Regulatory capital and internal capital targets: An examination of the Australian banking industry

James R. Cummings

Macquarie University

Kassim J. Durrani

Macquarie University

November 2018

This research was funded by the Centre for International Finance and Regulation (project number T023). Kassim Durrani gratefully acknowledges financial support from the Capital Markets Cooperative Research Centre. The authors gratefully acknowledge comments by Kevin Davis, Jean-Pierre Fenech, Iftekhar Hasan, Jean Helwege, John Hotham, Gianni La Cava, John Laker, Charles Littrell, David Mayes, David Norman, Junho Park, Maurice Peat, Harald Scheule, Alden Toevs, Boris Vallée, Ron Vidal, Barry Williams and Mario Wüthrich, as well as seminar participants at the Australian Prudential Regulation Authority, Reserve Bank of Australia, Monetary Authority of Singapore, International Paris Finance Meeting 2014, International Finance and Banking Society 2015 Conference, RMIT University 2015 Finance Day, Centre for International Finance and Regulation 2016 Research Showcase: Banking, Asian Finance Association 2017 Annual Conference, Financial Research Network 2018 Banking and Financial Stability Meeting and Macquarie University. We thank David Connolly and Scott Walker at the Australian Prudential Regulation Authority for helping us extract the data used in this study. Address correspondence to James Cummings, Department of Applied Finance, Faculty of Business and Economics, Macquarie University NSW 2109; telephone +61 2 9850 1169; fax +61 2 9850 9956; email james.cummings@mq.edu.au.

Regulatory capital and internal capital targets: An examination of the Australian banking industry

Abstract

Using a unique but confidential database, this study examines the capital management practices of Australian banks under the Basel regulatory framework. We find evidence of a negative relationship between the internally targeted capital buffers of banks and the current state of the economic cycle. This finding supports the view that the capital conservation buffer and countercyclical capital buffer under the Basel III rules are necessary reforms to address the tendency of banks to manage their capital buffers in a pro-cyclical fashion. However, we also find evidence of forward-looking capital management: Banks set higher capital targets when economic activity is gathering momentum and the demand for loanable funds is increasing. We find clear evidence that banks adjust their actual capital buffers having regard to the pre-defined target capital levels established within the banks.

JEL classification: G21, G28

Keywords: Commercial banks, Bank regulation, Capital management, Business cycle fluctuations

1. Introduction

In its Basel III reform package, the Basel Committee on Banking Supervision (BCBS) has sought to improve the banking sectors' ability to absorb shocks arising from financial and economic stress, thus reducing the risk of spill-over from the financial sector to the real economy. A major focus of these reforms has been to raise both the quality and size of the regulatory capital base, as well as to build capital buffers at individual banks that can be used in stressed economic conditions and to protect banks at times of excess credit growth. The outcome of these reforms will depend on the extent to which they act to modify the behaviour of banks in setting their regulatory capital targets and the approach taken by banks in managing their capital adequacy under the new standards. Using a confidential dataset, this study examines the characteristics that may influence a bank's strategic behaviour in setting its capital targets and the extent to which banks adjust their actual capital buffers in relation to internally targeted levels. We also analyse the determinants of the actual buffers that banks maintain above regulator-imposed minimum capital levels.[1]

An ongoing challenge for empirical research on banks' capital management practices has been to separately identify supply-side effects, through banks' capital buffer decisions, from demand-side effects, working through customers' loan demand. In examining the relationship between banks' actual capital buffers and the state of the economic cycle, previous studies provide conflicting evidence about the impact of economic cycle fluctuations on banks' capital buffer decisions. The results of studies using data for banks in single countries suggest that banks reduce their desired capital buffers during economic upturns (Ayuso, Pérez and Saurina, 2004; Coffinet, Coudert, Pop and Pouvelle, 2012; Shim, 2013). In contrast, the results of a study by Fonseca and González (2010), using data for banks in 70 countries, suggest that in most countries the state of the economic cycle has no effect on banks' desired capital buffers. If customers' loan demand increases in buoyant economic conditions, the resultant increases in banks' asset growth can have the effect of weakening banks' capital buffers. However, this weakening in capital buffers may be temporary and does not necessarily correspond to short-sighted banks. This type of identification problem has limited the effectiveness of the research literature in describing banks' responses to variations in capital regulation and industry conditions.

[1] We thank the Australian Prudential Regulation Authority for allowing us access to the data for this study.

In contrast to several previous studies (for example, Jokipii and Milne, 2008; Memmel and Raupach, 2010), we examine the capital management practices of banks in a jurisdiction that imposes bank-specific capital requirements under Pillar 2 of the Basel framework.[2, 3] The Australian banking regulator routinely exercises its power to set capital requirements above minimum levels established by the Basel Committee and periodically reviews the requirements for each bank (see International Monetary Fund, 2012: 54). This provides a natural setting to examine bank behaviour in response to customised capital requirements that incorporate the regulator's assessment of the risk profiles of individual institutions. The regulator applies Pillar 2 supervisory adjustments for risks not fully captured or not taken into account under Pillar 1 minimum capital requirements (for example, credit concentration risk, liquidity risk, strategic risk and reputation risk) and for risks arising from external factors (for example, economic cycle effects).[4] Studies of how banks manage their regulatory capital positions in the context of industry-wide Pillar 1 requirements alone are likely to provide an incomplete picture of how banks respond to requirements that allow for these additional risks.

To our knowledge, this is the first study to examine information about banks' internally targeted capital ratios. In previous studies of banks' capital management practices (for example, Ayuso, Pérez and Saurina, 2004; Jokipii and Milne, 2008; Francis and Osborne, 2012; Shim, 2013), the desired capital stock is unobservable and is therefore approximated by various cost and revenue variables. A concern with this approach is that the identification of characteristics that influence banks in setting their capital targets is sensitive to assumptions made by the researcher about the adjustment process (see Berger, DeYoung, Flannery, Lee and Öztekin, 2008; De Jonghe and Öztekin, 2015),[5] and is potentially biased by a failure to adequately account for changes in loan demand over the economic cycle (Gambacorta and Mistrulli, 2004; Carlson, Shan and Warusawitharana, 2013). We overcome this limitation by utilising a unique database maintained by the Australian banking regulator, which contains internally targeted capital ratios for Australian-incorporated banks. This information allows

[2] Many jurisdictions do not formally assess additional Pillar 2 capital, or when they do, the levels are often not disclosed by regulators or the banks (exceptions include Sweden and Denmark).
[3] Three studies that examine capital management practices in response to bank-specific capital requirements are those by Ediz, Michael and Perraudin (1998) and Francis and Osborne (2010; 2012) in the United Kingdom. They evaluate the impact of bank-specific capital requirements set by the Bank of England and the UK Financial Services Authority on banks' capital decisions.
[4] Credit risk, interest rate risk in the banking book (for internal ratings-based banks), operational risk and market risk are assessed for capital adequacy under Pillar 1 of the Basel framework.
[5] In relation to the speed of adjustment of capital structure for non-financial firms, Iliev and Welch, (2010) argue that implausible assumptions about the underlying process explain starkly different estimates reported in the corporate finance literature.

us to identify factors that are relevant to banks' strategic behaviour in setting their capital targets and to more accurately assess whether banks adjust their actual capital buffers in relation to internally targeted levels. For comparison with previous studies, we estimate a partial adjustment model to explain how banks' actual capital buffers behave under the Basel framework.

Based on quarterly data for thirty banks operating in Australia from the September quarter 2003 to the June quarter 2015 (representing about three-quarters of the number of banks and ninety-nine per cent of the total assets of locally-incorporated banks), we find evidence of a significantly negative relationship between the internally targeted capital buffers of banks and recent economic growth. This finding supports the view that the capital conservation buffer and countercyclical capital buffer under Basel III are sensible reforms to address the tendency of banks to manage their capital buffers in a pro-cyclical fashion. However, we also find evidence of forward-looking behaviour by bank managers that is likely to reduce the impact of fluctuations in credit market conditions on their lending activities: Banks set higher capital targets when the demand for loanable funds is increasing (reflected in increases in dwelling approvals and business confidence). We find evidence that banks actively adjust their actual capital buffers having regard to the pre-defined target capital levels established within the banks. Our analysis identifies other tactical or transitory factors that impact on banks' actual capital buffers, but that are not reflected in their target capital buffers: Higher capital buffers maintained by internal ratings-based (IRB) banks mitigate against the model risk associated with determining the capital requirement using their internal models. In relation to costs, the results suggest that banks economise on capital when the competitive landscape limits the extent to which they can pass on the costs of servicing surplus capital to their customers.

2. Capital management in banks

Several reasons have been put forward to explain why banks maintain more capital than required by prudential regulators (see among other studies Berger, Herring and Szegö, 1995; Alfon, Argimon and Bascuñana-Ambrós, 2004; Estrella, 2004; Gropp and Heider, 2010; Berger and Bouwman, 2013).[6] Banks generally assess their risks differently from regulators; for instance, using their own economic capital models or stress testing programs. Consequently, banks assess their capital needs according to their own assumptions and risk appetites. Banks may accumulate excess capital to signal soundness to the market and to satisfy the expectations of ratings agencies (Berger, 1995; Jackson, Perraudin and Saporta, 2002; Nier and Baumann, 2006; Flannery and Rangan, 2008). Banks may also maintain a buffer of capital to protect against violating the regulatory minimum requirements (Marcus, 1984; Rime, 2001; Lindquist, 2004; Peura and Keppo, 2006; Memmel and Raupach, 2010). By maintaining capital as a buffer, the bank insures itself against costs arising from a supervisory intervention in response to a violation of the requirements.

