan ratio. For the foreign banks (Panel D), the trends for the housing loan ratio and business loan ratio are different compared to Australian banks. While the two ratios are negatively correlated with each other, the housing loan ratio does not exhibit a decline (an increase) during (post) the GFC period.

- Figure 2 about here –

The other bank financial variables which are used to control for their funding and lending constraints are the deposits ratio, liquidity ratio, capital adequacy ratio and the log change in

total assets. The deposits ratio captures the proportion of a bank's total assets which is funded by its deposit liabilities. The liquidity ratio denotes cash or liquid assets expressed as a proportion of total assets. Greater liquidity suggests that a bank has more funds available to lend, invest or meet its liability obligations. The capital adequacy ratio (*CAR*) is a measure of bank's available capital expressed as a percentage of a bank's risk-weighted credit exposures; its level reflects the minimum capital requirement imposed by APRA. The difference in log total assets represents the growth rate of the overall bank size. It captures the ease with which banks could raise funds, invest or supply credit (since loans are represented as an asset on the balance sheet). These monthly observations are converted into quarterly data by taking the three month average.

- Table 1 about here –

Table 1 summarizes the statistics of financial variables for the Big Four banks and other banks, which are divided into other Australian banks and a combination of other Australian and foreign banks. There are 19 banks altogether.[6] All units are in millions of AUD unless presented as a ratio. There is a striking difference in the average value of loans of the Big Four banks relative to the other banks. The Big Four banks, on average, have about twelve times the value of business loans and thirteen times the value of housing loans compared to the other Australian banks. Furthermore, for the Big Four banks, the value of housing loans (business loans) relative to total private sector loans is about 66% (26.4%). The figures are comparable for other Australian banks; 62.3% for housing loans and 26.6% for business loans. However, when including foreign banks in the sample of other Australian banks, the value of housing loans (business loans) relative to total private sector loans fall (rise) to about 33% (32%). This implies that many of the foreign banks in our sample do not supply housing loans but concentrate on providing business loans. The average total asset value of the Big Four banks is about twelve times larger than those of other Australian banks. This may suggest a significant difference in the Big Four Banks' ability to raise capital and extend credit in response to housing price appreciations relative to the other banks. Accordingly, our empirical analyses are performed

[6] We omit banks in our sample that lack data on key variables like business loans and housing loans.

separately for the sample of the Big Four banks and the sample comprising other Australian and foreign banks. Based on preliminary panel unit root test of Im et al. (2003) and the Augmented Dickey-Fuller (ADF) test conducted on the total assets, housing loans, business loans and consumer credit, we find evidence of a unit root. Hence, the logarithm of these series is first differenced so that they are expressed as the growth rate of the variables concerned. For brevity, these results are not reported here but are available from the authors upon request.

2.2. Macroeconomic variables

Macroeconomic variables are used to control for factors which may influence the supply and demand of credit. The macroeconomic control variables used are the percentage change in seasonally adjusted real GDP, the change in the cash rate, the NAB Business Conditions survey and the economic policy uncertainty index (see Appendix A2 for data source). Percentage change in GDP captures cyclical demand effects which may influence the decision of firms and individuals to borrow. The NAB business conditions survey is conducted monthly on 400 non-farm firms based on factors such as sales, profit and employment for that month. The observations are expressed as deviations from the average in seasonally adjusted terms. The cash rate is the target overnight money market interest rate set by the Reserve Bank of Australia (RBA), which is a proxy for the cost of credit. Since this is a monthly measure, the average cash rate over the quarter is employed. Results of the Augmented Dickey-Fuller (ADF) unit root test suggest that cash rate has a unit root, hence the first differences of the average quarterly cash rate are employed. The results of the ADF test on business conditions and percentage change in GDP suggest that these variables are stationary.

The economic policy uncertainty index uses newspaper coverage of policy uncertainty from eight major Australian newspapers, constructed from the methods of Baker et al. (2016).[7] As noted by Bloom (2009), firms only invest when business conditions are sufficiently good, but businesses become more cautious and take longer time to respond to positive conditions when uncertainty is higher. The uncertainty index captures the normalized volume of news articles discussing policy uncertainty. As such, even if business conditions are perceived to be better

[7] This data is available at: http://www.policyuncertainty.com/australia_monthly.html

than average, investment decisions and hence demand for credit may be delayed if there is a high level of economic uncertainty. Bordo et al. (2016) find using bank level data that aggregate credit growth falls in response to higher economic uncertainty, which supports the inclusion of this control variable in the regression.

In the PVAR model, we use the growth rate of business investment, which refers to new private business gross fixed capital formation, expressed as the first difference of the logarithm of business investment (*dbi*) to control for the demand of business loans. Business loans can be used to finance business investment, dwelling investment and other investment. For the period examined, on average business investment makes up for about 70% of total investment while dwelling investment makes up the rest. We have chosen to use business investment because we are concerned with: (i) controlling the demand for business loans arising from business investment when evaluating the crowding out effect; (ii) assessing the real impact of crowding out of business loans from rising housing loans; and (iii) the confounding effect induced by including dwelling investment as demand for business loans is expected to increase with house price appreciations. In the robustness test, we employ the sum of business and dwelling investment in place of business investment to demonstrate that our results are robust to the choice of investment variable. Panel B of Table 1 shows the summary statistics of these macroeconomic variables. On average, the quarterly GDP growth rate is about 2.89% while the quarterly average growth rate of business investment is about 0.44% over the sample period.

2.3 Housing Price Variable

The housing price variable comprises the Residential Property Price Index (RPPI) sourced from the Australian Bureau of Statistics (ABS). The RPPI is an aggregation of the Housing Price Index (HPI) and Attached Dwellings Price Index (ADPI), measuring the price evolution of all residential dwellings within the eight greater capital city statistical areas (GCCSAs) over time. The HPI and ADPI measure the price evolution of all established detached houses and attached dwellings within the eight GCCSAs, respectively. All three indexes are constructed for each capital city and this is followed by obtaining a weighted average of eight capital cities as the

national figure. We use the RPPI index as the housing price variable because it more broadly reflects the value changes in all types of dwellings throughout the country. The methodology for compiling the housing price indices involves the use of stratified sampling which was introduced in 2005 causing a series break in the HPI at the start of 2002. The RPPI begins in the third quarter of 2003 which dictates the starting period of our sample.

- Figure 3 about here –

Figure 3 shows the time series plots of all three housing indices, namely RPPI, HPI and ADPI. All three housing price indices follow a similar upward trend. Due to the presence of a unit root in the RPPI variable (as verified by the ADF test), we use the log difference of the RPPI index in the regression, which gives rise to the interpretation of the growth rate of (or change in) housing price. This variable is denoted by *dresprice*. Table 1 shows that the average increase in the residential dwelling price is about 5.4% per annum. Table A2 provides the variable definitions and data sources for the empirical analyses.

3 Empirical Specifications

3.1 Single equation framework

If banks are shifting their loan portfolio from business loans to housing loans in response to higher housing prices, we expect a negative association between business loans and housing prices, and a positive association between housing loans and housing prices. To test these conjectures, we estimate the relationship between changes in housing prices and loan growth at the bank level. We run the following fixed effects regression:

$$Loan\ growth_{it} = \alpha + \beta_1 dresprice_{i,t-1} + \beta_2 \boldsymbol{X_{it}} + \beta_3 \boldsymbol{Y_t} + \boldsymbol{f_i} + \boldsymbol{d_t} + \boldsymbol{\varepsilon_{it}} \qquad (1)$$

where loan growth is proxied by *dbusloan* for the growth in business loans, and *dhl* for the growth in housing loans. Given that both series *dbusloan* and *dhl* are highly correlated, we do not include both variables in the regression to avoid the problem of multicollinearity. Changes in housing price are captured by the variable *dresprice*, which has a one period lag (i.e. lagged by a quarter). The use of lagged *dresprice* instead of a contemporaneous term is to alleviate the

endogeneity and simultaneity bias between housing loan and housing price. We believe that it takes time for households, firms and banks to process changes in housing price and make decisions relevant for demand and supply of loans. The macroeconomic control variables are reflected in $\boldsymbol{Y_t}$ which comprises the real GDP growth rate, the changes in cash rate, the NAB Business Conditions survey and the economic policy uncertainty index. These variables serve to control for the demand side of loan growth. Additionally, we include *dbi*, changes in business investment, as a control variable to capture the demand for loan growth in the regressions but this variable is found not to be statistically significant at conventional significance levels. Accordingly, this variable is dropped from the baseline regression. The banks' specific control variables are denoted by $\boldsymbol{X_{it}}$ which comprises balance sheet variables like deposits ratio, liquidity ratio, capital adequacy ratio and the change in total assets. We also include bank fixed effects, $\boldsymbol{f_i}$, and the time fixed effect, $\boldsymbol{d_t}$. The bank fixed effects control for heterogeneity in the bank's loan growth arising from possible omitted variables. The time fixed effect captures any domestic macroeconomic shocks that may affect all banks in the same way, such as the increase in migration inflow into Australia which may give rise to an increase in loan growth, and the 2007/2008 global financial crisis which is likely to dampen loan growth.

The coefficient of interest is β_1 which is predicted to be negative and statistically significant if business loan growth is expected to decline with housing price increases. On the other hand, for housing loan growth, we expect β_1 to be positive and statistically significant. To further verify that crowding out of business loans is associated with higher housing price, we replace the loan growth variable in equation (1) with the variable Δ*RATIO*, which is the change in the proportion of business loans with respect to combined business and housing loans. In this regression, if rising housing price is associated with relatively smaller business loans and relatively larger housing loans (i.e. a fall in the variable Δ*RATIO*), then β_1 is expected to be negative and statistically significant.

