MACROECONOMIC CONDITIONS AND BANK RISK-TAKING IN AUSTRALIA

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A thesis submitted in partial fulfillment of the requirement for MRes degree in economics,

Faculty of Business and Economics, Macquarie University

SEPTEMBER 2016

ACKNOWLEDGEMENT

I am deeply grateful to Associate Professor Tony Bryant and Dr Ben Wang for providing supervision and support academically during my study.

I would like to thank Associate Professor Roselyne Joyeux, Senior Lecturer Daehoon Nahm, Macquarie university, Dr. Anh Tuan Bui, Torrens University Australia, Dr. Thu Phuong Pham, University of Adelaide for data collection and helpful discussion.

I am also thankful to all other academics, postgraduate coordinators and managers, administrative staffs at HDR and Department of economics for their support and hospitality

Finally, I would also like to thank the Macquarie Research Excellence Scholarship for International Research Training Pathway for financial supports.

Minh Dang Bui, Sydney, September 2016

STATEMENT OF ORIGINALITY

This is to certify that to the best of my knowledge, the content of this thesis is my own work.

This thesis has not been submitted for any degree or other purposes.

Minh Dang Bui

Sydney, September 2016

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ABBREVIATIONS

APRA	The Australian Prudential Regulation
ECB	European central bank
RBA	Reserve Bank of Australia
SNIBs	Small non-investment banks

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Aim: The aim of this study is to investigate the relationship between bank risk taking and the macro-economic environment in Australia, at institution level, from July 2002 till December 2015.

Abstract

There are strong arguments in economic theory suggesting that macroeconomic conditions may have significant impacts on the risk-taking behavior among banks. This thesis uses about 8100 monthly observations of Australia banks from July 2004 to December 2015 to study the empirical relationship between the macro environment and bank risk-taking behavior. The results of this study find relationships between general macro indicators and bank risk taking behavior are varying with different types of bank, time frame and with different proxy for bank risk taking. Interest rates and in particular the prolonged low interest rate environment does encourage bank increase the portion of risky assets to total assets through housing market loans. This makes banks more reliant on lending for housing and hence more risky propositions.

Chapter 1 : Introduction and Motivation

1.0. Introduction

In recent years, extended periods of low interest rate have attracted a lot of attention globally. Narrative states that low interest rates encourage risk taking behavior among financial institutions. At current interest rate, another crisis might occur the very same dynamic.

Rajan (2006) suggested that investment managers tend to take risk to search for yield in low interest rate environments. Previous studies in this field suggest that there are ways in which low interest rate encourages banks to accept higher risk.

Low interest rate environments could have impact on valuation, cash flow, which could influence the process of risk measuring or scanning process (Adrian et al., 2009a; 2009b; Borio et al., 2008). In addition, lower return on risk free assets and investment urge banks, business managers and insurance companies seeking riskier investment to reach target return (Brunnermeier, 2001; Rajan, 2006). The above arguments, which imply that changing in interest rates affect the riskiness of the borrowers, are also supported by the financial models of Bernanke and Gertler.[1]

While most of the variability in banks' performance is due to variances between banks, macroeconomic indicators are also found to have strong influences on each banks' risk and profitability. For example, the share of interest payments in the corporate and household sectors' income, real credit growth and property prices are most strongly correlated with banks' risk and profitability.

These are many studies support the idea that macroeconomic shocks or policies that cause weaker informational asymmetries, stronger competition and credit booming encourage banks to lower lending standard and increase risk assets ratio which cause devaluation of charter value and increase probability of banking crises.[2]

[1] Ben Bernanke, Mark Gertler, Simon Gilchrist (1996)

[2] See Laubach and Williams (2003), Borio and Zhu (2008), Bernanke (2010), Caballero and Farhi (2014) Hanson and Stein (2015)

Despite there being a strong theoretical literature relating risk taking are macroeconomic conditions, empirical studies in this field are quite limited to the studies of Jimenez et al. (2008); Ioannidou et al. (2009); Brissimis and Delis (2009) and Delis et al. (2010) which focus on European and US banking systems.

More studies are needed on investigate the relationship between interest rate and banking risk. Therefore, this term aims to contribute to the literature in following ways:

First, the paper is concern with the impact of the level of interest rate before and post financial crisis rather than that of monetary policy in general. It's expected that an empirical study on both interest rate level and the prolonged low interest rate is more consistent with the previous literature proposed by Dell' Ariccia and Marquez (2006) and Rajan (2006) because high level of interest rates could also imply in an expansionary monetary policy. Since from 2012, the interest rate level in Australia has remained relatively stable at low level and have downward trend, a simple sensitivity analysis that only capture the impact of interest rate level but "prolonged" low interest rate environment may not consistent with proposed studies.

Second, the papers focus on single economic, Australia, which is not covered in the previous studies about bank risk taking and Australian banking system has very different characteristics and regulations to other developed countries' banking systems suggested by Hawtrey (2009) and Bologna (2010). For specific, while US and most of European countries have witnessed bank collapses and bailouts supported by the government since the most recent financial crisis, Australian banks have shown remarkable resilience. No Australian bank have been bailed out, downgraded in credit rating or faced liquidity crunch. In addition, Australian banks have also avoided abnormal loan write-downs and their share price remained relatively stable during the crisis.

There are several key factors that explain the outstanding resilience of Australian banks. The first factor is that the role of Australian banks is intermediation not securitization. Australia's impaired loan was the lowest in the world during the crisis, at just 0.2 per cent of total loans outstanding. This number is substantial in other developed countries, notably the UK

(0.9); US (1.1); France (2.8); Germany (3.4); Italy (5.3)[3]. Although securitization has been appeared in Australia before the crisis, intermediation still dominate the market, particularly in house purchase lending. The "non-conforming housing loan" sector in Australia (which is similar to sub-prime market in US) has remained small, at only 1 per cent of outstanding mortgages – compare to 12 per cent in US. In addition, the provision of Australia banks is far higher than the amount of impaired loan. In 2008, Australia is one of the few countries in the world keeping a provision ratio greater than 100 per cent, which is far greater than that of US and about four times that of UK banks.

Another factor is that Australia banks are well capitalized. In the end of 2008, at the peak of the financial crisis, Australian banks achieved the minimum capital requirement of Basel II framework contentedly. Also, banks in Australia have not had to raise new capital to offset loan write-down. APRA concluded the position this way: "ADI in Australia are meeting their capital-adequacy requirements and the ADI sector is sound and well-capitalized"[4].

A stable funding base is also an important factor contributing to the resilience of Australian banks. Australian bank generally raise their funds from customer deposit – core deposit (around 50 per cent) and whole sale funding, with both short-term and long-term stay around 25 per cent. Since the global capital market turmoil, many financial institutions, particularly in US, UK and Euro area, has had considerable difficulty in raising fund. Short term funding costs have unusual unpredictable while long term funding have become limited and investors have become more selective. However, Australian banks have witnessed a rapid growth in retail funding. Australian banks deposits have grown at about 20 per cent, the fastest growth in many years. In addition, whole sale funding of Australian banks has increased dramatically during this period. Despite Australian banks may have had to pay more for funds, they can still have mobilized enough funds to expand their balance sheets. From 2007 to the end of 2008, Australian banks raised funds their own without government's assistant.

[3] International Monetary Fund, Global Financial Stability Report, April 2008
[4] Australian Prudential Regulation Authority 2008

Beside aforementioned factors contributing to the stable of Australian banks, other factors are the Australian industry is marked by dynamic competition, good corporate governance, renowned prudential regulation system, separation of commercial banking from social-assistant policy[5] .

Despite being resilience during the last financial crisis, Australian banks have not been totally immune to the subsequence effects. The increasing possibility of assets price bubble, the reliance on wholesale funding which leads to very high cost debts and morale hazard in lending due to government guarantee are causes for concern.[6] While in some countries, the central banks have made timid openings to the idea of having credit aggregates and assets price in their policy decisions (Bernanke 2011; Mishkin 2011), most central banks, including Australian central bank have maintained their pre-crisis policy frameworks. These policy frameworks, in general, have two mains weakness (Dell'Ariccia 2012).

The first weakness is that they have not been very good at dealing with aggregate credit dynamics associated with real estate booms. Before the crisis, there was the long-standing viewpoint is that it was better to deal with the crisis bust than trying to prevent it. Central banks typically focus on price stability as their main objective and consider financial institution as the realm of bank regulatory. However, regulatory policy mainly focused on individual institutions and was not prepared for real estate booms and the associated credit booms.

Another gap in the previous economic literature is that, in models dealing with inflation and macroeconomics cycle, the role of finance and financial stability were not well mentioned. Corporate finance models dealing with bank risk-taking focus on reducing market failures caused by limited liability and asymmetric information. In general, these models ignored monetary policy (especially level of interest rate and the prolonged period of low interest rate) and property prices.

It's necessary to conduct a study about Australian banks that can capture both the effect of monetary policy and the property prices on bank risk taking behavior to fill the gaps in the literature. It's important to see how Australia policy frameworks have worked before, during

[5] Hawtrey, K. (2009).
[6] Dell'Ariccia, G. (2012) and Agarwal, S., and Jayasuriya, D. (2015)

and after the crisis and does these policy frameworks encourage bank risking or other underlying effects.

1.1. Thesis structure

The balance of this thesis comprises four main chapters with a conclusion. The next chapter begins with the theoretical work of Keeley (1990) and is devoted to a survey of theoretical argument which suggest a connection between interest rate levels and an increased propensity for banks to take greater risks. Work studied here includes Dell's Ariccia and Marquez (2006), Agur and Demertzis (2010) and Dell' Ariccia et al. (2014), among others.

Chapter 3, the thesis points out general experimental evidence on the connection between interest rates and risk taking behavior in previous studies, for example, Jimenez et al. (2008), Festic et al. (2011), Delis and Kouretas (2011), Altunbas et al. (2012), Buch et al. (2014)

Chapter 4 uses an appropriate empirical methodology of Delis et al. (2011) and other studies to examine the connection between macroeconomic variables and bank–risk taking. Notwithstanding the powerful theoretical arguments encountered in Chapter 2, backed up by the empirical evidence surveyed in Chapter 3 for a negative correlation between interest rates and bank risk–taking, the empirical study presented here begins with an open mind about:

(i) The existence of a connection between interest rates and bank risk–taking; and

(ii) The sign of any such connection, should one exist.

(iii) Direct interest rate level or prolonged low interest rate is the main factor affect bank risk taking

Chapter 5 is the about the conclusion and the policy implication for banks base on the above founding. Banks are the key part of the financial system, instability in banks has the potential to destabilize the entire financial system along with the whole economy. The thesis ends with a discussion of the implication of the result, potential for future research and some concluding remark.

Chapter 2 : Bank Risk–Taking and Macroeconomic Conditions: Theory

2.0. Introduction

In this chapter, theories about the link between macro-economic conditions and bank risk taking behavior, with concentration on monetary policy and interest rate, are reviewed. In general, theories suggest that lax monetary policy, low interest rate environment encourage risk taking behavior of bank through a mechanism defined as risk taking channel of monetary policy.

2.1. Literature review

2.1.0. Monetary policy and bank risk taking

The argument shows a possible connection between monetary policy and risk behavior, which defined as monetary policy's risk taking channel, has been triggered since the global financial crisis. It has been suggested that the interest rate level, one common tool of monetary policy, have effects not only on *quantity* but also *quality* of bank credit. A number of papers claim that a prolonged low interest rate environment will lead to financial crisis. For example, Taylor (2009) argued that low interest rate environment contributes to assets price boom, which is the main reason for the financial crisis in 2008. Take US economy for example, when interest rate stays lower than the level estimated by Taylor's Rule, it over encourages investors search for yield. It can be stated that inappropriate low interest rate combines with lax regulation will lead to a large but also fragile economy. The most outstanding evidence for this argument is the growth of house prices in US before the onset of the global financial crisis. In general, Taylor and many observers have the same agreement, however they do have difference of emphasis. Bernanke (2010), for example, only considered the role of interest rate to be secondary or indirect while the main contributor, according to him, is lax regulation.

