Three essays on market discipline in the banking industry

Yilian Guo

A thesis submitted in partial fulfilment of the requirements for the degree of
Doctor of Philosophy

Department of Applied Finance
Faculty of Business and Economics
Macquarie University
May 2019

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 previously for a higher degree or qualification at any other university or institute of higher learning. I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis, and sources used have been acknowledged.

Yilian Guo

Acknowledgements

First and foremost, I thank my academic supervisor, Dr James Cummings, for his consistently strong support and patience throughout the preparation of this thesis. It has been a great pleasure to work with James and learn from his expertise.

This research has also benefited greatly from thoughtful insights and feedback provided by Gordon Allison, Anthony Brassil, Christina Bui, Wayne Byres, Meryem Duygun, Elyas Elyasiani, Robert Faff, Jean-Pierre Fenech, Tricia Ho-Hudson, Gideon Holland, David Hughes, Shan Ji, John Laker, Charles Littrell, David Miles, Vito Mollica, David Norman, Maurice Peat, Michael Puli, Hong Ru, Mehdi Sadeghi, Rafael Schiozer, Robert Schwebach, Mohamed Shaban, Tom Smith, Gary Tian, James Vickery, Larry Wall, Terry Walter, Eliza Wu, Kazuo Yamada and Naoyuki Yoshino, and seminar participants at the Reserve Bank of Australia.

I thank David Connolly, Mark Stanley and Scott Walker at the Australian Prudential Regulation Authority for helping me extract the data used in this thesis.

I also gratefully acknowledge research funding provided by the Centre for International Finance and Regulation (project number T023), the Capital Markets CRC Limited and the Faculty of Business and Economics at Macquarie University.

Finally, a special thank you goes to my parents, friends and fellow research students. I am especially grateful to my husband Jun Luan for his wholehearted support and for enduring my neglect throughout my work on this thesis.

Synopsis

This thesis presents the results of empirical research on the pricing and liquidity of various funding instruments issued by Australian banks and investigates the effects of the Basel III regulatory framework in promoting the risk-based pricing of banks' funding instruments and reducing the implicit subsidies realised by systemically important banks. The research focuses on three related areas: the impact of more stringent capital regulation on the value extracted from implicit government guarantees and the associated funding cost advantage realised by systemically important banks; the impact of the Basel III bail-in mechanism (the discretionary point of non-viability trigger mechanism) on the pricing of banks' subordinated debt securities; and the impact of the Basel III contingent convertible loss absorbency requirements (the discretionary point of non-viability trigger mechanism and the mechanical common equity capital ratio trigger mechanism) on the pricing and liquidity of banks' hybrid debt-equity securities. An overview of previous literature identifies some important questions that this thesis aims to resolve for the benefit of regulators and industry practitioners.

The first study reported in this thesis examines whether systemically important banks realise an implicit subsidy when raising wholesale debt funding and evaluates the effectiveness of the Basel III capital reforms in reducing the subsidy. The estimations suggest that, before the reforms, systemically important banks realise a subsidy of around 29-35 basis points when they raise senior unsecured borrowings and that, after the reforms are implemented, the subsidy is reduced by approximately one-half. This study finds evidence that the default protection provided by a stronger capital base substitutes for the protection provided by implicit government guarantees in lifting investor confidence in a systemically important bank.

The second study examines the extent to which a bail-in risk premium is embedded in the credit spreads of bank subordinated debt securities issued with a discretionary point of non-viability trigger mechanism under the Basel III rules. Using monthly credit spreads of subordinated bonds issued by Australian banks and traded in the secondary market from 2013 to 2017, the results suggest that the Basel III point of non-viability trigger mechanism is assessed by investors when they price the subordinated debt securities issued by banks. The average bail-in risk premium is estimated to be approximately 73 basis points for fixed-rate subordinated bonds and 45 basis points for floating-rate subordinated bonds relative to old-style subordinated bonds without the bail-in mechanism. In addition, this study finds the pricing of Basel III bail-in subordinated debt has become more sensitive to bank-specific risk, as captured by market-based risk measures, than the old-style subordinated debt securities.

The third study examines whether investors in Basel III contingent convertible capital instruments (CoCos) demand an additional risk premium when transacting the instruments in the secondary market and which of the trigger mechanisms, the regulatory discretionary trigger or the mechanical trigger, has a greater impact on the pricing of the instruments. The estimations suggest that: (i) investors in Basel III CoCos with the discretionary trigger mechanism demand an additional risk premium of around 50-60 basis points compared with hybrid securities issued without the loss absorption triggers; (ii) the additional risk premium can be attributed to the discretionary point of non-viability trigger mechanism rather than the mechanical 5.125% common equity capital ratio trigger mechanism prescribed under the Basel III rules; and (iii) compared with conventional hybrid securities, the pricing of Basel III CoCos issued with both the discretionary and mechanical trigger mechanisms is more sensitive to systematic bank risk, however, the pricing is less sensitive to bank-specific risk as captured by the distance-to-default and idiosyncratic equity volatility. Furthermore, this study investigates whether the Basel III loss absorption triggers have had an impact on the secondary market liquidity for bank hybrid securities and finds no evidence that liquidity has deteriorated overall. The results suggest that the Basel III loss absorption features have enhanced the loss-absorbing capacity of banks without disrupting the liquidity of the capital instruments in the secondary market.

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Chapter 1

Introduction

Market discipline refers to the process whereby investors are incentivised to monitor and price bank risks when they provide funding to the bank (Flannery, 2001). If a bank's investors are exerting such discipline, the bank itself will be incentivised to take account of investors' perceptions when making its investment and financing decisions. Intuitively, if investors monitor bank risk diligently, they would ask for additional compensation in the form of lower security buy-in prices and raised yield spreads should bank risk increase. If uninsured debt holders are exposed to bank losses in the event that a bank fails, they have an incentive to monitor the bank's risk-taking activities before it fails (Balasubramnian and Cyree, 2014). Previous research provides support for using uninsured wholesale debt to promote risk monitoring by private investors, as well as a supplement to capital requirements for maintaining a sound and resilient banking system (Benston and Kaufman, 1994; Wall, 1989; Evanoff and Wall, 2000; Evanoff and Jagtiani, 2004). In contrast to equity investors, unsecured debt investors do not realise unlimited upside gains from banks' risky activities. When a bank is approaching insolvency and its common equity instruments, i.e. ordinary shares, have been exhausted, investors in preferred equity (hybrid securities) are the second in line to absorb bank losses, followed in turn by subordinated debt holders and unsecured senior debt holders. Theoretically, the characteristics of preferred equity and debt claims give investors in these instruments a strong incentive to monitor the risk-taking activities of the bank and a preference for low-risk investments by the bank. However, the 2007-2009 financial crisis provided evidence of a severe moral hazard problem and reduced market discipline due to the banking safety net. Public recapitalisation of failed systemically important financial institutions and massive central bank lending acted as a backstop to the banking system, which is likely to distort bank investors' incentive to monitor the risk profiles of banks and to weaken market discipline (Acharya, Anginer and Warburton, 2016). Furthermore, due to interconnectedness within the banking system, as well as between the financial sector and the real economy, policy initiatives that seek to impose banking losses on wholesale debt and preferred equity holders may come at the expense of financial stability.

This thesis focuses on the pricing of various non-common equity instruments issued by Australian banks and evaluates the impact of the Basel III capital reforms in promoting the risk-based pricing of banks' funding instruments and reducing the funding cost advantage realised by systemically important banks. The Basel III capital reforms address the problems created by a bank's systemic importance by increasing the size and quality of the regulatory capital base. The first of the three empirical studies presented in this thesis examines whether systemically important banks realise an implicit subsidy when raising wholesale debt funding, and the impact of the Basel III capital reforms in reducing the size of the funding cost advantage to these banks. In response to investor incentive problems identified during the 2007-2009 financial crisis, the Basel III capital reforms introduced additional loss absorbency requirements for banks' non-common capital instruments to qualify as regulatory capital. The new framework requires that the capital instruments be fully converted into common equity or have their principal values written down according to contractual trigger mechanisms as a bank approaches insolvency. For all non-common capital instruments, a point of non-viability trigger is required for the capital instruments to qualify as regulatory capital, that is activated at the discretion of the national banking regulator. In addition, for capital instruments classified as liabilities on banks' balance sheets to qualify as tier 1 capital,[1] a 5.125% common equity tier 1 capital ratio trigger is required that is activated irrespective of the regulator's discretion. The second empirical study presented in this thesis examines the extent to which a bail-in risk premium is embedded in the credit spreads of newly issued Basel III subordinated debt securities, which include the point of non-viability discretionary trigger alone, and whether the risk sensitivity of subordinated debt spreads has increased with the inclusion of the point of non-viability trigger. The third empirical study presented

[1] Tier 1 capital comprises the highest quality forms of bank capital, including common stock, retained earnings and non-redeemable non-cumulative preferred stock. Tier 1 capital must be available to absorb losses incurred by the issuing bank in the ordinary course of business.

in this thesis tests the impact of the different loss absorption trigger mechanisms, i.e., the discretionary point of non-viability trigger and the mechanical common equity capital ratio trigger, on the pricing and liquidity of Basel III contingent convertible capital instruments.

1.1 Implicit subsidy of systemically important banks

A major objective of the Basel III reform package devised by the Basel Committee on Banking Supervision (BCBS) is to address the greater risks that systemically important banks pose to the financial system.[2] Far-reaching government actions in a number of countries, including Australia, during the 2007-2009 financial crisis are likely to have entrenched perceptions that sufficiently large or complex financial institutions will not be allowed to fail. The expectation among debt investors that the government may provide support for a distressed bank weakens market discipline by reducing investors' incentives to monitor the risk-taking activities of systemically important banks and lowers those banks' cost of funding (Noss and Sowerbutts, 2012).[3] A cost advantage of this nature represents an implicit subsidy and may allow systemically important banks to expand at the expense of their competitors. The Basel III capital reforms address this problem by increasing both the quality and level of the regulatory capital base, thereby reducing the probability that a systemically important bank will become financially distressed. Using primary bond market data for Australian banks, the first study reported in this thesis examines the extent to which systemically important banks realise an implicit subsidy when they raise wholesale debt funding and evaluates the effectiveness of the Basel III capital reforms in limiting the extent to which systemically important banks capture the subsidy.

The study contributes to the research literature on the implicit subsidy of systemically important banks in three ways. First, I consider an economy with a strong dependence on bank lending for financing economic activity and with a highly concentrated banking

[2] A systemically important financial institution is defined as a financial institution whose distress or disorderly failure, because of its size, complexity and systemic interconnectedness, would cause significant disruption to the wider financial system and economic activity.

[3] A reduction in funding costs resulting from investors' expectations of government support for systemically important banks can be considered an implicit subsidy, because it is based on the market's assessment of the probability that the government will intervene to support a distressed bank but not on any explicit commitment by the government to intervene.

industry. Banks dominate the Australian financial system and the four largest banking companies hold assets worth more than 200 per cent of annual gross domestic product. Bank financing is more dominant as a source of investment funds than in other countries including the United States, Japan and Germany (International Monetary Fund, 2012). Furthermore, Australia's banking industry is much more concentrated than those of other countries, with the four largest banking companies accounting for almost 80 per cent of total banking assets. Although their pricing power contributes to sustaining profitability, their size implies that, in the event of a major bank failing, the impact on the financial system and on the domestic economy would be enormous (Kroszner, Laeven and Klingebiel, 2007). In these circumstances, it can be expected that there will be intense political and economic pressure on the government to intervene financially in the event that a major bank becomes distressed. These conditions provide an ideal environment to assess the value of the implicit subsidy to systemically important banks and to test the effectiveness of recent regulatory reforms in reducing the subsidy.

Second, the study uses a more direct measure of the size of the implicit subsidy of systemically important banks than that used in other studies. Using secondary market data for financial firms and non-financial firms, Acharya, Anginer and Warburton (2016) find evidence that expectations of government support are embedded in the credit spreads of unsecured bonds issued by large United States financial institutions. A potential limitation of using secondary market spreads is that smaller banks may have the ability to substitute alternative funding sources or reschedule their bond issuance programs to avoid periods when credit spreads are wider. Therefore, differences in secondary market spreads between large banks and small banks may exaggerate the funding cost advantage of large banks due to implicit government support. Using rating agency data, Ueda and Weder Di Mauro (2013) find evidence that expectations of government support are embedded in the credit ratings of large financial institutions. A limitation of using credit ratings is that estimates of the value of government support rely upon the subjective judgement of the rating agency and the mapping of ratings uplifts to funding cost differentials based on historical experience. To address the limitations of previous studies, this study uses primary market data that directly measure the cost for a bank of raising unsecured debt funding and examines differences in primary market spreads between systemically important banks and other banks.[4]

[4] Australia's depositor preference regime means senior debt ranks behind uninsured deposits, which makes

Third, the study provides an early view of the effectiveness of the Basel III capital reforms in reducing the implicit subsidy of systemically important banks. In the United States, Acharya, Anginer and Warburton (2016) find that recent financial regulations designed to address problems associated with systemically important financial institutions do not have a significant impact in eliminating investors' expectations of government support. They find that the passage of the Dodd-Frank Act in 2010 did not significantly alter investors' expectations of government support for the non-guaranteed bonds of major financial institutions.[5] However, the sample data for their study do not cover the period after the implementation of the Basel III capital reforms. In Australia, the banking regulator implemented the Basel III capital reforms two years ahead of the international phase-in timeline and banks increased the quality and level of their capital base to meet the new requirements earlier than banks in other jurisdictions (Bank for International Settlements, 2014). These responses from the regulator and the banking industry allow me to test the effectiveness of the capital reforms in reducing the extent to which systemically important banks derive a funding cost advantage from implicit government protection.

Using primary bond market data for Australian banks in the period from January 2004 to December 2017, evidence is found that systemically important banks realise a funding cost advantage due to implicit government support. This hypothesis is supported in two ways: (i) the credit spreads are lower for bonds issued by systemically important banks than for bonds issued by other banks after allowing for bank risk; and (ii) the credit spreads are less responsive to conventional measures of bank risk for bonds issued by systemically important banks than for bonds issued by other banks. The empirical results suggest that, prior to the implementation of the Basel III capital reforms, systemically important banks realise an implicit subsidy of around 26-30 basis points when they raise senior unsecured borrowings and that, after the implementation of the reforms, the implicit subsidy is reduced by approximately one-half. Increases in the equity capital base mandated under the Basel III rules serve to reduce the borrowing costs of smaller banks, but they are less effective in reducing the borrowing costs of larger banks. This pattern is consistent with

the issue spread of senior debt a suitable measure for banks' funding cost.

[5] The Dodd-Frank Act was signed into law on 21 July 2010. It implements changes to financial regulation including, among other changes, a new regulatory agency tasked with monitoring systemic risk, a new resolution procedure for large financial companies, more stringent capital requirements and reforms to the regulation of credit rating agencies.

the proposition that the default protection provided by a stronger capital base substitutes for the protection provided by implicit government guarantees in shoring up investor confidence in a systemically important bank.

1.2 Bail-in arrangements and the pricing of subordinated debt instruments

One objective of promoting market discipline in the banking industry is to engage private investors (including a bank's existing security holders) as monitoring agents, to mitigate excessive risk-taking behaviour brought about by industry safety nets (Flannery and Bliss, 2019). The intention is that the monitoring provided by market investors will complement the monitoring provided by official supervisory agencies. The Basel Committee on Banking Supervision introduced Pillar 3 as part of the Basel II framework to embrace the idea of market discipline and to ensure that banks disclose sufficient information for their security investors to assess the bank's financial condition and risk profile (Bank for International Settlements, 2006). Existing research on the role of private investors in exerting market discipline through monitoring bank risks and influencing banks' behaviour, has focused on subordinated debt holders and uninsured depositors (Goldberg and Hudgins, 2002; Hannan and Hanweck, 1988; Krishnan, Ritchken and Thomson, 2005; Flannery and Sorescu, 1996; Nguyen, 2013). As creditors of banks, these investors bear the downside risks of bank default without benefiting from the potential upside gains from the risky activities banks undertake, which makes them less likely to support a bank's high-risk activities than ordinary shareholders. If market discipline works effectively, the prices of a bank's securities, especially its debt instruments, will fall if there is an increase in the bank's probability of failure. The fall in security values would provide an indication to official supervisors and market investors alike that they need to pay more attention to the target bank.