3.2 Panel Vector Autoregression model

In view of the endogeneity issues that may be present, we adopt the panel data VAR (PVAR) methodology, which is first proposed by Love (2003). It combines the traditional VAR approach, which treats the key variables of interest in the system as endogenous, with the

panel-data approach, which allows for unobserved individual bank heterogeneity. For the purpose of studying the impact of changes in housing prices on bank lending behavior, we consider three endogenous variables of interest in the PVAR, namely *RATIO*, which is business loans as a proportion of the sum of housing loans and business loans, *dbi* (i.e. changes in business investment) and *dresprice* (i.e. changes in housing prices). The inclusion of *dbi* in the PVAR stems from the fact that changes in business investment may capture the demand side of business loans, and business loans in turn could have predictive power over *dbi*. In other words, *dbi* is a proxy of demand for business loans. In theory, these endogenous variables can simultaneously influence one another with a lead-lag effect so that it is appropriate to analyze them in a PVAR framework. In its general form, our model can be written as follows:

$$\boldsymbol{Z_{it} = \Gamma_0 + \Gamma_1 Z_{it-1} + \Lambda_0 X_{it} + \Lambda_1 Y_t + f_i + d_t + e_{it}} \quad (2)$$

where $\boldsymbol{Z_{it}}$ is a vector of the variables of interest: Δ*RATIO*, *dbi* and *dresprice*. The autoregressive structure allows all endogenous variables to enter the model with a lag for which the lag order is determined by the Akaike Information Criterion (AIC). The AIC indicates that 3 lags constitute the optimal lag length for the PVAR. The macroeconomic control variables are reflected in $\boldsymbol{Y_t}$ which comprises real GDP, the change in the cash rate, the NAB Business Conditions survey and the economic policy uncertainty index. On the other hand, banks' specific control variables are denoted by $\boldsymbol{X_{it}}$ which comprises balance sheet variables like deposits ratio, liquidity ratio, capital adequacy ratio and the change in total assets. Like the fixed effects panel regression (1), we also incorporate time fixed effects, $\boldsymbol{d_t}$, which captures any domestic macroeconomic shocks that may affect the banks' loan ratio, changes in house price and changes in business investment over time.

The advantage of the panel VAR is the same as the advantage of any panel approach in that it allows for explicit inclusion of a fixed effect in the model, denoted here as $\boldsymbol{f_i}$. The fixed effect captures all unobservable time-invariant factors at the bank level. This is important for our purposes as inclusion of these bank fixed effects controls for any unobserved factors in the model over and above the observed variables captured in $\boldsymbol{X_{it}}$ and $\boldsymbol{Y_t}$. For example, the fixed effects capture other time-invariant factors, such as heterogeneity among banks in their lending responses to housing price changes. However, the inclusion of fixed effects presents an

estimation challenge, which arises in any model which includes lags of the dependent variables. The fixed effects are correlated with the regressors and hence the mean-differencing procedure commonly used to eliminate fixed effects would create biased coefficients. To circumvent this problem, we use forward mean-differencing which is also known as the "Helmert procedure" (Arrelano and Bover, 1995). This procedure removes only the forward mean, that is the mean of all the future observations available for each bank-quarter. It preserves the orthogonality between transformed variables and lagged regressors, which permits the use of lagged regressors as instruments and estimate the coefficients by system GMM. The panel VAR estimation routine follows Love and Zicchino (2006).[8]

Model (2) is a reduced form model. The VAR system permits an evaluation of the impact of the orthogonal shocks—i.e., the impact of a shock in one variable on another variable. This is accomplished with the impulse response functions, which describe the reaction of variables to a one-time innovation in a particular variable in the system, while holding shocks to other variables equal to zero. We use Cholesky decomposition to identify orthogonal shocks in our variables of interest. It is equivalent to transforming the system in a recursive VAR for identification purposes (see Hamilton (1994) for the derivations and discussion of impulse response functions).

The identifying assumption of such recursive ordering is that the variables that come earlier in the ordering affect all the following variables contemporaneously and with a lag, while the variables that emerge later affect the previous variables only with a lag. We adopt the following recursive ordering: $dresprice \rightarrow \Delta RATIO \rightarrow dbi$. The variable $dresprice$ is placed at the very beginning of the ordering because we conjecture that housing price appreciations induce banks to adjust the composition of their loan portfolio, leading to changes in the proportion of business loans. The variable *dbi* is placed after $\Delta RATIO$ in the ordering because the proportion of business loans is expected to influence changes in business investment. Changes in business investment (*dbi*) are expected to be affected by changes in housing price through the composition of housing and business loans. However, it is possible that changes in

[8] The same methodology and program have been applied to study: firstly, the effect of macroeconomic shocks on bank loan portfolio quality (Love and Turk Aris, 2014); and secondly, the responses of macroeconomic and financial variables to the overall exchange rate volatility (Grossman et al., 2014).

business investment brings about a change in the proportion of business loans, which in turn affects housing prices. In such a case, the ordering is reversed such that *dbi*→ *ΔRATIO* → *dresprice*. The sensitivity of our results to the ordering of the variables is considered in the robustness analysis.

The impulse response functions are analyzed through their confidence intervals. Since the matrix of impulse response functions is constructed from the estimated VAR coefficients, their standard errors need to be taken into account. We generate the confidence intervals for impulse responses using Monte Carlo simulations.[9] In addition, we evaluate variance decompositions, which show the percentage of the variation in one variable that is explained by the shocks to other variables, accumulated over time. The variance decompositions reveal the magnitude of the total effect. We report the total effect accumulated over 10 quarters, but longer time horizons (20 periods) produced equivalent results. Last but not least, model (2) also permits testing of Granger causality amongst the variables of interest which allows us to determine whether there has been a shift in the allocation of banks' loan in favor of housing loans at the expense of decreasing business loans, and whether this crowding out effect predicts a fall in business investment.

3. Empirical Results

3.1 Single equation

Column 1 of Table 2 shows that business loan growth decreases when housing prices increase after controlling for macroeconomic and bank factors, and bank fixed effects. This negative effect is similar to the findings reported by Chakraborty et al. (2018) for the U.S. data. A standard deviation increase in quarterly housing price growth rates (1.826%) is associated with a fall in the quarterly growth rate of business loans by about 1.61% (=1.826*0.884). It is important to recognize that housing prices may be endogenous to the borrowing and investment decisions of businesses. In particular, if there are correlations between housing price and any omitted variables that explain banks' business loans, the coefficient estimate of β_1 may

[9] In practice, we randomly generate a draw of regression coefficients in model (2) using the point estimates and their variance-covariance matrix and we re-calculate the impulse responses. We repeat this procedure 500 times and then generate the 5th and 95th percentiles of this distribution, which we use as confidence intervals for the impulse responses. These bounds are plotted on the graph.

be biased. However, this bias is likely to be positive as housing prices are generally positively correlated with factors that promote demand for business loans. For instance, the borrowing capacity of businesses increases with the market value of commercial buildings which are commonly used as collaterals. If indeed this bias is positive, it will work against finding a negative association between business loan growth and housing prices increase. As such the coefficient estimate reported here is a conservative estimate of the true housing exposure of banks. We show in the panel VAR model (see Section 4.2) the robustness of our results to the possibility of an endogeneity problem that exists between business loan growth and changes in housing prices.

- Insert Table 2 about here -

For the control variables, only capital adequacy (*capadeq*), growth in total assets (*dtotass*) and business conditions (*buscond*) are statistically significant at the 1% level. An increase in the capital adequacy ratio has a negative effect on the growth of business loans. An improvement in business condition and growth in banks' total assets are found to promote growth in business loans. Both results accord with intuition; banks tend to increase their business loans when business conditions are optimistic and there is a natural positive association between growth in business loans and growth in total assets, given that business loans are part of a bank's assets.

Column (2) shows that, holding all things constant, housing loan growth increases as housing prices rise. The magnitude of the β_1 estimate is smaller in absolute magnitude than that of the business loan growth regression. Nevertheless, it is statistically significant at the 5% level. This result is indicative that the rise in housing prices is associated positively with an increase in housing loans growth. In so far, the results from columns (1) and (2) suggest there has been a change in the composition of banks' business and housing loans with respect to changes in housing prices. In column (3), we further test the conjecture that the rise in housing prices is associated with the crowding out of business loans due to an increase in housing loans. It can be seen that the change in business loan proportion (*ΔRATIO*) is negatively associated with the increase in housing prices. This effect is statistically significant at the 1% level and this outcome

implies there is evidence of business loans crowding out as banks shift their loans allocation in favor of housing loans during housing price appreciations.

Like the business loans growth regression, growth in banks' total assets in column (2) is positively related to growth in housing loans, and the effect is found to be statistically significant at the 1% level. Liquidity ratio is found to be negatively associated with housing loans. Given that housing loans are non-liquid assets, an increase in a bank's liquidity ratio reduces the growth in housing loans. This effect is statistically significant at the 5% significance level. The effect of real GDP growth on housing loans has the wrong sign albeit the estimate is not statistically significant at the 5% level. For the *ΔRATIO* regression results reported in column (3), only the control variables – *CAR* and *buscond* – are statistically significant. As banks' capital adequacy ratio rises, typically reflecting a more stringent regulatory capital requirement, the proportion of business loans to total housing and business loans falls. This result could be due to the perception that business loans are more risky than housing loans, and to that end banks shift their loans away from business loans to housing loans in response to a stricter capital requirement, ceteris paribus. Business conditions continue to exert a positive influence on the change in the proportion of business loans.

3.2 The PVAR model

Table 3 reports the panel VAR results. Column (2) indicates the regression where *ΔRATIO* is the dependent variable. It can be seen that other than *ΔRATIO* lagged for one period, *dresprice* lagged for one period has predictive power over current changes in business loan ratio. The negative estimate indicates that an increase in housing prices is associated with a fall in the business loan ratio. As we have demonstrated in the single equation regression results, any increase in housing prices has a negative (positive) influence on business (housing) loans growth to the extent that the proportion of business loans to the sum of business and housing loans declines. This indicates that crowding out of business loans does occur as banks respond to the housing market boom by increasing the supply of housing loans, which corroborates the results from the single equation regression (i.e. column (3) of Table 2). Both capital adequacy ratio and business conditions are statistically significant and they have the expected sign concerning their influence on *ΔRATIO*.