Following the financial crisis of 2007 to 2009, a major focus of regulatory reform has been to address the pro-cyclical effects of bank capital requirements.[7] During cyclical downturns, losses erode banks' capital, while risk-based capital requirements such as those under the Basel II framework become more onerous (Estrella, 2004; Repullo and Suarez, 2013). The risk of a credit crunch transpiring in these circumstances is increased if banks respond to greater perceived risk by tightening credit and building up their capital buffers above levels required by regulators. Consistent with this prediction, Ayuso, Pérez and Saurina (2004), Stolz and Wedow (2011), and Shim (2013) find that the actual capital buffers of banks exhibit negative co-movement with the economic cycle.[8] However, it is unclear whether risks actually increase during downturns. To the contrary, Rajan (1994) and Crockett (2002) argue that portfolio risks increase during upturns.[9] Favourable conditions associated with an

[6] Brown and Davis (2009) develop a model of capital management and risk management in mutual financial institutions and test their model using data for Australian credit unions.
[7] In their *Declaration on Strengthening the Financial System* of 2 April 2009, the Group of Twenty (G20) committed to "mitigate procyclicality, including a requirement for banks to build buffers of resources in good times that they can draw down when conditions deteriorate".
[8] In Europe, Jokipii and Milne (2008) find that capital buffers of large banks, and of commercial and savings banks, co-move negatively with the economic cycle. However, the capital buffers of small banks and co-operative banks co-move positively with the cycle. Their results for small banks are likely to be caused by capital market frictions. Small banks find it relatively costly to raise new equity capital while co-operative banks are unable to make such issues at all. These banks are thus reliant on retained earnings as a protection against insolvency and this can explain their preference for building up capital during economic upturns.
[9] See also Borio, Furfine and Lowe (2001).

economic expansion could lead to excessive increases in lending and a relaxation of lending standards. In this case, banks may build up their capital buffers during cyclical upturns to protect against future potential losses. Using an international sample, Fonseca and González (2010) find that the actual capital buffers of banks exhibit negative co-movement with the economic cycle in seven countries, positive co-movement in five countries and no statistically significant co-movement in 59 other countries. In this study, we test whether the internally targeted capital buffers of banks are influenced by the current state of the economic cycle.

Aside from the current state of the economic cycle, banks may act in response to expected future growth opportunities in managing their capital positions (Berger, Herring and Szegö, 1995). Banks that have a comfortable buffer over regulator-imposed minimum capital levels are favourably poised to raise wholesale funds quickly and at competitive interest rates and to ensure uninterrupted relationships with their borrowers in the event that profitable investment opportunities emerge (Berger and Bouwman, 2013). Conversely, banks that are thinly capitalised in relative terms may lose market share to those that are well capitalised in the event of a substantial increase in loan demand. This study tests whether banks set higher capital targets above minimum regulatory requirements when the outlook for economic activity is improving and the demand for loanable funds is increasing.

Using capital has a direct cost for banks, because the holders of the capital instruments need to be remunerated. In the context of debt tax shields and implicit subsidies, capital may be more costly for banks than other sources of funding such as retail deposits or wholesale debt (Miles, Yang and Marcheggiano, 2013). Banks may also be discouraged from keeping larger capital buffers by the nature of competition in financial services (Fonseca and González, 2010). Arguably, the most important competitive edge that banks have is the ability to fund themselves cheaply. If a bank maintains a more conservative capital buffer that raises its cost of funding relative to other intermediaries, it may lose a substantial portion of its business. In support of this hypothesis, Hanson, Kashyap and Stein (2011) find that banks gravitate towards lower and more uniform capital ratios in response to regulatory changes that increase the degree of competition. In this study, we test whether banks set lower capital targets when the costs of servicing surplus capital are higher and when the level of competitive intensity in the banking industry makes it more difficult for individual banks to pass on those costs to their customers.

In the presence of adjustment costs, banks may be lethargic about adjusting their actual capital ratios in response to the targets determined within the banks (Alfon, Argimon and Bascuñana-Ambrós, 2004). For example, banks may be reluctant to react to negative capital disturbances instantaneously, recognising that capital raisings may be interpreted as a negative signal with regard to the bank's value (Myers and Majluf, 1984). Based on analysis of the behaviour of banks' actual capital ratios, Berger, DeYoung, Flannery, Lee and Öztekin (2008) provide evidence that banks actively manage their capital ratios, set target capital ratios substantially above regulatory minimum levels and make rapid adjustments towards their targets. However, without being able to observe the pre-defined target capital ratios set by the banks, it is unclear whether banks adjust their capital ratios in response to those targets or whether they adjust them in an ad hoc fashion in response to changes in business performance and market conditions. In this study, we use data on banks' internally targeted capital ratios to test whether banks adjust their actual capital ratios in relation to pre-defined target levels established within the banks.

3. The Australian banking industry

The Australian banking industry emerged from the 2007-2009 financial crisis in a stronger position than banking systems in many other countries. Although there was a weakening in asset quality, the deterioration was less severe than in the early 1990s following the 1987 stock market crash and ensuing recession. The impact of the financial crisis on the Australian economy was cushioned by the maintenance of high lending standards before the crisis and by effective monetary and fiscal policy responses to the crisis (see Davis, 2011). In addition, Australia's major trading partners, particularly China, recovered more quickly from the global downturn than the rest of the world economy. Consequently, the drop in demand for Australia's commodity exports was not as steep as it would have been without strong demand from China. Remarkably, Australia and Canada were the only G20 countries not to provide government funds to recapitalise their banking systems (McDonald and Morling, 2011).

The majority of Australian banks are focussed on traditional banking services – deposits and loans – primarily to the domestic market. Loans represent about two-thirds of banks' total assets.[10] Australian banks' holdings of residential mortgages (60 per cent of all lending) are significantly higher than in many other developed economies. Business lending grew strongly in 2007 and 2008, when access to corporate bond markets was limited and companies increasingly turned to banks for funding, but weak business credit growth in recent years has contributed to a marked shift in bank lending from business loans to residential mortgages. In general, trading activities are a relatively small part of banks' risk exposures, with capital allocated against market risk representing five per cent of the total capital requirement for all banks. Banks' use of wholesale funding has declined to around one-third of total funding, from a peak of about 50 per cent in mid-2008.[11]

The Australian banking industry has become more concentrated in recent years, with the four largest banks holding more than 80 per cent of bank deposits compared with 68 per cent in mid-2008. This greater concentration reflects the acquisition of smaller banks by the four largest banks during the financial crisis and a steady decline in the market share of foreign subsidiary banks.

[10] Industry statistics in this section are sourced from the Australian Prudential Regulation Authority publication, *Quarterly Authorised Deposit-taking Institution Performance Statistics*, June 2018 (released 13 September 2018).
[11] See the Reserve Bank of Australia publication, *The Australian Economy and Financial Markets Chart Pack*, June 2018, page 30.

4. Capital adequacy regulation in Australia

In Australia, banks are regulated by the Australian Prudential Regulation Authority (APRA), which was established in 1998. APRA has the power under federal legislation to set prudential standards, which underpin its approach to supervising depository institutions. The prudential standards set out minimum capital, governance and risk management requirements, which are legally binding.

4.1 Implementation of the Basel Accord capital requirements

Capital adequacy refers to the amount of capital maintained by depository institutions to absorb unanticipated losses. Prior to 1 January 2008, APRA's approach to assessing a bank's capital adequacy was based on the Basel I capital framework (the Basel Accord of 1988).[12] Under the rules of the Basel Accord, capital for supervisory purposes was considered in two tiers: Tier 1 capital included ordinary shares, retained earnings and specific types of preferred shares and convertible securities. Tier 2 capital included subordinated debt, preferred shares and general reserves for credit losses (up to 1.25 per cent of risk-weighted assets). A bank's capital base was the sum of its tier 1 and tier 2 capital less any deductions. At least fifty per cent of a bank's capital base was required to be tier 1 capital. Under Basel I, all banks used standardised risk weights to calculate the capital requirement. The Basel Accord required that the ratio of a bank's capital to risk-weighted assets (referred to as the risk-based capital ratio) be at least 8 per cent. Where it believed there were prudential reasons for doing so, APRA may have required a bank to maintain a minimum capital ratio above 8 per cent (in which case at least half of the ratio must have taken the form of tier 1 capital).

From 1 January 2008 to 31 December 2012, APRA's approach to assessing a bank's capital adequacy was based on the Basel II capital framework.[13] An innovation of the revised framework was the greater use of risk assessments provided by banks' internal systems as inputs to capital calculations. In particular, a bank that had received approval from APRA to use the IRB approach to credit risk was permitted to use its own internal models to quantify the capital required for credit risk. Aside from this feature, the revised framework retained

[12] For details of the Basel I capital framework, refer to the Basel Committee on Banking Supervision's publication, *International Convergence of Capital Measurement and Capital Standards*, released in July 1988.
[13] For details of the Basel II capital framework, refer to the Basel Committee on Banking Supervision's publication, *International Convergence of Capital Measurement and Capital Standards: A Revised Framework*, revised in June 2006.

key elements of the 1988 capital adequacy framework, including the requirement for banks to hold total capital equivalent to at least 8 per cent of risk-weighted assets and the definition of eligible capital. APRA continued to have the discretion to increase the capital requirements for individual banks above Basel minimum requirements.

From 1 January 2013, APRA implemented the Basel III capital framework.[14] This reform package has sought to address lessons from the financial crisis of 2007-2009, by raising both the quality and quantity of the regulatory capital base. The new framework established a minimum requirement for common equity tier 1 capital (comprising common shares and retained earnings) of 4.5 per cent of risk-weighted assets and increased the minimum requirement for tier 1 capital to 6 per cent of risk-weighted assets.[15] After the period examined in this study (from 1 January 2016), the new framework introduced a conservation buffer for common equity tier 1 capital of 2.5 per cent of risk-weighted assets that can be drawn down in periods of stress and a countercyclical buffer of between 0 and 2.5 per cent of risk-weighted assets to protect the banking sector from periods of excess credit growth.

APRA is empowered to impose a range of sanctions should a bank breach minimum capital requirements and intervenes at an early stage to prevent capital from falling below minimum levels. If a bank's capital ratio declines below the required capital ratio set by the regulator and towards the Basel minimum, APRA would significantly increase its supervisory intensity and require the bank to develop and implement a plan to restore its capital ratio. In situations where the bank is unable or unwilling to respond, APRA may resort to the exercise of formal powers under the *Banking Act 1959*. These include the power to restrict bank operations and to suspend payments to shareholders. In more serious cases, it has the power to order a compulsory transfer of the business of a bank or to revoke a banking licence. Consequently, a bank with capital that APRA considers to be inadequate is likely to incur greater regulatory costs than a bank with adequate capital.