With increases in deposit insurance coverage in many jurisdictions since the 1990s, a greater reliance has been placed on subordinated debt investors monitoring and pricing bank risks. Results of research on market discipline in the 1990s are broadly consistent with the presence of market monitoring of banking risks; however, it also shows that the credit spreads on subordinated debt are not responsive to changes in default risk for all banks in all time periods (Kwast, Covitz, Hancock, Houpt, Adkins, Barger, Bouchard, Connolly, Brady, English and Evanoff, 1999; Flannery and Sorescu, 1996). In the lead-up to the 2007-2009 financial crisis, subordinated debt prices did not reflect the risks building up in banks and the financial system. The crisis also demonstrated an additional drawback of conventional subordinated debt: banks must go through a formal bankruptcy process for losses to be imposed on subordinated debt holders. In many countries, governments intervened to recapitalise banks and provide extraordinary liquidity support before losses were imposed on subordinated debt holders. These actions exposed taxpayers to potential future losses and have exacerbated moral hazard problems in the banking industry (Noss and Sowerbutts, 2012; Acharya, Anginer and Warburton, 2016). The limitations of bank capital regulation in addressing the distortions in investor incentives to monitor banking risks have stimulated policy debate about new mechanisms to complement capital requirements. Policy-makers are concerned about improving the efficiency of capital instruments in providing investor exposure to banking risks and improving banks' loss-absorbing capacity.

As part of the Basel III capital reforms, new loss absorption requirements for tier 2 capital instruments have been introduced to help resolve failed banks before formal bankruptcy proceedings are initiated.[6] These capital instruments must have principal loss absorption through either conversion to common shares or have their principal value written down when a bank is assessed to be non-viable (Bank for International Settlements, 2010). A newly designed discretionary point of non-viability trigger is required for subordinated debt securities to qualify as tier 2 capital under the Basel III rules. Domestic supervisors have full discretion to decide whether a bank is non-viable based on their review of the financial condition and risk profile of the bank. In circumstances where the trigger is activated, the tier 2 capital instrument provides additional loss-absorbing capacity for the bank. This loss absorption feature is designed to facilitate the bail-in of junior creditors when a bank is non-viable before capital needs to be injected from the public sector; thereby minimising the exposure of taxpayers to failed banks. The new trigger mechanism is designed to improve the resolvability of banks and provide investors with limited liability for losses incurred through banks' risk-taking activities. The Australian banking regulator implemented the

[6] Tier 2 capital includes other components of capital that, to varying degrees, fall short of the quality of tier 1 capital but nonetheless contribute to the overall strength of a bank and its capacity to absorb losses.

Basel III capital reforms from 1 January 2013, and Australian banks are transitioning to the new loss absorbency requirements over a ten-year phase-in period from 1 January 2013 to 1 January 2023. During the transition phase, subordinated debt securities with the new point of non-viability trigger trade concurrently in the secondary market with old-style subordinated debt securities without the trigger. This provides an appropriate experimental environment to test whether investors price the Basel III loss absorption feature when they transact the securities in the secondary market.

Since the new loss absorption feature potentially increases the exposure of subordinated debt investors to banking losses, it is expected that investors would demand an additional risk premium to hold the securities. If this is the case, there will be a positive difference between the credit spreads of the new-style subordinated debt securities issued with the loss absorption feature and the credit spreads of the conventional subordinated debt securities, i.e. those issued under the Basel I and Basel II regimes. As the majority of subordinated debt investors are institutional investors (Nguyen, 2013), it can be expected that these investors are relatively well informed about the reasons for banks issuing subordinated debt, the likelihood of being bailed in and the potential losses that may be imposed if the local regulator calls for conversion or principal write-down. The second empirical study reported in this thesis examines whether investors demand an additional risk premium to compensate for the possibility of being called upon to absorb losses when a point of non-viability trigger is activated for Basel III tier 2 subordinated debt. Focusing on secondary market credit spreads on subordinated debt issued by Australian banks over the period from January 2013 to December 2017, the study provides evidence about the impact of the regulatory discretionary loss absorption feature on the pricing of bank subordinated debt. The analysis is undertaken separately for fixed-rate and floating-rate subordinated debt. After controlling for other factors that can be expected to influence credit spreads, I find that credit spreads are higher by approximately 73 basis points and 45 basis points on fixed-rate bonds and floating-rate bonds respectively, that include the new discretionary loss absorption trigger, relative to subordinated debt securities that do not include the trigger. These results are statistically significant for both fixed-rate bonds and floating-rate subordinated bonds. These results suggest that the loss absorption feature is priced when subordinated debt investors trade the securities in the secondary market.

Previous research examining the sensitivity of subordinated debt spreads to banks' default risks has produced mixed evidence (Kwast, Covitz, Hancock, Houpt, Adkins, Barger, Bouchard, Connolly, Brady, English and Evanoff, 1999; Flannery and Sorescu, 1996; Sironi, 2003; Balasubramnian and Cyree, 2011; Evanoff, Jagtiani and Nakata, 2011). The findings of Davis and Saba (2016) suggest that an additional risk premium for Basel III subordinated debt may derive from the uncertainty associated with the conversion mechanism rather than from increased sensitivity to bank default risks. To further investigate whether this bail-in risk premium can be attributed to uncertainty about potential future regulatory assessments or a heightened sensitivity to bank default risk, I test whether the credit spreads on subordinated debt are more sensitive to banks' risk profiles with the introduction of the Basel III loss absorbency requirement. The regression results for both fixed-rate bonds and floating-rate bonds show a heightened sensitivity of subordinated debt spreads to market-based measures of bank risk, in particular, the Merton distance-to-default and equity volatility. However, the heightened sensitivity is not evident in relation to accounting-based measures of banking risk (which typically provide a less timely indication of changes in a bank's risk profile).

1.3 Impact of loss absorbency requirements on the pricing and liquidity of bank hybrid securities

To address moral hazard problems and systemic risk concerns, researchers and policy-makers have proposed that additional mechanisms be deployed to help mitigate the perceptions of government support and restore the safety and soundness of the banking system. One potential solution advocated by researchers and regulators is to make wholesale debt claims more like equity claims. In this way, wholesale debt holders might become more sensitive to bank risk and take a more active role in monitoring banks' risk-taking activities. A contingent convertible capital instrument (CoCo), a hybrid debt-equity instrument that converts into common equity when a bank is over-leveraged with low core capital but is yet to become insolvent, is proposed to respond to the experiences of the recent financial crisis and reduce the likelihood of government interventions and bailouts. CoCos are unsecured hybrid securities designed to improve the absorption of any bank's unexpected future losses through automatic recapitalisation when a pre-defined trigger point is reached (Avdjiev, Kartasheva and Bogdanova, 2013). Since Flannery (2002), many studies have evaluated an appropriate design of CoCos to be included as a component of regulatory capital. During the crisis, many banks had insufficient capital to support the risks they had taken. To prevent further spread of the crisis, costly bank recapitalisation, government intervention and central bank lending were relied upon (Noss and Sowerbutts, 2012). Even when it is difficult for a going-concern bank to issue new common shares in a bad state, CoCos convert into ordinary shares to recapitalise the bank and replace bailout capital support from taxpayers with bail in capital support from private investors.

CoCos not only automatically convert into common equity to inject capital into the banking sector and help alleviate the need for government bailouts, but also potentially stimulate investors' incentive to monitor bank default risks due to the potential losses associated with the conversion event. CoCo investors are likely to demand higher compensation when they assess a bank is taking excessive risks that expose them to the possibility of conversion to common equity or principal write-down. It is expected by policy-makers that the introduction of CoCos will help improve market discipline by encouraging investors to better monitor banks' risk-taking activities, which would contribute to improved market discipline in the banking system. The optimal design and strengths and weaknesses of different trigger mechanisms have been analysed in previous research. Potential triggers are based on accounting ratios, bank management's discretion, and stock market prices (Squam Lake Working Group, 2009; Flannery, 2009; Duffie and Lando, 2001; Birchler and Facchinetti, 2007; Berg and Kaserer, 2015; Sundaresan and Wang, 2015). Several researchers argue in favour of using market prices as the basis for a mandatory-conversion trigger for CoCos. However, multiple price equilibria and incentive problems make regulators reluctant to include CoCos with a market price trigger as regulatory capital. Also, market-price-based triggers may exacerbate financial instability and provide a pretext for market manipulation.

The role of CoCos in the new Basel III capital framework is in both a newly defined additional tier 1 category that can replace up to 1.5% of the common equity in tier 1 capital (Bank for International Settlements, 2010) and the tier 2 category that supplements a bank's total capital base. As defined by the Basel Committee, hybrid securities that are eligible to be included as regulatory capital need to be issued with loss absorption contingent convertible features, which comprise both a discretionary point of non-viability trigger controlled by the national regulator and, for tier 1 capital instruments classified as liabilities under financial reporting standards, a mechanical capital ratio trigger. That is if the issuing bank breaches either a 5.125 per cent common equity tier 1 capital ratio where applicable or a discretionary point of non-viability trigger, the Basel III CoCos will be written down or converted into ordinary shares.[7] The mechanical loss absorption feature would potentially turn hybrid security investors into shareholders to fill the gap in core tier 1 capital when a bank is close to failure. Both loss absorption features potentially provide hybrid investors with a greater level of exposure to bank risks. As such, part of the rationale for the loss absorption contingent convertible mechanisms is to increase the risk-monitoring activities of hybrid security investors and thereby improve market discipline in the banking system. The Basel III capital reforms have been progressively implemented in Australia from 1 January 2013 and domestic banks commenced the transition process in a timely fashion. This provides an appropriate experimental environment to test the impact of different Basel III loss absorption features on the pricing and liquidity of bank non-common equity capital instruments. Australian banks started to issue CoCos from September 2011. There are 3 types of CoCo instruments issued by Australian banks, 1) CoCos with only a gone-concern discretionary point of non-viability trigger; 2) CoCos issued before the Basel III implementation period with only a going-concern mechanical common equity capital ratio trigger; and 3) CoCos with both a point of non-viability trigger and a capital ratio trigger.

The third empirical study reported in this thesis investigates the extent to which the pricing and liquidity of bank capital instruments changed after the implementation of the Basel III capital reforms, by assessing the impact of the different loss absorption trigger mechanisms. Using secondary market hybrid security transactions, the study presented in this thesis investigates whether credit spreads are wider for hybrid securities issued with the loss absorption features than for hybrid securities without the features, and investigates which of the trigger mechanisms explains the additional risk premium. To further elaborate on the effectiveness of the Basel III loss absorption mechanisms, this study tests whether there is a more significant relationship between bank default risk and credit spreads for Basel III CoCos with the different loss absorption trigger mechanisms. When a bank is exposed to

[7] In this thesis, Basel III CoCos refer to instruments issued with one or both of the Basel III loss absorption trigger mechanisms.

higher default risks, it is expected the credit spreads on CoCos will increase to a greater extent than for conventional hybrid securities, if the loss absorption mechanism represents a credible method for exposing investors to expected future losses incurred by the bank. In addition, this study investigates whether the secondary market liquidity of hybrid securities is impacted by the Basel III loss absorption features. With the risk profiles of CoCos being more complex than conventional hybrid securities, investors may be less willing to transact in bank CoCos than in conventional hybrid securities. This will potentially lead to higher transaction costs for market participants, which may impede the ability of Basel III Cocos to promote greater loss-absorbing capacity in the banking system.

As a complement to past research, which mainly focuses on the risk-monitoring effects of wholesale debt and bank deposits and the theoretical design and pricing of bank-issued CoCos, this study contributes to the literature on both market discipline and security design by documenting the extent to which the credit spreads of CoCos are sensitive to bank default risk and other firm-specific characteristics. Using data on secondary market transactions for hybrid securities, evidence is provided on the pricing of a risk premium on CoCos due to the regulatory discretionary loss absorption mechanism introduced under Basel III. The results suggest that the wider credit spreads for CoCos can be attributed to the gone-concern point of non-viability trigger rather than the going-concern common equity capital ratio trigger. A wider credit spread for CoCos relative to conventional hybrid securities would indicate that investors attribute a non-zero probability of CoCos being converted into common equity or having their principal written-down if a bank experiences substantial losses. That is, it would suggest CoCo investors demand an additional risk premium because they are more exposed to bank risk. The estimations suggest an approximately 50-60 basis points difference in credit spreads between conventional hybrid securities and CoCos issued with the regulatory discretionary point of non-viability trigger. This difference is statistically significant. This study further investigates whether the contingent convertible feature has the effect of producing a stronger relation between credit spreads and bank risk. Based on the analysis, little evidence is found for increased sensitivity of CoCo credit spreads to measures of a bank's default probability. This result may be due to the fact that investors' attention is more focused on the design of the loss absorption feature and the opaque nature of national regulators' assessment of a bank's viability. In addition, there is a compelling argument that bank CoCos have a high-risk profile only due to the uncertainty about the future potential conversion point (Australian Securities and Investments Commission, 2013). However, there is evidence of a stronger relationship between measures of a bank's systematic risk (i.e., hybrid security betas) and hybrid security credit spreads with the inclusion of the combination of the discretionary and mechanical loss absorption mechanisms. This evidence suggests that investors increasingly take account of banks' systematic risks when pricing Basel III CoCos.

While prudential regulatory frameworks, including the Dodd-Frank Act and the Basel III capital reforms, attempt to build a robust financial system that has the ability to absorb unpredictable shocks, they rely upon bank capital instruments often traded in open capital markets as a source of bank capital. In these cases, the stability objectives of the reforms will be undermined if the market is illiquid or easily disrupted by information shocks. As generally defined, market liquidity is the ability to execute transactions immediately with limited price impact and low transaction costs. A less liquid market place will typically be less price efficient and less useful for the efficient allocation of economic resources (Amihud and Mendelson, 1986). Even in normal times, market liquidity can differ from asset class to asset class. Assets with worse liquidity tend to have a higher liquidity risk premium, which is associated with higher transaction costs for market participants. As a potential consequence of having enhanced capital and loss-absorbing capacity in the banking system, there might be less liquidity for banks' capital instruments during normal times, which also leads to the concern regarding market liquidity in potential future stressed market conditions (Adrian, Fleming, Shachar and Vogt, 2017).

Previous literature has addressed an incentive issue associated with the use of CoCos, which is the concern regarding not only the issuers' incentive to issue CoCo bonds but also the cost for investors of participating in the trading of CoCos (Flannery, 2014; Chen, Glasserman, Nouri and Pelger, 2013; Albul, Jaffee Dwight and Tchistyi, 2015). CoCos might be less liquid than conventional hybrid securities, due to the uncertainty about the national regulators' assessment of a bank's non-viability and the timing of future potential conversion or write down. In this case, investors will be reluctant to hold these securities or will demand a large liquidity premium for doing so. Motivated by this concern, this study investigates the impact of the loss absorption features on the market liquidity of hybrid securities. Using the time-weighted bid-ask spread as a measure of market illiquidity, this study finds no significant evidence that CoCos with the different Basel III loss absorption features are less liquid on average than conventional hybrid securities. To further understand the impact of the loss absorption features on market illiquidity, I examine whether bid-ask spreads in the secondary market are more sensitive to bank default risk than for conventional hybrid securities. The findings indicate that CoCo illiquidity is exacerbated by the same factor that is observed to be relevant to CoCo pricing: increases in systematic risk as measured by the hybrid security beta. This result suggests that CoCo market liquidity is relatively more vulnerable to increases in a bank's systematic risk profile than for conventional hybrid securities.