- Insert Table 3 about here -

Turning to column (3) for the regression where *dbi* is the dependent variable, we find that positive growth in housing prices in the previous period is negatively associated with the change in business investment. This result implies that growth in business investment tends to slow down in a stronger housing market captured by faster growth in housing prices, indicating a potential negative real effect of housing market boom. The control variables capital adequacy ratio and real GDP growth are statistically significant at the 5% and 1% levels, respectively. An increase in real GDP growth captures stronger demand side for business investment, hence leading to an increase in business investment growth.

Finally, the results in column (1) for the regression where changes in housing prices are the dependent variable, suggest there is some degree of correlation between current changes in housing prices and past changes. Growth in business investment is found to be negatively associated with housing price changes, and the relationship is statistically significant at the 1% level. This finding corroborates the result described above, confirming a significant and negative association between changes in housing price and changes in business investment. The story underlying this negative association is to be examined from the impulse response functions below. There is no evidence to suggest that any of the control variables is able to predict significant changes in housing prices.

- Insert Tables 4 and 5 about here -

Table 4 reports the Granger causality results amongst the three endogenous variables. The results are consistent with our predictions; there is bidirectional causality between changes in housing prices and changes in business investment, and that changes in housing prices have predictive power over changes in the ratio of business loans. The forecast error variance decomposition results in Table 5 are also consistent with the findings from the Granger causality tests. About 23% of the forecast error variance of the change in housing prices is explained by the change in business investment shock while its own shock dominates its forecast error variance. The forecast error variance of the change in business loans ratio is explained largely by its own shock, while shock from changes in housing prices (changes in business investment)

explains about 12% (8%) of its variation. Finally, a large part of the forecast error variance of the change in business investment is explained by its own shock.

- Insert Figure 4 about here -

The first row of Figure 4 shows impulse response functions for changes in housing prices, changes in business investment, and changes in business loans ratio in response to a positive one standard deviation shock in the change in housing prices. A positive shock to changes in housing prices results in a fall in business investments in the following quarter and a decline in business loans ratio in subsequent quarters, suggesting that banks respond to housing price increases by substituting out of business loans into housing loans leading to a decline in business investment. These impulse responses support the crowding out effect of housing price increases on commercial lending which leads to a fall in business investment. The second row of the impulse response functions diagram shows that a positive shock to changes in business investment gives rise to a fall in housing prices in the subsequent two quarters and a gradual increase in business loans ratio, although the confidence intervals indicate that the responses of the change in business loans ratio are not statistically significant. Finally, a positive shock to the change in business loans ratio fails to engender any statistically significant response on changes in housing prices. However, it has an immediate negative impact on changes in business investment despite the confidence interval indicating that such an effect is not statistically significant.

3.3 Bank Profitability

The reason underlying the Big Four banks' lending behavior which leads to crowding out of business loans for housing loans during the strong housing market might be that banks find housing price appreciations present attractive and good lending opportunities that will increase their profits. Accordingly, we perform the time series regression below to test our conjecture:

$$Profitmargin_t = \beta_0 + \beta_1 liquidratio_t + \beta_2 HLratio_t + \beta_3 dresprice_t + \beta_4 depratio_t + \beta_5 CAR_t + \beta_6 dtotass_t + \beta_7 trend + \varepsilon_t \quad (3)$$

Here, $Profitmargin_t$ is the Big Four banks' weighted quarterly profit margin for the period 2004Q2-2017Q4 (see Appendix Table A2 for the data source). Since quarterly data on the

individual Big Four banks' profit margin are not available, we are restricted to perform a time-series analysis on the relationship between the four banks' profit margin and the housing loan ratio, $HLratio_t$, defined as the ratio of housing loans to the sum of housing loans and business loans. The other control variables are defined in the same way as in the single equation specification and the PVAR model. The only exception is that where these control variables were previously defined for the individual Big Four banks, they are now aggregated by taking a simple average of the Big Four banks' data. We include a time trend in the regression. The regression results are reported in Table 6.

- Insert Table 6 about here -

The results in column (1) show that only four control variables are statistically significant at the 5% significance level in explaining the Big Four banks' profit margin. In particular, the coefficient of $HLratio_t$, which is of interest, is statistically significant and positive, thus supporting our conjecture that an increase in housing loans ratio translates into higher profit margins of the Big Four banks. The profit margins also display a statistically significant and positive trend. For the deposit ratio ($depratio_t$) and the capital adequacy ratio (CAR_t), we find them to be negatively related to the banks' profit margin. A higher deposit ratio presents a more stringent banks' fiduciary obligation to meet depositors' demand for liquid cash and hence banks are obliged to limit their loans exposure, which reduces their profit margin. The capital adequacy ratio which measures a bank's available capital expressed as a percentage of the bank's risk-weighted credit exposures serves to protect depositors and promote the stability and efficiency of the financial system. In that regard, a higher *CAR* restricts banks' risk-weighted credit exposures by reducing loans, which inadvertently decreases their profit margin.

If the Big Four banks are substituting business loans for the more profitable housing loans, we can ascertain whether business loans present less profitable lending opportunities relative to housing loans. We re-run regression (3) by replacing housing loan ratio ($HLratio_t$) with the business loan ratio ($BLratio_t$). Since the sum of $HLratio_t$ and $BLratio_t$ is unity, this perfect collinearity prevents the inclusion of both control variables in the regression. Column (2) depicts the results of this regression. Like the results in column (1), the same four control variables are statistically significant at the 5% level. The main difference lies in the coefficient of

$BLratio_t$ which is negative and implying that as the Big Four banks allocate a higher proportion of their loans to business loans, their profit margin is predicted to decline. Collectively, these findings corroborate our conjecture that the Big Four banks strategically substitute business loans for housing loans to boost their profits in response to profitable lending opportunities during strong housing markets.

3.4 Consumer Credit

Tai (2017) demonstrates that the U.S. housing boom in the early 2000s led to credit expansion amongst home owners but at the expense of home renters. In particular, banks reduced non-mortgage credit supply when they expanded mortgage lending to homeowners. Using consumer credit data of the Big Four banks, we examine whether the crowding out of consumer credit is also observed in the same way as business loans are crowded out during house price appreciations. Here, consumer credit comprises the sum of loans to households in the form of credit cards and others. To that end, we estimate equation (1) by replacing the change in business loan (*dbusloan*) with the change in consumer credit (*dconscr*) for the Big Four banks.[10] In place of changes in business investment, we employ the change in consumer durables to control the demand for consumer credit. However, changes in consumer durables do not turn out to be statistically significant, so this variable is dropped in the single equation regression. Further, we replace the dependent variable with the change in the ratio of consumer credit to the sum of consumer credit and housing loans to test for a possible crowding out effect.

The results which are reported in Table 7 show house price appreciations have no statistically significant effect on the change in consumer credit (see column (1)). While we observe crowding out of business loans, we do not observe statistically significant crowding out of consumer credit (see columns (1) and (2)). The PVAR model results also corroborate this finding; the panel Granger causality test results fail to show there is any predictive power amongst the endogenous variables examined: change in the ratio of consumer credit over the sum of consumer credit and housing loans, change in housing prices, and change in consumer durables. The PVAR estimation results further support the lack of predictive power of these

[10] Private consumer credits are loans to households in the form of credit cards, which is the gross value of credit card liabilities incurred by Australian households.

variables to warrant support for a crowding out effect in consumer credit.[11] The absence of evidence in support of consumer credit crowding out effect could be driven by the fact that consumer credit only makes up for less than 5% of the Big Four banks' loans to the private sector. As such, it may be difficult to pick up any crowding out effect in consumer credit due to its relatively small value compared to the housing loans value.

- Insert Table 7 about here -

4. Robustness Analyses

4.1 Other Australian banks excluding the Big Four banks

We repeat the analyses for the single equation regressions and PVAR model for other Australian banks (see Table A1 for a list of the 5 other Australian banks), and the results are reported in Tables 8 and 9, respectively. We do not find that the growth of business loans declines when the growth of housing prices increases. There is also no statistically significant impact of an increase in the growth of housing prices on the growth of business or housing loans. The panel VAR model results further confirm these findings. These results suggest that the crowding out effect is not apparent in the sample of other Australian banks.

- Insert Tables 8 and 9 about here -

One possible explanation is that the other Australian banks play a more regional role compared to the Big Four banks and they are less influenced by the housing market boom which occurred in the bigger cities like Melbourne and Sydney. The Big Four banks, on the other hand, could exploit their dominant role as lenders in the credit market and could behave more strategically in their lending to capitalize on the profit-making opportunities presented by the housing market boom. When we analyze our results for the sample of other Australian banks and foreign banks, again we do not find any evidence of crowding out effect. Suffice to say, this strategic lending behavior is predominantly observed in the Big Four banks.

4.2 Alternative ordering of variables in the PVAR model

[11] Both the panel Granger causality test results and the PVAR model estimates are not reported here for brevity, but they are available from the authors upon request.

Impulse responses can be sensitive to the ordering of variables and as such we re-estimate the PVAR model with the ordering of *dbi*→ *ΔRATIO* → *dresprice*. Here, it is envisaged that changes in the business investment could influence the proportion of business loans, which in turn affects housing prices. Figure 5 illustrates the impulse responses associated with this ordering. It can be seen that the results remain largely unchanged, thereby confirming that our results are not sensitive to the ordering of the endogenous variables.