[14] For details of the Basel III capital framework, refer to the Basel Committee on Banking Supervision's publication, *Basel III: A Global Regulatory Framework for More Resilient Banks and Banking Systems*, released in December 2010 and revised in June 2011.

[15] The framework revises the definition of non-common equity capital, given that some instruments previously classified as regulatory capital were not available to absorb losses during the financial crisis. In particular, non-common equity capital instruments must contain a non-viability trigger and, in some cases, a loss absorption trigger, for conversion to common equity or write-off (see *Prudential Standard APS 111 Capital Adequacy: Measurement of Capital*, January 2013). Capital instruments that no longer qualify as non-common equity tier 1 or tier 2 capital are being phased out over a ten-year horizon from 2013.

4.2 Setting of target levels of capital

Australian banks are required to have capital management plans (see Prudential Standard APS 110 Capital Adequacy, July 2003). The plan should set out: (i) the bank's strategy for maintaining adequate capital resources, including by outlining its capital needs for providing a buffer against the risks involved in its activities, how the desired level of capital is to be met and the means available for sourcing additional capital where required; and (ii) the process for monitoring the bank's compliance with regulatory capital requirements. As part of their capital management plans, banks are required to set targets for their tier 1 and total capital ratios that exceed regulatory minimum levels. From the time that the Basel II capital framework was implemented in Australia, the setting of capital targets became a mandatory component of a bank's internal capital adequacy assessment process (ICAAP) (see Prudential Standard APS 110 Capital Adequacy, January 2008).

In the guidance that it provides to banks, APRA specifies that the capital targets should be consistent with the risk appetite of the bank. In determining its capital targets, a bank may take a range of considerations into account: (i) the risk appetite of the bank; (ii) regulatory capital requirements; (iii) internal assessments of capital needs, including those arising from the bank's business plans and strategy; (iv) the likely volatility of profit and the capital surplus; (v) dividend policy; (vi) where relevant, ratings agency assessments; and (vii) access to additional capital (see Prudential Practice Guide CPG 110 Internal Capital Adequacy Assessment Process and Supervisory Review, March 2013). Subject to meeting the capital standards, banks have the flexibility to set their capital targets in a manner best suited to achieving their business objectives.

5. Data and sample

This study focuses on 30 banks operating in Australia with at least twelve quarters of relevant data in the period from the September quarter 2003 to the June quarter 2015.[16] These banks represent about three-quarters of the number of banks and ninety-nine per cent of the total assets of Australian-incorporated banks. Table 1 presents the sample banks, comprising twenty-five banks that used the standardised approach to credit risk across the entire sample period (in panel A) and five banks that received approval to use the IRB approach to credit risk commencing in the Basel II period (in panel B).[17] Quarterly data are obtained from APRA's statistical data collections on the actual capital base, regulatory capital requirements, internal capital targets, risk-weighted assets, non-performing loans, total loans, trading assets, total assets, shareholders' equity and earnings for the sample banks. Quarterly macroeconomic and financial market data are obtained from the Australian Bureau of Statistics and Bloomberg respectively.

The internal capital targets examined in this study represent the floor to a target band for capital set by the bank. The bank will also typically set a ceiling – and together the floor and ceiling reflect the target operating band for capital for the business. As capital levels fluctuate from day-to-day, this band allows the business to operate effectively while also ensuring enough capital is maintained to meet the bank's risks and strategic ambitions (the floor) while ensuring the bank performs efficiently by not becoming needlessly overweight on costly capital (the ceiling). For prudential purposes, APRA is naturally more concerned with a bank having too little, rather than too much, capital invested in its business. Therefore, it captures and monitors the floor to the target band for capital in its systems, but not the ceiling.

[16] We redo all of the analysis based on a reduced sample that excludes the period from 1 January 2013, when capital instruments that no longer qualify as non-common equity capital began to be phased out as part of the implementation of the Basel III capital framework. The results are similar to those reported in this article.
[17] For non-retail portfolios, there are two broad approaches within the IRB framework: foundation IRB banks are permitted to provide their own estimates of probability of default (PD) and maturity (M) and must use supervisory estimates for loss given default (LGD) and exposure at default (EAD), whereas advanced IRB banks are permitted to provide their own estimates of all the credit risk components. Macquarie Bank is a foundation IRB bank and the four major banks are advanced IRB banks.

Table 1
Sample banks

This table presents the Australian-incorporated banks included in the sample. The sample period is the September quarter 2003 to the June quarter 2015. *Listed* indicates whether the bank or its parent company is listed on a stock exchange. *Foreign subsidiary* indicates whether the bank is a foreign bank authorised to carry on banking business in Australia through a locally incorporated subsidiary. *IRB adoption* is the quarter that a bank began using the internal ratings-based approach to credit risk.

Panel A: Standardised banks

Bank name	Listed	Foreign subsidiary	Period
Adelaide Bank Limited	Yes	No	Q3 2003-Q3 2008
AMP Bank Limited	Yes	No	Q3 2003-Q2 2015
Arab Bank Australia Limited	Yes	Yes	Q4 2003-Q2 2015
Bank of China (Australia) Limited	Yes	Yes	Q2 2011-Q2 2015
Bank of Cyprus Australia Limited	Yes	Yes	Q3 2003-Q4 2011
	Yes	No	Q1 2012-Q2 2012
Bank of Queensland Limited	Yes	No	Q3 2003-Q2 2015
Bank of Sydney Ltd	Yes	Yes	Q3 2003-Q2 2015
Bank of Western Australia Ltd	Yes	Yes	Q3 2003-Q3 2008
	Yes	No	Q4 2008-Q3 2012
Bendigo and Adelaide Bank Limited	Yes	No	Q3 2003-Q2 2015
Citigroup Pty Limited	Yes	Yes	Q3 2003-Q2 2015
Defence Bank Limited	No	No	Q2 2012-Q2 2015
Heritage Bank Limited	No	No	Q1 2012-Q2 2015
HSBC Bank Australia Limited	Yes	Yes	Q3 2003-Q2 2015
ING Bank (Australia) Limited	Yes	Yes	Q3 2003-Q2 2015
Investec Bank (Australia) Limited	Yes	Yes	Q1 2005-Q2 2014
	Yes	No	Q3 2014-Q1 2015
MECU Limited	No	No	Q4 2011-Q2 2015
Members Equity Bank Limited	No	No	Q3 2003-Q2 2015
NM Rothschild & Sons (Australia) Limited	Yes	Yes	Q3 2003-Q2 2006
QT Mutual Bank Limited	No	No	Q1 2012-Q2 2015
Rabobank Australia Limited	No	Yes	Q3 2003-Q2 2015
Rural Bank Limited	Yes	No	Q3 2003-Q2 2015
St.George Bank Limited	Yes	No	Q3 2003-Q4 2009
Suncorp-Metway Limited	Yes	No	Q3 2003-Q2 2015
Teachers Mutual Bank Limited	No	No	Q3 2012-Q2 2015
Victoria Teachers Limited	No	No	Q2 2012-Q2 2015

Panel B: Internal ratings-based banks

Bank name	Listed	Foreign subsidiary	Period	IRB adoption
Australia and New Zealand Banking Group Limited	Yes	No	Q3 2003-Q2 2015	Q1 2008
Commonwealth Bank of Australia	Yes	No	Q3 2003-Q2 2015	Q1 2008
Macquarie Bank Limited	Yes	No	Q3 2003-Q2 2015	Q1 2008
National Australia Bank Limited	Yes	No	Q3 2003-Q2 2015	Q3 2008
Westpac Banking Corporation	Yes	No	Q3 2003-Q2 2015	Q1 2008

The analysis is restricted to licensed banks which are required to maintain capital in Australia.[18] These include domestic banks and foreign subsidiary banks. The domestic banks include six mutual banks, which converted from building societies or credit unions to banks from mid-2011. Two other banks for which neither the bank nor its parent company is listed on a stock exchange are included in the sample from the beginning of the study period. Branches of foreign banks are not required to maintain capital in Australia and these banks are excluded from the sample.[19]

6. Results

6.1 Descriptive statistics

Table 2 presents descriptive statistics for the banks in our sample. Figures in this table are presented in annual terms. Figure 1 illustrates bank capital ratios as a percentage of total risk-weighted assets and the real GDP growth rate from the September quarter 2003 through the June quarter 2015. The average total assets for all sample banks is $113.4 billion in constant 2015 Australian dollar terms (table 2).

The mean actual capital ratios for all sample banks are 11.4 per cent for tier 1 capital and 13.9 per cent for total capital, suggesting that on average banks had a comfortable buffer over the Basel minimum requirements.[20] The actual capital ratios were generally above the corresponding target capital ratios set by the banks. Banks changed the targets they set for their tier 1 capital ratios once every two years and nine months; and changed the targets they set for their total capital ratios once every three years, on average over the sample period (not shown in table 2). These average rates of change understate the frequency with which banks reviewed their target capital ratios, because they disregard times when banks reviewed their target capital ratios and decided to leave them unchanged. After remaining steady for several years, both the tier 1 and total capital ratios increased substantially as banks responded to the financial crisis of 2007-2009 and prepared for more stringent requirements under Basel III (see figure 1).