The remainder of this thesis is organised as follows. Chapter 2 reviews the literature relating to the role of banks, bank capital, implicit government guarantees, market discipline and the pricing and liquidity of contingent convertible instruments. Hypotheses for the three empirical studies are developed based on the gaps identified in previous research. Empirical analyses, including descriptions of the new regulation, data sources and methodology, as well as the results of the three studies are presented in chapters 3, 4 and 5. Chapter 6 summarises the main findings and discusses the potential implications of the research.

Chapter 2

Literature review and hypothesis development

This chapter reviews previous research literature related to the three empirical studies presented in this thesis, identifies gaps in the literature and builds a case for the hypotheses to be tested in each study. The first part of the literature review discusses the role of banks as liquidity insurers and delegated monitors, and the nature of explicit deposit insurance schemes that work as a safety net but create certain moral hazard problems in the banking system. The ways in which the moral hazard problems are addressed by bank capital regulation, in the context of the Basel Accord, are discussed. The second part of the literature review provides an overview of previous studies related to implicit subsidies in the banking industry, the role of subordinated debt investors in exerting market discipline, and the design of contingent convertible instruments, including those adopted as part of the Basel III capital reforms.

2.1 Entrenched problems faced by bank-reliant economies

2.1.1 Preserving the role of banks and banking safety nets

In the 1990s, industry observers presumed that banks were on the decline and that they would be crowded out by competitors, especially institutional investors (Llewellyn, 1996;

Davis, 1996). Banks faced challenges from the transition to new technologies, new entrants into the financial services industry, the growth of the fund management industry and the increasing significance of financial markets. However, instead of fading away, banks evolved and became even more important than before. How have banks been able to maintain and expand their market position? To answer this question, we need to consider why we need banks within a modem economy and what makes banks different from their competitors.

Banks typically borrow short-term and lend long-term, and this maturity transformation function of banks is fundamental to the value they contribute within an economic system. Banks take deposits from customers. A deposit is a claim on the bank that can be redeemed at par on demand for cash or used to make payment (Ellis, 2016). Banks promise to return funds for most deposit products when requested, while most other investment funds cannot promise full redemption on demand. The ability to provide depositors with liquidity insurance makes banks valuable and enables the liquidity risks of individuals to be shared among households that have different consumption needs over time (Diamond and Dybvig, 1983). In addition, depositors can be confident that the deposits banks collect are subject to minimal risk. In other words, depositors can avoid worrying about a bank's creditworthiness when they lend money to the bank in the form of a deposit. When depositors make payments, to the providers of real economic goods and services, the deposit funds may be recognised as having the same transaction value as cash.

Aside from the role of providing deposits, a second special role of banks is to offer credit. This service is essential to retail customers, who cannot get access to borrowing from wholesale debt markets. These customers include households and small businesses. In cases where these households and small businesses have predictable future income streams, they may be ideal candidates for debt finance, and debt finance may be their only option on account of their size.[8] The existence of banks meets the demand for credit from potential small borrowers. Banks set up credit facilities for small borrowers, and attain sufficient market reach to be able to diversify the individual borrowers' credit risks with many other retail borrowers. Furthermore, as credit risk monitoring consumes real resources, that need not be duplicated between large numbers of individual depositors, banks become delegated

[8] Large borrowers are more likely to have access to the capital markets and have the ability to issue bonds and pay fixed servicing costs, whereas households or small business are less likely to have sufficient scale to participate directly in the capital markets.

monitors and help reduce the costs of monitoring the loans (Diamond, 1984). The monitoring costs include those associated with assessing loan applications and enforcing the terms of loan covenants. On account of these costs, an individual depositor is unlikely to be able to finance a household or business borrower directly. If the loan has to be apportioned between multiple lenders, the monitoring costs are likely to be duplicated between them. By delegating monitoring to banks, who can perform this function efficiently, the aggregate monitoring costs are reduced and borrowers can get access to finance at a lower cost.

The role of accepting deposits and providing transaction services explains the relatively short maturities of banks' liabilities, while their role of offering credit and acting as delegated monitors explains the relatively long maturities of their assets. However, both depositors and borrowers care about liquidity services (Diamond and Rajan, 2001). Depositors are concerned about liquidity due to the uncertainty in the timing for them withdrawing their claims, while borrowers are concerned about liquidity as it relates to their ability to ask for additional finance. A financial intermediary acting as both a deposit-taker and a delegated monitor is unique because it not only allows depositors to use their funds at any time on demand but also because it provides borrowers with the flexibility to access finance without concern that funding will be cut off. Due to the important role of banks in the financial system and economy, the reliability and stability of the banking system are of concern to regulators. A significant misadventure of a single bank can have implications reaching far beyond that bank. The adverse effects of a banking collapse are not limited to counterparties within the banking sector itself but are likely to extend to the broader economy. The interconnected nature of the banking system is revealed by the extent of interbank activities and the commonality in the deposit and loan markets they service. When depositors run on one bank, uncertainty transmits to other participants in the financial sector. In addition, with the development of international banking, the linkages between countries in which the banks operate drives the information uncertainty to other markets in the transmission chain. Furthermore, the banking system is connected with most sectors of the real economy through its roles as a deposit-taker and wholesale borrower and as a supplier of credit. The adverse effects of a banking crisis are likely to rapidly spillover to other sectors of the economy.

The strong prudential supervision of deposit-taking institutions is, therefore, essential for preserving financial stability (Dewatripont and Tirole, 2012). Deposits represent a large proportion of the funding base for banks, representing between 60 and 80 per cent of total liabilities for international banks (based on Bank for International Settlements statistics). As observed from the historical experience of banking crises, there are recurring times when bank deposits lose their status from the perspective of investors as "risk-free" claims, because the assets backing the deposits produce uncertain payoffs. In the multiple equilibria demonstrated by Diamond and Dybvig (1983), if depositors' confidence is unwavering, banks are capable of transforming maturity and creating liquidity. However, in historical crisis events, when depositors became concerned about the solvency of banks, they have unanimously demanded cash instead of deposits immediately (Gorton, 2012). In a self-fulfilling manner, all depositors attempt to withdraw their funds before other depositors and the collapse that each depositor feared eventuates. As shown in the model of Diamond and Dybvig (1983), a bank run can be caused by shifts in expectations, when investors anticipate that other investors will withdraw their funds for reasons other than their own expenditure needs. When the panic spreads, this leads to a run on the bank and an otherwise sound bank is unable to meet its obligations. Economic downturns starting with banking crises are typically more severe than those during which banks remain resilient (Reinhart and Rogoff, 2009). Even with the best-designed resolution plans implemented for banking firms, a significant impact on real economic activity is likely to eventuate from a banking crisis.

To ensure the "risk-free" characteristic of deposits in all possible states of the world, governments have moved to guarantee the convertibility of these contracts. When a crisis eventuates and depositors ask to redeem their claims for cash, it will inevitably be more damaging to economic activity for banks to meet redemptions by calling in loans. This action will induce a drop in asset values and reduce borrowers' ability to finance their businesses (Brunnermeier and Pedersen, 2009). Facing challenges of this nature, regulatory policy has been designed and implemented to reduce the likelihood of bank runs and the subsequent significant contagious effects of bank collapses. One way to avoid bank runs is for the public sector to guarantee the convertibility of deposits. Government deposit insurance working as a complement to central bank liquidity support is an effective mechanism for countering the destabilising effects of bank runs (Diamond and Dybvig, 1983). In 1934, the US government established the first national deposit insurance scheme to prevent banks runs during the Great Depression. In the 1980s, the adoption of deposit insurance accelerated in most OECD countries and some developing countries. In theory, when government deposit insurance is available, bank runs can be prevented and banks can function as usual to accept deposits and provide liquidity services.

The explicit government insurance of deposits contains systemic contagion when crisis occurs. However, a downside of its implementation is the moral hazard problem. An extensive literature has investigated the strengths and weaknesses of deposit insurance, as well as the optimal design and challenges associated with this explicit safety net. Kyei (1995) and Garcia (1999) provide a comprehensive survey of deposit insurance schemes introduced internationally. Summarising from the survey, there are different explicit depositor protection schemes around the world. Some countries have extensive deposit insurance that covers all depositors, while others have strict limitations on the amount and nature of deposits covered. There are also different arrangements for insurance funds, and they can be managed by the government or even the private sector. For countries without an explicit deposit insurance scheme, depositors are protected on an ad hoc basis. Some early studies have examined whether insured depositors perceive their deposit contracts to be absolutely safe when the government guarantees the claims. Cook and Spellman (1994) find evidence that the interest rates on insured certificates of deposit (CDs) fluctuate with the financial position of banks; this can be attributed to the credit-worthiness of the guarantor and restitution costs. Flannery (1998) contends that depositors are sensitive to the financial condition and risk-taking activities of banks. He argues that depositors are also concerned about the solvency of the insurer and the credibility of government support. Focusing on both insured depositors and uninsured depositors, Park and Peristiani (1998) provide evidence that insured depositors pay attention to the risk profile of the bank, but that uninsured depositors pay significantly closer attention to the risk profile of the bank when deciding whether to deposit their funds.

Although deposit insurance was endorsed by policymakers in the 1980s and early 1990s, the previous academic literature has examined its controversial impact on banks' risk-taking, in terms of moral hazard. When deposits are insured, depositors arguably lose their incentive to monitor bank risk. Banks, in turn, have a greater incentive to invest in high-risk projects to increase profit, as their deposit profile will not reflect their asset risk (Demirgüç-Kunt and Detragiache, 2002). The moral hazard created by deposit insurance may thus increase the likelihood of bank failure and reduce market discipline (Grossman, 1992; Wheelock and Wilson, 1995). Matutes and Vives (1996) examine the welfare effects of deposit insurance in an endogenous banking industry and demonstrate its benefit in avoiding systemic confidence crises. However, they also highlight the pitfall of deposit insurance in terms of inducing competition between banks and increasing failure probabilities. Reviewing data from the World Bank, Demirgüç-Kunt and Detragiache (2002) illustrate the variation in deposit insurance schemes in 61 countries with regard to their presence and design structure. Using data on 40 systemic banking crisis during the 1980-1997 period in those countries, they provide evidence that deposit insurance had a negative impact on bank stability and market discipline. The adverse impact of deposit insurance tends to be stronger the more extensive the coverage offered and where the scheme is run and funded by the government rather than by the private sector. Hovakimian and Kane (2000) argue that government safety nets create risk-shifting opportunities for large banks, especially those with low capital and a higher proportion of deposits compared with wholesale debt. Demirgüç-Kunt, Kane and Laeven (2014) extend the deposit insurance data to 2013, which show that deposit insurance has become more widespread and more extensive in coverage since the global financial crisis, which also triggered a temporary increase in the government protection of non-deposit liabilities and bank assets. In most cases, these guarantees have since been formally removed but coverage of deposit insurance remains above pre-crisis levels, raising concerns about implicit coverage and moral hazard going forward.

Another stream of the literature explores the way in which the design of an explicit deposit insurance system and the institutional environment affect the impact of deposit insurance on bank risk-taking and banking stability. Demirgüç-Kunt and Kane (2002) provide evidence that, for banks with weak institutional infrastructure, deposit insurance with large explicit reserves entrenches moral hazard and increases the level of banking fragility. Demirgüç-Kunt and Detragiache (2002) provide similar evidence and conclude that countries' contracting environments have a significant effect on the outcomes of deposit insurance policies. In contrast, Gropp, Vesala and Vulpes (2004) find that the introduction of deposit insurance for banks in European countries has reduced their risk-taking, but that this impact is less pervasive for banks with high charter values and less uninsured subordinated debt. They provide evidence that large banks' risk-taking is unaffected by explicit deposit insurance, which they argue to be consistent with the presence of implicit government support for too-big-to-fail banks in Europe.

2.1.2 Bank capital regulation

Although equity capital accounts for only a small proportion of a bank's balance sheet, banks seek to maintain sufficient levels of capital to support their own solvency positions and promote investor and customer confidence in the banks (Berger, Herring and Szegö, 1995). In past banking crises, banks with stronger capital ratios (lower debt-to-total-assets ratios) entering the crisis period have generally emerged from the crisis in a stronger market position (Berger and Bouwman, 2013). However, the policy debate regarding optimal bank capital levels is far from resolved. The notion of optimal or desired bank capital challenges the assumptions underlying the seminal work of Modigliani and Miller (1958), which depicted a frictionless world with competitive capital markets and full information. The debt-equity neutrality principle developed by Modigliani and Miller (1958) suggests that, to the extent that their assumptions hold, a firm's capital structure has no impact on the cost of funding the firm and all capital structures yield identical value. Compared with non-financial firms, banks have much lower equity capital levels (higher leverage ratios), which is contrary to the debt-equity neutrality principle and regarded as a puzzle by many economists. Leverage-related distortions, such as debt tax shields and government subsidies, moral hazard and information asymmetry, are considered by researchers as potential explanations for banks' capital structure (Berger, Herring and Szegö, 1995).

Following a market breakdown in the 1970s, when many European banks collapsed due to severe losses in the foreign exchange market, the global banking system became exposed to the turmoil. In response to the ensuing crisis in banking markets, the central bank regulators of the G10 countries established the Basel Committee on Banking Supervision with the mandate to strengthen financial stability. In 1988, the Basel Capital Accord was approved by the G10 countries and released to banks, which established capital adequacy as the primary reference point for examining bank soundness. In the first Basel Accord, credit risk was considered as the only risk component, and a weighted approach to the measurement of both on- and off-balance sheet credit risks emerged. The first Basel Accord called for a minimum total capital ratio of 8% of risk-adjusted on- and off-balance sheet assets, of which at least half was required to be tier 1 (going-concern) capital (Bank for International Settlements, 1988). Since January 1993, capital requirements have been adopted in various nations as the principal mechanism to maintain the reliability and resilience of the banking system. Since its global implementation, the original Basel Accord has been challenged owing to its various limitations and to financial innovations that gave banks incentives and opportunity for regulatory capital arbitrage.[9] Debate on the design of capital requirements and their diverse effects on banks' risk-taking led to the amendment of the 1988 Basel Accord and a proposal for a new capital adequacy framework to replace the 1988 Accord.

As a result of the policy deliberations of supervisory agencies and central banks, and negotiations between these agencies and banking industry representatives, the Basel II capital framework was released in 2004 and implemented from 2008. The new framework introduced three pillars: risk-based capital requirements, supervisory review and increased market transparency. However, these three pillars were inadequately structured to cope with problems in bank regulation identified during the 2007-2009 financial crisis. Due to the opacity of banks' assets, capital regulation alone cannot be relied upon to indicate banks' financial health and to resolve market failures (Duffie, 2009). Banks quickly learned how to game the capital requirements, and banks with high regulatory capital ratios found ways of taking risks that were not captured by the regulatory requirements. The moral hazard created by deposit insurance and central bank liquidity support encouraged banks to take on excessive risks (Hellmann, Murdock and Stiglitz, 2000). With the increased size and complexity of financial institutions, the financial system became more vulnerable to disruption and posed a significantly greater systemic risk for the wider economy. The expanded deposit insurance coverage globally and public rescue actions for troubled "too-big-to-fail" banks increased the urgency for an overhaul of bank regulation. The extensive infusion of central bank lending and the identification of explicit and implicit guarantees have demonstrated the need to reform the existing financial insolvency process for banking firms.