In addition, Borio and Zhu (2008) and Adrian and Shin (2009) claimed low interest rate environment creates incentive for financial institutions to increase leverage and risky behavior by reducing the risk aversion of banks. This mechanism is defined as the risk-taking channel. Diamond and Raijan (2010) and Farhi and Tirole (2012) even questioned the current

exceptionally lax monetary policy, maintained by unconventional monetary tool such as asset purchases and swaps between short and long term paper and securities. Theories that support this argument can be traced back to Keeley (1990) and Dell's Ariccia and Marquez (2006). In general, they conclude that external shocks which cause poor information asymmetries, higher competition or credit boom will push banks search more yield in higher risky investment. Thus, such exogenous shocks will cause bank's charter value to decrease and increase the possibility of crises. Specifically, Keeley (1990) stated that fixed rate deposit insurance cause moral hazard and promote taking excess risk taking. Later, Rajan (2006) extended this theory by suggest that the main source for this moral hazard is because of low interest rate environment and this mechanism is defined as "search for yield". Obviously, search for yield is a common behavior in all kind of financial institutions including banks. Investors search for yield, and in this case, investment managers of banks searching for a possible solution to allocate the fund to their most productive use. However, previous literature uses the term "search for yield" for an activity that has a "less efficient state of affairs". Rajan argued that financial institutions such as insurance companies have to pay minimum guaranteed nominal rate of return and these managers have to make a decision to allocate funds along with this nominal target. It's understandable that when inflation and real interest rate decrease, these managers tend to find it harder to reach their targets and instead of selecting a more reasonable standard, they tend to take more risk. At the same time, very low interest rates usually go along with a reduced margin between bank level lending interest rate and deposit rate, which also creates incentive for bank to search for more yield, suggested by Dell's Ariccia and Marquez (2006). The described mechanism focus on lax monetary policy, which later was characterized introduced by Borio and Zhu (2008) as "risk taking channel of monetary policy transmission"

Based on the above studies, numerous theoretical papers have analyzed the impact of monetary policy as well as interest rate level on bank fragility. Such studies share the same view that bank tend to have risky attitude when in stage of credit booming and agency problems are critical. Adrian and Shin (2010) has pointed out balance sheets of financial institutions are

important in determining the price of risk. This study finds that the short-term interest rate has strong impact on the size of financial institution's balance sheet, which suggest the importance of using balance sheet for building efficient monetary policy. Dell'Ariccia et.al (2014) came up with similar finding by showing that when real interest rates and demand for loan decreases, banks tend to take higher leverage and accepting more risk. The effect may vary depending on degree of leverage as well as the curve of loan demand function in case the funding structure is fixed. From different approach, Freixas et.al (2011) suggested that lower interbank rate in the stage of crisis is crucial for reducing the risk of bank run. During the crisis, banks have to face the uncertainty about their liquidity needs. A lower interbank rate will help the banking system allocate funds more efficiently. Extending from this study, Farhi & Tirole (2012), Diamond and Rajan (2012) suggested central banks increase the rate during normal times to compensate for the reduction during adverse times. The mechanism is that authorities in general have to choose to bail out banks being run during crisis. Unconditioned bailouts damage the disciplinary role of deposits for banks search for higher risk investment. Those researches use the term "Greenspan put" for a mechanism which reflect the behavior of bank for taking excessive liquidity risk when banks expect a strong monetary policy along with a large negative shock. This behavior of bank will increase of possibility that central bank will provide necessary liquidity to the banking system.

2.1.2. Asset price bubble

Acharya and Naqvi (2012) were more concerned about how banks can cope with assets price bubble when there is abundant liquidity when there is a surplus of savings compare to the accessible productive investments. Thus, by demand and supply equation, this surplus of savings lowers the interest rate. In addition, it's noted that because of government interventions or different target of monetary, it could be impossible for the interest rate to decrease low enough to match the demand and the supply in the market which leads to a bubbly economy because of these excess funds, Summers (2014). Its reasonable that purchasing assets is particularly attractive and an assets bubble is expected to be formed during depressed economic

condition. Caballero and Farhi (2014) continued the previous study of Summer by pointing out how the world economy places itself in a "safty-trap" when there is a chronic shortage of safe assets. In this condition, other risky assets are crowded out and leave demand and wealth stable but with lower growth. It also can be argued that asset investment is only temporary solution for excess savings but does not solve the real hidden problem. Matutes and Vives (2000), Hellmann and Stiglitz (2010), Cordella and Yeyati (2003), Repullo (2004), Boyd and Nicolo (2005) shared the same view about this "risk-shifting effect". It can be implied that in the competitive market, an increase in equilibrium deposit rate leads to compress intermediation margins and creates incentive for bank to not invest in safe assets which creates excessive credit and asset price bubble.

Beside monetary policy, low interest rate for specific, and risk attitude of bank, the relationship between bank regulations and bank risk taking behavior is backed up in the literature. Furlong (1989), Saunders (1990), Calem et.al (1999), Laeven (2009) suggested the impact of deregulation in banking system encourages risk taking behavior and this impact is also confirmed by an empirical study of Gonzalez (2005)

2.2. Conclusion

Although "search for yield" is a common behavior, a surge in the risk-taking behavior of banks could lead to an unstable banking system or even a global financial crisis. Lax monetary policy and prolonged low interest rate environment are suggested the causes for increasing risk taking behavior among banks. As can be seen, previous literature in this field have not paid any attention to the risk-taking behavior of Australia banks under low interest rate environment. There aren't any study directly points out the joint effect of monetary policy (low interest rate level and prolonged low interest rate environment) and asset price bubble. In Australia, the low interest rate has also created favorable environment for lending for housing to flourish. In other words, the impacts of macroeconomic conditions are underestimated if the effects of monetary policy and asset prices are considered separately.

Chapter 3 : Bank Risk–Taking and Macroeconomic Conditions: Theoretical and Empirical Evidence

3.0. Introduction

This chapter provides a theoretical model and general empirical evidences on the connection between macroeconomics conditions and bank risk taking. Although there are various techniques, scopes of dataset, proxies for risk taking behavior, previous studies have come up with similar results confirming the relationship between bank risk taking and macroeconomics variables as well as other bank characteristics. Work studied here includes Jimenez et al. (2008), Festic et al. (2011), Delis and Kouretas (2011), Altunbas et al. (2012), Buch et al. (2014), among others.

3.1. Theoretical model

This section represents a model proposed in Dell'Ariccia, Laeven and Marquez (2014). This model is constructed by Dell'Ariccia, et al. (2016) and shares the same idea with the model of Cordella and Levy-Yeyati (2003) but where banks can select different portfolios with different risk and return characteristics.

In perfect competition, loans are risky assets that need to be supervised to increase the repayment probability through monitoring technology. Denote by q a monitoring effort which guarantees an identical probability of loan repayment. To make it simple, assume bank is similar to other producers which's cost function is given by C(Q) = $\frac{cQ^2}{2}$ [7]."q" is defined as the probability of loan repayment. "q" = 0 if bank have no monitoring effort, hence, pay back rate is equal to 0 and q = 1 if loan repayment is guaranteed. Denote "c" as cost per effort or bank's technology. Lower c means lower cost for technology effort. So at effort level q, the cost to maintain this effort level is equal to $\frac{cq^2}{2}$ per dollar lend.

[7] Previous studies use quadratic form to capture the effect of increasing cost for monitoring. To ensure higher probability of success loan, higher cost margin is required.

Bank managers increase deposits (or issue debt liabilities) to fund their lending activities. Denote k for bank equity or bank capital and 1-k is bank's portfolio backed by deposits. In this model, k is treated as exogenous. Dell'Ariccia et. al (2014) achieves same results when k is endogenized.

Limited liability allows banks to only pay back depositors when they have a successful operation. Denote r^*as the economy's risk free rate in real terms. This is real risk free interest rate for simplicity and without loss of generality. In short, from bank's perspective, their deposits are secured, does not response to risk aversion and equal to risk free rate $r_D = r^*$.

Bank also have to pay equity at the higher rate compare to risk free rate. Denote ξ as equity premium so $r_E = (r^* + \xi)/q$, with $\xi \geq 0$. r_E can be defined as opportunity cost for investing and be adjusted to represent the riskiness of bank with repay rate q. ξ is assumed independent of r^*. Despite correlation between them which is expected since both could be affected by other factors, results still hold if the within-period correlation between ξ and r is significant different from one. Definition and assumption of ξ consistent with with previous studies such as Hellmann et. al (2000), Repullo (2004) Dell'Ariccia and Marquez (2006) and Allen et. al (2011).

A two-stage decision model is generated. Firstly, for a fixed risk free rate r^*, the lending rate is expected to be set in competitive market that make banks zero profit in equilibrium. Then in next stage, banks select effort level q to monitor their portfolio.

Bank's expected profit can be written as:

$$\Pi = \left(q\left(r_L - r_D(1-k)\right) - r_E k - \left(\frac{1}{2}\right) cq^2\right) L(r_L), \qquad (3.1)$$

Which reflects a negative sloped demand function for loan $L(r_L)$, r_L is bank level lending rate. Function (3.1) also represent that the bank's portfolio yields at q rate. The owner receives r_L per success loan and earn $\left(r_L - r_D(1-k)\right)$ after paying back depositors. No revenue be received and due to limited liability, owners do not repay depositors in the case loan defaults.

Substitute: $(r^* + \xi)$ into r_E[8] and replace r_D for r^*

$$\Pi = \left(q\left(r_L - r^*(1-k)\right) - (r^* + \xi)k - \left(\frac{1}{2}\right)cq^2\right)L(r_L), \qquad (3.2)$$

Having:

$$\Pi'(\mathrm{q}) = \left(\left(r_L - r^*(1-k)\right) - cq \quad \right)L(r_L),$$

Maximizing (3.2) with respect to q yield to following condition for bank monitoring effort q yield: (when $\Pi' = 0$)

$$\hat{q} = \min\{\frac{\mathrm{r_L} - r^*(1-k)}{c}, 1\} \qquad (3.3)$$

Substitute $\hat{q}$ into (3.2) yield:

$$\Pi(\hat{q}) = \frac{(\mathrm{r_L} - r^*(1-k))^2}{2c} - (r^* + \xi)\mathrm{k} \qquad (3.\ 4)$$

Obtain lending rate $\mathrm{r_L}$ by imposing zero profit (free entry competitive equilibrium):

$$\mathrm{r_L} = r^*(1-k) + \sqrt{2ck(r^* + \xi)} \qquad (3.5)$$

Substitute (3.5) into (3.3) yield:

$\mathrm{q}^* = \frac{\sqrt{2ck(r^*+\xi)}}{c}$ which implies that $\frac{\partial q^*}{\partial r} > 0$ and $\frac{\partial (q^*)^2}{\partial r \partial k} > 0$

From (3.3), it can be revealed that changes in reference rate (risk free rate) affect banks effort in monitoring by two separate channels. First, due to limited liability, there is the traditional risk-shifting channel. The rate of banks have to pay on its deposits goes up, ceteris paribus, in the case of success loan, which reduces banks' profits in case of success, thus, it's incentive to monitor their portfolio. At the same time lending rate $\mathrm{r_L}$ also determined by risk free rate r^*. The higher bank's lending rate will lead to higher profit when success and creating bank's incentive in monitoring. In short, changes in references rate affect bank monitoring through risk-shifting channel and pass-through channel. As can be seen, the strength of both channel correlates with capitalization level.

In specific, the risk-shifting channel suggests a positive relationship between interest rate and bank risk taking. The asymmetric information between banks and borrowers prevents

[8] q=1 since in this case the loan is success

bank creditors/depositors from pricing risk at the margin which, along with limited liability, causes banks to take excessive risk. The strength of the risk shifting effect depends on the leverage/capital of banks and is the strongest for the least capitalized banks.

However, the model also reveals the way changes in risk free rates affect bank risk taking depends on how much banks can pass these changes onto lending rates and on how they optimally adjust their capital structure in response to such changes. This effect reduces the bank gross return conditional on its portfolio repaying which reduces incentives for bank to monitor.

Since there are two different channels affecting banks effort in monitoring which's effect tend to offset each other, the net effect of interest rates on bank risk taking behavior is therefore an empirical question.