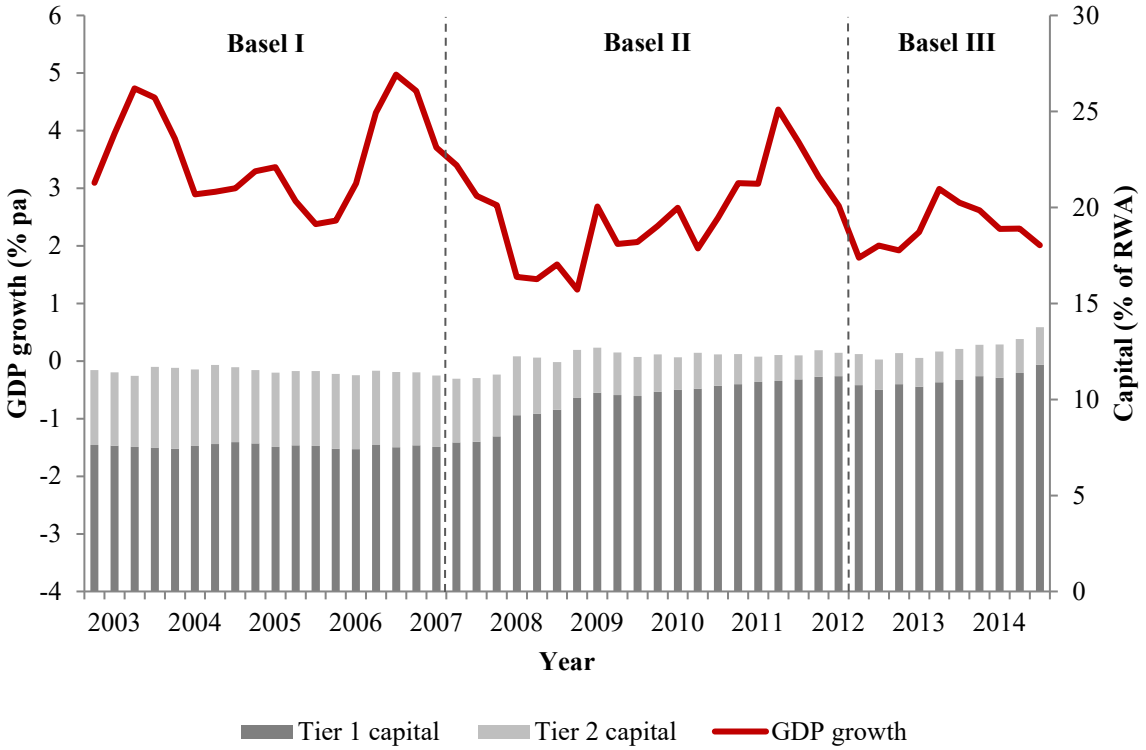
[18] Fifty-one observations for banks with extraordinarily large buffers over APRA-imposed minimum capital levels are excluded from the sample.
[19] Foreign bank branches are not permitted to accept retail deposits from Australian residents.
[20] Furthermore, Australian banks generally maintained a comfortable buffer over APRA-imposed minimum capital levels in the period examined in this study.

Table 2
Descriptive statistics for sample bank-observations

This table reports summary statistics for the banks in our sample. The sample period is the September quarter 2003 to the June quarter 2015. *Total assets* is the book value of assets in constant 2015 Australian dollars. *Tier 1 capital ratio* is the tier 1 risk-based capital ratio. *Total capital ratio* is the total risk-based capital ratio. *Loans to households* is loans to households divided by total loans. *Loans to businesses* is loans to businesses divided by total loans. *Loans to government* is loans to government divided by total loans. *Non-performing loans* is non-performing loans divided by total loans. *Trading assets* is the ratio of trading assets to total assets. *Total RWA* is the ratio of total risk-weighted assets to total assets. *Return on equity* is after-tax profit, divided by average shareholders' equity. *GDP growth* is the real GDP growth rate. *Dwelling approvals* is the change in private dwelling approvals. *Business confidence* is the level of the National Australia Bank business confidence index. *Concentration ratio* is the market share of deposits held by the four largest banks. Bank specific variables, except for the target capital ratios, are based on 1,086 observations for 30 banks. The target tier 1 capital ratio is based on 417 observations for 22 banks. The target total capital ratio is based on 515 observations for 27 banks. All flow variables in this table are presented in annual terms.

Data item	Mean	Standard deviation	Lower quartile	Median	Upper quartile
Total assets $mil	113,383	202,604	3,637	19,170	80,752
Tier 1 capital ratio					
Actual	11.4	4.6	8.3	10.1	13.1
Target	8.5	3.0	6.5	7.8	9.5
Total capital ratio					
Actual	13.9	4.1	11.3	12.5	15.3
Target	11.1	1.8	10.0	11.0	11.8
Loans to households %	59.4	30.7	43.3	64.9	84.1
Loans to businesses %	40.4	30.7	15.9	34.8	56.7
Loans to government %	0.1	0.4	0.0	0.0	0.1
Non-performing loans %	1.80	2.36	0.55	0.97	1.99
Trading assets %	3.7	5.3	0.0	0.0	6.0
Total RWA %	64.9	23.3	51.9	59.9	69.4
Return on equity % pa	9.4	6.9	4.6	8.8	13.6
GDP growth % pa	2.87	0.88	1.99	2.97	4.02
Dwelling approvals % pa	4.2	13.0	-10.7	3.2	20.6
Business confidence %	5.1	7.3	2.5	5.7	10.4
Concentration ratio %	78.3	5.6	73.4	75.4	85.5

Figure 1
Bank risk-based regulatory capital ratios



This figure plots bank capital ratios as a percentage of total risk-weighted assets and the real GDP growth rate from the June quarter 2003 through the June quarter 2015. *Tier 1 capital* is the tier 1 risk-based capital ratio. *Tier 2 capital* is the tier 2 risk-based capital ratio. *GDP growth* is the average real GDP growth rate over the past four quarters. The Basel II Capital Framework was implemented in Australia from 1 January 2008. The Basel III Capital Framework was implemented in Australia from 1 January 2013. The capital ratios presented in this figure are weighted based on the total risk-weighted assets of the bank.

In this study, we measure the risk associated with a bank's assets using the ratio of non-performing loans to total loans;[21] and we measure the current state of the economic cycle using the average real GDP growth rate over the past four quarters. Further, we measure expected future growth opportunities using forward-looking indicators of credit market conditions, including: the change in private dwelling approvals relative to the previous quarter; and the level of the National Australia Bank business confidence index.[22] For sample banks, the median ratio of non-performing loans to total loans is 0.97 per cent. The median annualised GDP growth rate is 2.97 per cent.

Table 3 presents the correlations among the variables used in our analysis. Banks with greater exposure to business lending have larger buffers over regulator-imposed minimum capital levels. Banks have larger capital buffers when business confidence is higher and when competitive forces in the banking industry, as measured by the market share of deposits held by the four largest banks, are less intense. Larger banks and those with larger trading books and higher returns on equity have smaller buffers (over bank-specific requirements for both the tier 1 and total capital ratios).

[21] A loan is non-performing when payments of interest and principal are 90 days or more past due or payments are less than 90 days past due, but there are other good reasons to doubt that payments will be made in full.
[22] The National Australia Bank business confidence index is based on a survey of more than 400 firms across the non-farm business sector. It is a measure of respondents' expectations of business conditions in their industry for the upcoming period.

Table 3
Pearson correlation coefficients for key variables of the sample bank-observations

T1BUF is the difference between the actual tier 1 risk-based capital ratio and the required tier 1 risk-based capital ratio for the bank set by the regulator. *TOTBUF* is the difference between the actual total risk-based capital ratio and the required total risk-based capital ratio for the bank set by the regulator. *LBUS* is loans to businesses divided by total loans. *NPL* is non-performing loans divided by total loans. *TRADB* is the ratio of trading assets to total assets. *GDPG* is the average real GDP growth rate over the past four quarters. *PSDA* is the change in private dwelling approvals relative to the previous quarter. *CONF* is the level of the National Australia Bank business confidence index. *ROE* is the average return on equity over the past four quarters. *CR4* is the market share of deposits held by the four largest banks. *LOGSIZE* is the logarithm of total assets in billions of constant 2015 Australian dollars. *, ** and *** indicate significance at the 10%, 5% and 1% levels.

	T1BUF	**TOTBUF**	**LBUS**	**NPL**	**TRADB**	**GDPG**	**PSDA**	**CONF**	**ROE**	**CR4**
TOTBUF	0.89***									
LBUS	0.02	0.05*								
NPL	-0.04	-0.01	0.44***							
TRADB	-0.14***	-0.14***	-0.03	-0.02						
GDPG	0.04	0.00	0.04	-0.13***	0.06*					
PSDA	0.02	0.04	-0.06*	0.03	-0.05	-0.12***				
CONF	0.03	0.06*	0.02	-0.08***	0.00	0.28***	0.25***			
ROE	-0.16***	-0.16***	-0.14***	-0.21***	0.15***	0.14***	-0.06*	0.07**		
CR4	0.08***	0.15***	-0.17***	0.14***	-0.17***	-0.39***	0.25***	-0.03	-0.18***	
LOGSIZE	-0.38***	-0.31***	-0.13***	-0.13***	0.46***	-0.04	-0.01	-0.04	0.44***	-0.02

6.2 Estimation results

6.2.1 The determinants of banks' target regulatory capital buffers

In this subsection, we use a panel regression approach to examine the determinants of banks' target regulatory capital buffers (that is, the difference between the target risk-based capital ratio set by the bank and the required risk-based capital ratio for the bank set by the regulator). Specifically, banks' target regulatory capital buffers are regressed on various bank characteristics including measures of asset quality, current macroeconomic conditions, expected future economic opportunities, the cost of servicing surplus capital and competitive intensity in the banking industry.

The specification of the panel regression is as follows:

$$\begin{aligned} BUF^{*}_{i,t} &= \alpha + \beta_1 \times NPL_{i,t} + \beta_2 \times GDPG_t + \beta_3 \times LEAD_t + \beta_4 \times IRB_{i,t} \\ &\quad + \gamma_1 \times ROE_{i,t} + \gamma_2 \times CR4_t + \gamma_3 \times LOGSIZE_{i,t} + \gamma_4 \times LISTED_{i,t} \\ &\quad + \gamma_5 \times FORS_{i,t} + u_{i,t} \end{aligned} \tag{1}$$

$$u_{i,t} = \nu_i + \varepsilon_{i,t}$$

where $BUF^{*}_{i,t}$ is the difference between the target risk-based capital ratio set by the bank and the required risk-based capital ratio for the bank set by the regulator, $NPL_{i,t}$ is non-performing loans divided by total loans, $GDPG_t$ is the average real GDP growth rate over the past four quarters, $LEAD_t$ is a leading indicator of credit market conditions (the change in private dwelling approvals relative to the previous quarter or the level of the National Australia Bank business confidence index), $IRB_{i,t}$ is a zero-one dummy variable which equals one if the bank has received approval to use the internal ratings-based approach to credit risk, $ROE_{i,t}$ is the average return on equity over the past four quarters, $CR4_t$ is the market share of deposits held by the four largest banks, $LOGSIZE_{i,t}$ is the logarithm of total assets in billions of constant 2015 Australian dollars, $LISTED_{i,t}$ is a zero-one dummy variable which equals one if the bank or its parent company is listed on a stock exchange and $FORS_{i,t}$ is a zero-one dummy variable which equals one if the bank is a foreign bank authorised to carry on banking business in Australia through a locally incorporated subsidiary.