The main purpose of bank capital regulation is to ensure that, when unexpected shocks impact their operating performance, banks are still capable of remaining solvent, and meeting obligations to depositors and other claimants. Studies of bank capital's impact on banks' risk-taking behaviour provide mixed evidence. A number of theoretical studies demonstrate the role of bank capital in absorbing unexpected losses and reducing bank

[9] Regulatory capital arbitrage refers to the process by which securitisation and other financial innovations have provided unprecedented opportunities for banks to reduce substantially their regulatory capital requirements with little or no corresponding reduction in their overall economic risks (Jones, 2000).

default risk (Repullo, 2004; Von Thadden, 2004). In these studies, banks with higher capital ratios allocate risks more efficiently and are more accurately screened by investors. Other theoretical papers focus on the issue of moral hazard and its relationship with bank lending and risk-shifting. These studies depict the constrained risk-shifting incentives for banks with greater capitalisation (Calomiris and Kahn, 1991; Rochet, 1992). Bank capital increases bank managers' incentive to manage bank risk and discourages them from taking excessive risks, which has a positive influence on financial stability (Coval and Thakor, 2005; Holmstrom and Tirole, 1997; Mehran and Thakor, 2011). In contrast, other conceptual arguments predict a negative relationship between higher capitalisation and individual bank solvency. Koehn and Santomero (1980) argue that higher capital ratios may lead to a bank's higher asset portfolio risk, which causes the bank to be more fragile on the whole. Consistent with this argument, Calem and Rob (1999) document a U-shaped relationship between the level of bank capital and risk-taking. When a bank has a very low capital ratio, it will invest in risky portfolios to maximise the value derived from deposit insurance. When banks' capital levels increase, they take fewer risks. When capital levels increase beyond a certain level, banks' risk-taking increases again, which portends the difficulty in regulating the risk-taking activities of well-capitalised banks using risk-based standards.

Banks' capital levels affect not only the individual bank default risks but also the systemic risks the banks pose to the financial and real sectors. Bank capitalisation works as a shock-absorption system that protects banks from unexpected losses and the contagious shocks induced by other banks' failures. Individual bank insolvency can transmit to other financial institutions through contagious panics and the interbank market (Allen and Gale, 2000; Eichberger and Summer, 2005). Moreover, the capital position and policy of one bank will affect the equity value and default risk of other correlated banks. Asset-substitution moral hazard brought about by banking safety nets can be reduced by having banks maintain higher capital ratios. Because asset-substitution at individual banks is often correlated, higher capital ratios help mitigate systemic risk (Bhattacharya, Boot and Thakor, 1998). Failures of correlated banks are likely to have a significant adverse impact on the economy and society. To avoid this severe societal cost, regulators bailout creditors which lead to perceptions of implicit guarantees. These perceptions generate multiple equilibria which correspond to differential effects of capital on systemic risk (Acharya, Mehran and Thakor, 2016).

A recent stream of empirical studies investigates the impact of capital on the performance and risk of large financial institutions, especially during the 2007-2009 financial crisis. Beltratti and Stulz (2012) examine the stock returns of banks with more than $10 billion in total assets across 32 countries and report that large banks with higher capitalisation performed better during the financial crisis. Demirguc-Kunt, Detragiache and Merrouche (2013) find that better performance during the crisis period is related to banks' stronger capital positions, especially for big banks. They also find that this relationship is more significant for capital ratios measured using unweighted assets compared with risk-based capital ratios. Berger and Bouwman (2013) investigate the impact of bank capital on the performance (survival and market share) of US banks during crisis times and normal times, comparing small banks and larger banks. Their findings suggest that higher levels of capital help improve the performance of medium-sized and large banks mainly in crisis periods, while higher levels of capital always help smaller banks with their probability of survival and market share. Laeven, Ratnovski and Tong (2016) examine the capital and systemic risk of banks with assets greater than $10 billion during the banking crisis period. Their findings indicate a significantly positive relationship between bank size and systemic risk, but a significantly negative relationship between bank capital and systemic risk.

2.2 Contemporary policy initiatives and hypothesis development

2.2.1 Implicit subsidies in the banking industry

The implicit subsidy of systemically important banks creates a variety of problems. If debt investors perceive that the government will protect them from bearing the full cost of failure, they will provide funding without paying sufficient attention to the bank's risk profile. Banks that benefit from the implicit subsidy have a competitive advantage and may engage in riskier activities, increasing systemic risk (Dam and Koetter, 2012; Afonso, Santos and Traina, 2014). The implicit subsidy may also undermine financial stability by reducing margins for competitor banks and pushing these banks toward higher risk-taking (Hakenes and Schnabel, 2010; Gropp, Hakenes and Schnabel, 2010).

Several studies provide empirical evidence that systemically important banks realise a funding cost advantage due to implicit government support. Penas and Unal (2004) and Brewer and Jagtiani (2013) examine the credit spreads on new debt issues by acquiring banks before and after the announcement of merger transactions between banking companies. They find that banks face a lower cost of funding if they reach a systemically important threshold size through the merger. Acharya, Anginer and Warburton (2016) find that expectations of government support are embedded in the secondary market credit spreads of unsecured bonds issued by large US financial institutions. They find that credit spreads are risk-sensitive for most financial institutions, yet lack risk sensitivity for the largest financial institutions. Their estimates suggest that the implicit subsidy provides large financial institutions with a funding cost advantage of approximately 30 basis points over the 1990-2012 period. Ueda and Weder Di Mauro (2013) estimate the value of the implicit subsidy to systemically important banks in various countries using the level of government support embedded in credit ratings. They find a significant funding cost advantage for systemically important banks of about 60 basis points as at end-2007, coinciding with the onset of the financial crisis, and 80 basis points by end-2009, after key governments confirmed bailout expectations.

In assessing the value of implicit government guarantees, the previous research employs indirect measures of funding cost differentials, by examining the market response to merger transactions, bond pricing in secondary markets or ratings agency assessments. However, the research seldom employs a direct measure of the cost of raising funds for systemically important banks relative to other banks. If unsecured creditors perceive that the government will intervene to protect them from the risk of bank failure, I hypothesise that, after controlling for bond characteristics, bank characteristics and macroeconomic factors:

H1: The credit spreads at issuance will be lower for bonds issued by systemically important banks than for bonds issued by other banks.

H2: The credit spreads at issuance will be less sensitive to bank risk and equity capital levels for bonds issued by systemically important banks than for bonds issued by other banks.

Previous research examines the effect of various policy and legislative changes on the implicit subsidy for systemically important banks. Flannery and Sorescu (1996) examine the credit spreads on the subordinated debt of US banks over the 1983-1991 period. They argue that the strength of implicit government guarantees declined over the period, which began with the public rescue of Continental Illinois in 1984 and ended with the passage of the Federal Deposit Insurance Commission Improvement Act (FDICIA) in 1991. They find that credit spreads came to reflect the risks of individual issuing banks when regulators stopped protecting failed banks' subordinated debt holders from losses. Sironi (2003) reaches a similar conclusion based on his study of European banks over the 1991-2000 period.[10] The findings of Flannery and Sorescu (1996) and Sironi (2003) suggest that legislative restrictions on government bailouts and improvements in resolution regimes for banks may reduce the value of implicit guarantees for systemically important banks.

Two objectives of the FDICIA are to reduce both the potential for a systemic banking crisis and bank regulatory agencies' incentives to follow a too-big-to-fail policy (Wall, 2010; Benston and Kaufman, 1997).[11] The act generally requires the resolution of failed banks at the lowest cost to the Federal Deposit Insurance Commission, except when a bank's failure would pose a widespread, systemic risk to other parts of the financial system. However, Balasubramnian and Cyree (2011) document that the relationship between spreads on subordinated debt and risk for the largest banks flattened after the rescue of a non-banking financial institution, Long-Term Capital Management, in 1998. Their finding implies that, in spite of the FDICIA, bond investors strongly believe that a too-big-to-fail policy applies to banks.[12]

The Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act) was passed into law by the US Congress in 2010 in an attempt to solve some of the problems that contributed to the financial crisis of 2007-2009. Among its major objectives, the Act is intended to end implicit government guarantees, such as the too-big-to-fail policy. Bringing an end to federal government intervention to bail out large, complex and interconnected financial institutions is expected to promote better market discipline by increasing investors' incentives to monitor the risks of the individual institutions. Schäfer, Schnabel and Weder di

[10] Sironi (2003) argues that the strength of implicit government guarantees declined over the 1990s, due to the loss of monetary policy by national central banks and the rigid public sector budget constraints imposed by the European Monetary Union. He finds that the sensitivity of credit spreads at issuance on subordinated debt to measures of stand-alone bank risk increased, with the perception of implicit government guarantees gradually disappearing during the decade.

[11] A bank is considered "too-big-to-fail" when it is thought to be too large to close in a way that imposes losses on uninsured depositors and certain other creditors.

[12] See Morgan and Stiroh (2005) for a further study of bond spreads after the passage of the FDICIA.

Mauro (2016) find that the enactment of the Dodd-Frank Act and related reforms led to a significant increase in credit default swap spreads for systemically important banks.[13] However, Acharya, Anginer and Warburton (2016) find that credit spreads on unsecured bonds continue to be less risk sensitive for the largest financial institutions than for smaller institutions after the passage of the Dodd-Frank Act. Their finding suggests that the Dodd-Frank Act may not provide a credible mechanism for imposing losses on the uninsured creditors of a systemically important bank in the event that it becomes insolvent.

The previous research on implicit subsidies in the banking industry does not examine the period after the implementation of the Basel III regulatory framework. If the combined package of capital and resolution reforms limits the extent to which the value of implicit government guarantees is captured by systemically important banks, I hypothesise that:[14]

H3: The disparity in credit spreads at issuance on bonds between systemically important banks and other banks will be reduced after the implementation of the Basel III capital reforms.

There are two possible explanations for observing a reduction in the borrowing cost advantage of systemically important banks relative to other banks after the implementation of the Basel III capital reforms. The first possible explanation relates to efforts to strengthen the resolution regimes for systemically important banks.[15] Resolution and recovery plans have been established to reduce the cost of government bailouts, potentially leading to a lower probability of such events. Changes to resolution powers and tools have been implemented in countries including Australia, Canada, France, Germany, Japan, Spain, the United Kingdom and the United States (International Monetary Fund, 2014: 123-4). The objective of the resolution reforms is to allow authorities to deal with distressed financial institutions, in a way that protects systemically important functions and minimises the extent to which taxpayers are exposed to losses. The resolution plans include powers to transfer assets, liabilities and business operations to other institutions, either directly or via bridge institutions, and

[13] Other research suggests that the Dodd-Frank Act has been effective in promoting market discipline of large banks. Using secondary market subordinated debt transactions, Balasubramnian and Cyree (2014) find that the discount in credit spreads associated with being too-big-to-fail is reduced in the post-Dodd-Frank period.

[14] The Basel Committee's reform agenda in response to the financial crisis of 2007-2009 includes efforts to strengthen the resolution regimes for systemically important banks (see paragraph 2 of the Basel III rules text).

[15] For details of the core elements that it considers to be necessary for an effective resolution regime, refer to the Financial Stability Board's publication, *Key Attributes of Effective Resolution Regimes for Financial Institutions*, released in October 2011 and revised in October 2014.

to resolve claims. If investors anticipate that resolution plans make it more feasible to impose losses on the uninsured creditors of a systemically important bank in the event of its failure, I hypothesise that:

H4: The yield premium for bearing the default risks of systemically important banks will be increased relative to the yield premium for bearing the default risks of other banks after the establishment of resolution plans for the banks.

A second possible explanation runs contrary to the effectiveness of resolution plans in reducing investors' expectations of government support for systemically important banks. The establishment of resolution plans may have had limited effect in neutralising perceptions of government support for systemically important banks, because these perceptions were reinforced by government actions during the 2007-2009 financial crisis. If investors have continued to perceive that systemically important banks will not be allowed to fail, increases in equity capital mandated under the Basel III framework are less likely to have been effective in reducing the borrowing costs of systemically important banks than in reducing the borrowing costs of smaller banks. The credit spreads on the bond issues of systemically important banks will have been relatively unaffected by higher equity capital levels, if investors have been wholly or partly indifferent to the increased default protection provided by that capital because they believe that the banks were already protected by the government. In this case, I hypothesise that:

H5: The credit spreads on bonds issued by systemically important banks will reflect the greater safety brought about by equity capital to a lesser extent than the credit spreads on bonds issued by other banks after the implementation of the Basel III capital reforms.

2.2.2 Regulatory bail-in arrangements and the monitoring of banking risks by subordinated debt investors

In the banking literature, market discipline refers to the process by which market investors, i.e., depositors, creditors and stockholders, scrutinise the investing and financing decisions of banks, as an adjunct to official supervision (Bliss and Flannery, 2002; Berger, 1991). In particular, the banking industry policy may seek to facilitate oversight by private investors of banks' risk-taking activities. This concept gained momentum from the mid-1970s, and it became a prominent feature of bank capital regulation with the adoption of the Basel II framework in 2004. Subsequently, several barriers to effective market discipline were identified during the 2007-2009 financial crisis, and these barriers have been used as the rationale for key elements of the Basel III capital reforms. Market discipline itself is not a theory but a collection of ideas on the role of market investors in assisting regulatory authorities to supervise banks. For market discipline to work effectively, there are two steps involved: monitoring and influence (Bliss and Flannery, 2002). To maximise their own payoffs, security holders, especially bank debt investors, monitor the risk profiles of banks and incorporate the information they collect in the pricing of new security issuances and in the pricing of secondary market transactions. With regard to influence, the role of investors can be separated into direct influence and indirect influence. Direct influence pertains to the pressure from the monitoring activities of market investors, which influences bank managers to adjust their risk-taking behaviour. Indirect influence pertains to the actions of third parties, mainly official supervisors, in responding to monitoring provided by market investors and resulting in changes in bank behaviours (Flannery and Bliss, 2019). There are both *ex ante* and *ex post* forms of market discipline. *Ex ante* discipline refers to the way in which investors' monitoring influences banks and leads them to take prudently-calculated risks, while *ex post* discipline refers to the way in which investors' monitoring leads banks to reverse unjustifiably reckless risk-taking behaviours.

In the equilibrium constructed by Diamond and Dybvig (1983), there is a costly consequence in terms of bank runs of relying on depositors to scrutinise bank risks. However, some studies portray a less-destabilising monitoring role for uninsured depositors. Calomiris and Kahn (1991) describe how uninsured demandable-debt depositors can help monitor bankers' activities when the depositors make decisions about their next investment or whether to roll over their existing deposits. Flannery (1994) also argues that depositors have a disciplining effect in terms of discouraging bank managers from undertaking risky investment strategies that expropriate depositors' wealth. Diamond and Rajan (2001) emphasise the disciplining advantages of demandable deposits. As demandable deposits are redeemed on a first-come-first-served basis, depositors have an incentive to acquire information and prevent banks from engaging in excessive risk-taking behaviours. Uninsured depositors penalise banks' excess risk-taking by asking for their money back. Poorly performing banks will be unable to raise additional uninsured deposits and will be compelled to increase the interest rates on their existing deposit offerings (Maechler and McDill, 2006).

A number of studies focus on large certificates of deposit (CDs), which constitute a substantial proportion of uninsured bank liabilities. Fama (1986) shows that the spreads between the interest rates on bank CDs and risk-free treasury bills are time-varying. However, this time-varying spread can be attributed to market imperfections, market liquidity or taxation differences, and is not necessarily attributable to differences in bank risk. After the eleven largest national banks in the United States were deemed by the Comptroller of the Currency in 1984 to be too-big-to-fail, investors in bank CDs plausibly had less incentive to monitor bank risks and incorporate risk assessments in the traded credit spreads of CDs. Because it is difficult to distinguish insured deposits from uninsured deposits, most of the early studies included both insured and uninsured deposits in the analysis and produced mixed evidence on the disciplining effects of bank deposits. Hannan and Hanweck (1988) find that the yields on partially insured CDs are positively correlated with bank risk measures, capturing financial leverage and asset risk. However, their risk measures indicate no significant effect on the CD rates paid by the largest banks in their sample. In contrast to those findings, Ellis and Flannery (1992) estimate time series models of individual banks' CD rates and find that the interest rates paid on CDs by large money centre banks in the US contain rational risk premia.