3.2. Previous empirical evidence

Although well stated in previous literature and having a solid theoretical model, there are limited empirical study about the relationship between macroeconomic indicators and risk aversion of banks, especially for Australia. Most evidence only covers America and Eurozone banking systems. Lown and Morgan (2006) find out that a tightening of monetary policy, in which interest rate increases, leads to higher credit standard, however the empirical results are not significant. A similar study, Maddaloni and Peydro (2011), use euro dataset and achieves a stronger evidence, points out that lower overnight rate leads to lax credit standard. In addition, by using Taylor rule residuals, both studies find that prolonged low interest rate environment reduce the lending standard. Altunbas et.al (2010) also come up with similar result when use rating agency estimates of default rate as a proxy for risk taking behavior. Another recent evidence by Paligorova and Santos (2012) finds that, during lax monetary policy period, cost for loan creates more advantages for riskier borrowers compare to less risky, thus increases risky behavior. This finding is consistent with theoretical theory proposed by Jimenez et al. (2008) and Ioannidou et al. (2009).

This thesis is most closely related to Ioannidou et.al (2009), Delis (2009 & 2010), Jimenez et al. (2008) and Dell' Ariccia et.al (2014). Jimenez et al. (2008) analyzed quarterly

banking data in Spain from 1984 to 2006 and uses short-term interest rate as exogenous monetary policy variable, comes to a conclusion that lower interest rate creates incentives to banks to increase credit to riskier borrowers, thus, increasing its credit risk. The result also points out that low overnight rate encourages banks increase leverage, accept longer and larger loan. In addition, Ioannidou et al. (2009) uses Bolivia banking data also finds similar conclusion as Jimenez et al. (2008). The authors examine the effect of changing in interest rate on price of loan and figure out that low interest rate encourages banks accept more new risky loans and change lending standard to be more favorable for riskier borrowers. In addition, Brissimis and Delis (2009) studies on impacts of monetary policy fluctuations on the behavior and decisions of banks suggests that there are different impacts depend on internal bank characteristic which latter be confirm by Delis (2011). The most recent studies by Dell'Ariccia, Laeven and Suarez (2016) provides a strong relationship between low short term interest rate and bank risk taking behavior of bank. The study figures out that low rate in short period decrease the risky attitude of bank for a short period however, prolonged low interest rate environment could increase the loan default risk considerably. As can be seen, such results are consistent with the theoretical models of bank leverage and shifting in risky behavior.

3.2.1. Bank leverage

The aforementioned studies vary in selecting risk measure, most of studies except Jimenez et al. (2008) and Delis (2011) do not consider bank leverage. For example, Maddaloni and Peydro (2011) use lending standards collected in survey or default loan rates such as Jimenez et al (2008), Altunbas et al (2010) or Delis (2011). However, the survey used in previous studies (Federal Reserve's SLOO and ECB's Bank Lending Survey) only concentrate on changings in lending standards compared to the previous periods rather than about a specific level of lending requirements in different criteria. In addition, the changes in lending standards also can be influenced by another macro conditions that affect the quality of borrowers in general and may not fully represent the riskiness of bank's decisions. Furthermore, the use of either ex-post or ex-ante measure of loan defaults could be ambiguous since these indicators

represent the riskiness of the borrowers over time and also strongly affected by business cycle. Beside default loan rate, risk asset ratio is most common used risk measure. But there are two major issues with risk asset ratio. Risk asset ratio in all previous studies is defined as ratio of all assets but cash and liquidity assets over total asset which represent the liquidity of the bank rather than risk attitude in allocating resources. Second, beside cash and liquidity, other assets have different risk attribute, for example loans to general government have far lower risk compare to risk compare to financial institutions, but by definition, they are all just risk assets. Also, fix assets (used for building, equipment) and intangible assets also be included in balance sheet and by definition they are also considered risk assets which makes the use of risk asset ratio as risk measure is spurious. Beside risk measure, all previous studies when using consolidated dataset from the balance sheet of banks all face another major issue. Most of banks have many international brands, which face different macro environments, risk levels of customer pool, interest rate levels as well as regulation systems in local areas. Taking into account such overseas brands obviously leads to inconsistencies in the dataset and reduces the meaning of previous empirical evidence, this thesis uses risk operational assets (all assets exclude fix, intangible assets, cash and other liquidities) over total operational assets (exclude fix and intangible assets). In addition, the thesis only consists domestic book value, which means all information about oversea brands are excluded from the dataset.

All previous empirical evidence on bank risk taking behavior is obtained by using non-Australia dataset (major parts of empirical evidence focus on Eurozone and U.S). Since Australian banks were well capitalized and relied heavy on wholesale funding which can have different impacts on banks' monitoring effect through risk shifting channel and pass-through channel compare to other advanced banking systems. More detail will be discussed in next chapter.

3.3. Conclusion

Previous empirical studies have provided some evidences for the connection between monetary policy, interest rate and lending rate on bank risk taking behavior. Acknowledging

the limitation of previous studies in proxy of bank risk taking, scope of sample and variables used. this thesis extends the previous studies and retest the connection between macroeconomic conditions and bank risk taking behavior among Australia banks.

Chapter 4 : Bank Risk–Taking and Macroeconomic Conditions: Australian Case

4.0. Introduction

In this chapter, we introduce our dataset and propose econometric models which is similar to previous studies to capture the relationship between bank risk-taking behavior and macroeconomic conditions.

4.1. Econometric model and data

In this section, simple risk taking model is first estimated:

Having:

$$risk_{it} = \alpha_i + \beta_1 ir_t + \boldsymbol{\beta}_2 \boldsymbol{b}_{it} + \boldsymbol{\beta}_3 \boldsymbol{c_t} + u_{it}, \quad (4.1)$$

In equation (4.1), $risk_{it}$ measures the risk-taking behavior of bank i at time t. ir_t measure the interest rate. $\boldsymbol{b}$ a set of bank level control variables and $\boldsymbol{c}$ collects a set of macroeconomic variables that are common for all banks. Equation (4.1) serves as the benchmark model in this analysis. α_i is bank-specific fixed effect. In general, model (4.1) estimate the effect of various bank level controls and macro indicators along with different interest rate levels on risk taking behavior of banks.

We construct a large unbalanced panel dataset[9] to inspect how different interest rates affect risky appetite of banks. Monthly bank level data are collected from The Australian Prudential Regulation Authority (APRA) database. The panel includes 108 banks in Australia and covers from July 2004 to the end of 2015. Different from previous literature, we also include investment banks in our analysis. Only banks have no deposit throughout the full period of study are excluded[10]. In case, a bank stop receiving deposit during the period of study (all

[9] See Data Appendix for a detailed description of the data

[10] The Dell' Ariccia and Marquez (2006) study proposed a mechanism in which, reduction in the gap between lending and deposit rate encourage bank to search for yield. Previous empirical study excludes investment banks because they do not take deposit, however, most investment banks in Australia do accept deposits.

observations of that bank prior to that date are still count). In our dataset, most banks have offshore branches, which are likely to be affected by macroeconomic conditions and operate with a strategy suits the local market. We therefore only consider domestic books of the banks to elicit banking activity of banks within domestic market.[11]

The original dataset contains 9030 monthly observations. However, after removing banks and observations that do not meet deposit requirement as suggested above, the final sample only contain 8089 observations. On average, each bank has about 75 observations. The main body of this thesis have similar structure to Delis (2011) and many other studies.

Independent variables are risky assets ratio and abnormal growth of loans and advances (The different between bank's loan growth rate and the mean of loan growth rate of all banks at the same period).

The explanatory variables are as follows: size is the nature logarithm of total residential assets, loan to deposit ratio (loandep), inflation rate (inf), GDP growth rate (growth), yearly growth of residential property price index (weighted average of eight capital cities) measured by comparing with the same period of previous year. Interbank interest rate/cash rate target (ir1), shorterm rate (ir2) is 3-month bank accepted bills/negotiable certificates of deposit, monthly average and long term rate (ir3) is 10 year Australia government bond.

4.1.0. Measures of bank risk taking behavior

We measure the banks' risk taking behavior banks by two different ratios. Firstly, the ratio of risky assets to total assets (risky asset ratio) and secondly abnormal growth of loans and advances (loan growth). Data for both ratios are based from dataset collected from APRA and descriptive statistics are reported in Data Appendix. The first measure reflects the riskiness of bank behavior. Different from previous literatures (for example see Ashcraft (2006), Demirguc-

[11] See Data Appendix for a detailed description of the data.

Kun et al (2006), Delis (2011) and Gambacorta (2005)), we only consider the operations/transactions conducted with residents as provided above.

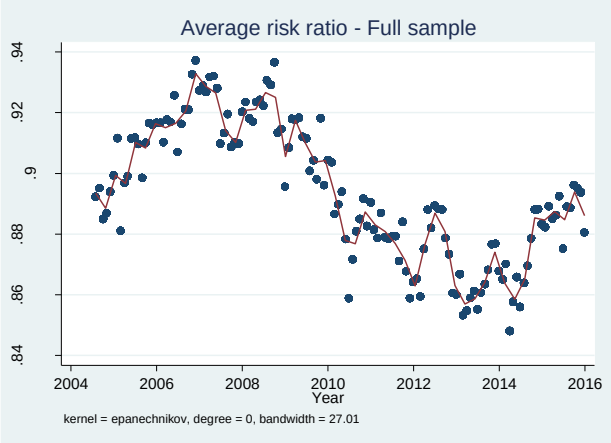


Figure 4-1 Average risk ratio – Full sample

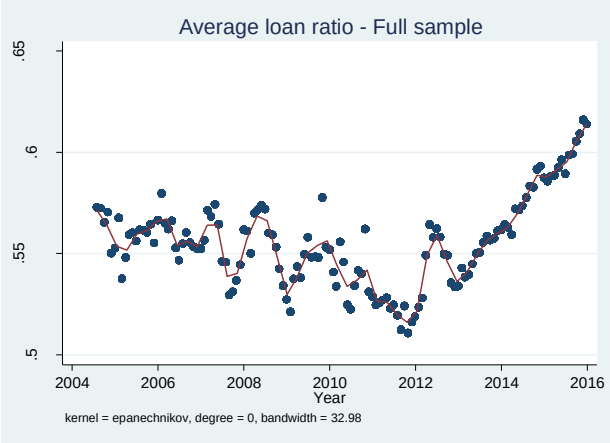


Figure 4-2 Average loan ratio – Full sample

Figure 4-1 and 4-2 represent the average value across all banks

This approach is more closely related to the definition of "risk taking". Non-operating assets (fix assets such as branch building or equipment) are also considered as risk assets in previous literature but are affected by macro-economic environment such as interest rate but are irrelevant to decision on risk. Risky assets include total operating assets on bank's domestic books except cash and liquidity assets and loan to government. Thus, a higher the risky asset ratio indicates the bank takes on higher risk.

From Figure 4.2, the average risky asset ratio increased from 0.8849 in September 2004 to 0.937 in November 2006. This ratio reaches another peak of 0.936 in September 2008 before starting to decrease due to "flight to quality" in banking system after the financial crisis. In general, in the stage of uncertainty, bank managers and other investors tend to convert their risk assets to other safer ones. This 5% increase from 2004 to 2008 in risky asset ratio could not be ignored since it suggests a significant shift in average risk tolerance. The graph also points out another considerable shift in risk taking behavior from 2013. The average risk ratio increased by 5% and has upward trend which should be taken into consideration for future stability of banking system.

The second measure of bank risk taking behavior used in literature is abnormal growth of loans and advances. Lending is the most important activity of a bank and loans and advances are also

considered as risk assets. Köhler (2012) has pointed out that the banks with high rate of loan growth are riskier and also shows that growth of loan is one of key determinants of bank risk, which indicates that bank lower their required lending standards and collaterals to their customer. In addition, banks that have considerable higher loan growth rate than their rival, attract a large share of customers are demanding a too low borrowing rate or fall short of collateral relative to their credit quality (Foos et al., 2010). Following this research, we also define irregular loan growth rate as the different between bank's loan growth rate and the average loan growth rate of all banks at the same period. The abnormal growth rate of loans and advances represents individual risk taking behavior compare with other banks, which is different from systematic risk of loan growth rate which will be discussed later. It's obvious that activities such as lowering screening standard, reducing required collaterals or both are associated to higher abnormal loan growth (Foos et al., 2010). Foos et al. (2010) also points out that when a bank has a significant high abnormal loan growth, it may attract low credit quality borrowers which does not reach other bank's screening standard which is similar to the conclusion of Keeton (1999) that the rapid expansion of lending activities correlated with increasing risk. The most recent study of Gonzalez et al. (2013) abnormal loan growth is one of the most significant variables in explaining the increasing in default loan, and bank leverage, thus, a good proxy for bank risk taking behavior.