Based on the results of specification tests, we select a random-effects model for this analysis. A Hausman test is used to compare fixed effects and random effects estimators. For all of the

regressions in this subsection, we fail to reject the null hypothesis that the random effects estimator is an efficient (and consistent) estimator of the true parameters. A Breusch-Pagan Lagrange multiplier test is used to compare ordinary least squares and random effects estimators. We reject the null hypothesis that there are no random effects.

The regression results are presented in table 4. Following Ayuso, Pérez and Saurina (2004) and Jokipii and Milne (2008), we measure the risk of a bank's asset portfolio using the ratio of non-performing loans to total loans. Banks with higher levels of non-performing loans are required to make provisions for loan losses and face greater uncertainty with respect to their future earnings. The coefficient on NPL is expected to be positive if banks with riskier portfolios seek to build stronger capital buffers in excess of regulatory requirements. There is no evidence for this conjecture in the results. To the contrary, the coefficient on NPL is negative in all four regressions and is statistically significant in the regressions for total capital (columns 3 and 4). This result suggests that banks with more conservative profiles tend to set higher capital targets over bank-specific regulatory requirements and may have a smaller appetite for risk in general.[23]

[23] As an alternative to NPL, we try using the ratio of loan-loss provisions to total loans to measure the risk associated with a bank's asset portfolio. The coefficient on this variable is negative in all four regressions and is statistically significant in the regressions for total capital. This result further supports the view that some banks have more conservative profiles; in relation to both their asset quality and their target capital buffers.

Table 4

The effects of asset quality and macroeconomic conditions on bank target capital buffers: Random-effects GLS regressions

This table examines the effects of asset quality and macroeconomic conditions on bank target regulatory capital buffers. *Target tier 1 capital buffer* is the difference between the target tier 1 risk-based capital ratio set by the bank and the required tier 1 risk-based capital ratio set by the regulator. *Target total capital buffer* is the difference between the target total risk-based capital ratio set by the bank and the required total risk-based capital ratio set by the regulator. *NPL* is non-performing loans divided by total loans. *GDP growth* is the average real GDP growth rate over the past four quarters. *Dwelling approvals* is the change in private dwelling approvals relative to the previous quarter. *Business confidence* is the level of the National Australia Bank business confidence index. *IRB approach* is a zero-one dummy variable which equals one if the bank has received approval to use the IRB approach to credit risk. *Return on equity* is the average return on equity over the past four quarters. *Concentration ratio* is the market share of deposits held by the four largest banks. *Log size* is the logarithm of total assets in billions of constant 2015 Australian dollars. *Listed* is a zero-one dummy variable which equals one if the bank or its parent company is listed on a stock exchange. *Foreign subsidiary* is a zero-one dummy variable which equals one if the bank is a foreign bank authorised to carry on banking business in Australia through a locally incorporated subsidiary. Regressions are estimated using quarterly data from the December quarter 2004 to the June quarter 2015. Robust *z*-statistics in parentheses are based on standard errors clustered at the bank level. *, ** and *** indicate significance at the 10%, 5% and 1% levels.

	Target tier 1 capital buffer		**Target total capital buffer**	
Independent variables	**(1)**	**(2)**	**(3)**	**(4)**
Intercept (α)	0.0644	0.0624	-0.0060	-0.0072
	(1.10)	(1.08)	(-0.21)	(-0.25)
NPL (β_1)	-0.0837	-0.0787	-0.1939**	-0.1919**
	(-0.66)	(-0.62)	(-2.12)	(-2.08)
GDP growth (β_2)	-0.6388**	-0.6315***	-0.5063***	-0.5158***
	(-2.49)	(-2.58)	(-3.45)	(-3.47)
Dwelling approvals (β_3)	0.0090***		0.0105***	
	(2.67)		(3.52)	
Business confidence (β_3)		-0.0011		0.0042*
		(-0.26)		(1.67)
IRB approach (β_4)	0.0026	0.0024	-0.0004	-0.0003
	(0.46)	(0.42)	(-0.11)	(-0.08)
Return on equity (γ_1)	0.0003	0.0006	0.0089	0.0080
	(0.01)	(0.02)	(0.41)	(0.38)
Concentration ratio (γ_2)	-0.0331	-0.0300	0.0342	0.0358
	(-0.50)	(-0.45)	(1.04)	(1.07)
Log size (γ_3)	-0.0032	-0.0032	0.0000	0.0001
	(-1.27)	(-1.22)	(-0.01)	(0.04)
Listed (γ_4)	-0.0023	-0.0020	-0.0009	-0.0011
	(-0.28)	(-0.24)	(-0.17)	(-0.22)
Foreign subsidiary (γ_5)	0.0013	0.0008	0.0031	0.0031
	(0.29)	(0.18)	(1.22)	(1.20)
R^2: within	0.05	0.05	0.10	0.10
between	0.11	0.10	0.26	0.26
overall	0.09	0.08	0.17	0.17
Wald test	89.31***	129.10***	47.30***	52.13***
Banks	22	22	27	27
Observations	417	417	515	515

The GDP growth variable captures the effect of recent macroeconomic conditions on target regulatory capital buffers, beyond the risk profile of an individual bank. A negative coefficient on GDP growth would provide support for the view that during upturns banks underestimate portfolio risks because they fail to adequately recognise the cyclical nature of economic output. A positive coefficient would indicate that banks use capital buffers to offset the effects of pro-cyclical capital requirements. The coefficient on GDP growth is negative and statistically significant in all four regressions, suggesting that banks set lower target capital buffers when economic growth has been stronger in recent quarters. The effect of macroeconomic conditions on bank capital targets is economically significant. An increase of one per cent in the average real GDP growth rate over the past four quarters is associated with a decrease in the target tier 1 capital buffer of 64 basis points and a decrease in the target total capital buffer of 51 basis points (based on the estimated coefficients in columns 1 and 3 of table 4). This finding is consistent with previous literature that documents a negative relationship between recent economic growth and actual capital buffers for banks (Ayuso, Pérez and Saurina, 2004 in Spain; Stolz and Wedow, 2011 in Germany; Coffinet, Coudert, Pop and Pouvelle, 2012 in France; Shim, 2013 in the United States).[24] In unreported analysis, we try using the seasonally-adjusted unemployment rate as an alternative measure of recent macroeconomic conditions. The results are consistent with those obtained using the GDP growth variable: the coefficient on the unemployment rate is positive and significant in all four of the regressions, suggesting that banks set lower target capital buffers when the economy is closer to its full employment level of output.

Turning to the forward-looking indicators of credit market conditions, the coefficients on the dwelling approvals and business confidence variables can be expected to be positive if banks set higher capital targets when the outlook for lending activity is improving. The estimated coefficient on the change in dwelling approvals is positive and significant in the regressions for both tier 1 capital and total capital (columns 1 and 3 of table 4). The coefficient on business confidence is positive and significant at the 10 per cent level in the regression for total capital (column 4). These results are consistent with forward-looking behaviour by bank managers, who set higher capital targets when the outlook for future economic activity is improving and the demand for loanable funds is increasing. In unreported analysis, we

[24] Studies of the cyclical behaviour of bank actual capital buffers generally do not control for demand-side effects. For example, total assets may increase in an upturn along with the demand for loans. However, the bank target capital buffers examined in this study are not directly affected by demand conditions.

investigate whether the results are robust to using other forward-looking indicators of credit market conditions (including residential property prices, stock market prices, housing credit growth and business credit growth). The results are broadly consistent with the evidence we report based on dwelling approvals and business confidence.

The other variables are not statistically significant. There is no evidence that IRB banks set higher target capital buffers to protect against the model risk associated with determining the capital requirement using their own internal models. Following previous studies of banks' capital management practices (for example, Ayuso, Pérez and Saurina, 2004; Jokipii and Milne, 2008; Fonseca and González, 2010), we include the return on equity in the regressions to control for the direct costs of servicing surplus capital. We acknowledge a limitation of using this variable is that it reflects both revenue and cost. According to the revenue interpretation, a bank with strong earnings may be willing to operate with a reduced capital buffer because earnings substitute for capital as a buffer against unexpected shocks. In any event, the expected sign of the coefficient on this variable is negative under both the cost and revenue interpretations. We also include the industry concentration ratio in the regressions to control for the competitive environment, which may influence the extent to which banks can pass on the costs of servicing surplus capital to their customers. Based on these variables, there is no evidence that banks set lower target capital buffers when the costs of servicing surplus capital are higher or when the level of competitive intensity in the banking industry makes it more difficult for them to recover those costs from their customers. The coefficient in front of log size is negative in the regressions for tier 1 capital, suggesting that larger banks set marginally lower targets over bank-specific regulatory requirements. There is no support for the idea that listed banks set lower target capital buffers anticipating that they may be able to raise additional capital through seasoned equity offerings; or that foreign subsidiary banks set lower target capital buffers anticipating that they may be able to source additional capital from a foreign parent company.

6.2.2 The adjustment of banks' actual capital buffers in relation to internally targeted levels

In this subsection, we use a panel regression approach to examine whether banks adjust their actual regulatory capital ratios having regard to the pre-defined target levels established within the individual banks. Specifically, the change in a bank's actual capital buffer over the past quarter is regressed on the difference between the target capital buffer set by the bank and the actual capital buffer at the beginning of the quarter.[25] The panel data available for this analysis are unbalanced for two reasons. First, there are nine banks that enter and six banks that exit the sample over the study period (see table 1 for details). Second, data on target capital ratios are available only for a subset of bank-observations (see table 2).[26]

The specification of the panel regression is as follows:

$$BUF_{i,t} - BUF_{i,t-1} = \mu_i + \delta \times (BUF^{*}_{i,t} - BUF_{i,t-1}) + \varepsilon_{i,t} \qquad (2)$$

where $BUF_{i,t}$ and $BUF^{*}_{i,t}$ are the actual and target buffers over APRA-imposed minimum capital levels, respectively, of bank i at time t.[27] The proportionate adjustment in relation to the target capital buffer in each quarter is the delta, δ. The estimated delta is expected to be positive and statistically significant, if banks actively adjust their actual capital ratios in relation to the target capital levels set by the banks. The smaller the delta, the more rigid is bank capital and the longer it takes for a bank to adjust in relation to its target after a shock to bank capital. Bank-specific intercepts capture the influence of the width of the target band for capital set by a bank (that is, the distance between the floor and the ceiling to its target operating band for capital) and any drift in a bank's capital buffer over time that is unrelated to the adjustment in relation to its targeted level. All t-statistics are adjusted for cross-sectional and time-series dependence in the regression residuals by clustering the standard errors at both the bank and quarter levels (as suggested by Thompson, 2011).