- Insert Figure 5 about here -

4.3 Business investment proxy

Previously, demand for business loans is proxied by business investment and excludes dwelling investment. Here, we proxy the demand for business loans by factoring both business and dwelling investment. This is denoted by the variable *dbdi*. The PVAR model (2) is re-estimated and the results are reported in Table 10. Like the results for PVAR with *dbi*, we find in column (2) that house price appreciations bring about a decline in the change in business loans ratio, suggesting that there is crowding out of business loans for increased housing loans. In column (3), house price appreciations also exert a negative influence on the change in business and dwelling investment. Finally, in column (1) both changes in business and dwelling investment and in the proportion of business loans wield a negative influence on house price growth rate. The latter, in particular, is not found to be statistically significant in the PVAR results for *dbi*. There are two possible reasons that give rise to these results. An increase in business loans could give rise to an increase in dwelling investment which increases the supply of housing and hence reduces house prices. In addition, an increase in business loans reduces the supply of housing loans leading to a fall in house prices. These results are consistent with the panel Granger causality results documented in Table 4 (Panel B). Comparing the Granger causality results in Panels A and B, it can be seen that the only distinction is in the predictive power of *ΔRATIO* on *dresprice* in the PVAR model with changes in business and dwelling investment (*dbdi*); recall that *ΔRATIO* is found to have no predictive power on *dresprice* in the PVAR model with changes in business investment (*dbi*). The inclusion of dwelling investment improves the explanatory power of *dbdi* and *ΔRATIO* over changes in housing prices.

- Insert Table 10 about here -

- Insert Figure 6 about here -

Turning to the impulse response functions of the PVAR model with *dbdi* in Figure 6, by and large we find that the responses of the endogenous variables to various shocks are consistent with those of the PVAR model with *dbi* in Figure 4, albeit with a different magnitude. These results show that our findings for business loans crowding out and a decline in business investment are robust to the inclusion of dwelling investment.

5. Conclusion

The bank lending channel plays a central role in the propagation of asset price shock on the real economy. Much of the literature has focused on the contractionary effect of bank lending resulting from asset price crashes. An emerging literature on the subject of bank lending in the presence of an asset price boom is primarily focused on the U.S. economy which experienced a housing market boom prior to the GFC. This paper explores this stream of research on the Australian economy with its unique banking industry and sustained housing market boom.

Our results demonstrate the crowding out of business loans in the face of housing price appreciations. Based on bank level data, our findings corroborate those of Chakraborty et al. (2018) which are based on loan facility level data. There is evidence that banks respond to increased opportunities in the housing markets by increasing their supply of housing loans at the expense of business loans. An important difference in our findings is that we find that this behavior is evident only for the Big Four banks which are not as capital constrained. Further, we discover that their profits are positively associated with the provision of loans allocated to housing markets. These results, as well as the oligopoly market structure of the Australian banking sector, call for a theory of banks' lending portfolio selection that goes beyond the existing capital constraint story.

The shifting of bank lending from the commercial sector to housing markets could have negative real effects on the economy as suggested by the fall in business investment in the face of housing price increases that we find. This effect can be big, depending on the importance of bank lending for private capital formation. In our case, the Big Four banks are dominant lenders

in the Australian economy. The long and sustained period of Australian housing market booms could have impeded firms from undertaking investment and hampered real activity through shifting the bank lending behavior as discussed. The quantitative aspects of this potential negative real effect require further examination in future studies.

Our findings also have important policy implications. In contrast to the view that policy-makers should support the housing market to enhance and protect consumer wealth, consumer spending and real economic activity, our findings point to certain distorting effects of housing market booms on bank lending and the real economy. These effects should be taken into account in housing and banking related policies.

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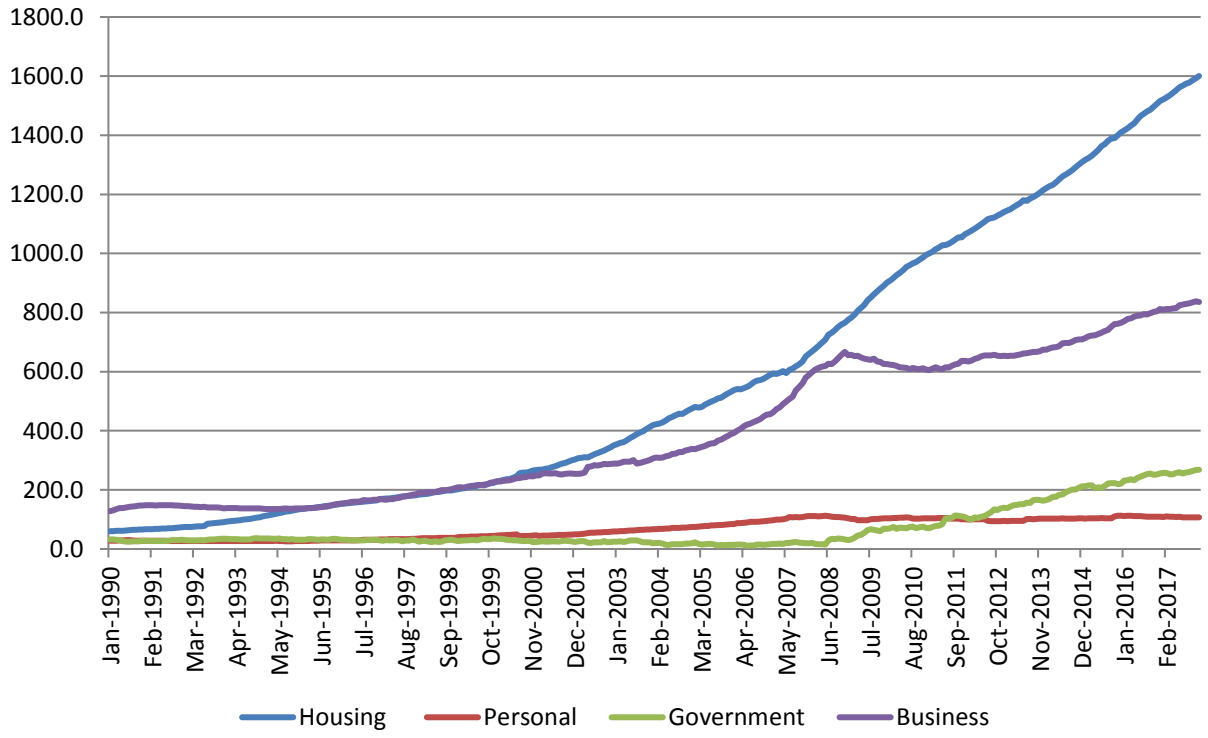
Figure 1 Bank lending in Australia

Note: Panel A shows banks' aggregate lending for housing (both for investors and owner-occupiers), for business, personal and government for the period 1990-2017. The vertical axis of Panel A is in $billion. Panel B shows the proportion of housing and business loans over total credit for the same period.

Panel A: Aggregate bank lending



Panel B: Proportion of housing and business loans over total private credit

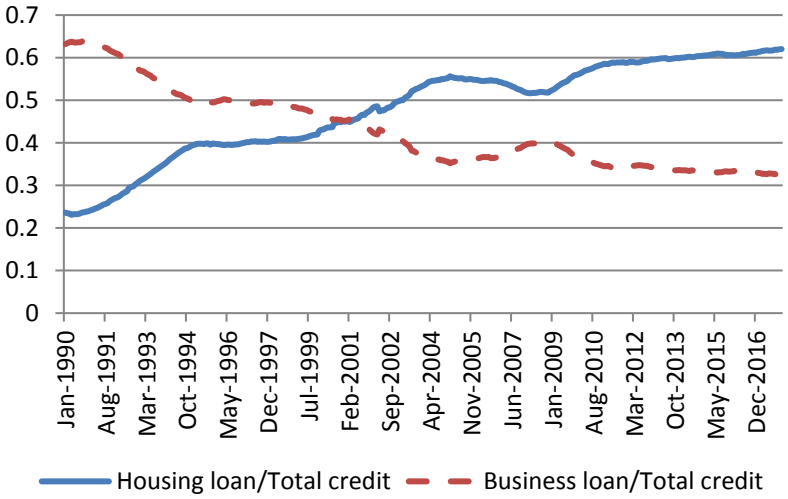
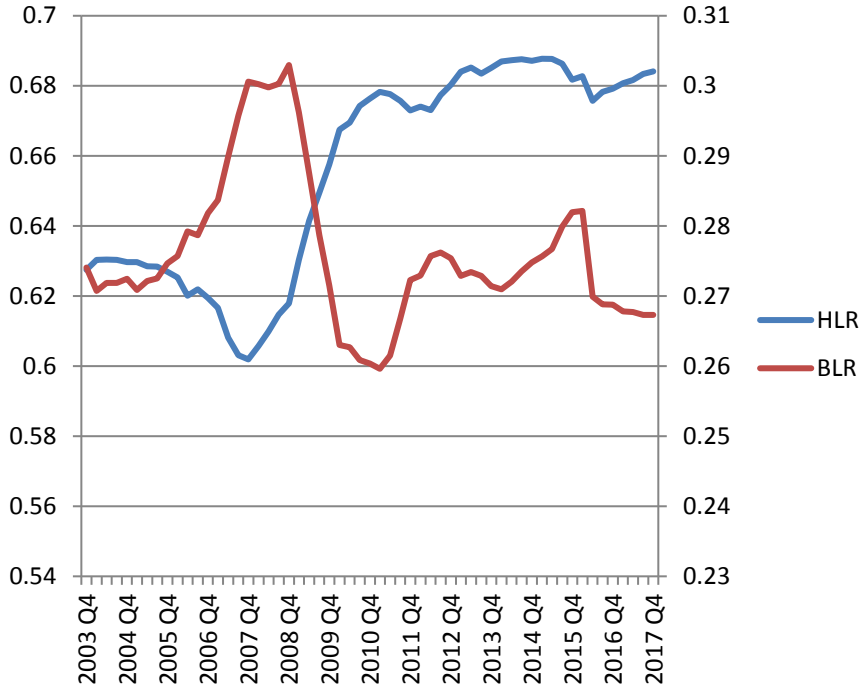