From figure 4.3, big four banks do not have abnormal loan growth during the sample period while investment banks and SNIBs witness a high frequency of taking abnormal loan. Different from previous studies, we use dummy variable for abnormal loan growth. For specific, dummies take value 1 when abnormal loan growth are equal or greater than 0.1% and the rest take value 0. Selecting the threshold value was done on the basis of a graphical analysis. It can be clearly seen from a graph of the data for certain number of months, some banks had very high abnormal loan growth rates. The threshold chosen is designed to capture those outstanding loan growth rates.

Figure 4.1 reveals that average loan ratio fluctuates across time and has downward trend since the financial crisis up to 2012. It could be explained by "flight to quality" in banking system. However, from 2012 onward, there are a dramatically shift in average loan ratio from 0.518 to 0.616 (an increase of roughly 10%) which suggest an end of "fly to quality". This

could be the result of boon in lending for house purchasing which will be discussed in later stages.

By using these two dependent variables and the definition of bank risk taking, we also tackle endogeneity problem suggested by other empirical studies. Previous studies such as Jimenez et al. (2008) or Ioannidou et al. (2009) recommend that both interest rate and bank risk are correlated to general economic conditions. However, in this thesis setting, the use of different interest rates other than bank-level lending rate and focusing only on bank risk taking behavior not bank risk. Also, there is no evident that RBA set up the general level of interest rate by taking bank risk incentive into consideration during the study period.

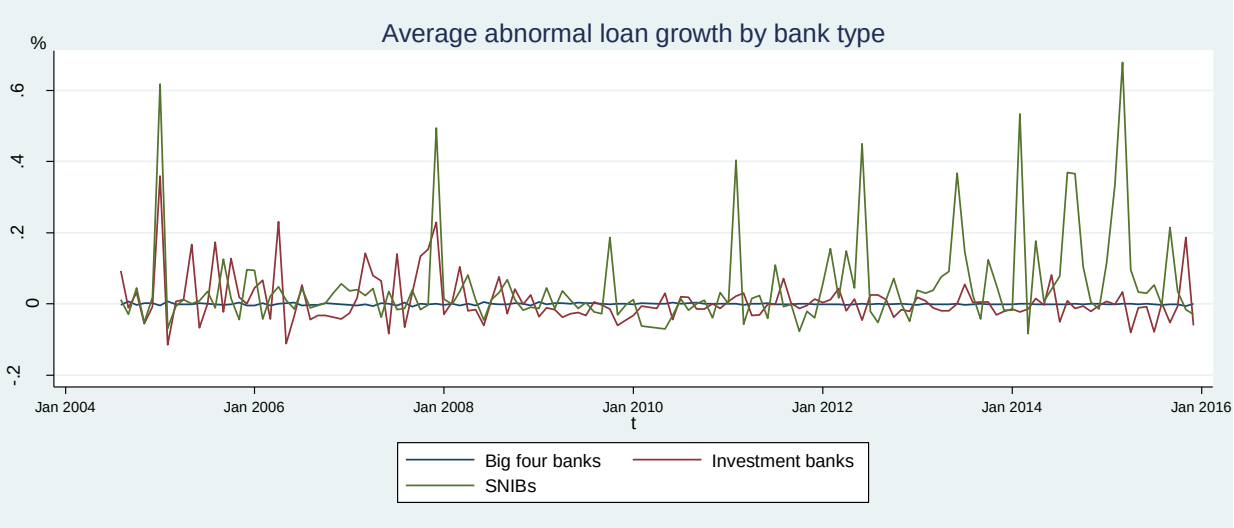


Figure 4-3 Average abnormal loan growth by bank type

Figure 4-3 represents the average value across all banks of specific type of bank.

Another endogeneity problem suggested by Delis (2010) and Kohler (2012) and other empirical studies is that bank managers could change a number of bank characteristics, operation structure when the risk is high. However similar to above argument, this problem is tackled by different definition of risk taking behavior and thesis's setting. For example, Kohler (2012), Boyd and De nicolo (2005), Laeven and Levine (2009), Foos et al. (2009) and others use Z-score as measurement for bank risk taking. Z-score is defined as "the ratio of the return on assets plus the capital ratio divided by standard deviation of return on assets". In short, Z-score measures insolvency risk not risk taking behavior of bank. The thesis proxy risk taking

by risk assets ratio and loan to assets ratio, which represent how bank taking higher risk by changing risk assets structure and lending activities. In this thesis setting, bank characteristics such as size, funding structure (loan to deposit ratio), important of bank (big fours bank) are not like to change due to risk behavior of bank manager and are considered as predetermined variables.

4.1.1. Interest rate

Previous literature suggests a connection between risk tolerance of banks and level of interest rate. To test whether this relationship holds in Australia, we consider various measures of interest rate, including a measure of short-term rate, a measure of long-term rate and the Reserve Bank of Australia (RBA) cash rate target. Monthly data for these interest rates are obtained from Reserve Bank of Australia (RBA) website. Specifically, the short-term interest rate is measured by the monthly average of 3-month Bank Accepted Bills and Negotiable Certificates of Deposit; the long term rate is measured by the 10-year government bond yield. In general, all these rates have been increased till 2008 and significantly fall right after the financial crisis. After a recover during 2010 to 2012, these interest rates reduced considerably and remain relatively stable at 2% for cash rate target and short term rate and 3% for long term rate. See figure 4.4. The thesis experiment with various interest rate which is similar to the studies of Dell'Ariccia, Laeven and Suarez (2016) and Delis (2011) to capture the effects of different interest rates level on bank risk taking behavior. Beside interest rate, we also measure the duration of prolonged low interest rate. After the financial crisis, every time the cash rate target (ir1) do not increase, we start counting from 1, otherwise restart count at 0. This measurement can be used to substitute for interest rate level after Jul 2008. Time series bar plot of this variable can be found in the appendix. Although after 2008, some interest rate is still high, however, the method to construct the period of prolonged low interest rate is only base on cash rate target. The definition of low interest rate is varied among previous studies. In general, fairy low interest rate is about under 4-6%; very low interest rate is under 2-4% while extremely low interest rate is around 0-1%12. After Jul 2008, the cash rate target is always under 5% so it can be considered as low interest rate.

[12] Caballero, Farhi and Gourinchas (2006); Ichiue and Ueno (2007), Delis (2008); Buzacott (1975) and other studies

Figure 4-4 Interest rates

4.1.2. Control variables

Banks take on different level of risks may simply because their inherited operating strategies. We thus control for banks' operating strategy by controlling for their bank size, funding structure and type of the bank.

Bank size is an elements of bank's operating strategy. Bank size is measured here is the logarithm of bank assets. Similar to bank size, importance of a bank should also be taken into consideration. Different from previous literature's dataset, the banking system in Australia is oligopolistic rather than competitive market so we first classify banks into two major group, big four banks and non-big four banks. Chan et. al (2007) have pointed out that both Australia and New Zealand banking system are "conjectural variation oligopolists or monopolists" since the markets are dominated by few large players. In Australia, about 80% of home loan markets is hold by big four banks and their combined assets in 2012 is about 200% of Australia GDP. Big fours include National Australia Bank (NAB); Commonwealth Bank (CBA); Australia and New Zealand Banking group (ANZ) and Westpac (WBC). In later stages of the analysis, we will divide banks into 2 subsets, big four banks and non-big four banks to compare their strategy as well as risk taking behavior throw different periods. Despite there being different suggestions about whether or not a relationship between concentration and bank's risk taking, for example, Boyd et., al (2005) reveal a connection between competition and bank failure and suggest that bank's probability of failure as well as bank profits are positively and significantly related to

concentration while Jimenez et al., (2007) suggest that there is no correlation between concentration and loan default, it is still necessary to include important of banks in this thesis. Different strategies and reaction is expected between big four banks and smaller banks.

In addition, the dataset includes investment banks, which are not included in previous studies in this field. Different from traditional banks, investment bank solely depends on their advice, financing, trading and research service not lending activities. However, investment banks in Australia appear to be more like universal banks which provide both traditional lending activities and investment services. Based on our data collected, most investment banks in Australia still accept deposit, which makes them fall into theoretical consideration about bank risk taking, hence, it's necessary to include them in this study. Investment banks depend heavily on their advice, financing, trading and research service not lending activities. It's expected that investment banks have significant different behavior from traditional type of bank. Delis (2010) also point out banks with more nontraditional activities (lending and borrowing) tend to have higher risk incentive. So we also divide banks into non-investment and investment banks.

The ratio of total loans and advances to total deposit is also important to characterize bank strategies. Normally, this ratio is used for assessing bank's liquidity and efficiency, however in this thesis, loan to deposit ratio is also considered as a factor affect bank risk taking. A higher ratio indicates that banks require more capital than core deposit to fund their lending activities. During the low interest rate environment, the demand for loans is significantly higher due to lower cost, however, on supply size, banks also find it more difficult to extract core deposit or looking for new depositors. To fill this gap, banks are forced to rely on other sources of funds (i.e wholesale market) at higher required rate of return then lend at even higher rate. Although high loan to deposit ratio is not directly lead to higher risk, but it does creating risk taking incentive in lending activities and encourage banks search for more yield to cover the costs. In general, loan to deposit ratio is also represent bank leverage and how banks rely on wholesale funding. Whole sale funding can help bank to take investment opportunities regardless of limitation in attracting deposit supply, improving market discipline (Calomiris,

1999) and covering unexpected deposit withdrawals (King, 1998). However, Huang and Ratnovski (2008) points out bank tend to exploit wholesale funds to aggressively finance their risky investment. In this study, we would want to test how wholesale funds affect the risky behavior of bank in changing in risky assets structure (risk ratio) and taking abnormal loans.

Explained by Calomiris and Karceski (2000), bank's characteristics on their own are not enough to explain their risk taking behavior which is also driven by system wide variations (see Laeven and Levine 2009; Barrell et al 2010). Therefor we also control for GDP growth rate, inflation and unemployment rate. Data on these variables are obtained from ABS database. We expect that during economic expansions (typically associated with low interest rates), banks tend to increase their lending in search for higher yield and therefore a negative relationship between interest rate level and risk taking is expected.

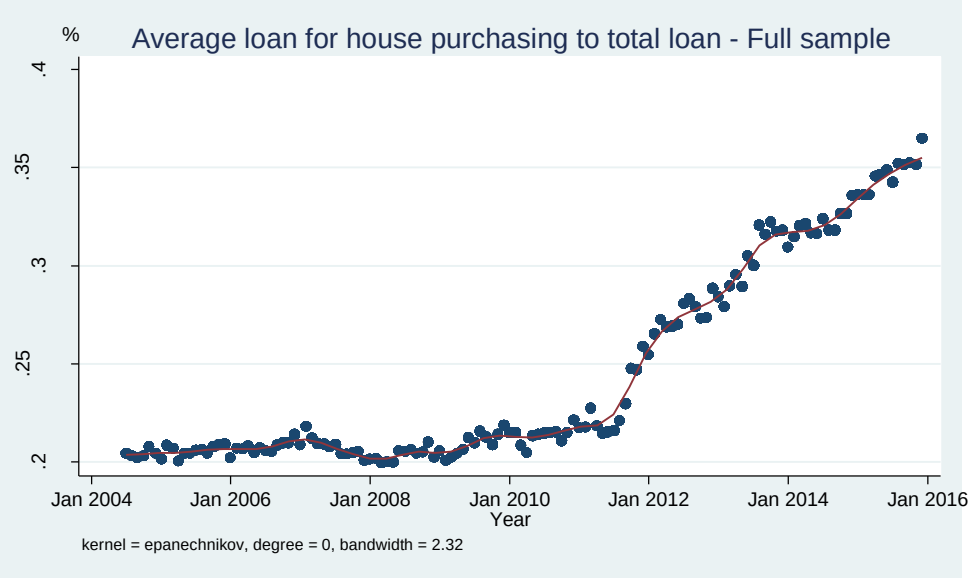


Figure 4-5 Average loan for house purchasing to total loan – Full sample

Figure 4-5 represent the average value across all banks

Beside commonly used variables, housing price is an important factor that influence the observed risk measures of banks. Before 2012, loan to housing (owner-occupied and investment) accounts for 20% of total bank loans on average. Since 2012, with low interest rate policy and fast growing property price, Australia's property market has become a vibrant market and has strong impact on banking system which will be explain in next sections. The

portion of lending to housing market to total loans has surged from average 22% to more than 35% at the end of 2015. See Figure 4.5.