[25] Two observations for a bank with extraordinary changes in its actual tier 1 capital buffer, both as a consequence of a merger transaction, are excluded from the analysis in this subsection.
[26] Data on target capital ratios set by banks are available from December 2004, initially for seven banks, and the number of banks reporting their capital targets increases over the sample period.
[27] To eliminate the impact of changes in APRA-imposed minimum capital levels on estimated adjustment speeds, $BUF_{i,t-1}$ is calculated as the actual risk-based capital ratio at time t-1 minus the required risk-based capital ratio at time t. This procedure allows for changes in required capital ratios for individual banks that occur at irregular intervals and in varying amounts over the sample period.

Table 5 reports the regression results. The coefficient on the variable measuring the gap between the target capital buffer and the actual capital buffer at the beginning of the quarter is positive and significant in both regressions. This finding supports the proposition that banks actively manage both their tier 1 and total capital buffers; adjusting these buffers in relation to targeted levels whenever they move away from internally targeted levels (for example, due to higher than expected earnings or portfolio losses). The estimated coefficients in the two regressions are similar in magnitude, indicating that the costs of adjustment pertaining to the tier 1 and total capital ratios are similar. The coefficients correspond to a speed of adjustment towards desired capital buffers of around 56 per cent per annum.

Table 5
The adjustment of bank actual capital buffers in relation targeted levels

This table examines the adjustment of bank actual regulatory capital buffers in relation to internally targeted levels. *Actual tier 1 capital buffer* is the difference between the actual tier 1 risk-based capital ratio and the required tier 1 risk-based capital ratio for the bank set by the regulator. *Actual total capital buffer* is the difference between the actual total risk-based capital ratio and the required total risk-based capital ratio for the bank set by the regulator. *Target tier 1 capital buffer* is the difference between the target tier 1 risk-based capital ratio set by the bank and the required tier 1 risk-based capital ratio set by the regulator. *Target total capital buffer* is the difference between the target total risk-based capital ratio set by the bank and the required total risk-based capital ratio set by the regulator. Regressions are estimated using quarterly data from the December quarter 2004 to the June quarter 2015. Robust *t*-statistics in parentheses are based on standard errors clustered at both the bank and quarter levels. *, ** and *** indicate significance at the 10%, 5% and 1% levels.

	Change in actual tier 1 capital buffer$_{i,t}$	**Change in actual total capital buffer$_{i,t}$**
Independent variables	**(1)**	**(2)**
Target tier 1 capital buffer$_{i,t}$ - Actual tier 1 capital buffer$_{i,t-1}$ (δ)	0.1843***	
	(3.77)	
Target total capital buffer$_{i,t}$ - Actual total capital buffer$_{i,t-1}$ (δ)		0.1797***
		(3.94)
Bank intercepts	Yes	Yes
Quarter intercepts	No	No
R^2	0.08	0.13
Banks	22	27
Observations	415	515

We do further analysis to investigate the extent to which the adjustment by banks of their actual capital buffers in relation to internal targets varies between banks and whether it varies with supervisory pressure and in stressed market conditions (not reported). First, we run the regression specified in equation (2) separately for each individual bank and for the change in each capital buffer. For the 22 banks with data available on their target tier 1 capital ratios, the adjustment coefficient is positive and significant for 12 banks and is statistically insignificant for the other 10 banks. For the 27 banks with data available on their target total capital ratios, the adjustment coefficient is positive and significant for 11 banks and is insignificant for the other 16 banks. In both sets of individual-bank regressions, the adjustment coefficients vary greatly across banks and correspond to adjustment speeds ranging from less than zero to nearly 100 per cent per annum.

Second, to investigate whether the adjustment may be affected by supervisory pressure, we interact the variable measuring the gap between the target and actual capital buffers with a dummy variable identifying banks when they have below-median actual capital buffers at the beginning of the quarter. To construct the dummy variable, the median actual capital buffer we use is the median actual capital buffer above regulator-imposed minimum capital levels across all of the bank-observations in the dataset. The interaction term is included in the regression specified in equation (2) together with the main effects. In the regressions for both the change in actual tier 1 capital buffer and the change in actual total capital buffer, the coefficient on the interaction term is statistically insignificant. Based on this analysis, there is no evidence that pressure from supervisors affects adjustment speeds (contrary to the findings of Berger, DeYoung, Flannery, Lee and Öztekin, 2008 in the United States and Memmel and Raupach, 2010 in Germany).

Third, to investigate whether the adjustment may be affected by market conditions, we interact the variable measuring the gap between the target and actual capital buffers with a dummy variable identifying the financial crisis period from the September quarter 2007 to the June quarter 2009. The interaction term is included in the regression together with both of the main effects involved in the interaction term. In the regressions for both the change in actual tier 1 capital buffer and the change in actual total capital buffer, the coefficient on the interaction term is positive and statistically significant, indicating that banks make faster adjustments in the financial crisis period than in other times (consistent with the finding by

De Jonghe and Öztekin, 2015, using an international sample of banks, that banks adjust their capital structure significantly more quickly in times of crisis).

We do further analysis to identify the types of actions taken by banks to adjust their regulatory capital buffers towards internally targeted levels (not reported). For this purpose, the change in a bank's actual capital buffer in each quarter is decomposed into two components: (i) a component that represents the change in the amount of eligible regulatory capital maintained by the bank, relative to the bank's risk-weighted assets at the end of the previous quarter; and (ii) a component that represents the impact of the change in the bank's risk-weighted assets over the quarter on its actual capital buffer. The regression analysis specified in equation (2) is repeated, with the change in the bank's actual capital buffer substituted by its separate components as dependent variables. The results suggest that banks adjust their capital buffers towards internally targeted levels predominantly by way of adjusting the amount of regulatory capital; that is, either by modifying earnings retention rates or by raising or retiring external capital. For both the tier 1 and total capital ratios, more than three-quarters of the adjustment that banks make towards their internally targeted levels in a given year can be attributed to adjustments that they make to the amount of capital eligible to be counted in the numerators of their capital ratios. Consequently, the results suggest that actions by banks to adjust their capital buffers by controlling portfolio growth rates or by rebalancing asset portfolios across risk-weight categories play a relatively minor role in banks' capital management practices in the period examined in our study.

6.2.3 The determinants of banks' actual regulatory capital buffers

In this subsection, we use the same set of cost and revenue variables used in the preceding analysis to approximate the desired capital stock and we test the significance of those variables within a partial adjustment framework for banks' actual capital buffers. This analysis allows us to compare our results with those from studies that do not have access to data on banks' internally targeted capital ratios (for example, Ayuso, Pérez and Saurina, 2004; Jokipii and Milne, 2008; Stolz and Wedow, 2011). Furthermore, it allows us to better distinguish characteristics that are relevant to a bank's strategic behaviour in setting its target capital buffer from other characteristics that impact on the size of the bank's actual capital base over time.[28]

The specification of the partial adjustment model is as follows:

$$\begin{aligned} BUF_{i,t} = \delta(&\beta_1 \times NPL_{i,t} + \beta_2 \times GDPG_t + \beta_3 \times LEAD_t + \beta_4 \times IRB_{i,t} \\ &+ \gamma_1 \times ROE_{i,t} + \gamma_2 \times CR4_t + \gamma_3 \times LOGSIZE_{i,t} + \gamma_4 \times LISTED_{i,t} \\ &+ \gamma_5 \times FORS_{i,t}) + (1-\delta) \times BUF_{i,t-1} + u_{i,t} \end{aligned} \quad (3)$$

where $BUF_{i,t}$ is the difference between the actual risk-based capital ratio and the required risk-based capital ratio for the bank set by the regulator and the other variables are as defined in equation (1). Following previous studies of banks' actual capital buffers, including Ayuso, Pérez and Saurina (2004), Jokipii and Milne (2008) and Stolz and Wedow (2011), the partial adjustment model is specified with the level of the capital buffer as the dependent variable. Identical inferences are drawn if the model is estimated with the change in the capital buffer as the dependent variable, as was done in equation (2).

Since the model includes the lagged dependent variable among the regressors and since some of our other explanatory variables are likely to be endogenous, we employ the two-step system generalised method of moments (GMM) procedure developed by Arellano and Bover (1995) and Blundell and Bond (1998). The instruments chosen include two to five lags of the dependent variable (BUF) together with two lags of ROE. In each case, the number of lags is chosen to avoid correlation with the error term $u_{i,t}$ and, at the same time, problems associated

[28] Eight observations for banks with extraordinary changes in their actual tier 1 capital buffers and four observations for banks with extraordinary changes in their actual total capital buffers, all as a consequence of merger transactions, are excluded from the analysis in this subsection.

with instrument proliferation. A concern when using the GMM estimator is that a large number of instruments can lead to biased estimates of the coefficients on endogenous variables and invalidate the Hansen test statistic (see Roodman, 2009). Consequently, we collapse the instrument matrix for the endogenous variables so that there are no longer unique instruments for each time period. Explanatory variables other than BUF and ROE are considered to be exogenous and are therefore used as their own instruments.