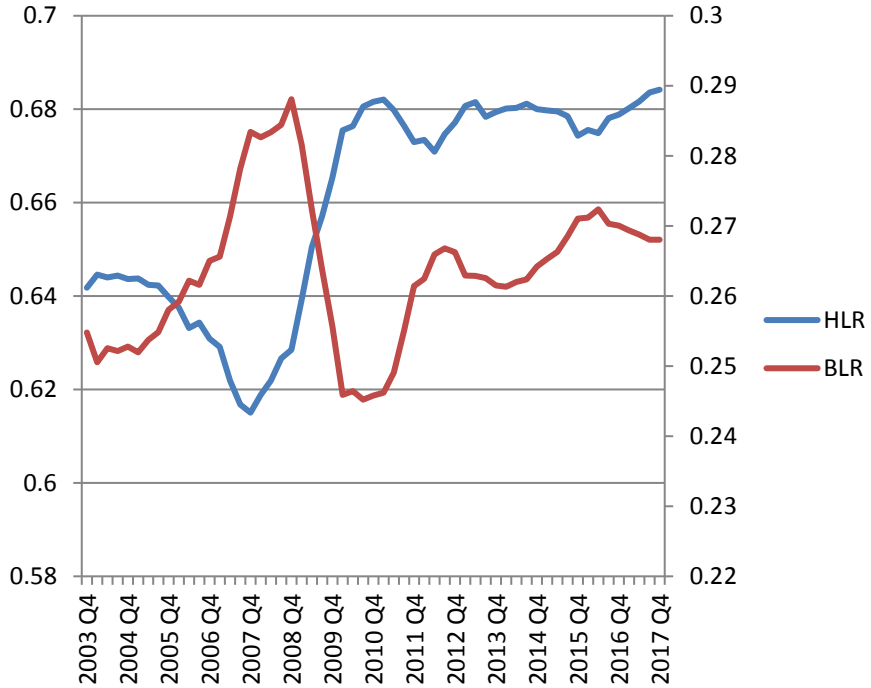
Figure 2 Business Loans, Private Credit and Housing Loans Ratios

Note: HLR and BLR denote the ratio of housing loans and business loans to the total loan value for banks in the sample, respectively. The vertical axis on the left-hand side represents the HLR while that on the right-hand side is for BLR and PCR.

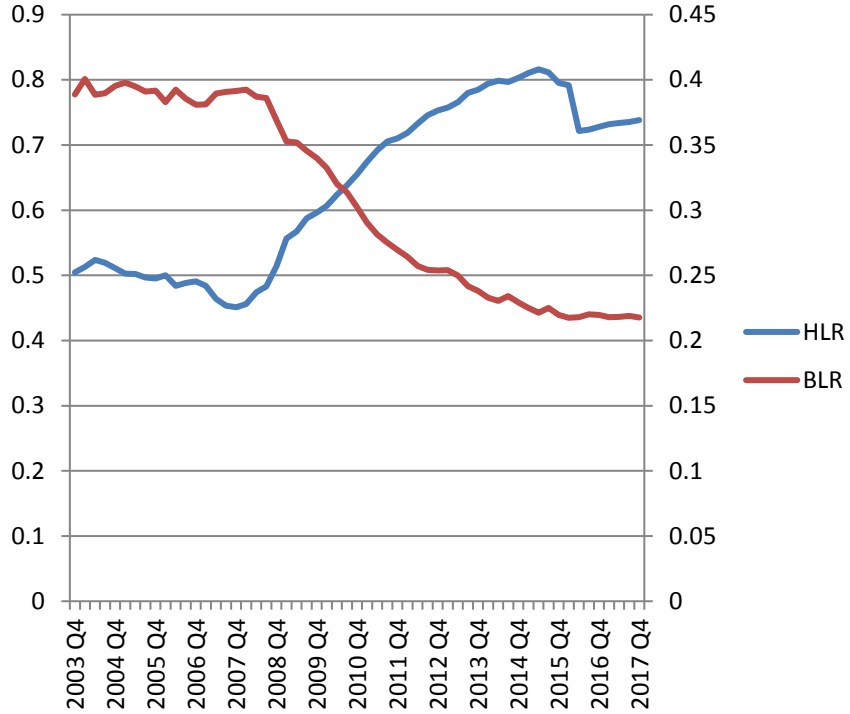
Panel A: The Big Four banks, other Australian banks and foreign banks



Panel B: The Big Four banks



Panel C: Other Australian banks



Panel D: Foreign banks

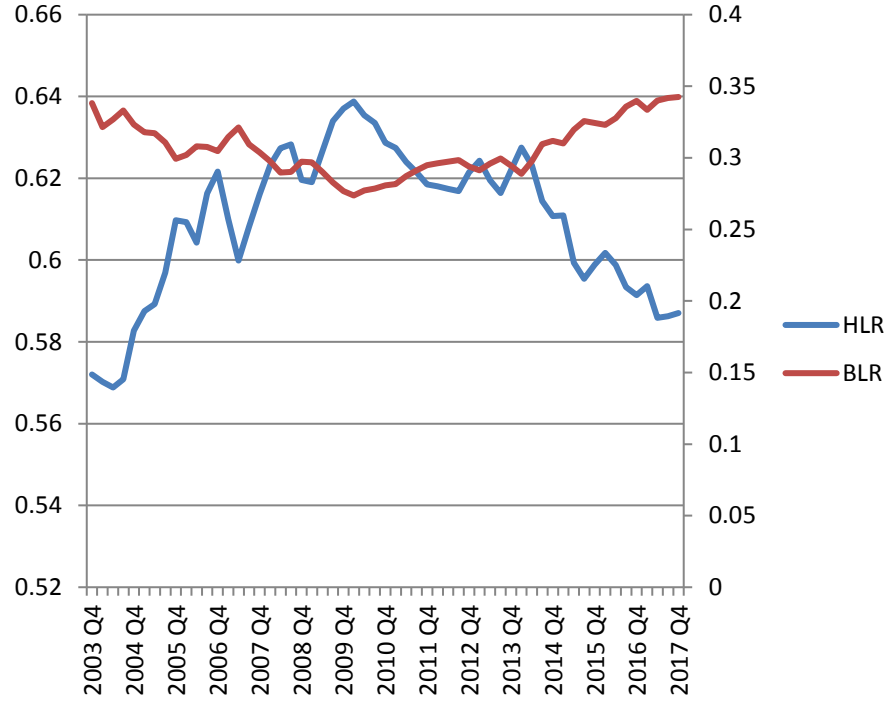


Figure 3 Housing Price Indices

Note: Residential Property Price Index (RPPI) is an aggregation of the Housing Price Index (HPI) and the Attached Dwellings Price Index (ADPI). HPI is a measure of the price evolution in all established detached houses within the eight greater capital city statistical areas (GCCSAs). ADPI is a measure of the price evolution of attached dwellings within the eight GCCSAs.

Figure 4 Impulse Response Functions for the PVAR model with ordering *dresprice*, *ΔRATIO*, *dbi*.

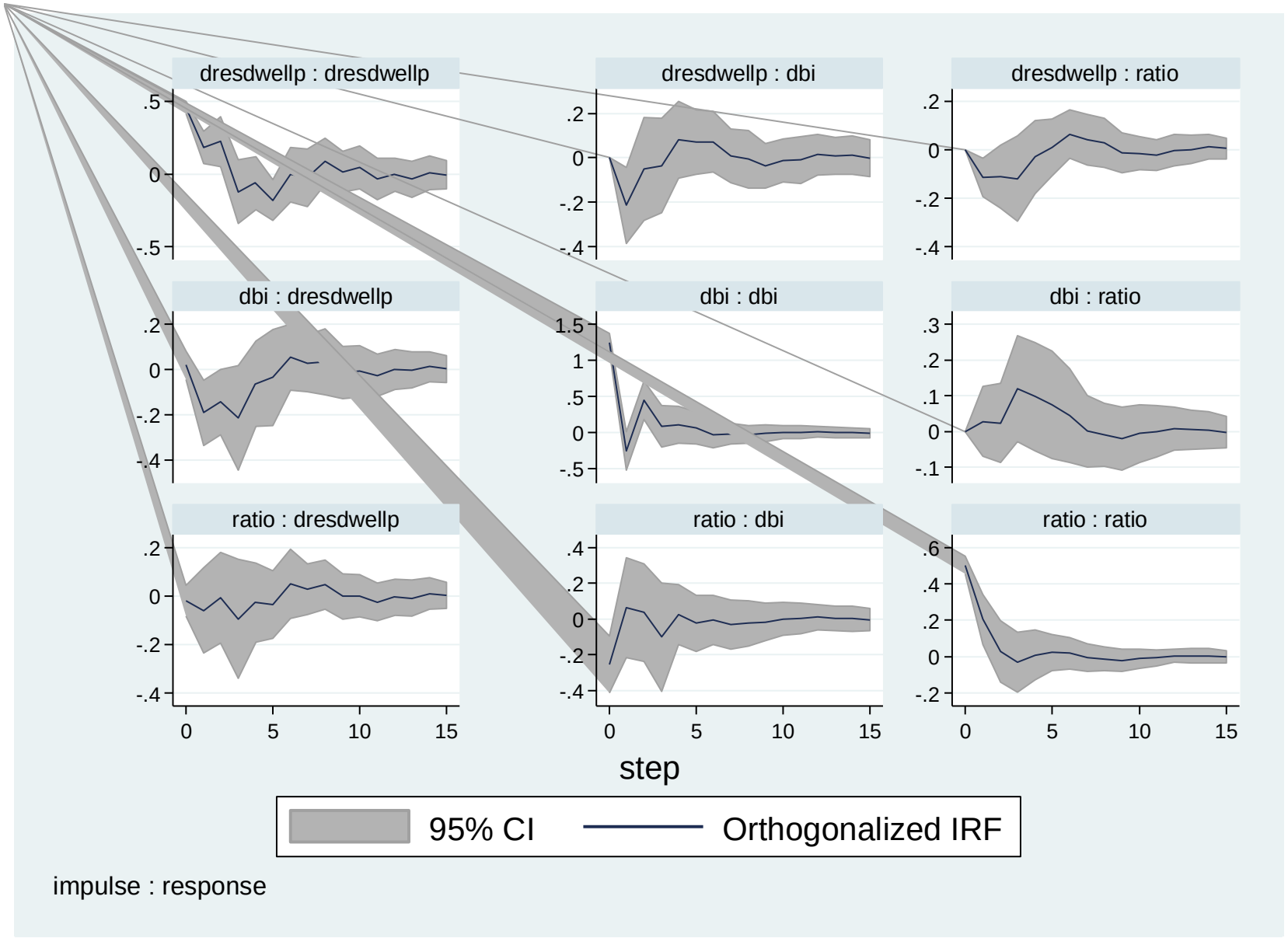


Figure 5 Impulse Response Functions for the PVAR model with ordering *dbi*, *ΔRATIO*, *dresprice*.