It is widely contended that deposit insurance distorts market discipline within the banking system and potentially creates moral hazards within banks. Some studies investigate how banks change their propensity to raise deposit financing and how depositors adjust their deposit holdings when bank conditions change. Billett, Garfinkel and O'Neal (1998) report that banks rely more on insured deposits as bank risk increases. However, they find a costly consequence of increasing reliance on insured deposits, in the form of negative abnormal returns on bank shares that are associated with credit rating downgrades and increased bank risks. Goldberg and Hudgins (2002) examine the role of uninsured deposits as a funding source for thrift institutions from 1984 to 1994. They find that uninsured depositors, responding to market forces such as indications of impending failure, adjusted their holdings of deposit contracts at thrifts and that this reaction changed over time with the implementation of new regulations. The findings of their study suggest that the actions of uninsured depositors are consistent with an active monitoring role and that reducing the insurance limits on deposits will increase market discipline on thrifts. Egan, Hortaçsu and Matvos (2017) provide empirical evidence that banks' demand for uninsured deposits decreases with their default risk, while this is not the case for insured deposits.

According to the hierarchy of claimants on a bank's assets, holders of bank debt-equity hybrid securities are second in line, after common equity holders to bear bank losses, followed by subordinated debt holders. For market discipline to be effective in the banking industry, the prices of banks' debt instruments need to be risk-sensitive, which requires that investors price banks' risk profiles diligently when they transact in the securities. Also, investors must perceive that there will be no government rescue if a bank becomes insolvent (Nguyen, 2013). In this case, investors in hybrid securities and subordinated debt securities can reasonably expect higher compensation in return for assuming a more junior claim than other creditors. However, far-reaching public rescue packages and central bank lending programs, such as those initiated in response to the 2007-2009 financial crisis, have encouraged perceptions of government support for distressed banks. In many jurisdictions, taxpayers were called upon to bear the risks before hybrid security and subordinated debt investors forfeited their capital (Acharya, Anginer and Warburton, 2016; Noss and Sowerbutts, 2012; Krishnan, Ritchken and Thomson, 2005).

To address the various impediments to market discipline in the banking industry, financial economists and policy-makers have advocated that banks be required to issue unsecured debt instruments to promote the efficient pricing of bank risks. Since the 1980s, proposals to include subordinated debt in bank capital have been evaluated as a means to increase market discipline (see Evanoff and Wall, 2000). Subordinated debt is not the only bank debt instrument that could potentially facilitate market discipline in the banking sector; however, subordinated debt has several characteristics that potentially make it conducive to improving market discipline (Kwast, Covitz, Hancock, Houpt, Adkins, Barger, Bouchard, Connolly, Brady, English and Evanoff, 1999). First, subordinated debt securities are uninsured and represent the most junior debt obligations among bank liabilities.[16] Therefore,

[16] Hybrid securities are more junior than subordinated debt securities. In most countries, hybrid securities including preferred equity securities are classified as part of shareholders' equity. However, in some jurisdictions, hybrid securities are classified as liabilities according to accounting standards.

subordinated debt holders should be the first, after equity holders, to absorb losses when a bank fails (Ellis and Flannery, 1992). In theory, its yield should be sensitive to bank risk factors. Second, as distinct from the holders of ordinary shares who potentially benefit from the unlimited upside associated with a bank's risky activities, the holders of subordinated debt securities do not realise any exceptional upside gains but are exposed to losses in the case of bank default. As shown by Black and Cox (1976) and Gorton and Pennacchi (1990), when a bank starts from a solvent position, and its asset risk increases, the market value of subordinated debt claims decreases. This gives subordinated debt holders a strong incentive to monitor the risk-taking behaviour of their invested banks and demand higher compensation if the bank takes additional risks. This process helps to limit the excessive risk-taking activities of banks and potentially works in a similar fashion to official supervision. Third, the investors, who are active in the subordinated debt market are mostly institutional investors who are more sophisticated and capable of examining banks' condition and taking actions accordingly (Nguyen, 2013). Fourth, subordinated debt securities generally have longer maturities than senior bonds. Fixed income instruments with longer maturities are more responsive to the risk profile changes of the issuing firm. This feature is likely to result in a magnified sensitivity of subordinated debt prices to changes in bank risk profiles (Hart and Zingales, 2012).

An extensive literature examines the question of whether subordinated debt yields are sensitive to banks' risk-taking activities and presents mixed conclusions. In a study conducted on behalf of the US Federal Reserve Board, Kwast, Covitz, Hancock, Houpt, Adkins, Barger, Bouchard, Connolly, Brady, English and Evanoff (1999) reviewed eleven proposals for using mandatory issuances of subordinated notes and debentures (SND) as a tool for protecting the safety and soundness of the banking industry. These proposals vary on the SND primary issuance details and also on the extent to which subordinated debt investors were expected to exert their direct and indirect market influence. This study supports the argument that the regular issuance of SND will assist in increasing market liquidity for the securities and in providing signals via primary issue prices. In these proposals, changes in primary SND yields were designed to trigger mandatory responses by banks and their regulators. Early studies, in the pre-FDICIA period, find that subordinated debt yield spreads are not sensitive to bank risk and that the securities are not likely to provide useful pricing signals (Avery, Belton and Goldberg, 1988; Gorton and Santomero, 1990). However, studies in the post-FDICIA period provide evidence of the risk-based pricing of bank subordinated debt. In their seminal paper, Flannery and Sorescu (1996) examine whether investors have the ability to price bank risks by examining secondary market yields on subordinated debt issued by banks in the period of 1983 to 1991. Their results suggest that market pricing is more risk-sensitive in the period 1989 to 1991, leading up to the implementation of the FDICIA, which sought to improve the resolution process for too-big-to-fail banks. However, they do not find supporting evidence for the risk sensitivity of subordinated debt spreads during the period prior to the passage of the FDICIA. Sironi (2003) provides similar evidence using data for European banks over the formation period for the European Monetary Union. Berger, Davies and Flannery (2000) provide evidence that subordinated debt markets may produce more accurate and timely information than regulatory examinations in relation to the risk-adjusted performance of a bank.

Later studies examining bank subordinated debt suggest that the yields on the securities are either insensitive or weakly sensitive to bank risk factors. Controlling for market and liquidity risks, Krishnan, Ritchken and Thomson (2005) find no strong and consistent evidence that the credit spreads for subordinated debt securities are responsive to changes in bank default risk proxies. Neither do they find evidence that the first issue of subordinated debt changes the risk-taking behaviour of a bank. Balasubramnian and Cyree (2011) provide evidence that the lack of risk sensitivity of yield spreads on subordinated debt is caused by expectations of government bailouts of large banks and the selling of new trust-preferred securities that are junior to subordinated debt. Their empirical findings suggest that expectations of government bailouts were exacerbated by the government rescue of a non-bank financial firm, Long Term Capital Management, in the late-1990s. Using pooled data for senior and subordinated bonds issued by US banks, Acharya, Anginer and Warburton (2016) provide evidence that risk-based pricing is impeded by too-big-to-fail perceptions. They find a flat credit spread-risk relationship for large financial institutions, which runs contrary to an upward-sloping relationship for smaller financial institutions and for non-financial firms. Moreover, bond pricing is relatively insensitive to the risks of large financial institutions. Balasubramnian and Cyree (2014) examine the impact of the Dodd-Frank Act of 2010 on the pricing of subordinated debt securities and provide evidence that too-big-to-fail pricing distortions were reduced but not eliminated after the passage of the reform package.

As a response to the market distortions brought about by implicit government protection for the banking industry, the Basel III capital reforms introduced minimum loss absorbency requirements for bank subordinated debt to qualify as tier 2 gone-concern regulatory capital. Within the original Basel capital framework, tier 2 capital instruments were to contribute to a bank's overall loss-absorbing capacity and to facilitate the orderly resolution of the bank in the event that it failed. This role of tier 2 capital, including subordinated debt, was undermined by government actions during the financial crisis of 2007-2009. As part of the Basel III capital reforms adopted after the crisis, tier 2 capital instruments must include a contractual loss absorption mechanism that converts the claims into common equity or extinguishes them completely at the point of non-viability (Bank for International Settlements, 2010, 2011). The non-viability trigger event is determined at the discretion of the regulator and no guidance is required to be provided by the regulator about how it will exercise its discretion for supervised banks. In this way, subordinated debt holders may be bailed in by the banking regulator to support the resolution of a failed bank, thus obviating the need for taxpayers to be called upon to bail out the bank. In contrast with market-value-based loss absorption triggers examined in previous research (Sundaresan and Wang, 2015), the regulatory discretionary trigger for tier 2 subordinated debt overcomes the multiple price equilibrium problem and issues associated with the unreliability of book-value accounting data. However, a potential criticism is that the ambiguity about the regulatory discretionary non-viability decisions will inevitably create market uncertainty regarding the nature of trigger events (Avdjiev, Kartasheva and Bogdanova, 2013). In addition, the bail-in process relies upon the integrity with which the regulator performs its role, and regulatory actions have often been observed to be deficient (Flannery, 2014).

The second empirical study presented in this thesis examines whether the bail-in arrangements for subordinated debt under the Basel III framework, introduced to mitigate the moral hazard problem created by implicit government support for banks, are perceived by investors as a credible mechanism for exposing them to possible future bank losses. The study investigates whether the regulatory discretionary loss absorption feature is priced when subordinated debt investors transact in the secondary market for the securities. In addition, I examine whether the transaction data are consistent with subordinated debt investors having an increased incentive to monitor bank risks after the implementation of the Basel III regulatory discretionary bail-in requirement. If the loss absorption mechanism is priced by investors and incentivises them to monitor banks' risk profiles more diligently, I hypothesise that, after controlling for bond characteristics, bank characteristics and macroeconomic factors:

H6: The credit spreads on banks' Basel III tier 2 subordinated debt with the regulatory discretionary point of non-viability trigger will be higher than for subordinated debt issued without the trigger.

H7: The credit spreads on Basel III tier 2 subordinated debt will be more sensitive to changes in a bank's risk profile compared with subordinated debt issued without the regulatory discretionary loss absorption trigger.

2.2.3 Loss absorbency requirements and the pricing and liquidity of contingent convertible capital instruments

Since the implementation of the 1988 Basel Accord, capital adequacy has been the main focus of prudential regulation in the banking system. Member countries, acting through the Basel Committee on Banking Supervision, have developed a mechanism to tie a bank's capital requirements to the risk profile of the bank. Under the second pillar of the Basel Accord, national supervisors are tasked with ensuring that banks in each jurisdiction maintain adequate levels of capital to support the risks they take. However, we observe from the 2007-2009 financial crisis that capital requirements failed to contain risk in the banking system, in part due to regulatory capital ratios based on accounting quantities that overstated banks' real capability to absorb losses. As an example, when the market value of Citigroup's tier 1 capital was reduced to 1% of total assets, its book value still amounted to 11.8% of total risk-weighted assets at the end of 2008 (Duffie, 2009). Furthermore, US banking firms that filed for bankruptcy or were acquired during the financial crisis had tier 1 capital ratios of between 12.3% and 16.1% at the quarter-end before they closed (Kuritzkes and Scott, 2009). The market turmoil provided anecdotal evidence that regulatory capital requirements alone might not be enough to ensure that banks take sensible risks and maintain adequate loss-absorbing ability.

The calls for alternative oversight forces have increasingly emanated from academics, practitioners and regulators, to address the limitations of official supervision. For this reason, the Basel Committee introduced market discipline as the third pillar of the Basel Capital Accord (Basel II framework), which it was envisaged would complement official supervision in supporting the resilience and soundness of the banking system. Market discipline, as it pertains to financial institutions and regulators, is the process by which investors in the institution's funding instruments act as monitoring agents to the risk-taking activities of the firm (Berger, 1991). As defined by Bliss and Flannery (2002), two steps are involved in the market discipline process: monitoring and influence. The first step, monitoring, refers to the way in which bank security holders and other investors monitor the risk-taking activities of the bank and demand reasonable compensation for bearing bank risk. For marketable securities, the risk profile of the issuing bank should be reflected in the transaction prices of the securities. The second step, influence, is the way in which changes in the bank's security prices stimulate the bank to adjust its involvement in risk-taking activities and the amount of capital set aside to support those risks. Among the proposals for promoting market discipline, the most prominent is that subordinated debt claims be used as an additional layer of regulatory capital. Under the Basel Accord, a bank's qualifying subordinated debt is eligible to be included as part of its total regulatory capital. Part of the rationale for the Pillar 3 disclosure requirements under the Basel II framework was to release sufficient information for subordinated debt investors to be able to monitor the risk-taking activities of the bank.

A broad range of studies focuses on the disciplining effect of subordinated debt in the last two decades (Flannery and Sorescu, 1996; Demirgüç-Kunt and Huizinga, 2004; Krishnan, Ritchken and Thomson, 2005; Balasubramnian and Cyree, 2011, 2014). Indeed, there is evidence that bank information and risks are embedded in the subordinated debt spreads prior to the market turmoil in 2008. However, investor expectations of government support for systemically important institutions may impair market discipline in the banking industry (Flannery, 1998; Sironi, 2003; Gropp, Vesala and Vulpes, 2004). For market discipline to be effective in the banking industry, the prices of banks' debt instruments need to be risk-sensitive, which requires that investors price banks' risk profiles diligently when they transact the instruments. Also, investors must perceive no government rescue if the issuing bank becomes insolvent. Following the hierarchy of claims, investors in hybrid securities should be second in line after common equity holders to bear bank losses, followed by subordinated debt holders. However, far-reaching public rescues and central bank lending in the United States and European countries during the 2007-2009 financial crisis have encouraged expectations of government support for systemically important banks. The expectation of potential government bailouts weakens market discipline by reducing bank investors' risk monitoring incentives, which is reflected in a lower cost of bank funding, especially for systemically important financial institutions (Noss and Sowerbutts, 2012). Investors' lack of risk sensitivity encourages banks to take excessive risks and is likely to accentuate moral hazard problems in the financial sector. The banking safety net also imposes a potentially large financial burden on taxpayers.

In response to the lack of loss-absorbing capacity and breakdown in market discipline identified during the financial crisis, the Basel III capital reforms introduce loss absorption requirements for hybrid securities to be included as non-common equity capital. There are two different treatments for contingent convertible instruments (CoCos)[17] in the Basel III capital reforms: capital instruments issued with only a discretionary point of non-viability trigger, which provide gone-concern regulatory capital that is available to absorb losses when a bank becomes insolvent; and additional tier 1 capital instruments issued with a mechanical common equity capital ratio trigger, which provide going-concern capital that is available to recapitalise the bank before failure. If the additional tier 1 capital instruments are reported as liabilities on the bank's balance sheet, they are required to be issued with both the discretionary point of non-viability trigger and the mechanical common equity capital ratio trigger. When the bank's common equity falls below a prescribed minimum level, the additional tier 1 CoCos will be forced to convert into ordinary shares or have their principal written down. The conversion to common equity or principal write-down is intended to help restore an adequate level of capital and allow the bank to continue operating with sufficient loss-absorbing ability. If the regulator declares the bank to be non-viable, the instrument is written down or converted to common equity to absorb the losses of the gone-concern bank.