The results for the partial adjustment model are presented in table 6. The results with respect to the impact of the risk of a bank's asset portfolio and the current state of the economic cycle on actual capital buffers are generally consistent with those with respect to the impact of the same variables on target capital buffers (table 4). The coefficient on NPL is negative in all four regressions and is statistically significant in the regressions for total capital (table 6, columns 3 and 4). This result further supports the view that some banks have more conservative profiles; in relation to both their asset quality and the size of the buffers they maintain against potential future losses (consistent with Alfon, Argimon and Bascuñana-Ambrós, 2004; Lindquist, 2004).[29] The coefficient on GDP growth is negative in all four regressions and is statistically significant in the regressions for total capital. This result suggests that banks allow their capital stocks to decrease during periods when the domestic economy is expanding at a faster-than-average rate (consistent with Ayuso, Pérez and Saurina, 2004; Francis and Osborne, 2010; Stolz and Wedow, 2011; Coffinet, Coudert, Pop and Pouvelle, 2012; Shim, 2013). We try using the seasonally-adjusted unemployment rate as an alternative measure of recent macroeconomic conditions and the results are similar.

[29] A negative relationship between NPL and actual capital buffers may also reflect that banks are reluctant to raise capital after disclosing higher levels of impaired loans, because investors respond to such disclosures by demanding a higher risk premium on the bank's capital instruments.

Table 6

The effects of asset quality and macroeconomic conditions on bank actual capital buffers: Dynamic panel estimation, two-step system GMM

This table examines the effects of asset quality and macroeconomic conditions on bank actual regulatory capital buffers. The sample period is the September quarter 2003 to the June quarter 2015. *Actual tier 1 capital buffer* is the difference between the actual tier 1 risk-based capital ratio and the required tier 1 risk-based capital ratio for the bank set by the regulator. *Actual total capital buffer* is the difference between the actual total risk-based capital ratio and the required total risk-based capital ratio for the bank set by the regulator. *NPL* is non-performing loans divided by total loans. *GDP growth* is the average real GDP growth rate over the past four quarters. *Dwelling approvals* is the change in private dwelling approvals relative to the previous quarter. *Business confidence* is the level of the National Australia Bank business confidence index. *IRB approach* is a zero-one dummy variable which equals one if the bank has received approval to use the IRB approach to credit risk. *Return on equity* is the average return on equity over the past four quarters. *Concentration ratio* is the market share of deposits held by the four largest banks. *Log size* is the logarithm of total assets in billions of constant 2015 Australian dollars. *Listed* is a zero-one dummy variable which equals one if the bank or its parent company is listed on a stock exchange. *Foreign subsidiary* is a zero-one dummy variable which equals one if the bank is a foreign bank authorised to carry on banking business in Australia through a locally incorporated subsidiary. Robust *t*-statistics in parentheses are based on standard errors adjusted for extra variation due to estimated parameters in the weight matrix using the Windmeijer correction. *, ** and *** indicate significance at the 10%, 5% and 1% levels. AR(1) and AR(2) represent first and second order residual autocorrelation tests.

	Actual tier 1 capital buffer$_t$		**Actual total capital buffer$_t$**	
Explanatory variables	**(1)**	**(2)**	**(3)**	**(4)**
NPL ($\delta\beta_1$)	-0.0435	-0.0424	-0.0470*	-0.0451*
	(-1.12)	(-1.07)	(-2.04)	(-1.97)
GDP growth ($\delta\beta_2$)	-0.1112	-0.1265	-0.3267**	-0.3397**
	(-0.90)	(-1.02)	(-2.08)	(-2.16)
Dwelling approvals ($\delta\beta_3$)	-0.0052		-0.0070	
	(-1.42)		(-1.47)	
Business confidence ($\delta\beta_3$)		0.0051		0.0091*
		(1.00)		(1.82)
IRB approach ($\delta\beta_4$)	0.0052**	0.0053**	0.0058***	0.0061***
	(2.23)	(2.30)	(3.03)	(3.23)
Return on equity ($\delta\gamma_1$)	-0.0382	-0.0371	-0.0365	-0.0402
	(-1.24)	(-1.33)	(-0.88)	(-1.09)
Concentration ratio ($\delta\gamma_2$)	0.0152*	0.0146*	0.0252***	0.0245***
	(1.83)	(1.74)	(3.77)	(3.78)
Log size ($\delta\gamma_3$)	-0.0009	-0.0009	-0.0020***	-0.0020***
	(-1.20)	(-1.16)	(-2.79)	(-2.80)
Listed ($\delta\gamma_4$)	-0.0001	-0.0001	0.0042	0.0041
	(-0.04)	(-0.05)	(1.32)	(1.31)
Foreign subsidiary ($\delta\gamma_5$)	0.0038	0.0039	0.0045	0.0046
	(1.24)	(1.21)	(1.66)	(1.67)
Actual tier 1 capital buffer$_{t-1}$ (1-δ)	0.8421***	0.8443***		
	(9.34)	(9.19)		
Actual total capital buffer$_{t-1}$ (1-δ)			0.6451***	0.6438***
			(5.70)	(5.67)
Instruments	16	16	16	16
AR(1) (*p*-value)	0.00	0.00	0.00	0.00
AR(2) (*p*-value)	0.14	0.16	0.38	0.44
Hansen test (*p*-value)	0.45	0.46	0.48	0.50
Banks	30	30	30	30
Observations	1,078	1,078	1,082	1,082

The results with respect to the impact of the forward-looking indicators of credit market conditions on actual capital buffers provide less consistent evidence than those with respect to the impact of these variables on target capital buffers (table 4). The coefficient on business confidence is positive and significant at the 10 per cent level in the regression for total capital (table 6, column 4). This result supports the idea that banks seek to increase their capital stocks in anticipation of future expected economic opportunities. However, the coefficient on dwelling approvals is statistically insignificant in the regressions for both tier 1 and total capital (columns 1 and 3). Thus, increased lending activity flowing from increases in residential building approvals may prevent banks from achieving their objective of increasing their actual capital buffers in these circumstances. In unreported analysis, we examine the impact of other forward-looking indicators of credit market conditions (such as residential property prices and housing credit growth) on actual capital buffers and the results are generally statistically insignificant.

The coefficient on the IRB dummy variable is positive and significant in all four regressions. This finding supports the proposition that internal ratings-based banks maintain higher capital buffers to mitigate against the model risk associated with estimating the risk weightings on assets using their internal models. However, it also reflects a widening divergence in mortgage risk weights between the standardised and IRB approaches to credit risk after the introduction of the IRB approach (see Australian Treasury, 2014: 60-6). As calibrated during the sample period, the IRB approach generates, on average, a lower capital requirement for residential mortgage exposures than the standardised approach.[30] To some extent, the lower average capital requirement can be explained by the deliberate structure of incentives within the Basel II framework; intended to encourage banks seeking IRB accreditation to enhance their risk management capabilities.

For the cost-related variables, the results suggest that the level of competitive intensity in the banking industry is more influential in determining the size of capital buffers than the cost of servicing capital per se. The estimated coefficient on the return on equity is statistically insignificant in all four regressions. Thus, there is no evidence that banks reduce their capital buffers when the cost of servicing surplus capital is higher. However, the coefficient on the industry concentration ratio is positive and significant in all of our regressions. This result

[30] As of early 2014, the average risk weight for housing lending under the IRB approach was 18 per cent, as compared to 39 per cent under the standardised approach (APRA, 2014: 74).

suggests that banks economise on capital when competitive intensity is higher (indicated by a greater dispersion of deposits beyond the four major banks).[31] In these circumstances, banks are likely to be more restricted in the extent to which they can pass on the costs of servicing surplus capital to their customers (for example, by paying lower interest rates on deposits or charging higher interest rates on loans). This finding is consistent with research by Hanson, Kashyap and Stein (2011), who observe that banks gravitate towards lower and more uniform capital ratios when faced with more intense competition.

The coefficient on the size variable is negative in all four regressions and is statistically significant in the regressions for total capital, consistent with the notion that larger banks have more diversified portfolios.[32] The coefficients in front of the dummy variables indicating that a bank or its parent company is listed on a stock exchange or that it is a foreign subsidiary bank are statistically insignificant. Thus, there is no evidence that listed banks are content to maintain smaller capital buffers seeing that they have greater access to capital markets; or that foreign subsidiary banks maintain smaller capital buffers seeing that they may be able to source additional capital from a foreign parent.

The costs of adjusting capital, captured by the lagged dependent variable, are positive and significant in all four regressions. The coefficients in the regressions for the actual tier 1 capital buffer (columns 1 and 2) and the actual total capital buffer (columns 3 and 4) correspond to speeds of adjustment towards desired capital of around 50 per cent per annum and around 83 per cent per annum respectively. Owing to estimation uncertainty associated with measuring adjustment speeds with reference to proxy variables for desired capital buffers, the differences between the estimated adjustment speeds for the tier 1 capital buffer and those for the total capital buffer are not statistically significant at conventional levels.[33] The standard errors of the estimated adjustment speeds obtained using equation (3) with data on banks' actual capital ratios are about twice as large as those obtained using equation (2) with data on banks' actual and target capital ratios. This pattern in the standard errors demonstrates the far greater precision with which the speed of adjustment can be measured in

[31] As an alternative to the concentration ratio, we try using a Herfindahl-Hirschman index to measure the level of competitive intensity in the banking industry. The index is calculated by squaring the market share of deposits held by each bank and summing the resulting numbers. The results are very similar.
[32] This result is also consistent with the idea that large banks keep lower levels of capital, in the expectation that they will be supported by government in the event that they become financially distressed.
[33] In unreported analysis, we test the significance of the differences assuming that the adjustment speeds for the tier 1 capital buffer and the total capital buffer are estimated independently.

studies that have access to data on banks' target capital ratios compared with studies that do not have access to such data.

7. Conclusion

Based on confidential regulatory data collected by APRA, this study examines the capital management practices of 30 banks operating in Australia in the period from the September quarter 2003 to the June quarter 2015. In previous studies of banks' capital management practices (for example, Ayuso, Pérez and Saurina, 2004; Jokipii and Milne, 2008), the desired capital stock is unobservable and is therefore approximated by various cost and revenue variables. We overcome this limitation by utilising information about the internally targeted capital ratios of Australian-incorporated banks. This information allows us to identify factors that are relevant to banks' behaviour in setting their capital targets and to more accurately assess the extent to which banks adjust their actual capital ratios in relation to internally targeted levels. For comparison with previous studies, we estimate a partial adjustment model to explain how banks' actual capital buffers behaved in the sample period.