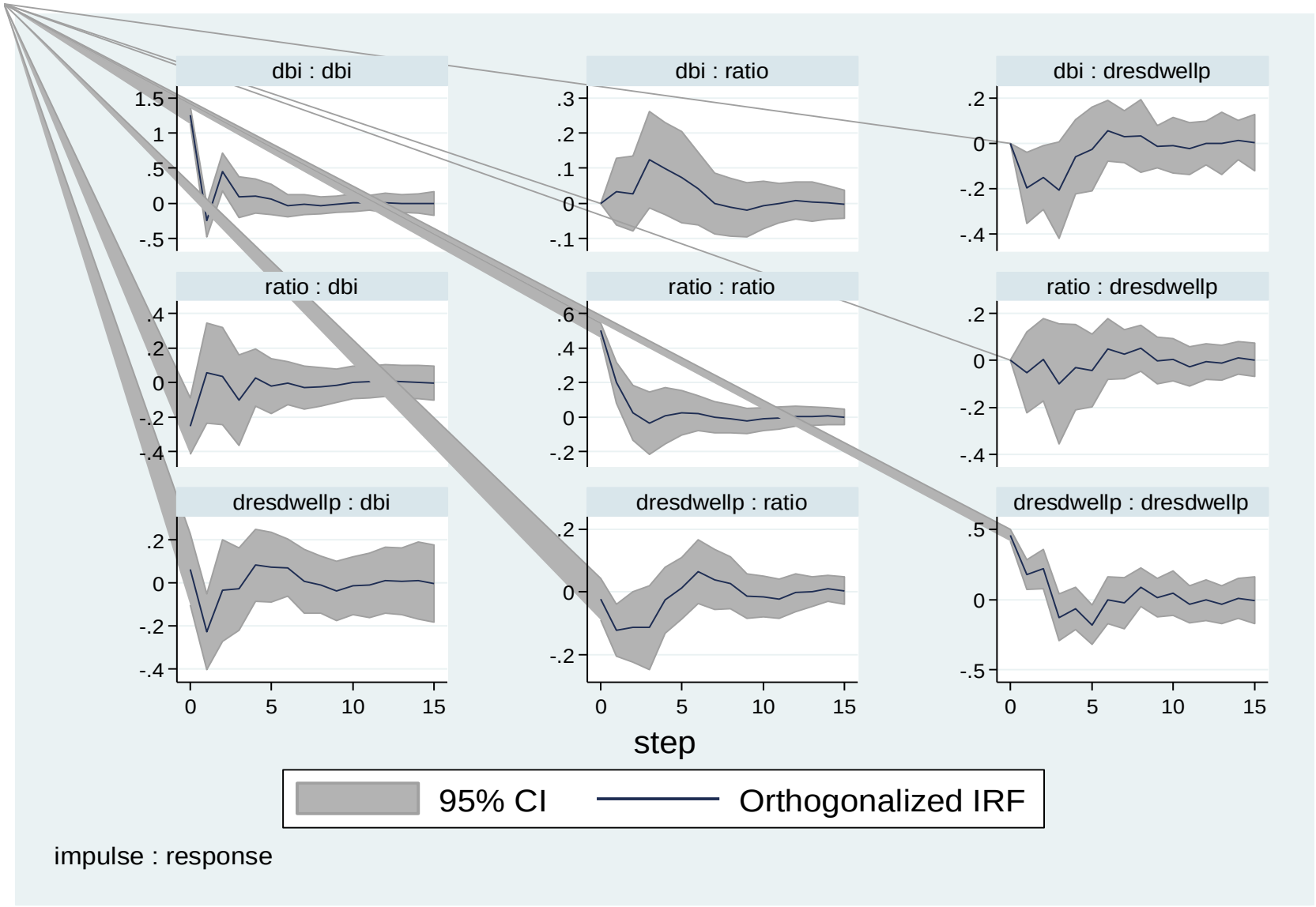


Figure 6 Impulse Response Functions for the PVAR model with ordering *dresprice*, *ΔRATIO*, *dbdi*.

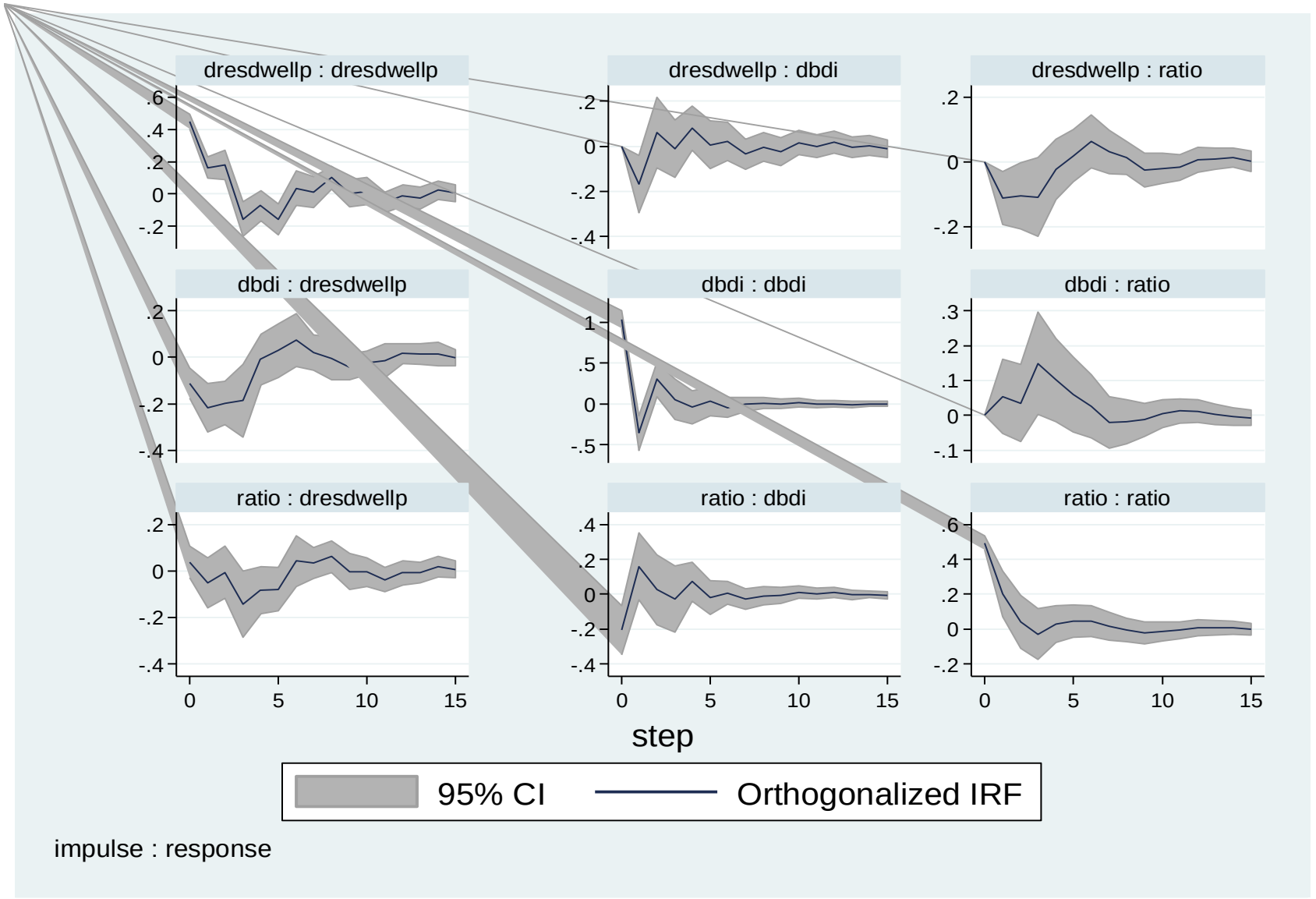


Table 1 Data summary statistics

Note: The list of banks for the Big Four, other Australian banks, and foreign banks are found in Table A1. The sample of other Australian banks and foreign banks comprise the last 15 banks in Table A1. Private sector loan excludes loans to government and charitable, non-profit organizations. Change in variable denotes the growth rate of the variable and it is computed by taking the first difference of the logarithm of the series. For variables definitions refer to Table A2.