Before the introduction of Basel III, many researchers have designed and discussed the use of CoCos as a potential solution to recapitalise going-concern financial institutions. In the design of CoCos, it has been argued that this new type of instrument may help in mitigating investors' anticipation of government support and reducing systemic risk in the

[17] Contingent convertible capital instruments (CoCos) are hybrid capital securities that absorb losses when the capital of the issuing bank falls below a certain level (Avdjiev, Kartasheva and Bogdanova, 2013).

financial sector. Treasury (2009) advocated that CoCos would not dilute earnings attributable to existing shareholders as they function as a fixed-income instrument in benign market conditions. Thus, CoCos may counter the problem of banks' reluctance to raise equity when they are in good condition. Moreover, if a bank's common equity financing has been depleted, conversion of a sufficient amount of CoCos will help restore the level of common equity capital and allow the bank to continue operating (Squam Lake Working Group, 2009). Furthermore, the potential for a punitive conversion of CoCo bonds may restore bank managers' incentives to contain risk-taking and maintain sufficient levels of capital (Himmelberg and Tsyplakov, 2012). Because of the benefits that CoCos may bring in maintaining strong solvency positions among banks and reducing financial distress, some financial economists have urged prudential regulators to require banks to use CoCo bonds as regulatory capital (Flannery, 2002; Sundaresan and Wang, 2015).

The appropriate design of CoCos has been debated by banking industry observers and prudential regulators, including the trigger mechanism for CoCos, as well as their conversion rate. Several studies assess the design of alternative trigger mechanisms, including those using market-based capital ratios (Flannery, 2002, 2005), accounting-based capital ratios (Squam Lake Working Group, 2009), and management discretion (Glasserman and Wang, 2011). Flannery (2002) first explores the potential to incorporate 'reverse convertible debentures' (RCD) in banking firms' capital structure, which convert into common equity if the firm's capital ratio declines below a pre-specified level. Unlike conventional convertible bonds, the new RCD instrument would convert to common equity at the banking firm's current stock market price, which meets the purpose of forcing existing shareholders to bear the full cost of any excessively risk-taking activities. However, each trigger design would have its limitations. For instance, triggers based on accounting measures may not be activated in a timely fashion, because accounting information provides a delayed indication of a bank's solvency position. Also, accounting ratios can be manipulated by bank managers. On the other hand, allowing bank managers to have the discretion to decide conversion might create an incentive for them to delay conversion or abandon conversion. From bank managers' perspective, they may prefer a bailout rather than having banks' CoCo bonds convert to common equity which dilutes existing shareholdings. Because of those concerns, many studies evaluate the original design of Flannery (2002), paying most attention to conversion triggers based on market prices. In the original design of CoCo bonds, the trigger event is based on a bank's market capital ratio, while the CoCo bonds would convert at the stock's current market price. However, this mechanism may provide unusual opportunities to short sellers, who attempt to trigger conversion by bidding down the stock price. Flannery (2009) then proposes an alternative specification for the conversion rate, which converts CoCo bonds into a certain number of common shares based on a pre-determined trigger price, irrespective of the current share price. However, this arrangement exposes bondholders to a disproportionately high-value loss if the trigger price has been breached (Flannery, 2014).

Among the design problems analysed in the literature, the problem of multiple equilibrium prices is one of the major issues identified in relation to market price-based triggers. When the conversion of CoCo bonds is triggered, the conversion price in relation to the value of bank assets determines the value redistributed between existing shareholders and CoCo investors (Prescott, 2012; Berg and Kaserer, 2015; Glasserman and Nouri, 2016). This value transfer is used as a rationale by Birchler and Facchinetti (2007) to support the idea that supervisors might use market prices as the basis for policy actions. Berg and Kaserer (2015) apply a model initially proposed by Duffie and Lando (2001), which takes account of the uncertainty regarding a bank's true asset value. Based on this model, Berg and Kaserer (2015) contend that investors' uncertainty about asset values may mitigate the problem of multiple equilibrium prices. However, their study does not prescribe an exact mechanism for the trigger event. Sundaresan and Wang (2015) examine the characteristics of CoCo bonds using stock market prices as the basis for the trigger mechanism, and treat CoCo bonds as American options. They apply a discrete time model and try to solve the equilibrium price problem. An insight from their study is that, for a unique competitive equilibrium to exist, a mandatory conversion must not transfer value between equity holders and CoCo investors.

As a prominent component of the Basel III capital reforms, newly defined Basel III CoCo capital instruments are intended to provide an extra level of loss-absorbing capacity for banks. Unlike proposals in the majority of past studies that use market prices as the trigger mechanism for CoCos, eligible Basel III CoCos are issued with two different contractual triggers: (i) a book value-based 5.125 per cent common equity tier 1 (CET1) capital ratio trigger; and (ii) a regulatory discretionary point-of-non-viability trigger. There are three types of CoCo instruments issued by Australian banks, 1) CoCos with only a gone-concern discretionary point of non-viability trigger; 2) CoCos issued before the Basel

III implementation period with only a going-concern mechanical common equity capital ratio trigger; and 3) CoCos with both a point of non-viability trigger and a capital ratio trigger. It is intended that CoCos with these two conceptual triggers would overcome the problems associated with market price triggers and pure accounting ratio triggers discussed in the literature. Moreover, an expectation of regulators is that the implementation of contingent convertible capital instruments will help restore loss-absorbing capacity and incentivise investors to monitor bank risk. However, few studies have investigated the potential effect of this new regulatory instrument in improving market discipline. Spiegeleer and Schoutens (2012) apply conventional asset pricing techniques to analyse the pricing of Cocos issued by Lloyds Bank. However, the CoCos issued by Lloyds were issued with only a mechanical CET1 ratio trigger, and the Spiegeleer and Schoutens study focuses on a structural model that describes the mechanical trigger point. Contributing to the existing literature, this study examines the effectiveness of the Basel III contingent convertible capital instruments in facilitating credible loss absorption by private investors. Examining the correlation between the credit spreads of hybrid securities and various security-specific and bank-specific variables, this study tests the following hypotheses:

H8: The yield premium for Basel III CoCos with the regulatory discretionary loss absorption mechanism will be higher than for conventional hybrid securities without contractual loss absorption features.

H9: The yield premium for Basel III CoCos with the mechanical loss absorption mechanism will be higher than for conventional hybrid securities without the contractual loss absorption features.

H10: The credit spreads on Basel III CoCos with the regulatory discretionary loss absorption mechanism will be more sensitive to changes in a bank's risk profile compared with conventional hybrid securities without the loss absorption features.

H11: The credit spreads on Basel III CoCos with the mechanical loss absorption mechanism will be more sensitive to changes in a bank's risk profile compared with conventional hybrid securities without the loss absorption features.

A second major issue in relation to contingent convertible capital is incentive effects, which manifest through market supply and demand for the issued securities. From the issuers' perspective, one concern that needs to be addressed is whether bank shareholders would choose to issue contingent convertible capital instruments instead of junior debt voluntarily. Albul, Jaffee Dwight and Tchistyi (2015) analyse a firm that issues perpetual debt and apply a model proposed initially by Leland and Toft (1996). Their model suggests that, because the initial infinite-lived bondholders realise all of the consequent reduction in expected bankruptcy costs, firm shareholders would never voluntarily issue CoCo bonds. In contrast, Chen, Glasserman, Nouri and Pelger (2013) apply a similar model, in which they assume an endogenous and finite debt maturity. With the intuition that the reduction in bankruptcy costs will lead to a decline in interest rates required by subsequent debt holders, shareholders would eventually realise the benefit and are thus willing to issue CoCo bonds.

From the investors' perspective, complexities in the valuation in CoCos raise the question of whether investors fully understand the risks involved in contingent convertible capital instruments and whether the valuation uncertainties would have a negative impact on investor demand. Glasserman and Nouri (2016) analyse hypothetical CoCos that are issued with a capital ratio trigger based on stock prices. They document the relationship between the fair yield of contingent capital in their model and several input variables, such as the volatility of the firm's assets, the issue size of the CoCos, and the recovery rates when a firm breaches the capital ratio trigger for the CoCos. However, they highlight a shortcoming in their design, which is the inability to observe or reliably estimate some of these inputs. The same shortcoming poses a serious obstacle to the market demand for Basel III CoCo bonds. Therefore, this study examines the impact of the Basel III loss absorption features on hybrid market liquidity and tests the following hypotheses:

H12: The introduction of the Basel III regulatory discretionary loss absorption feature weakens the market liquidity of hybrid securities issued by banks.

H13: The introduction of the Basel III mechanical loss absorption feature weakens the market liquidity of hybrid securities issued by banks.

H14: The secondary market liquidity of hybrid securities issued by banks will be more sensitive to bank risk after the introduction of the regulatory discretionary loss absorption feature.

H15: The secondary market liquidity of hybrid securities issued by banks will be more sensitive to bank risk after the introduction of the mechanical loss absorption feature.

Chapter 3

Do the Basel III capital reforms reduce the implicit subsidy of systemically important banks? Australian evidence

3.1 Introduction

The 2007-2009 global financial crisis highlighted the too-big-to-fail problem as one of its most troubling legacies. The fact that some large financial institutions are systemically important and their failure would threaten the health of the whole economy potentially provides these institutions with a funding cost advantage. The perception that governments will intervene to protect systemically important banks distorts the competitive dynamic, causes moral hazard problems in the banking sector and exposes taxpayers to additional risk. The existence of the implicit government guarantee may also allow systemically important banks to expand at the expense of their competitors (Santos, 2014). The Basel III capital reforms address this problem by increasing both the quality and level of the regulatory capital base; thereby reducing the probability that a systemically important bank will become financially distressed. The empirical study reported in this chapter examines the extent to which systemically important banks realise an implicit subsidy when they raise wholesale debt funding. To better understand the source of their funding cost advantage, this study then examines the relationship between the risk of systemically important banks and their bond yield spreads. In Australia, the banking regulator implemented the Basel III capital reforms two years ahead of the international phase-in timeline and banks increased the quality and level of their capital base to meet the new requirements earlier than banks in other jurisdictions (Bank for International Settlements, 2014). Utilising data from the early implementation, I test the effectiveness of the capital reforms in reducing the extent to which systemically important banks derive a funding cost advantage from implicit government protection.

The remainder of this chapter is organised as follows. Section 3.2 describes the Basel III capital reforms and the way in which they have been implemented in the Australian banking industry. Section 3.3 describes the data and methodology for this study. Section 3.4 reports the empirical results on the funding cost advantage realised by systemically important banks and the impact of the Basel III capital reforms in reducing the funding cost advantage from implicit government protection. Section 3.5 summarises the findings of this study.

3.2 The Basel III capital reforms

A bank's capital provides it with capacity to absorb losses (Berger, Herring and Szegö, 1995). The 2007-2009 financial crisis demonstrated that banks in several countries were not maintaining sufficient loss absorbing capital for the risks they were taking (Demirguc-Kunt, Detragiache and Merrouche, 2013; Miles, Yang and Marcheggiano, 2013). In response, the international bank standard-setting body, the BCBS, developed the Basel III capital framework, which it finalised in June 2011.[18] The reform package raises the quality and size of the regulatory capital base and enhances the risk coverage of the capital framework.[19] To address the greater risks that they pose to the financial system, the BCBS developed a framework to identify global systemically important banks (G-SIBs) and ensure that banks identified as G-SIBs have a greater capacity to absorb losses through higher capital requirements.[20]

[18] 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.

[19] To improve the risk coverage, counterparty credit risk on over-the-counter derivatives attract an additional capital charge and credit exposures to central counterparties are subject to a new capital charge.

[20] For details of its framework for dealing with global systemically important banks, refer to the Basel Committee on Banking Supervision's publication, *Global systemically important banks: updated assessment*

The Basel III capital framework came into effect in Australia from 1 January 2013. The framework increased the proportion of regulatory capital that must be met by common equity. The framework established a minimum requirement for common equity of 4.5 per cent of risk-weighted assets (RWA) and increased the minimum requirement for tier 1 capital (which includes common equity and non-cumulative non-redeemable preferred equity) from 4 to 6 per cent of RWA.[21] From 1 January 2016, Basel III introduced a conservation buffer for common equity tier 1 capital of 2.5 per cent of RWA that can be drawn down in periods of stress and a countercyclical buffer of between 0 and 2.5 per cent of RWA to protect the banking sector from periods of excess credit growth. The minimum requirement for total capital remains unchanged at 8 per cent of RWA; by including at most 2 per cent of so-called tier 2 capital.

In December 2013, the Australian banking regulator identified the four major banks as domestic systemically important banks (D-SIBs) and increased their capital requirement by one per cent of RWA, which must be met by common equity from 1 January 2016 (see Australian Prudential Regulation Authority, 2013).[22] APRA's methodology to identify D-SIBs is based on the Basel Committee's four key indicators of systemic importance: size, interconnectedness, substitutability and complexity. APRA (2013: 18) emphasises that "the designation of a bank as a D-SIB does not make it immune from failure, and shareholders and investors should draw no inferences about public sector support for a D-SIB in the event of distress". Rather, the designation is intended to ensure that banks perceived to be 'too-big-to-fail' are subject to more intense supervisory oversight and have greater capacity to absorb losses, thereby increasing their resilience to failure.

In Australia, the banking regulator implemented the Basel III capital framework two years ahead of the Basel Committee's phase-in timeline and banks increased their capital ratios to meet the new requirements earlier than banks in most other jurisdictions (Bank

methodology and the higher loss absorbency requirement, released in November 2011 and revised in July 2013. For details of its framework for dealing with domestic systemically important banks, refer to the Basel Committee on Banking Supervision's publication, *A framework for dealing with domestic systemically important banks*, released in October 2012.

[21] 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 discretionary non-viability trigger and, in some cases, a mechanical loss absorption trigger, for conversion to common equity or write-off.

[22] The higher loss absorbency requirement for D-SIBs is implemented in Australia through an extension of the capital conservation buffer.

for International Settlements, 2014).[23] APRA determined that Australian banks did not need the extended transition period made available to national supervisors by the BCBS, with the exception of transitional arrangements on pre-existing non-common equity capital instruments (see Researve Bank of Australia, 2013). Australian banks were comfortably placed to meet the 2013 minimum capital requirements and were on track to meet the 2016 minimum requirements. Australian banks were able to raise private capital during the 2007-2009 financial crisis and their robust profitability over subsequent years enabled them to further strengthen their capital positions.[24] The accelerated timetable followed by the regulator and banking industry in implementing the Basel III capital reforms make Australia a suitable jurisdiction for examining the effectiveness of the reforms in reducing the extent to which systemically important banks derive a funding cost advantage from implicit government protection.

3.3 Empirical implementation

3.3.1 Data and sample

This study focuses on 359 senior unsecured floating-rate bonds issued by 13 Australian banks in the period from January 2004 to December 2017. The sample comprises 213 bonds issued by four banks that are identified by APRA as D-SIBs and 146 bonds issued by nine banks that are not identified as D-SIBs. Table 3.1 presents the sample banks. On average over the sample period, these banks represent about forty-two per cent of the number of Australian-incorporated banks and ninety-three per cent of the total assets of Australian-incorporated banks. Bond issue data are collected from Bloomberg that include the quoted margin over the reference rate, coupon frequency, issue price, issue size, issue

[23] In regard to specific timing, APRA required that banks meet the new requirements for common equity and tier 1 capital at the start of 2013 (two years ahead of the BCBS's phase-in deadline) and the full capital conservation buffer requirement at the start of 2016 (three years ahead of the BCBS's phase-in deadline). A number of other countries, including Canada and Singapore, implemented certain aspects of the Basel III capital framework ahead of the BCBS's timelines.

[24] Based on APRA aggregate statistics, the tier 1 risk-based capital ratio for the four major banks increased from 6.7 per cent at the end of 2007 to 12.5 per cent at the end of 2017. Over the same period, the tier 1 risk-based capital ratio for other domestic banks increased from 9.5 per cent to 12.1 per cent.