Our results, obtained before the introduction of the conservation buffer and countercyclical buffer under the Basel III capital framework, support the view that these reforms are necessary to address the propensity of banks to manage their regulatory capital buffers in a pro-cyclical fashion. In particular, we find evidence of a significantly negative relationship between the internally targeted capital buffers of banks and recent GDP growth. This finding is consistent with previous literature that documents a negative relationship between banks' actual capital buffers and the state of the economic cycle (Ayuso, Pérez and Saurina, 2004; Stolz and Wedow, 2011; Shim, 2013). By focussing on banks' internal targets, our research demonstrates that the potential pro-cyclical impact of the Basel II capital framework originates through two channels: (i) In a deteriorating macroeconomic environment, regulatory requirements are more burdensome (as bank exposures are downgraded); and (ii) banks set higher target capital buffers above regulatory requirements. An important caveat is that we do not examine a period of severe economic downturn, such as that of the early 1990s which had a significant impact on banks' capital positions. It remains to be tested whether our results are relevant in a more volatile macroeconomic environment.

Despite the negative relationship of target capital buffers with recent GDP growth, we find evidence of forward-looking behaviour by bank managers that is likely to dampen the impact

of fluctuations in credit market conditions on their lending activities. Banks set higher target capital buffers over regulatory requirements when economic activity is gathering momentum and the demand for loanable funds is increasing (reflected in increases in dwelling approvals, business confidence and other leading indicators of credit market conditions). This finding implies that banks adjust their capital targets in light of future expected economic opportunities. However, this type of behaviour is less consistently evident in relation to banks' *actual* capital buffers than it is in relation to their *target* capital buffers. Credit portfolio growth associated with improving economic conditions may prevent banks from achieving their strategic objective of increasing their regulatory capital adequacy in these circumstances; or alternatively, capital raisings initiated to fund future expected economic opportunities may fall behind in an upturn.

This study reveals other tactical or transitory factors that impact on banks' actual capital buffers, but that are not reflected in their capital targets. Higher capital buffers maintained by IRB-accredited banks mitigate against the model risk associated with determining the capital requirement using their internal models (although this finding may simply reflect the widening divergence in mortgage risk weights between the standardised and IRB approaches to credit risk in the sample period). The results suggest that the level of competitive intensity in the banking industry is more influential in determining the size of capital buffers than the cost of servicing surplus capital. Consistent with the findings of Fonseca and González (2010) and Hanson, Kashyap and Stein (2011), banks are observed to economise on capital when competitive intensity is greater. In these circumstances, depository institutions are likely to be more restrained in the extent to which they can pass on the costs of servicing surplus capital to their customers.

References

Alfon, I., Argimon, I. and Bascuñana-Ambrós, P. (2004), 'What determines how much capital is held by UK banks and building societies?', Financial Services Authority Occasional Paper No. 22, July.

Arellano, M. and Bover, O. (1995), 'Another look at the instrumental variable estimation of error-components models', *Journal of Econometrics*, 68 (1), 29-51.

Australian Prudential Regulation Authority (2014), *Financial System Inquiry: Submission*, 31 March.

Australian Treasury (2014), *Financial System Inquiry: Final report*, Canberra: Commonwealth of Australia.

Ayuso, J., Pérez, D. and Saurina, J. (2004), 'Are capital buffers pro-cyclical? Evidence from Spanish panel data', *Journal of Financial Intermediation*, 13 (2), 249-64.

Berger, A.N. (1995), 'The relationship between capital and earnings in banking', *Journal of Money, Credit and Banking*, 27 (2), 432-56.

Berger, A.N. and Bouwman, C.H.S. (2013), 'How does capital affect bank performance during financial crises?', *Journal of Financial Economics*, 109 (1), 146-76.

Berger, A.N., DeYoung, R., Flannery, M.J., Lee, D. and Öztekin, Ö. (2008), 'How do large banking organizations manage their capital ratios?', *Journal of Financial Services Research*, 34 (2), 123-49.

Berger, A.N., Herring, R.J. and Szegö, G.P. (1995), 'The role of capital in financial institutions', *Journal of Banking and Finance*, 19 (3), 393-430.

Blundell, R. and Bond, S. (1998), 'Initial conditions and moment restrictions in dynamic panel data models', *Journal of Econometrics*, 87 (1), 115-43.

Borio, C., Furfine, C. and Lowe, P. (2001), 'Procyclicality of the financial system and financial stability: Issues and policy options', Bank for International Settlements Papers No. 1, 1-57.

Brown, C. and Davis, K. (2009), 'Capital management in mutual financial institutions', *Journal of Banking and Finance*, 33 (3), 443-55.

Carlson, M., Shan, H. and Warusawitharana, M. (2013), 'Capital ratios and bank lending: A matched bank approach', *Journal of Financial Intermediation*, 22 (4), 663-87.

Coffinet, J., Coudert, V., Pop, A. and Pouvelle, C. (2012), 'Two-way interplays between capital buffers and credit growth: Evidence from French banks', *Journal of International Financial Markets, Institutions and Money*, 22 (5), 1110-25.

Crockett, A. (2002), 'Market discipline and financial stability', *Journal of Banking and Finance*, 26 (5), 977-87.

Davis, K. (2011), 'The Australian financial system in the 2000s: Dodging the bullet', in Gerard, H. and Kearns, J. (eds.), *The Australian Economy in the 2000s, Proceedings of a Conference held in Sydney on 15-16 August 2011*, Sydney: Reserve Bank of Australia, 301-48.

De Jonghe, O. and Öztekin, Ö. (2015), 'Bank capital management: International evidence', *Journal of Financial Intermediation*, 24 (2), 154-77.

Ediz, T., Michael, I. and Perraudin, W. (1998), 'The impact of capital requirements on U.K. bank behaviour', *Federal Reserve Bank of New York Economic Policy Review*, 4 (3), 15-22.

Estrella, A. (2004), 'The cyclical behavior of optimal bank capital', *Journal of Banking and Finance*, 28 (6), 1469-98.

Flannery, M.J. and Rangan, K.P. (2008), 'What caused the bank capital build-up of the 1990s?', *Review of Finance*, 12 (2), 391-429.

Fonseca, A.R. and González, F. (2010), 'How bank capital buffers vary across countries: The influence of cost of deposits, market power and bank regulation', *Journal of Banking and Finance*, 34 (4), 892-902.

Francis, W.B. and Osborne, M. (2010), 'On the behavior and determinants of risk-based capital ratios: Revisiting the evidence from UK banking institutions', *International Review of Finance*, 10 (4), 485-518.

Francis, W.B. and Osborne, M. (2012), 'Capital requirements and bank behavior in the UK: Are there lessons for international capital standards?', *Journal of Banking and Finance*, 36, (3), 803-16.

Gambacorta, L. and Mistrulli, P.E. (2004), 'Does bank capital affect lending behavior?', *Journal of Financial Intermediation*, 13 (4), 436-57.

Gropp, R. and Heider, F. (2010), 'The determinants of bank capital structure', *Review of Finance*, 14 (4), 587-622.

Hanson, S.G., Kashyap, A.K. and Stein, J.C. (2011), 'A macroprudential approach to financial regulation', *Journal of Economic Perspectives*, 25 (1), 3-28.

Iliev, P. and Welch, I. (2010), 'Reconciling estimates of the speed of adjustment of leverage ratios', working paper, Brown University, 20 October.

Jackson, P., Perraudin, W. and Saporta, V. (2002), 'Regulatory and "economic" solvency standards for internationally active banks', *Journal of Banking and Finance*, 26 (5), 953-76.

Jokipii, T. and Milne, A. (2008), 'The cyclical behaviour of European bank capital buffers', *Journal of Banking and Finance*, 32 (8), 1440-51.

Lindquist, K.-G. (2004), 'Banks' buffer capital: How important is risk', *Journal of International Money and Finance*, 23 (3), 493-513.

Marcus, A.J. (1984), 'Deregulation and bank financial policy', *Journal of Banking and Finance*, 8 (4), 557-65.

McDonald, T. and Morling, S. (2011), 'The Australian economy and the global downturn Part 1: Reasons for resilience', Australian Treasury Economic Roundup Issue 2, 1-31.

Memmel, C. and Raupach, P. (2010), 'How do banks adjust their capital ratios?', *Journal of Financial Intermediation*, 19 (4), 509-28.

Miles, D., Yang, J. and Marcheggiano, G. (2013), 'Optimal bank capital', *Economic Journal*, 123 (567), 1-37.

Myers, S.C. and Majluf, N.S. (1984), 'Corporate finance and investment decisions when firms have information that investors do not have', *Journal of Financial Economics*, 13 (2), 187-221.

Nier, E. and Baumann, U. (2006), 'Market discipline, disclosure and moral hazard in banking', *Journal of Financial Intermediation*, 15 (3), 332-61.

Peura, S. and Keppo, J. (2006), 'Optimal bank capital with costly recapitalization', *Journal of Business*, 79 (4), 2163-201.

Rajan, R.G. (1994), 'Why bank credit policies fluctuate: A theory and some evidence', *Quarterly Journal of Economics*, 109 (2), 399-441.

Repullo, R. and Suarez, J. (2013), 'The procyclical effects of bank capital regulation', *Review of Financial Studies*, 26 (2), 452-90.

Rime, B. (2001), 'Capital requirements and bank behaviour: Empirical evidence for Switzerland', *Journal of Banking and Finance*, 25 (4), 789-805.

Roodman, D. (2009), 'Practitioners' corner: A note on the theme of too many instruments', *Oxford Bulletin of Economics and Statistics,* 71 (1), 135-58.

Shim, J. (2013), 'Bank capital buffer and portfolio risk: The influence of business cycle and revenue diversification', *Journal of Banking and Finance*, 37 (3), 761-72.

Stolz, S. and Wedow, M. (2011), 'Banks' regulatory capital buffer and the business cycle: Evidence for Germany', *Journal of Financial Stability,* 7 (2), 98-110.

Thompson, S.B. (2011), 'Simple formulas for standard errors that cluster by both firm and time', *Journal of Financial Economics*, 99 (1), 1-10.