I. Banks variables	Big Four banks					Other Australian banks					Other Australian and Foreign banks				
	Mean	Std dev	Min	Max	Obs	Mean	Std dev	Min	Max	Obs	Mean	Std dev	Min	Max	Obs
Total Asset (in mil)	449147	184889	155604	820973	228	35415	21914	2286	85868	285	23723	25478	67	132933	769
Housing loan value (in mil)	200726	90367.7	64689.6	412553	228	15301	11507	552.5	41311	285	10434	13706	0.4	76711	769
Business loan value (in mil)	79641.5	31161.5	25671.6	151941	228	6623.9	5376	311.3	24088	285	4496.8	5366.9	5.7	25277.6	769
Change in total assets (*dtotass*)	2.459	2.527	-4.198	14.351	228	2.656	5.282	-17.238	35.281	285	2.196	7.544	-47.208	63.638	855
Change in housing loans (*dhl*)	1.108	1.129	-0.983	11.312	228	1.733	4.959	-40.252	31.754	285	1.095	6.456	-59.598	86.332	832
Change Business loans (*dbusloan*)	2.501	2.965	-5.561	23.527	228	2.037	5.427	-30.270	27.502	285	2.067	19.723	-203.43	183.094	855
Change in consumer credit (*dconscr*)	0.454	1.998	-8.388	13.026	228	-	-	-	-	-	-	-	-	-	-
Housing loan ratio (to private sector loan)	0.6601	0.0688	0.5402	0.7657	228	0.6233	0.2043	0.1012	0.8761	285	0.3251	0.2715	0.0003	0.8761	769
Business loan ratio (to private sector loan)	0.2636	0.0603	0.1721	0.3666	228	0.2656	0.1111	0.0735	0.5167	285	0.3179	0.3074	0.0006	0.9997	769
Capital adequacy ratio (*CAR*)	11.543	1.351	9.7	14.7	228	11.543	1.351	9.7	14.7	285	11.543	1.351	9.7	14.7	285

Liquidity ratio (*liquidratio*)	2.499	0.845	0.892	6.245	228	4.145	5.310	0.280	27.862	285	5.598	9.441	0.028	81.884	855
Deposit ratio (*depratio*)	53.938	5.427	41.152	69.946	228	64.393	17.380	24.156	87.020	285	54.758	24.707	2.397	89.514	855
ΔRatio	-0.0117	0.615	-3.245	2.191	228	0.0069	0.1299	-1.311	0.383	285	-.0360	3.882	-15.820	100	855
Profit margin	0.316	0.060	0.081	0.398	55	-	-	-	-	-	-	-	-	-	-
II. Macroeconomic variables															
Real GDP growth (*realgdp*)	2.891	0.860	1.4	5.1	57										
Change in business investment (*dbi*)	0.438	1.457	-2.280	4.807	57										
Change in business and dwelling investment (*dbdi*)	0.347	1.054	-1.605	3.302	57										
Change in residential dwelling price (*dresprice*)	1.359	1.826	-2.222	5.532	57										
Change in cash rate (*dcashrate*)	-0.057	.392	-1.886	0.573	57										
Business condition Index (*buscond*)	6.358	7.893	-13.548	18.032	57										
Uncertainty (*uncertainty*)	102.589	53.521	30.343	255.672	57										

Table 2 Loan growth and the change in business loans ratio regressions for the Big Four Banks

Note: For variables without a time subscript, they indicate contemporaneous variables with respect to the dependent variable. Figures in parentheses are p-values. For variables definitions refer to Table A2.

	(1) dbusloan	(2) dhl	(3) ΔRatio
$dresprice_{t-1}$	-0.884	0.232	-0.229
	(0.001)	(0.027)	(0.000)
depratio	0.018	0.015	0.005
	(0.730)	(0.479)	(0.623)
liquidratio	-0.247	-0.216	0.199
	(0.320)	(0.034)	(0.720)
CAR	-1.361	0.153	-0.508
	(0.002)	(0.342)	(0.000)
dtotass	0.425	0.189	-0.011
	(0.000)	(0.000)	(0.544)
realGDP	-0.023	-0.200	0.022
	(0.933)	(0.078)	(0.730)
buscond	0.150	0.014	0.052
	(0.004)	(0.485)	(0.000)
uncertainty	0.004	0.003	0.0003
	(0.358)	(0.131)	(0.694)
dcashrate	0.067	-0.224	-0.456
	(0.925)	(0.336)	(0.005)
Intercept	-2.678	4.661	-0.187
	(0.425)	(0.001)	(0.000)
Fixed effects and time dummy	Yes	Yes	Yes
Obs.	224	224	224
Adjusted R^2	0.318	0.256	0.250

Table 3 Panel VAR regression for the Big Four Banks

Note: For variables without a time subscript, they indicate contemporaneous variables with respect to the dependent variable. Figures in parentheses are p-values. For variables definitions refer to Table A2.

	(1) dresprice	(2) ΔRATIO	(3) dbi
$\Delta RATIO_{t-1}$	-0.181	-0.411	0.011
	(0.280)	(0.002)	(0.967)
$\Delta RATIO_{t-2}$	0.095	-0.155	0.164
	(0.511)	(0.180)	(0.512)
$\Delta RATIO_{t-3}$	-0.211	-0.007	-0.217
	(0.207)	(0.947)	(0.385)
dbi_{t-1}	-0.158	0.026	-0.197
	(0.009)	(0.504)	(0.052)
dbi_{t-2}	-0.085	-0.023	0.247
	(0.137)	(0.558)	(0.013)
dbi_{t-3}	-0.043	0.045	0.127
	(0.482)	(0.220)	(0.149)
$dresprice_{t-1}$	0.400	-0.251	-0.467
	(0.001)	(0.006)	(0.014)
$dresprice_{t-2}$	0.209	-0.027	-0.014
	(0.152)	(0.781)	(0.954)
$dresprice_{t-3}$	-0.625	-0.076	0.294
	(0.000)	(0.326)	(0.084)
depratio	-0.003	-0.048	0.275
	(0.983)	(0.488)	(0.129)
liquidratio	0.179	0.159	-0.129
	(0.496)	(0.287)	(0.716)
CAR	-0.102	-0.555	1. 345
	(0.745)	(0.040)	(0.030)
dtotass	0.002	-0.009	0.067
	(0.942)	(0.787)	(0.234)
realGDP	0.187	-0.132	1.053
	(0.347)	(0.355)	(0.003)
buscond	0.011	0.046	-0.031
	(0.732)	(0.057)	(0.521)
uncertainty	-0.002	0.001	0.000
	(0.346)	(0.647)	(0.988)
dcashrate	-0.200	-0.083	1.189
	(0.672)	(0.822)	(0.077)

Table 4 Panel VAR Granger causality Wald test

Note: The null hypothesis is that the excluded variable does not Granger-cause the equation variable, while the alternative hypothesis is that the excluded variable Granger-causes the equation variable. For variables definitions refer to Table A2.

Panel A: dbi

Equation/ Excluded	χ^2	p-value
ΔRATIO		
dbi	3.353	0.340
dresprice	7.672	0.053
dbi		
ΔRATIO	1.137	0.768
dresprice	12.294	0.006
dresprice		
ΔRATIO	2.230	0.526
dbi	9.277	0.026

Panel B: dbdi

Equation/ Excluded	χ^2	p-value
ΔRATIO		
dbdi	3.283	0.350
dresprice	7.919	0.048
dbdi		
ΔRATIO	2.006	0.571
dresprice	16.599	0.001
dresprice		
ΔRATIO	7.473	0.058
dbdi	26.900	0.000

Table 5 Forecast error variance decomposition

Note. The figures in column (1) denote the time period associated with the forecast error variance that is explained by the impulse variable. For variables definitions refer to Table A2.

Response variable	Impulse variable		
dresprice	dresprice	ΔRATIO	dbi
0	0.000	0.000	0.000
1	1.000	0.000	0.000
2	0.852	0.009	0.138
3	0.816	0.007	0.177
4	0.720	0.030	0.250
5	0.715	0.032	0.254
6	0.731	0.033	0.236
7	0.723	0.038	0.240
8	0.721	0.039	0.240
9	0.720	0.044	0.237
10	0.720	0.043	0.237
ΔRATIO	dresprice	ΔRATIO	dbi
0	0	0	0
1	0.002	0.998	0.000
2	0.050	0.946	0.003
3	0.086	0.908	0.006
4	0.115	0.836	0.049
5	0.114	0.812	0.074
6	0.112	0.799	0.088
7	0.122	0.787	0.091
8	0.125	0.784	0.091
9	0.127	0.782	0.091
10	0.127	0.781	0.092
dbi	dresprice	ΔRATIO	dbi
0	0	0	0
1	0.002	0.039	0.959
2	0.032	0.038	0.930
3	0.029	0.035	0.936
4	0.029	0.040	0.931
5	0.032	0.040	0.928
6	0.035	0.040	0.926
7	0.037	0.039	0.923
8	0.037	0.040	0.923
9	0.037	0.040	0.923
10	0.038	0.040	0.922

Table 6 Profitability of the Big Four Banks, Housing and Business Loans

Note: The time series regression is for the Big Four banks over the period 2004Q2-2017Q4. The dependent variable is the profit margin. Figures in parentheses are p-values. HLratio is the ratio of housing loans over the sum of housing and business loans. BLratio is the ratio of business loans over the sum of housing and business loans. For variables definitions refer to Table A2.

	(1)	(2)
liquidratio	2.061	2.470
	(0.204)	(0.118)
HLratio	1.954	
	(0.015)	
BLratio		-2.321
		(0.003)
dresprice	0.002	-0.0002
	(0.816)	(0.983)
depratio	-1.257	-0.999
	(0.027)	(0.029)
CAR	-3.930	-4.088
	(0.007)	(0.004)
dtotass	0.101	0.105
	(0.714)	(0.692)
trend	0.004	0.005
	(0.021)	(0.001)
Intercept	-0.049	1.666
	(0.904)	(0.0001)
Obs.	55	55
Adjusted R^2	0.21	0.26

Table 7 Consumer credit growth and the change in consumer credit ratio regressions for the Big Four Banks

Note: For variables without a time subscript, they indicate contemporaneous variables with respect to the dependent variable. Figures in parentheses are p-values. The dependent variable dconscr is the change in the consumer credit while ΔRatio_Cons refers to the change in the ratio of consumer credit to the sum consumer credit and housing loans. For variables definitions refer to Table A2.