Table 3.1: Sample banks with senior bond issue-observations

This table presents the Australian domestic banks included in the sample. The sample period is January 2004 to December 2017. All of the sample banks are listed on the Australian Securities Exchange. Four of the sample banks are designated by the Australian Prudential Regulation Authority as domestic systemically important banks (D-SIBs). *N* is the number of bond-issue observations. *Issue size* is the amount issued of the bond in constant 2017 Australian dollars. *Total assets* is the book value of assets at the beginning of the quarter in which the bond is issued in constant 2017 Australian dollars, averaged over all of the bonds issued by the bank.

Bank name	Bank type	N	Issue size $mil	Total assets $bil
Westpac Banking Corporation	D-SIB	89	675	768.0
Commonwealth Bank of Australia	D-SIB	31	700	670.7
National Australia Bank Limited	D-SIB	67	912	617.2
Australia and New Zealand Banking Group Limited	D-SIB	26	546	551.5
St.George Bank Limited	Non-D-SIB	5	809	136.2
Macquarie Bank Limited	Non-D-SIB	11	308	132.9
Suncorp-Metway Limited	Non-D-SIB	50	231	63.2
Bendigo and Adelaide Bank Limited	Non-D-SIB	28	264	49.6
Bank of Queensland Limited	Non-D-SIB	25	215	35.9
Adelaide Bank Limited	Non-D-SIB	2	41	15.6
AMP Bank Limited	Non-D-SIB	15	279	12.8
Rural Bank Limited	Non-D-SIB	2	53	3.5
Auswide Bank Ltd	Non-D-SIB	8	26	2.6
All banks		359	539	425.3

date, maturity date and period of call protection.[25] Since I observe each bond only at issuance, I can be sure the issue prices are based on actual transactions and not estimated from pricing matrices or dealer quotes. Data on bank bill swap reference rates are obtained from the Australian Financial Markets Association and data on consumer price inflation rates are obtained from the Australian Bureau of Statistics.

For the purpose of obtaining a balanced sample of bonds between D-SIBs and non-D-SIBs, fixed-rate bonds and bonds denominated in currencies other than Australian dollars are excluded from the sample. Issuances of fixed-rate bonds by Australian banks are mostly made by D-SIBs and few issuances are made by non-D-SIBs.[26] Similarly, issuances of bonds denominated in non-local currencies by Australian banks are less common beyond the four D-SIBs.[27] Bonds that are explicitly guaranteed by the government are excluded from

[25] One of the floating-rate bonds in the sample has a step-up feature, such that the quoted margin above the reference rate increases at the first call date. Because this feature potentially provides the issuer with an incentive to redeem, I use the first call date as the effective maturity date of the bond.

[26] Data are available for 413 senior unsecured fixed-rate bonds issued by Australian banks in the local currency over the sample period. However, only thirty-five of these bonds are issued by non-D-SIBs.

[27] The APRA statistical data indicate that the debt securities issued by smaller banks are mainly Australian-dollar denominated securities.

the sample.[28]

To be able to separately identify the effect of systemic importance from those of the risk and profitability characteristics of the issuing bank on its borrowing costs, data are obtained from three sources. Daily data are obtained from Thomson Reuters Datastream on the equity returns and market capitalisation for the sample banking companies. Semi-annual data are obtained from Worldscope on the total assets, total liabilities, shareholders' equity, earnings and common and preferred dividends for the sample banking companies. Quarterly data are obtained from APRA's statistical data collections on the capital base, risk-weighted assets, non-performing loans,[29] total loans, trading assets,[30] cash and liquid assets and total assets for the sample banks.

To allow for the impact of credit market conditions on banks' borrowing costs, data are obtained from two sources. Average redemption yields and time-to-maturity for bonds in the S&P/ASX corporate bond 1-5 year index are obtained from Standard and Poor's.[31] Interest rates on Australian Government bonds and bank accepted bills of various maturities are obtained from the Reserve Bank of Australia.

3.3.2 Systemic importance, default risk and other variables

To measure a bank's systemic importance, I use the D-SIB status of the bank as determined by the regulator (Australian Prudential Regulation Authority, 2013). APRA assesses the impact of a bank's failure on the domestic economy, having regard to the bank-specific factors of size, interconnectedness, substitutability and complexity. The various indicators used in APRA's assessment methodology show that the four major banks consistently rank highest across a range of activities in the Australian financial system. The

[28] To restore banks' access to wholesale debt markets in a period when it had been severely disrupted, the Australian Government operated a voluntary guarantee scheme for senior unsecured debt instruments between 28 November 2008 and 31 March 2010. Twenty-nine floating-rate bonds issued under the guarantee scheme are excluded from the sample.

[29] 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.

[30] An asset is a trading asset if it is acquired principally for the purpose of selling it in the near term.

[31] Data on the S&P/ASX corporate bond 1-5 year index are available from 1 January 2005. Before this period, I use data on the Macquarie Bank Australia non-government corporate bond index.

indicators also show that there is a significant gap between the four major banks and the next group of banks across almost all indicators. Although the four major banks are not formally identified as D-SIBs until December 2013, they are dominant in terms of the factors that influence systemic importance throughout the study period.

In this study, I use five alternate measures of the default risk for individual banks:

(i) Merton's distance-to-default (see appendix 1 for details of the calculation);

(ii) equity volatility, calculated using daily returns, over the past twelve months;

(iii) accounting return on assets (ROA) volatility over the past five years;

(iv) the ratio of non-performing loans to total loans; and

(v) the ratio of trading assets to total assets.

I follow Acharya, Anginer and Warburton (2016) in using Merton's distance-to-default as a market-based risk measure.[32] The distance-to-default is based on Merton's (1974) structural credit risk model. The distance-to-default represents the number of standard deviations away from the default point, where the default point is defined as the point at which the assets of the bank are just equal to its liabilities. Gropp, Vesala and Vulpes (2006) find support for the distance-to-default as a leading indicator of bank fragility. However, Campbell and Taksler (2003) find that equity volatility is an important determinant of corporate bond yields and that it has a stronger effect on yields than can be explained by Merton's standard structural model. Thus, I use equity volatility, without imposing any structural form, as an alternative market-based risk measure. A further concern is that the distance-to-default and equity volatility measures may understate the risks of systemically important banks, if implicit government guarantees affect equity returns (see Gandhi and Lustig 2015; Kelly, Lustig and Van Nieuwerburgh 2016). Gandhi and Lustig (2015) find the equity securities of the largest commercial banks in terms of total assets have significantly lower risk-adjusted returns than the equity of small- and medium-sized banks, even though the largest banks are significantly more leveraged. To address this concern, I verify my results using accounting-based risk measures. I follow Williams (2016) in using ROA volatility. I follow previous studies of banks' bond spreads, including Brewer and Jagtiani (2013) and Balasubramnian and Cyree (2014), in using non-performing loans as a risk measure. Morgan and Stiroh (2001) find evidence that bond investors price the risks implicit in banks' trading assets. Thus, I also use

[32] Bharath and Shumway (2008) find that the usefulness of the Merton distance-to-default model for forecasting default is due to the functional form suggested by the model, rather than to the procedure used to solve the Merton model for default probability.

the relative size of a bank's trading book as a risk measure.

The analysis takes account of other variables that can be expected to influence banks' borrowing costs (see table 3.2 for variable definitions). Following Acharya, Anginer and Warburton (2016), I consider variables relating to the financial strength and profitability of the bank when it issues a bond: the equity ratio, cash holdings, return on assets and the market-to-book value of equity. Higher equity ratios and higher cash holdings indicate financially sounder banks and can be expected to produce lower borrowing costs. A higher return on assets could reflect greater market power, or greater operating efficiency, and result in lower borrowing costs. A higher market-to-book ratio could indicate a bank with greater growth potential and result in lower borrowing costs. I want to control for liquidity effects on bank-issued bonds relative to money market securities. Following Morgan and Stiroh (2001) and Sironi (2003), I consider the tenor and issue size of the bond. I also include two macroeconomic factors: the yield spread between bonds in the S&P/ASX corporate bond 1-5 year index and Australian Government bonds with nearest average time-to-maturity, as a proxy for default risk; and the yield spread between 10-year Treasury bonds and 90-day bank accepted bills, as a proxy for the term premium.

3.4 Results

3.4.1 Descriptive statistics

Table 3.2 presents descriptive statistics for the bank-bond issues in my sample. Figures in this table are presented in annual terms. Figure 3.1 illustrates credit spreads on floating-rate bonds issued by Australian banks from January 2004 through December 2017.

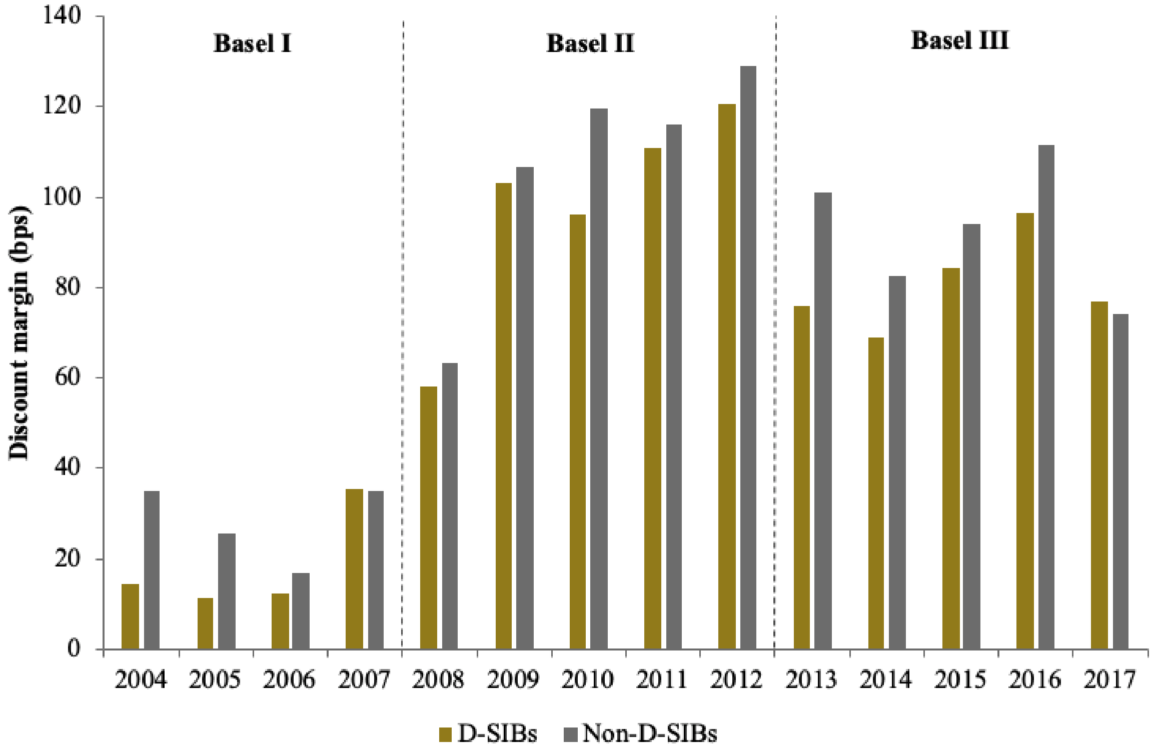
The mean issue spread (above the reference rate) is 65 basis points over the sample period (table 3.2). Bonds issued by D-SIBs pay lower spreads than bonds issued by non-D-SIBs in all of the sample years, except 2007 and 2017 (see figure 3.1). The spreads on bonds issued by both D-SIBs and non-D-SIBs increased dramatically following the onset of the financial crisis from mid-2007 and subsequently decreased coinciding with the implementation of the Basel III capital reforms at the beginning of 2013.

Table 3.2: Descriptive statistics for sample bank bond issue-observations, *N*=359

This table reports summary statistics for the bank-bond issues in my sample. The sample period is January 2004 to December 2017. *Tenor* is the time-to-maturity of the bond. *Issue size* is the amount issued of the bond in constant 2017 Australian dollars. *Discount margin* is the difference between the internal rate of return on the bond cash flows and the reference rate, assuming that the reference rate does not change over the life of the bond. *Total assets* is the book value of assets in constant 2017 Australian dollars. *Distance-to-default* is distance-to-default calculated using the Merton model. *Equity volatility* is the standard deviation of daily equity returns over the past twelve months. *ROA volatility* is the standard deviation of the accounting return on assets over the past five years. *Non-performing loans* is the ratio of non-performing loans to total loans. *Trading assets* is the ratio of trading assets to total assets. *Equity ratio* is the book value of equity divided by the book value of assets. *Tier 1 capital ratio* is the tier 1 risk-based capital ratio. *Total capital ratio* is the total risk-based capital ratio. *Cash holdings* is the ratio of cash and liquid assets to total assets. *Return on assets* is pre-tax profit divided by average assets. *Market-to-book ratio* is the market value of equity divided by the book value of equity. *Default premium* is the default risk premium, measured by the yield spread between bonds in the S&P/ASX corporate bond 1-5 year index and Australian Government bonds with nearest average time-to-maturity. *Term spread* is the term structure premium, measured by the yield spread between 10-year Australian Government bonds and 90-day bank accepted bills. All flow variables in this table are presented in annual terms.

Data item	Mean	Standard deviation	Lower quartile	Median	Upper quartile
Bond characteristics					
Tenor years	2.6	1.8	1.0	2.0	4.8
Issue size $mil	539	775	69	152	654
Discount margin bps	65	39	32	55	96
Bank characteristics					
Total assets $bil	425.3	339.0	60.7	489.2	751.9
Distance-to-default	3.9	1.6	2.9	3.9	5.2
Equity volatility % pa	21.6	7.5	16.2	20.2	24.8
ROA volatility % pa	0.26	0.25	0.09	0.18	0.36
Non-performing loans %	1.32	0.96	0.75	1.07	1.64
Trading assets %	6.0	4.7	2.6	4.8	10.2
Equity ratio %	7.6	3.8	5.9	6.5	7.2
Tier 1 capital ratio %	10.1	1.7	9.2	10.4	11.2
Total capital ratio %	12.7	1.3	11.6	12.7	13.5
Cash holdings %	4.5	3.5	2.0	3.6	6.2
Return on assets % pa	1.25	0.47	0.97	1.32	1.48
Market-to-book ratio	1.8	0.6	1.4	1.8	2.1
Macroeconomic factors					
Default premium bps	136	55	97	125	156
Term spread bps	27	78	-17	34	80

Figure 3.1: Credit spreads on floating-rate bonds issued by Australian banks



This figure plots credit spreads on floating-rate bonds issued by Australian banks from January 2004 through December 2017. *Discount margin* is the difference between the internal rate of return on the bond cash flows and the reference rate, assuming that the reference rate does not change over the life of the bond. *D-SIBs* are banks identified by the regulator as domestic systemically important banks. 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. Numbers in this figure are weighted based on the amount issued of the bond.

Table 3.3: Pearson correlation coefficients for key variables of the sample bank bond issue-observations

DSIB is a zero-one dummy variable which equals one if the bank is a domestic systemically important bank. *-MDD* is the negative distance-to-default, calculated using the Merton model, plus 8. *SIGE* is the standard deviation of daily equity returns over the past twelve months. *VROA* is the standard deviation of the accounting return on assets over the past five years. *NPL* is the ratio of non-performing loans to total loans. *TRADB* is the ratio of trading assets to total assets. *EQU* is the book value of equity divided by the book value of assets. *CASH* is the ratio of cash and liquid assets to total assets. *ROA* is pre-tax profit divided by average assets. *MTB* is the market value of equity divided by the book value of equity minus 1. *LOGT* is the logarithm of the time-to-maturity of the bond in years. *LOGIS* is the logarithm of the amount issued of the bond in millions of constant 2017 Australian dollars. *DEF* is the default risk premium, measured by the yield spread between bonds in the S&P/ASX corporate bond 1-5 year index and Australian Government bonds with nearest average time-to-maturity. *TERM* is the term structure premium, measured by the yield spread between 10-year Australian Government bonds and 90-day bank accepted bills. *, ** and *** indicate significance at the 10%, 5% and 1% levels.