4.2. Econometric model

4.2.0. Econometric challenges

There are a number of identification challenges in estimating Equation (4.1), the first challenge to arise is the possibility of a structural break in bank risk taking behavior due to the financial crisis and the fact that there is a sharp increase in the loans to housing market. We break the sample into two periods, before the financial crisis and after the financial crisis (boom in lending for house purchasing also occurs in this period). In addition, since the banking market in Australia is appear to be oligopoly, as mentioned above, it necessary to classify big four banks and the rest into different groups. We classify banks into three broad categories, the first group consists only the big four banks, the second group only consists investment banks and the rest into last group.

4.2.1. Dynamic risk model

Several reasons can be provided for the dynamic nature of bank risk taking. The first reason is suggested by Keeley (1990) and Cordella, Yeyati (2002) and others that the existence of intense competition tend to strengthen risk taking behavior of banks. Another reason is that the relationship between banks and risky borrowers has long lasting effect. Although one may argue that bank's efficiency will improve over time while repeatedly serving the same customers, however it is not always the case if the information in banking system is opaque or bank manager lower the lending standard. Phase of business cycle is also another explanation. It takes banks time to realize and respond to the effect of macro shocks. The last reason for risk taking incentive persist is regulation. In particular macro prudential policies may have persistent impact on banks risk taking behaviors. Thus, we extend equation (4.1) to include an AR(1) term of the risk measures

$$r_{it} = \alpha_i + \sum_1^n \delta_n r_{i,t-n} + \beta_1 ir_{it} + \beta_2 b_{it} + \beta_3 c_t + u_{it}, \quad (4.2)$$

The above equation can be estimated by using the general method of moments for dynamics panel data proposed by Arellano and Bover (1995) and Blundell and Bond (1998). If δ_n is equal to 0, bank risk taking is adjusted at high speed while a value equal to 1 means very low speed of adjustment. δ_n between 0 and 1 indicates risk taking persists but eventually to its equilibrium level. The use of Arellano-Bover/Blundell-Bond is also appropriate for it does not break down in the presence of unit roots (Binder et al., 2003) and accommodates the possibility of endogeneity between risk taking variables and independence variable. Number of n is determined by Arellano-Bond test for auto correlation.

As mentioned in previous sections, bank risk taking behavior depends on bank manager's decision and bank strategy. In this thesis, we assume that bank managers consider bank size and funding structure when determining the level of risk taking and bank strategies. In this setting, predetermined variables are instrumented with their own first order of lag and higher.

4.3. Results for risk ratio

4.3.0. Big four banks

	Before Jul 2008		After Jul 2008			
	Random effects	Arellano-Bond Dynamic panel-data	Random-effects		Arellano-Bond Dynamic panel-data	
	Estimation 4.1	Estimation 4.2	Estimation 4.3	Estimation 4.4	Estimation 4.5	Estimation 4.6
	Risk ratio	Risk ratio	Risk ratio	Risk ratio	Risk ratio	Risk ratio
Lag.1 (δ1)		0.6554*** (9.24)			0.44*** (8.74)	0.454*** (9.03)
Lag.2 (δ2)					0.31*** (6.19)	0.32*** (6.40)
Size	-0.045** (-2.72)	-0.0358* (-2.36)	0.0003 (0.10)	0.001 (0.25)	-0.0003 (-0.18)	-0.0005 (-0.18)
Loan deposit ratio	0.0217* (2.08)	0.0084 (1.01)	0.0028*** (3.30)	0.02* (2.20)	0.009 (1.40)	0.006 (0.98)
Inflation	0.0037* (1.11)	0.0018 (1.47)	0.0007 (0.7)	0.0007 (0.70)	-0.0005 (-0.78)	-0.0006 (-0.85)
GDP growth	-0.0007 (-1.35)	0.0002 (0.28)	0.0022*** (3.97)	0.0015** (2.78)	0.0003 (0.77)	0.0001 (0.26)
Property index growth	-0.0465 (-1.82)	-0.0094 (-0.50)	-0.023**** (-4.01)	-0.016** (-2.78)	-0.01* (-2.24)	-0.008* (-1.83)
Interest rate	0.008* (2.19)	0.0073* (2.10)	-0.0028*** (-5.40)		-0.0008* (-1.97)	
Duration				0.0001** (2.78)		0.00004 (1.24)
Sample size	196	188	356	356	356	356
Hausman test Fix vs random	0.0702		0.9999	1.0000		
Arellano-Bond test AR(1)		0.000			0.000	0.000
Arellano-Bond test AR(2)		0.722			0.080	0.073
Sargan		0.453			0.654	0.687

Table 1 Baseline models for big four banks

z statistics in parentheses

* p<0.05, ** p<0.01, *** p<0.001

Dependent variable is the ratio of risk assets to total assets. The explanatory variables are as follows: size is the nature logarithm of total residential assets, loan to deposit ratio (loandep), inflation rate (inf), GDP growth rate (growth), yearly growth of residential property price index (weighted average of eight capital cities) measured by comparing same period of previous year. Interbank interest rate/cash rate target (ir1), duration of prolonged low interest rate (Duration).

Note: Estimation (2) found no risk persist beyond first month while estimation (5) and (6) found no risk persist beyond first two months.

The result practically remains unchanged when replace cash rate target for short term and long term rate.

Overall, big four bank have increased their risk taking behavior before the financial crisis occurs. Their average risk ratio increases from 87% in the opening of sample period till 94% right before the crisis. The impact of financial crisis has drove big four banks to reduce their risk assets ratio by 10% on average from July 2008 till 2013, see figure 4.6.

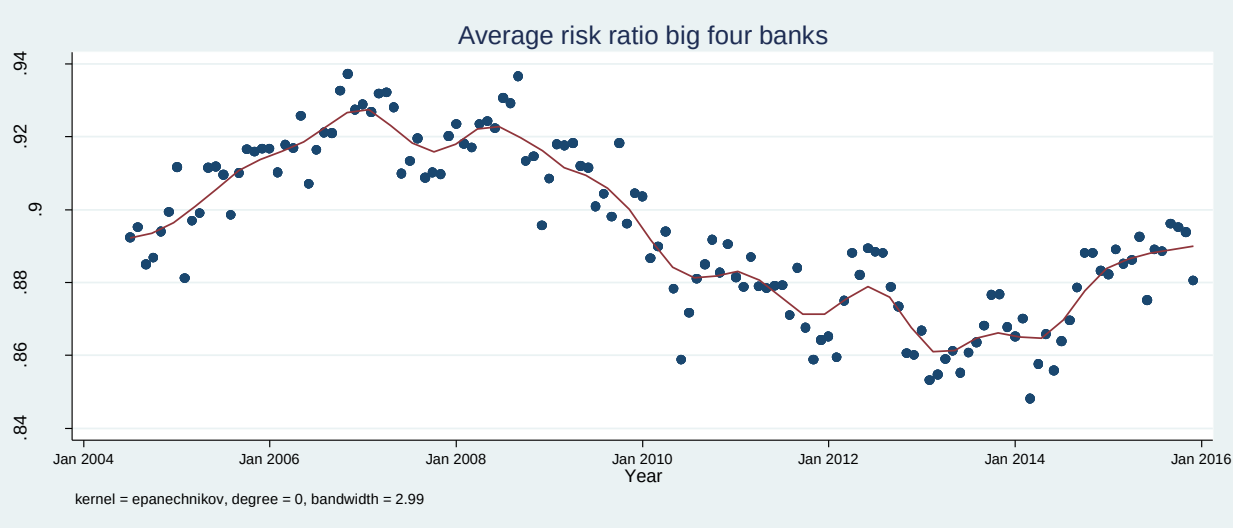


Figure 4-6 Average risk ratio big four banks

Figure 4-6 represent the average value across all big four banks

For sensitivity analysis, the negative coefficient of size in estimation 4.1 indicates that the bigger the size, the more risk aversion of banks which confirm the theory about relationship between size and risk taking of Boyd (2005). The impact of bank size is weaker in the dynamic estimation, -0.045 in estimation 4.1 and -0.0358 in estimation 4.2. However, after the financial crisis, bank size is no longer a significant variable in explaining bank risk taking. See estimation 4.3-4.6.

The sign of the ratio of loan to deposit (in estimation 4.1, 4.3 and 4.4) suggests banks with higher ratio tend to have riskier behavior. This finding confirm the hypothesis of Huang and Ratnovski (2008) about the relationship between wholesale funding and banks' risky behavior as suggested from previous section, but all dynamic estimations in table 1 do not find loan to deposit ratio significant.

Concerning macroeconomic conditions, economic growth and growth property price index only have impact on risk taking behavior of big four banks after the crisis while impact of inflation only significant before that in fixed effect estimation. See estimation 4.1 4.3 and 4.4. The positive coefficient of inflation and GDP growth (in estimation 4.1 and 4.3 respectively) suggest that big four banks tend to increase their risk ratio when inflation and GDP growth rate increase. The negative sign of property index growth in estimation 3 and 4 indicate a negative relationship between bank risk taking and growth of property price index. However, inflation, GDP growth are not significant in dynamic risk estimation (see estimation 4.2, 4.5 and 4.6) and only property index growth remains significant.

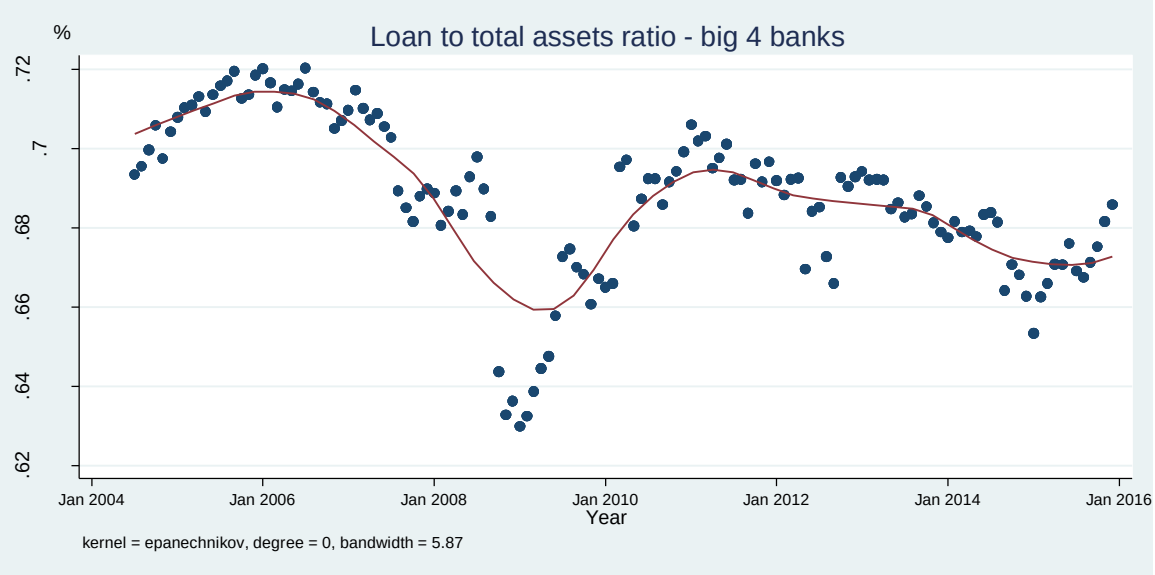


Figure 4-7 Loan to total assets ratio – Big four banks

Figure 4-7 represents the average value across all big 4 banks

The relationship between risk-taking behavior and interest rate level is also changed after the financial crisis. In particular, coefficient of interest rate has changed from positive to negative after the crisis. The positive sign of interest rate level has change from 0.008 and 0.0073 to -0.0028 and -0.0008 in estimation 4.1, 4.2, 4.3 and 4.5 respectively.

The explanation for this is shift between other risk assets and loan to household for housing. Figure 4.8 illustrates the average of loan for housing ratio (loan for housing to total loan) over time. As can be seen, lending for buying property play a very important role in big four banks' lending activities. Before the financial crisis, the interest rate of Australia stayed at

a very high level, which makes it difficult for big four banks to find borrowers for property purchasing. For specific, from the opening period to July 2008, cash rate target increase from 5.6 to about 7.5%, at the same time, the lending for house purchasing of big four banks has dropped by 5%. See figure 4.4 and 4.8. During this period, big four banks have reduced ratio of loan to total assets by about 10% but still have upward trend in risk ratio. This indicates an interesting fact is that big four bank have covert loan to other risky assets. From figure 4.6 and our calculation, the average risk ratio of big four banks remains stable at 92% while loan to total assets ratio drops by 9% from 2006 to Jul 2008. In other word, big four banks have converted 12.5% of total loan to other risk assets.