	(1) dconscr	(2) dhl	(3) ΔRatio_Cons
$dresprice_{t-1}$	0.3325	0.232	-0.1007
	(0.101)	(0.027)	(0.325)
depratio	0.063	0.015	0.149
	(0.126)	(0.479)	(0.000)
liquidratio	-0.265	-0.216	-0.127
	(0.175)	(0.034)	(0.197)
CAR	-0.412	0.153	-1.590
	(0.005)	(0.342)	(0.000)
dtotass	0.067	0.189	-0.034
	(0.290)	(0.000)	(0.285)
realGDP	-0.403	-0.200	-0.537
	(0.060)	(0.078)	(0.000)
buscond	0.042	0.014	0.183
	(0.221)	(0.485)	(0.000)
uncertainty	-0.003	0.003	0.0021
	(0.430)	(0.131)	(0.230)
dcashrate	0.423	-0.224	-1.442
	(0.412)	(0.336)	(0.000)
Intercept	3.291	4.661	0.1455
	(0.148)	(0.001)	(0.000)
Fixed effects and time dummy	Yes	Yes	Yes
Obs.	224	224	224
Adjusted R^2	0.13	0.256	0.523

Table 8 Loan growth and the change in business loans ratio regressions for the other Australian banks

Note: For variables without a time subscript, they indicate contemporaneous variables with respect to the dependent variable. Figures in parentheses are p-values. For variables definitions refer to Table A2.

	(1) dbusloan	(2) dhl	(3) ΔRatio
$dresprice_{t-1}$	-0.597	-0.606	-0.006
	(0.208)	(0.154)	(0.620)
depratio	-0.028	0.060	0.002
	(0.352)	(0.027)	(0.002)
liquidratio	-0.030	-0.074	0.001
	(0.814)	(0.515)	(0.727)
CAR	-0.515	0.125	-0.037
	(0.484)	(0.849)	(0.050)
dtotass	0.417	0.350	-0.001
	(0.000)	(0.000)	(0.495)
realGDP	0.159	-0.166	0.003
	(0.747)	(0.708)	(0.759)
buscond	0.045	-0.099	-0.0003
	(0.613)	(0.207)	(0.893)
uncertainty	-0.019	-0.001	-0.0001
	(0.013)	(0.862)	(0.319)
dcashrate	0.194	1.213	-0.008
	(0.875)	(0.274)	(0.791)
Intercept	2.027	-0.872	-0.031
	(0.732)	(0.869)	(0.838)
Fixed effects and time dummy	Yes	Yes	Yes
Obs.	280	280	280
Adjusted R^2	0.186	0.097	0. 160

Table 9 Panel VAR regression for the other Australian banks

Note: For variables without a time subscript, they indicate contemporaneous variables with respect to the dependent variable. Figures in parentheses are p-values. For variables definitions refer to Table A2.

	(1) dresprice	(2) ΔRATIO	(3) dbi
$\Delta RATIO_{t-1}$	0.771	0.513	1.295
	(0.124)	(0.003)	(0.037)
$\Delta RATIO_{t-2}$	-0.352	-0.039	0.574
	(0.462)	(0.611)	(0.489)
$\Delta RATIO_{t-3}$	-0.347	-0.009	0.754
	(0.501)	(0.909)	(0.218)
dbi_{t-1}	-0.193	0.005	-0.118
	(0.000)	(0.274)	(0.047)
dbi_{t-2}	-0.108	0.001	0.284
	(0.001)	(0.779)	(0.000)
dbi_{t-3}	-0.038	-0.007	0.103
	(0.256)	(0.111)	(0.011)
$dresprice_{t-1}$	0.328	0.004	-0.396
	(0.000)	(0.787)	(0.006)
$dresprice_{t-2}$	0.277	-0.002	0.044
	(0.000)	(0.891)	(0.788)
$dresprice_{t-3}$	-0.579	0.009	0.264
	(0.000)	(0.309)	(0.011)
depratio	-0.005	-0.001	0.042
	(0.668)	(0.490)	(0.041)
liquidratio	-0.012	-0.002	-0.830
	(0.608)	(0.637)	(0.072)
CAR	-0.209	0.044	1.578
	(0.251)	(0.235)	(0.001)
dtotass	-0.004	0.002	0.026
	(0.675)	(0.376)	(0.079)
realGDP	0.147	0.040	1.126
	(0.143)	(0.036)	(0.000)
buscond	0.015	0.007	0.080
	(0.363)	(0.032)	(0.028)
uncertainty	-0.001	-0.0004	0.0042
	(0.140)	(0.002)	(0.079)
dcashrate	-0.188	0.048	-1.688
	(0.214)	(0.124)	(0.000)

Table 10 Panel VAR regression with business and dwelling investment

Note: For variables without a time subscript, they indicate contemporaneous variables with respect to the dependent variable. Figures in parentheses are p-values. For variables definitions refer to Table A2.

	(1) dresprice	(2) ΔRATIO	(3) dbdi
$\Delta RATIO_{t-1}$	-0.204	0.437	0.090
	(0.038)	(0.000)	(0.280)
$\Delta RATIO_{t-2}$	0.092	-0.144	0.082
	(0.286)	(0.179)	(0.657)
$\Delta RATIO_{t-3}$	-0.246	-0.002	-0.042
	(0.016)	(0.982)	(0.805)
$dbdi_{t-1}$	-0.173	0.026	-0.386
	(0.000)	(0.615)	(0.000)
$dbdi_{t-2}$	-0.148	-0.036	0.089
	(0.001)	(0.453)	(0.350)
$dbdi_{t-3}$	-0.143	0.055	0.176
	(0.011)	(0.232)	(0.045)
$dresprice_{t-1}$	0.364	-0.251	-0.372
	(0.000)	(0.005)	(0.008)
$dresprice_{t-2}$	0.149	-0.024	0.177
	(0.084)	(0.766)	(0.293)
$dresprice_{t-3}$	-0.603	-0.086	0.208
	(0.000)	(0.242)	(0.098)
depratio	-0.050	-0.040	0.250
	(0.467)	(0.492)	(0.025)
liquidratio	0.240	0.173	-0.216
	(0.115)	(0.182)	(0.354)
CAR	-0.303	-0.497	1. 132
	(0.131)	(0.036)	(0.005)
dtotass	-0.010	-0.004	0.090
	(0.683)	(0.888)	(0.030)
realGDP	0.137	-0.114	0.935
	(0.226)	(0.354)	(0.000)
buscond	0.015	0.043	-0.042
	(0.458)	(0.058)	(0. 851)
uncertainty	-0.0004	0.001	0.001
	(0.705)	(0.604)	(0.724)
dcashrate	-0.150	-0.020	1.216
	(0.613)	(0.953)	(0.012)

Table A1 Samples of Banks

ABN	Name	Bank Type
Australian Big Four Banks		
11005357522	Australia and New Zealand Banking Group Limited	Aus
12004044937	National Australia Bank Limited	Aus
33007457141	Westpac Banking Corporation	Aus
48123123124	Commonwealth Bank of Australia	Aus
Australian Other Banks		
11068049178	Bendigo and Adelaide Bank Limited	Aus
15081596009	AMP Bank Limited	Aus
32009656740	Bank of Queensland Limited	Aus
46008583542	Macquarie Bank Limited	Aus
66010831722	Suncorp-Metway Limited	Aus
Foreign Banks		
17061700712	Credit Suisse AG	Foreign
24000893292	ING Bank (Australia) Limited	Foreign
27079372688	Mega International Commercial Bank Co., Ltd.	Foreign
36078577250	Taiwan Business Bank	Foreign
37002950745	Arab Bank Australia Limited	Foreign
44093488629	Bank of Sydney Ltd	Foreign
48006434162	HSBC Bank Australia Limited	Foreign
50001621129	Rabobank Australia Limited	Foreign
56060785284	United Overseas Bank Limited	Foreign
88004325080	Citigroup Pty Limited	Foreign

Note: ABN is a unique 11-digit Australian business number.

Table A2 Variables Definition and Data Source

Variables	Definition	Data Source
I. Bank Level variables		
Change in total assets (*dtotass*)	Log difference of total assets	APRA Monthly banking statistics
Change in housing loans (*dhl*)	Log difference of housing loans	
Change Business loans (*dbusloan*)	Log difference of business loans	
Change in consumer credit (*dconscr*)	Log difference of consumer credit	
Capital adequacy ratio (*CAR*)	The ratio of capital over risk-weighted assets (%)	
Liquidity ratio (*liquidratio*)	Cash and liquid assets divided by total assets (%)	
Deposit ratio (*depratio*)	Total deposits divided by total assets (%)	
ΔRatio	The change in the ratio of business loans over the sum of business and housing loans	
ΔRatio_Cons	The change in the ratio of consumer credit to the sum consumer credit and housing loans	
HLratio	The ratio of housing loans to the sum of housing and business loans	
BLratio	The ratio of business loans to the sum of housing and business loans	
Profit margin	The net profit for the period divided by total operating income for the period	APRA Quarterly authorized deposit-taking institution performance statistics
II. Macroeconomic variables		
Real GDP growth (*realgdp*)	Quarterly GDP growth	Reserve Bank of Australia
Change in cash rate (*dcashrate*)	The quarterly difference in cash rate	
Change in business investment (*dbi*)	First difference of logarithm of quarterly business investment. Business investment data exclude dwelling investment.	
Change in business and dwelling investment (*dbdi*)	First difference of logarithm of quarterly sum of business and dwelling investment.	
Change in residential dwelling price	Log difference of Residential Property Prices Index (RPPI) which is the	Australian Bureau of Statistics

(*dresprice*)	weighted average price index of all detached and attached dwellings across Australia.	
Business condition Index (*buscond*)	The business conditions index is obtained from the NAB monthly business survey. Quarterly data are obtained by taking the three monthly indices average for the quarter.	
Uncertainty (*uncertainty*)	Economic policy uncertainty index	http://www.policyuncertainty.com/australia_monthly.html