However, after the financial crisis, the big four banks go the opposite direction, and covert other risk assets to finance their lending activities, especially loan to household for housing. The low and stable interest rate environment has lifted the property market. From figure 4.8, lending for house purchasing total loan have increased from 57% to 64% in January 2011 and remain stable at 64% to 65%. The negative coefficient of property price index growth (in estimation 4.3 – 4.6) provide another information is that big four bank cut down other risk assets more than the amount of total lending for house purchasing increased.

We also experiment the effect of prolonged low interest rate environment on bank risk taking by substitute the interest rate level for the duration of low interest rate. The positive sign of the duration in estimation 4.4 confirm the theory about the longer the duration of low interest rate regime, the higher risk taking behavior of bank. However, this variable is no longer significant in dynamic estimation 4.6

In addition, we also find out big four bank have significantly reduced their loan to deposit ratio in attempt cut down their cost and leverage and turn to safer funding structure see figure 4.9.

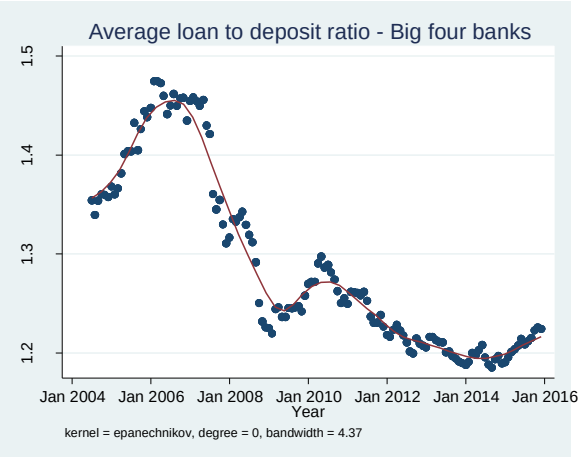


Figure 4-8 Average loan to deposit ratio – Big four banks

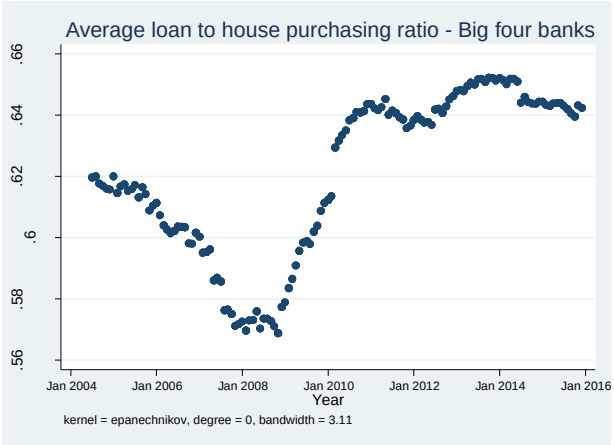


Figure 4-9 Average loan to house purchasing ratio – Big four banks

Figure 4-8 and 4-9 represent the average value across all big 4 banks

4.3.1. Small non-investment banks (SNIB)

	Before Jul 2008		After Jul 2008[13]	
	Random effects	Arellano-Bond Dynamic panel-data	Random effects	Random effect
	Estimation 4.7	Estimation 4.8[14]	Estimation 4.9	Estimation 4.10
	Risk ratio	Risk ratio	Risk ratio	Risk ratio
Lag.1 (δ1)		0.288** (2.91)		
Size	0.023*** (4.54)	-0.0222 (-1.09)	0.042*** (14.92)	0.0413*** (14.83)
Loan deposit ratio	0.001 (1.00)	0.0208* (2.15)	0.0002* (2.32)	0.0002* (2.43)
Inflation	-0.003 (-1.10)	-0.0022 (-0.82)	0.002 (-0.56)	-0.001 (-0.28)
GDP growth	0.0013 (0.79)	-0.0015 (-0.76)	0.0003 (0.17)	0.0007 (0.37)
Property index growth	0.0077 (0.19)	0.072 (1.59)	0.009 (0.42)	-0.0225 (-0.12)
Interest rate	0.012*** (3.60)	0.014 (1.81)	-0.002 (1.43)	
Duration				0.000004 (-0.06)
Sample size	1693	1599	3858	3858
Hausman test Fix vs random	0.9728		0.6635	0.0361
Arellano-Bond test AR(1)		0.000		
Arellano-Bond test AR(2)		0.712		
Sargan		0.398		

Table 2 Baseline models for small non-investment banks

z statistics in parentheses

* p<0.05, ** p<0.01, *** p<0.001

Dependent variable is the ratio of risk assets to total assets. The explanatory variables are as follows: size is the nature logarithm of total residential assets,loan to deposit ratio (loandep), inflation rate (inf), GDP growth rate (growth), yearly growth of residential property price index (weighted average of eight capital cities) measured by comparing same period of previous year. Interbank interest rate/cash rate target (ir1), duration of prolonged low interest rate (Duration).

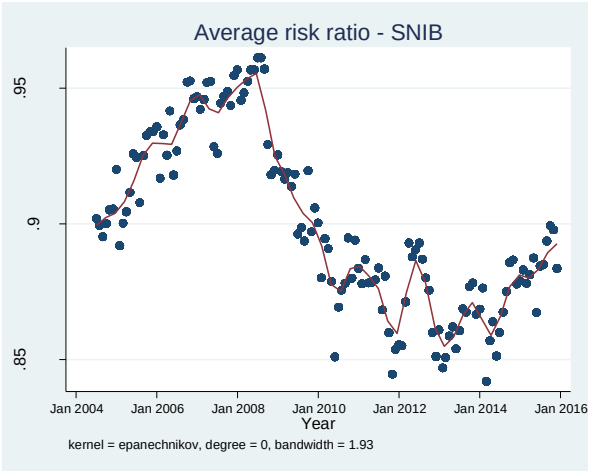
Note: The result practically remains unchanged when replace cash rate target for short term and long term rate.

We found no risk persistence beyond first month in estimation 4.8

[13] We do not find risk persistent in this period, hence, no dynamic estimation is estimated.

[14] Bank control level in this estimation are treated as exogenous and enter the estimation on their own because Sargan test of over identifying reject the validity of lagged bank control variables as instruments.

From estimation 4.7, 4.9 and 4.10, the sign of size indicates that, in both period, the bigger SNIBs tend to take higher risk compare to smaller one. This behavior is different from big four banks, in which bank size is negatively correlated with risk ratio (estimation 4.1 and 4.2). The coefficient of bank size in estimation 4.7, 4.9 and 4.10 also point out that the impact of bank size on risk taking is stronger after the financial crisis, from 0.023 in estimation 4.7 to 0.042 and 0.0413 in estimation 4.9 and 4.10 respectively. Although not significant in estimation 4.7, loan to deposit ratio is statistic significant in dynamic estimation 4.8 and both estimation 4.9 and 4.10 after crisis which indicate that banks with higher loan to deposit ratio, in general, have higher risk ratio. However, the effect of loan to deposit ratio is far weaker in estimation 4.9 and 4.10 compare to the dynamic estimation 4.8. The risk ratio of SNIBs does not response to any macro variables used in any baseline estimation except interest rate in estimation 4.7. The sign of interest rate level in estimation 4.7 suggest the higher the interest rate, SNIBs tend to take higher risk.



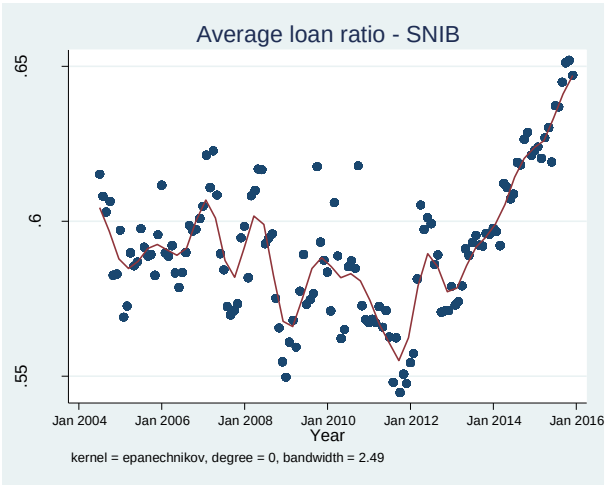


Figure 4-10 Average risk ratio – Small non-investment banks *Figure 4-11 Average loan ratio – Small non-investment banks*

Figure 4-10 and 4-1 represent the average value across all small non-investment banks

To get deeper understanding about the reaction of SNIBs, we have to take a look at SNIB's control variables. The movement of SNIBs can be divided into 3 phases. The first phase is from opening of sample period to right before the crisis. The second one is from the crisis to the end of 2011. And the last one is from opening of 2012 till the end of sample period.

In the first phase, similar to big four banks, SNIBs to increase their risky assets structure by increasing risk assets other than loan. As can be seen in figure 4.10. While loan ratio fluctuates and have a downward trend, from 62% at the opening period to 55% at July 2008, risk ratio of bank has increase by about 6%. In addition, with the steady growth of total deposit, SNIBs have reduced their loan to deposit ratio by about 30% from 1.28 from Jul 2004 to 0.95 in Jan 2008 before increase back to a peak of 1.27 right before the crisis due to a sharp increase in loan ratio. See figure 4.13.

In the second phase, SNIBs start to witness the impact of the financial crisis. In this period, SNIBs have cut down about 10% of its risk ratio, and have lost about 45% of total deposit on average. This also point out that during the stage of financial crisis, SNIBs are the more invulnerable to bank run compare to big four banks. See figure 4.12 and 4.14.

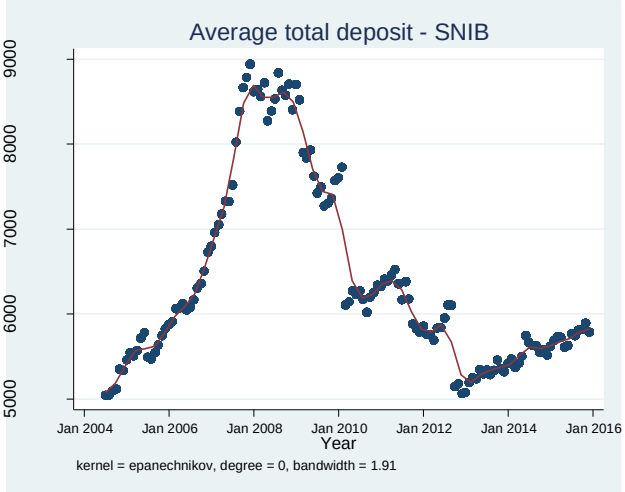


Figure 4-13 Average total deposit – Small non-investment banks

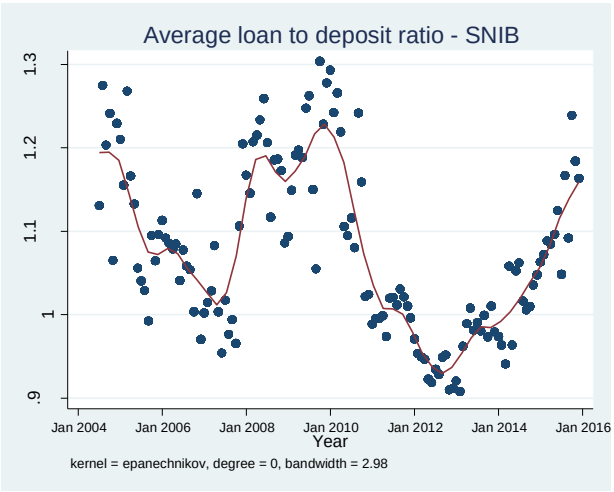


Figure 4-14 Average loan to deposit ratio – Small non-investment banks

Figure 4-12 and 4-13 represent the average value across all small non-investment banks

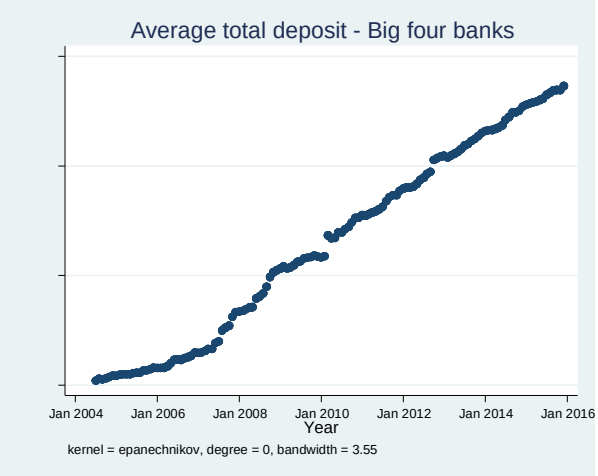


Figure 4-15 Average total deposit – Big four banks

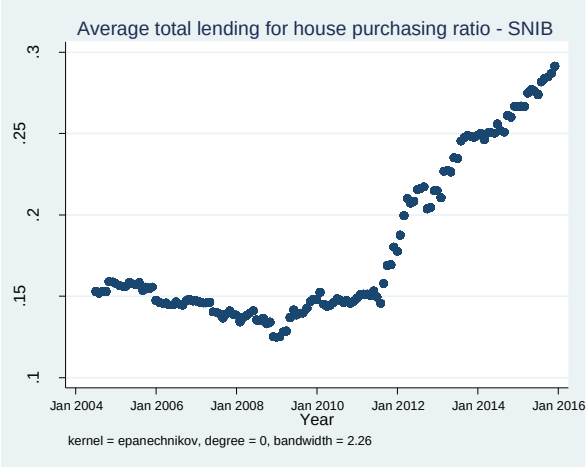


Figure 4-16 Average total lending for housing purchasing ratio Small non-investment banks

Figure 4-14 represents the average value across all big 4 banks while 4-15 represent the value across all small non-investment banks

The last phase starts with the opening of low interest rate environment. In this period, lending for house purchasing have driven SNIBs' risk ratio back to 90%. See figure 4.10 and 4.15. On average, the portion of lending for house purchasing to total assets have double from Jan 2012 till the end of period (an increase of 15% from 15% to nearly 30%). See figure 4.15. However, this surge of lending for house purchasing in SNIBs also lead to a dramatically increase in loan to deposit ratio due to limitation in extracting local core deposit. Loan to deposit ratios have increased about 30% in this period.

4.3.2. Investment banks (Universal banks)

	Before Jul 2008		After Jul 2008			
	Fixed effects	Arellano-Bond Dynamic panel-data	Fixed effects		Arellano-Bond Dynamic panel-data	
	Estimation 4.11	Estimation 4.12[15]	Estimation 4.13	Estimation 4.14	Estimation 4.15	Estimation 4.16[16]
	Risk ratio	Risk ratio	Risk ratio	Risk ratio	Risk ratio	Risk ratio
Lag.1 (δ1)		0.576*** (10.33)			0.44*** (8.74)	0.429*** (8.04)
Size	0.136** (22.99)	-0.014 (-0.59)	-0.0144* (-2.42)	-0.014* (-2.38)	-0.0743*** (-5.36)	-0.08*** (-0.18)
Loan deposit ratio	0.0001 (0.65)	0.0001 (0.18)	-0.00001 (-0.34)	-0.00002 (-0.36)	0.0001** (2.56)	0.0001** (2.46)
Inflation	-0.025** (-2.85)	-0.0111 (-1.85)	-0.024*** (-3.38)	-0.0252*** (-3.50)	-0.008** (-2.33)	-0.0086** (-2.35)
GDP growth	-0.008 (-1.57)	-0.0055 (-1.57)	-0.017*** (-4.85)	-0.0159*** (-4.53)	-0.0072*** (-3.39)	-0.0065** (-3.12)
Property index growth	-0.1885 (-1.55)	0.038 (0.40)	-0.014 (-0.36)	-0.016 (-0.43)	-0.0182 (-0.85)	-0.0289 (-1.39)
Interest rate	-0.03766*** (-4.48)	0.0019 (0.25)	0.0043 (1.84)		-0.005** (-1.97)	
Duration				-0.0003* (-2.07)		-0.0004*** (-3.19)
Sample size	653	610	1212	1212	1208	1208
Hausman test Fix vs random	0.0000		0.0000	0.0000		
Arellano-Bond test AR(1)		0.000			0.000	0.000
Arellano-Bond test AR(2)		0.126			0.756	0.808
Sargan		0.198			0.065	0.059

Table 3 Baseline models for investment banks

z statistics in parentheses

* p<0.05, ** p<0.01, *** p<0.001

Dependent variable is the ratio of risk assets to total assets. The explanatory variables are as follows: size is the nature logarithm of total residential assets, loan to deposit ratio (loandep), inflation rate (inf), GDP growth rate (growth), yearly growth of residential property price index (weighted average of eight capital cities) measured by comparing same period of previous year. Interbank interest rate/cash rate target (ir1), duration of prolonged low interest rate (Duration).

Note: The result practically remains unchanged when replace cash rate target for short term and long term rate.

We found no risk persistence beyond first month in Estimation 4.12, 4.15 and 4.16

[15] In estimation 4.12, the risk ratio is proxy with only first order of lag while size and loan to deposit ratio are treated as exogenous variable since Sargan test of over identifying restrictions reject higher order lag used as proxy for risk ratio and all lag used proxy for predetermined variables.

[16] Estimation 4.16 adopt the same setting as estimation 4.12.

In the random effect estimation (estimation 4.11), bank size, inflation and interest rate are statistically significant. The positive sign of bank size suggests that, before the crisis, the bigger investment banks tend to have higher risk taking behavior. The sign of loan to deposit ratio and interest rate indicate negative correlations between these two variable and bank risk taking. However, none of them are significant in dynamic Estimation (estimation 4.12). In other words, bank risk taking are only response to its own lag.

After the crisis, in random effect estimations (4.13 and 4.14), the sign of coefficient of size indicates that bigger investment bank tend to have lower risky behavior. The effect of bank size is even stronger in dynamic estimation (4.15 and 4.16). Although not significant before crisis and in random effect estimations, loan to deposit ratio is significant in dynamic estimations (4.15 and 4.16). The sign of loan to deposit ratio also confirm the hypothesis about the positive correlation between loan to deposit ratio and bank risk taking. Inflation and GDP growth rate have negative impact on bank risk taking after Jul 2008. Their impact also become weaker in the dynamic estimations. We also found interest rate and the prolonged period of low interest rate environment have negative impact on risk taking of investment banks.

When compared with the big four banks and SNIBs, investment banks have different risky asset structure during the first sub sample period. Half a year before the financial crisis, there is a considerable drop in average risk ratio, they have reduced the risk ratio from 89% in Jan 2007 down to nearly 80% in the end of this year. and right after the crisis, instead of cutting down risk assets ratio like other banks, investment bank's risk ratio takes an even higher peak. See figure 4.17. From 2010 and onward, investment banks' risk ratio has similar trend like big four banks and SNIBs. For specific, there is a "fly to quality" among investment banks from

2009 till the end of 2013 before they start to stock their risk assets with lending for house purchasing.

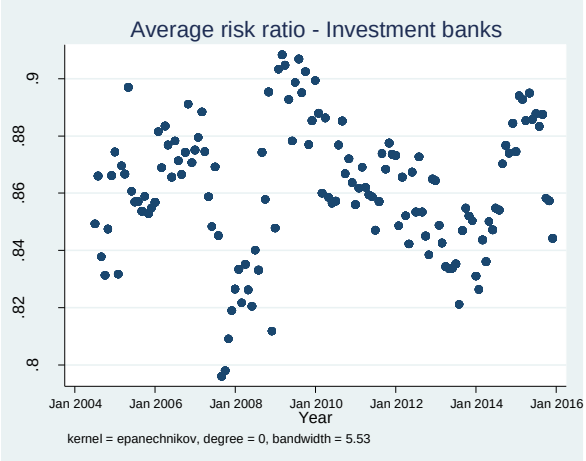


Figure 4-17 Average risk ratio – Investment banks

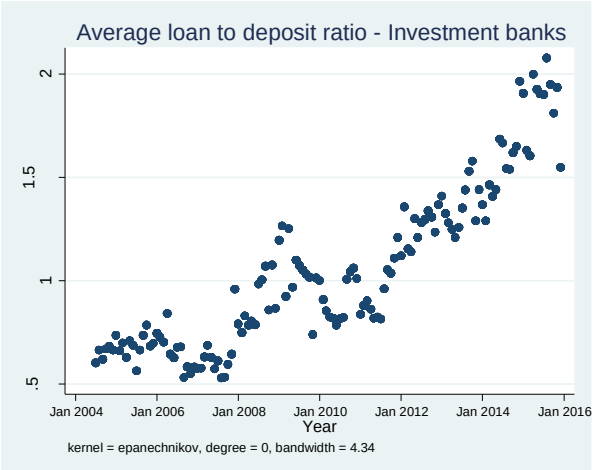


Figure 4-18 Average loan to deposit ratio – Investment banks

Figure 4-16 and 4-17 represent the average value across all investment banks

We also find out that investment banks have 2 sharp increase in loan to deposit ratio. The first 65% increase is from Jan 2007 to Jul 2008 (from about 60% to 125% on average) and second 120% increase is from 2011 till the end of sample period (from about 80% to more than 200% on average). See figure 4.16[17]. We do not find any direct explanation for the movement of loan to deposit ratio of investment banks. The reason for this movement could be the optimistic of investment banks proposed by Dugar & Nathan (1995). This study finds investment bankers are more optimistic, relative to non-investment ones in their investment forecast. We come up with a hypothesis for future study is that optimism drives investment banks to aggressively taking additional risky investments and loans and they use other source of funds (such as wholesale loan) to overcome the limitation in local deposit to finance these operations.

[17] Barclays bank PLC, Huanan bank and Taiwan Cooperative, ltd are not included due to extraordinary high loan to deposit ratio.

4.4. Results for abnormal loan growth

In this section, we estimate the probabilities of having abnormal loan growth by using simple logit model. Since we do not find any significant different across different groups of banks before and after the crisis. A logit estimation is estimated by using all observation.

From the table 4.4, it can be seen in estimation 4.17-4.20, the bigger the bank size, the lower probability for that bank to take abnormal loan. In other words, the bigger the bank, the higher the risk aversion. Although being significant in most previous risk estimation (risk ratio estimations), loan to deposit ratio is no longer significant in table 4. Which means loan to deposit ratio have a positive correlation with bank risk ratio but the possibility for taking abnormal loan growth. Inflation is found to have negative relationship with the possibility of having abnormal loan growth among banks in estimation 4.17-4.19 but not significant when replace different interest rate levels for period of prolonged interest rate. GDP growth rate is not significant in table 4 except estimation 19, in which long term interest rate is used. These results suggest banks tend to have higher possibility for taking abnormal loan in higher GDP growth and lower inflation rate.

Contrary to our expectations, higher property price index growth, lower interest rates and longer the prolonged period of low interest rate lead to lower possibility of taking abnormal loan. To explain this result, we come up with a hypothesis is that banks tend to make abnormal loans for other lending but not lending for house purchasing. So bank with higher portion of loan for house purchasing to total loan will have lower probability for making abnormal loan.

To test this hypothesis, we re-estimate estimation 4.17-4.20 by adding a new variable: loan for house purchasing to total loan ratio. The result from table 5 confirm the hypothesis about the negative correlation between loan for house purchasing to total loan ratio and abnormal loan growth. In general, every 1% increase in lending for housing ratio, bank have about 2.2% less likely to have abnormal loan growth.

Logit model				
	Estimation 4.17	Estimation 4.18	Estimation 4.19	Estimation 4.20[18]
	Abnormal loan growth	Abnormal loan growth	Abnormal loan growth	Abnormal loan growth
Size	-0.4*** (-21.23)	-0.4*** (-21.23)	-0.401*** (-21.31)	-0.3879 *** (-20.77)
Loan deposit ratio	-0.0017 (-1.01)	-0.0017 (-1.00)	-0.0015 (-0.92)	-0.0019 (-1.09)
Inflation	-0.214* (-2.14)	-0.227* (-2.24)	-0.267** (-2.63)	-0.151 (-1.56)
GDP growth	0.0821 (1.72)	0.0803 (1.67)	0.133** (3.12)	0.154*** (3.62)
Property index growth	-1.455* (-2.39)	-1.669** (-2.76)	-2.261*** (-3.77)	-1.34* (-2.23)
ir1	0.157*** (5.60)			
Ir2		0.1515*** (5.58)		
Ir3			0.2388*** (6.50)	
Period				-0.014*** (-5.40)
Sample size	7830	7830	7830	7830
Pseudo R2	0.0927	0.0927	0.0948	0.0926
Correctly classified	87.51%	87.52%	87.56%	87.50%

Table 4 Baseline model for estimating abnormal loan growth rate

z statistics in parentheses

* p<0.05, ** p<0.01, *** p<0.001

Dependent variable is the dummy variable for abnormal loan growth rate (dummy = 1 if abnormal loan growth rate equal or greater than 0.1% else dummy = 0). The explanatory variables are as follows: size is the nature logarithm of total residential assets, loan to deposit ratio (loandep), inflation rate (inf), GDP growth rate (growth), yearly growth of residential property price index (weighted average of eight capital cities) measured by comparing same period of previous year. Interbank interest rate/cash rate target (ir1), duration of prolonged low interest rate (Duration).

[18] Only cover the second period, from Jul 2008 and onward.

Logit model				
	Estimation 21	Estimation 22	Estimation 23	Estimation 24[19]
	Abnormal loan growth	Abnormal loan growth	Abnormal loan growth	Abnormal loan growth
Size	-0.2*** (-8.53)	-0.201*** (-8.53)	-0.203*** (-8.59)	-0.187*** (-7.99)
Loan deposit ratio	-0.0004 (0.41)	-0.0004 (0.41)	-0.0005 (0.48)	-0.0004 (0.40)
Inflation	-0.286** (-2.60)	-0.296** (-2.66)	-0.3145** (-2.82)	-0.3032** (-2.85)
GDP growth	0.1465** (2.83)	0.1462** (2.80)	0.1907*** (3.12)	0.1789*** (3.90)
Property index growth	-1.015 (2.83)	-1.19 (-1.80)	-1.67** (-2.53)	-0.6476 (-0.99)
Housing ratio	-2.20516*** (-11.32)	-2.204857*** (-11.32)	-2.194143*** (-11.23)	-2.28204*** (-11.73)
ir1	0.129*** (4.14)			
Ir2		0.123*** (4.09)		
Ir3			0.1865*** (4.55)	
Duration				-0.016*** (-5.91)
Sample size	7569	7569	7569	7569
Pseudo R2	0.0879	0.0879	0.0888	0.0920
Correctly classified	89.76%	89.76%	89.76%	89.76%

Table 5 Baseline model for estimating abnormal loan growth rate – include loan for house purchasing ratio.

z statistics in parentheses

* p<0.05, ** p<0.01, *** p<0.001

Dependent variable is the dummy variable for abnormal loan growth rate (dummy = 1 if abnormal loan growth rate equal or greater than 0.1% else dummy = 0). The explanatory variables are as follows: size is the nature logarithm of total residential assets, loan to deposit ratio (loandep), inflation rate (inf), GDP growth rate (growth), yearly growth of residential property price index (weighted average of eight capital cities) measured by comparing same period of previous year. Interbank interest rate/cash rate target (ir1), duration of prolonged low interest rate (Duration).

4.5. Conclusion

This chapter provides the result for empirical work. In general, the results are significantly different for each type of banks when risk behavior of banks is proxy by risk ratio. Pre and post financial crisis results also suggest a structure break in our dataset pre and post

[19] Only cover the second period, from Jul 2008 and onward.

financial crisis. On the other hand, when using abnormal loan growth rate as a measurement for bank risk taking behavior, we achieve broadly consistent results. In short, macroeconomic conditions, for particular, both interest rate level and the duration of prolonged low interest rate play important role in determining bank risk taking.

Chapter 5 : Reflection on findings and policy implications

From 2000 until the present, the world has witnessed a prolonged period of low interest rates along with liberation in banking system and significant credit expansion. Shleifer (2009) claims that a majority of economic theories consider these advances are necessary for economic growth. However, when measuring the impact and the nature of global financial crisis, Festic et al., (2011) points out the stability of banking system is not only a matter of integration nor liberalization but also involve an inclusive estimation of bank risk structure and risk tolerance of banks.

Following recent theoretical and empirical studies, this thesis aims to draw out the impact of bank's characteristics, macroeconomic conditions (specifically on interest rate levels and a prolonged period of low interest rate) on bank risk taking behavior. This thesis uses a large unbalanced monthly panel dataset of Australia listed banks from July 2004 till the end of 2015 (in which covers global financial crisis and prolonged period of low interest rate environment). The empirical result show that the impact of bank's characteristics, and macroeconomics conditions on risk asset structure varies with different type of banks and different sub sample periods and we also find that the housing market play an important role in shaping the assets structure of banks. When using abnormal loan growth rate as a proxy for bank risk taking, our results suggest a stable connection between our independent variables and dependent variables. Specifically, size, inflation rate, property price index growth and duration of prolonged low interest rate environment display negative correlations while higher GDP growth and interest rates encourage bank to have abnormal loan growth.

We believe that in future, monetary policy makers in Australia should consider the risky behavior of banks when setting monetary policy. In addition, banks have higher possibility of having abnormal loan growth rate should have higher required reserve or additional regulatory tools should be developed to control abnormal loan growth. Previous empirical studies such as Gonzalet et al., (2013) or Foos et al. (2010) have point out abnormal loan growth rate increase the nonperforming loans ratio in up to 3 years and it is also one of the most significant variables

in for bank failure. Increasing capital adequacy requirements not only can internalize the cost for excess risk taking behavior but also allow bank to absorb the effect of loan default and reduce the possibility of loan failure.

Since the housing market has strong impact on bank's assets structure, substantial increase in lending for house purchasing ratio can make banks more rely on housing market which can lead to severe damage for banking system if housing bubble occurs.

Data Appendix

Our dataset can be assets from

APRA

http://www.apra.gov.au/adi/Publications/Pages/monthly-banking-statistics.aspx

Note:

The domestic books of a bank have the following scope:

- includes operations/transactions booked or recorded inside Australia;

- does not consolidate Australian or offshore controlled entities;

- includes transactions of Australian-based offshore banking units;

- excludes transactions of overseas-based offshore banking units;

- excludes offshore branches; and

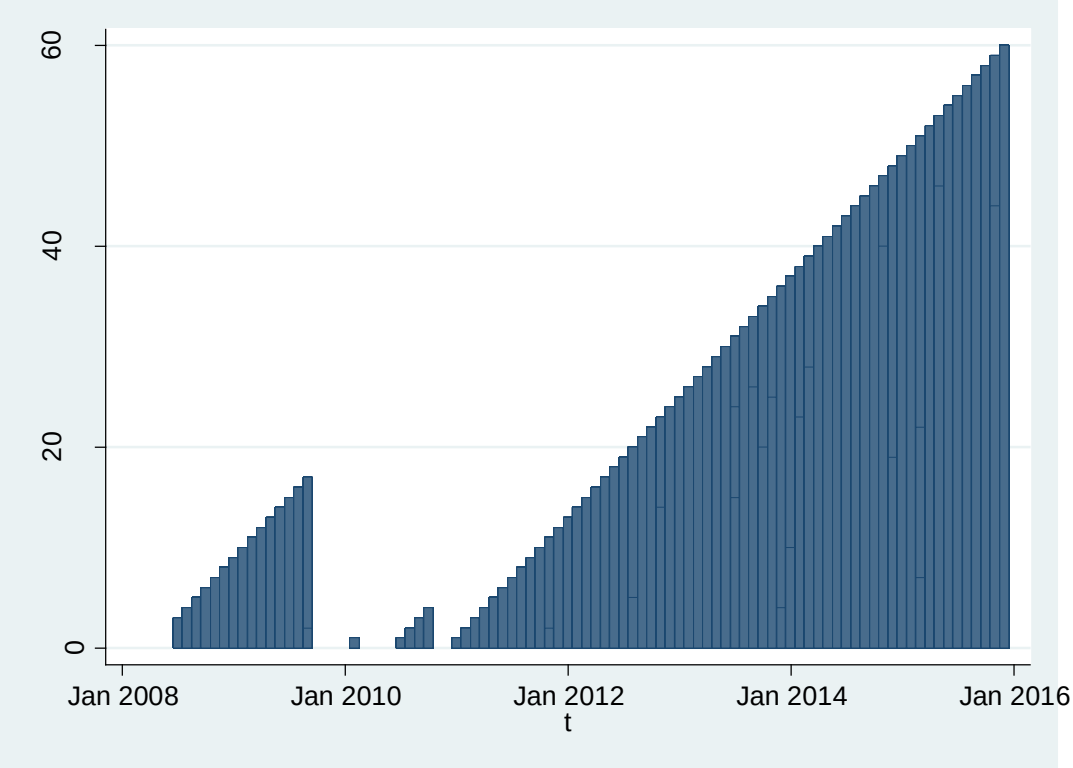
- excludes transactions, assets and liabilities with offshore branches.

- Banks that do not accept deposit for the whole sample period are excluded.

Type	Big four banks	Small non-investment banks	Investment banks
Banks	Australia and New Zealand Banking Group Commonwealth Bank National Australia Bank Westpac	All bank that do not offer investment banks' services. (exclude big 4 banks)	All banks that offer investment banks' services. (exclude big 4 banks)
Number of banks Before Jul 2008	4	48	17
Number of banks After Jul 2008	4	74	15
Average No. Period	137 (548 Observations)	64.0 (5374 Observations)	96.5 (1834 Observations)
Average No. Period Before Jul 2008	48 (192 Observations)	34.6 (1660 Observations)	36.8 (625 Observations)
Average No. Period After Jul 2008	89 (356 Observations)	50.2 (3714 Observations)	80.6 (1209 Observations)

Variable	Sources
Risk ratio	APRA and own calculation Risk ratio = $\frac{\text{Total resident assets} - \text{Cash and liquid assets} - \text{Loans to general government}}{\text{Total resident assets}}$
Excessive loan growth	APRA and own calculation Excessive loan growth = Total gross loan and advance loan growth – Average gross loan and advance loan growth at the same period
Size	APRA and own calculation Size = Nature logarithm of total residential assets
Loan to deposit ratio	APRA and own calculation Loan to deposit ratio = Total gross loan and advance loan growth/Total dep
Inflation	Reserve Bank of Australia
GDP growth	Reserve Bank of Australia
Property price index growth	Australian Bureau of Statistic and own calculation. Weighted average of eight capital cities measured by comparing same period of previous year Property price index growth = $\frac{\text{Property price index}_t - \text{Property price index}_{t-12}}{\text{Property price index}_{t-12}}$
Cash rate	Reserve Bank of Australia
Short term rate	Reserve Bank of Australia, 3-month Bank Accepted Bills and Negotiable Certificates of Deposit.
Long term rate	Reserve Bank of Australia, 10-year government bond yield

Time series plot of prolonged low interest rate from Jul 2008 to the end of 2015. The method to construct this variable is similar to previous study of Ziadeh-Mikati (2013).



Correlation matrix

	risk	size	loandep	inf	growth	index	ir1	ir2	ir3
risk	1.0000								
size	0.3114	1.0000							
loandep	0.0090	-0.1138	1.0000						
inf	0.0106	0.0171	-0.0116	1.0000					
growth	0.0334	-0.0044	-0.0212	0.0535	1.0000				
index	-0.0068	-0.0102	-0.0145	0.2236	0.0104	1.0000			
ir1	0.0827	0.0570	-0.0391	0.3417	0.4786	-0.0874	1.0000		
ir2	0.0819	0.0571	-0.0409	0.3720	0.4832	-0.0279	0.9947	1.0000	
ir3	0.0720	0.0659	-0.0448	0.4286	0.2614	0.1202	0.8445	0.8632	1.0000

Risk is the ratio of risk assets to total assets. Size is the nature logarithm of total residential assets, loan to deposit ratio (loandep), inflation rate (inf), GDP growth rate (growth), yearly growth of residential property price index (index) (weighted average of eight capital cities) measured by comparing same period of previous year. Interbank interest rate/cash rate target (ir1), the short-term interest rate (ir2) is measured by the monthly average of 3-month Bank Accepted Bills and Negotiable Certificates of Deposit; the long-term rate (ir3) is measured by the 10-year government bond yield

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