	DSIB	**-MDD**	**SIGE**	**VROA**	**NPL**	**TRADB**	**EQU**	**CASH**	**ROA**	**MTB**	**LOGT**	**LOGIS**	**DEF**	**TERM**
DSIB	1.00													
-MDD	-0.01	1.00												
SIGE	-0.06	0.80***	1.00											
VROA	-0.46***	0.20***	0.29***	1.00										
NPL	-0.26***	0.14***	0.12**	0.21***	1.00									
TRADB	0.18***	0.38***	0.21***	-0.14***	0.17***	1.00								
EQU	-0.51***	-0.29***	-0.09	0.42***	0.29***	-0.27***	1.00							
CASH	0.41***	0.07	0.06	-0.08	-0.01	0.32***	-0.34***	1.00						
ROA	0.12**	-0.29***	-0.22***	-0.08	-0.32***	-0.24***	0.37***	-0.03	1.00					
MTB	0.38***	-0.13**	-0.11**	-0.05	-0.51***	-0.13**	-0.44***	0.18***	0.16***	1.00				
LOGT	0.11**	0.10*	0.07	0.05	-0.04	0.18***	-0.15***	0.19***	-0.04	0.12**	1.00			
LOGIS	0.19***	-0.05	-0.04	-0.12**	-0.11**	0.06	-0.08	0.05	0.06	0.08	0.26***	1.00		
DEF	0.11**	0.69***	0.72***	0.10*	0.21***	0.29***	-0.14***	0.03	-0.20***	-0.19***	-0.12**	-0.02	1.00	
TERM	-0.06	-0.39***	-0.07	0.11**	0.09*	-0.15***	0.10*	0.00	-0.27***	-0.07	0.03	0.02	-0.36***	1.00

Table 3.3 presents the correlations between the explanatory variables used in my analysis. The distance-to-default and equity volatility are not significantly related to a bank's D-SIB status. D-SIB issuers have lower ROA volatility and fewer non-performing loans; albeit that they have larger trading books than non-D-SIB issuers. D-SIB issuers have significantly lower equity ratios than non-D-SIB issuers. However, they have higher pre-tax earnings and more cash, suggesting that the D-SIB issuers are more profitable and more liquid than the smaller issuers in the sample.

3.4.2 The effect of being systemically important on a bank's cost of debt

In this subsection, I examine the relationship between a bank's systemic importance and its cost of issuing senior unsecured debt. Following the structure of Morgan and Stiroh (2001) and Acharya, Anginer and Warburton (2016), the credit spread at issuance of a bond is regressed on measures of systemic importance, risk and profitability characteristics of the issuing bank, characteristics of the bond and credit market conditions. The specification of the regression is as follows:[33]

$$\begin{aligned} SPREAD_i = \alpha_1 + \alpha_2 DSIB_i + \beta RISK_i + \gamma EQUITY_i + \delta_1 CASH_i + \delta_2 ROA_i \\ + \delta_3 MTB_i + \delta_4 LOGTTM_i + \delta_5 LOGIS_i + \delta_6 DEF_i + \delta_7 TERM_i \\ + YearFE + \varepsilon_i \end{aligned}$$

where $SPREAD_i$ is the spread at issuance on bond i (measured by the discount margin on a floating rate note), $DSIB_i$ is a zero-one dummy variable which equals one if the bank is identified by the regulator as a domestic systemically important bank.[34] $RISK_i$ is a measure of bank risk (the negative of the Merton distance-to-default plus 8,[35] standard deviation of

[33] Twelve of the floating-rate bonds in the sample are callable by the issuer before maturity. For all of my regressions, I try including a dummy variable to identify the callable bonds. However, this term never carries the positive coefficient that could be expected if the call option imposed a significant burden on bondholders and my results are unaffected by its inclusion. Therefore, for simplicity, I omit the callable dummy variable from my preferred specification.

[34] The prudential regulator takes account of the size of the bank when determining its systemically important status. Consequently, to minimise identification problems, I omit bank size from my preferred regression specification.

[35] The distance-to-default measure is scaled to enhance the readability of the results tables that follow. Following Gropp, Vesala and Vulpes (2006), I take the negative of the distance-to-default, such that an increase in the variable signals greater risk. Further, I add a constant of 8 standard deviations in asset returns, such that

daily equity returns over the past twelve months, standard deviation of the return on assets over the past five years, ratio of non-performing loans to total loans or the ratio of trading assets to total assets)[36], $EQUITY_i$ is the book value of equity divided by the book value of assets, $CASH_i$ is the ratio of cash and liquid assets to total assets, ROA_i is pre-tax profit divided by average assets, MTB_i is the market value of equity divided by the book value of equity minus 1, $LOGTTM_i$ is the logarithm of the time-to-maturity of the bond in years, $LOGIS_i$ is the logarithm of the amount issued of the bond in millions of constant 2017 Australian dollars, DEF_i is the default risk premium at issuance (measured by the yield spread between bonds in the S&P/ASX corporate bond 1-5 year index and Australian Government bonds with nearest average time-to-maturity) and $TERM_i$ is the term structure premium at issuance (measured by the yield spread between 10-year Australian Government bonds and 90-day bank accepted bills). For each bond issue, the variables representing the risk and profitability characteristics of the issuing bank are for the period preceding the issue date. To avoid collinearity with the bank risk measure, the equity ratio is omitted as an explanatory variable if the risk measure incorporates the bank's equity capital adequacy (as is the case for the negative Merton distance-to-default and equity return volatility). The specification includes year effects, to control for any other effects that are common to all banks, for example, effects related to regulatory, market or macroeconomic conditions in the year of issuance. The year effects are scaled, by subtracting the observation-weighted mean of the year effects. As a result, the regression constant includes the mean of the year effects.

Table 3.4 reports the regression results. The coefficient on the D-SIB dummy variable is expected to be negative if bond investors anticipate that systemically important banks are more likely to receive government support than non-systemically important banks in the event that they become financially distressed. Consistent with this proposition, the coefficient on the D-SIB dummy variable is negative and statistically significant in all five regressions.[37] The regression results imply that borrowing costs in wholesale debt markets are lower for D-SIBs than for non-D-SIBs. This finding is consistent with evidence from previous studies that expectations of government support are embedded in the credit spreads of bonds issued

the intercept term represents a bank with low default risk.

[36] The different risk variables included separately to minimise multicollinearity problems and to simplify the interpretation of the results.

[37] As an alternative, I try using the logarithm of total assets in billions of constant 2017 Australian dollars to measure the systemic importance of a bank. The results are similar.

by large financial institutions in the United States (Penas and Unal, 2004; Brewer and Jagtiani, 2013; Santos, 2014; Acharya, Anginer and Warburton, 2016) and in Canada (Beyhaghi, D'Souza and Roberts, 2014). However, this finding is also consistent with other potential explanations. For example, D-SIB issuers may benefit from a longer-standing presence in wholesale debt markets than non-D-SIB issuers in my sample. My results suggest that, on average over the entire sample period, D-SIBs in Australia realise a cost advantage of around 21-26 basis points relative to non-D-SIBs when raising senior unsecured debt funding.

The results with respect to the impact of bank risk on bond issue pricing are less conclusive than those with respect to the impact of systemic importance. If bond investors demand greater compensation for investing in riskier banks, the coefficients in front of each of the five alternate variables used to measure the default risk of individual banks can be expected to be positive. The significantly positive coefficients on the negative Merton distance-to-default (in column 1) and on accounting ROA volatility (column 3) provide support for the idea that bond investors demand a risk premium for investing in banks with a higher probability of insolvency. However, the estimated coefficients on the other risk measures are statistically insignificant (columns 2, 4 and 5). There is no evidence that investors price bond issues based on bank risk captured by equity return volatility, non-performing loans or the size of a bank's trading book. These results are surprising, in view of previous research that finds that bond investors price the risks implicit in banks' asset portfolios (for example Flannery and Sorescu, 1996; Morgan and Stiroh, 2001). I present further analysis of this issue in the next subsection.

Turning to the variables that measure the financial strength of the issuing bank, the coefficient on the equity ratio is expected to be negative if bond investors anticipate that equity capital will protect them from potential future losses on assets and may ameliorate agency problems between shareholders and bondholders. Similarly, the coefficient on cash holdings is expected to be negative if bond investors perceive that banks with more liquid assets have greater capacity to meet future payment obligations. The estimated coefficients on both of these variables are negative, suggesting that investors take account of both a bank's capital adequacy and its liquidity resources when pricing the bonds that it issues.

The other explanatory variables produce coefficients with predictable signs. The return on assets has a negative sign, suggesting that more profitable banks are viewed by bond

Table 3.4: The effect of being systemically important on a bank's cost of debt

This table examines the effect of being systemically important on a bank's cost of debt. The sample period is January 2004 to December 2017. *Discount margin* is the difference (expressed in percentage) between the internal rate of return on the bond cash flows and the reference rate, assuming that the reference rate does not change over the life of the bond. *Constant* includes the observation-weighted mean of year effects. *DSIB* is a zero-one dummy variable which equals one if the bank is a domestic systemically important bank. Risk is a measure of bank risk (*-MDD*, *SIGE*, *VROA*, *NPL* or *TRADB*). *-MDD* is the negative distance-to-default, calculated using the Merton model, plus 8. *SIGE* is the standard deviation of daily equity returns over the past twelve months. *VROA* is the standard deviation of the accounting return on assets over the past five years. *NPL* is the ratio of non-performing loans to total loans. *TRADB* is the ratio of trading assets to total assets. *Equity ratio* is the book value of equity divided by the book value of assets. *Cash holdings* is the ratio of cash and liquid assets to total assets. *Return on assets* is pre-tax profit divided by average assets. *Market-to-book ratio* is the market value of equity divided by the book value of equity minus 1. *Log tenor* is the logarithm of the time-to-maturity of the bond in years. *Log issue size* is the logarithm of the amount issued of the bond in millions of constant 2017 Australian dollars. *Default premium* is the default risk premium, measured by the yield spread between bonds in the S&P/ASX corporate bond 1-5 year index and Australian Government bonds with nearest average time-to-maturity. *Term spread* is the term structure premium, measured by the yield spread between 10-year Australian Government bonds and 90-day bank accepted bills. Robust *t*-statistics in parentheses are based on standard errors clustered at the bank level. *, ** and *** indicate significance at the 10%, 5% and 1% levels.

	Dependent variable: Discount margin				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Independent variables	**-MDD**	**SIGE**	**VROA**	**NPL**	**TRADB**
Constant (α_1)	0.0118	0.1050	0.2249**	0.2027*	0.2600**
	(0.10)	(0.96)	(2.51)	(2.15)	(2.34)
DSIB (α_2)	-0.2145***	-0.2115***	-0.2308***	-0.2562***	-0.2546***
	(-8.23)	(-6.49)	(-7.11)	(-10.75)	(-13.31)
Risk (β)	0.0484***	0.0066	0.1156*	0.0030	-0.0052
	(3.41)	(1.64)	(1.81)	(0.30)	(-1.54)
Equity ratio (γ)			-0.0127**	-0.0085	-0.0092
			(-2.50)	(-1.29)	(-1.51)
Cash holdings (δ_1)	-0.0110***	-0.0103***	-0.0118***	-0.0104***	-0.0086***
	(-8.92)	(-9.59)	(-6.25)	(-8.05)	(-5.34)
Return on assets (δ_2)	-0.0636	-0.0983**	-0.0472	-0.0540*	-0.0612*
	(-1.77)	(-2.61)	(-1.64)	(-1.84)	(-1.87)
Market-to-book ratio (δ_3)	-0.0133	-0.0241	-0.0674**	-0.0458	-0.0635 *
	(-0.56)	(-0.96)	(-2.20)	(-1.52)	(-1.87)
Log tenor (δ_4)	0.3699***	0.3703***	0.3690***	0.3720***	0.3758***
	(25.02)	(25.00)	(23.89)	(23.34)	(23.36)
Log issue size (δ_5)	0.0181**	0.0183**	0.0195**	0.0189**	0.0201**
	(2.34)	(2.49)	(2.62)	(2.51)	(2.77)
Default premium (δ_6)	0.2489***	0.2537***	0.3043***	0.3141***	0.3066***
	(9.99)	(6.80)	(16.06)	(18.34)	(15.59)
Term spread (δ_7)	0.0160	0.0185	0.0371	0.0480**	0.0434*
	(0.92)	(0.82)	(1.77)	(2.44)	(1.94)
Year effects	Yes	Yes	Yes	Yes	Yes
Adj. R-sqaure	0.87	0.86	0.87	0.86	0.87
Observations	359	359	359	359	359

investors as less likely to default. The market-to-book ratio has a negative coefficient, suggesting that bond investors favour banks that utilise assets more efficiently and that have greater growth potential (as gauged by equity investors for the same banks). The variables used as controls for the tenor and issue size of the bond have significantly positive coefficients. The positive relationship with tenor implies that the default premiums are higher for bonds issued by banks with longer maturities. The positive relationship with issue size suggests that the market for a bank's floating-rate debt is elastic; that is, issuers are compelled to quote higher margins above the reference rate for the market to absorb larger-sized issues. These types of price concessions are evidently more influential in determining issue spreads than any potential benefits of larger issues to bond investors derived from more abundant liquidity in the secondary market. The default risk premium and the term structure premium each have positive coefficients, indicating that the cost of issuing senior debt for banks is closely tied to conditions that prevail in the corporate bond market at the time of issuance.

To simplify the interpretation of the coefficients, I omit the standalone credit rating of the bank from the baseline regression specification. However, the results are similar if I include a variable representing the standalone credit rating of the bank as an additional control variable in the regressions. To construct the additional variable, data are obtained from Moody's Investors Service on their Baseline Credit Assessments (BCAs) for the sample banks. A bank's BCA represents Moody's opinion of the bank's intrinsic strength, absent any extraordinary support from an affiliate or government (see the Moody's publication, Rating Methodology: Banks, updated on 1 August 2018). In determining the BCA, Moody's takes account of the bank's operating environment, the bank's own financial health reflecting Moody's view of its solvency and liquidity positions, as well as non-financial qualitative judgements. The BCAs are expressed on a scale from "aaa" to "c". I assign numerical values of 1-21, with 1 denoting the highest score ("aaa"). If I include the standalone credit rating variable in the regressions, the D-SIB dummy variable retains its negative and statistically significant coefficient in all the regressions. The results suggest that D-SIBs realise a cost advantage of around 28-35 basis points relative to non-D-SIBs when raising senior unsecured debt funding.

3.4.3 The effect of being systemically important on the relations between bank risk and equity capital and bond issue spreads

In this subsection, I examine whether a bank's systemic importance affects investors' sensitivity to the risks and capital adequacy of the bank when pricing its bond issues. To answer this question, I interact the D-SIB dummy variable with the variables used to measure the default risk of individual banks and with the equity ratio. The interaction terms are included in the regressions together with the main effects. Following this approach, the main effects capture the sensitivity of bond investors to the risks and equity capital of smaller banks and the interaction terms capture the incremental sensitivity of bond investors to the risks and equity capital of D-SIBs.

The results are presented in table 3.5. The estimated coefficients on three of the main effects relating to bank risk are positive and significant (in columns 1 to 3). These results provide evidence that bond investors are sensitive to the risks of smaller banks, as captured by the negative Merton distance-to-default, equity return volatility and accounting ROA volatility. The coefficients on these variables are larger in magnitude and more statistically significant than those on the same variables in the regressions reported in the preceding subsection (table 3.4). There is no evidence that bond investors are sensitive to the risks inherent in the non-performing loans or in the trading assets of smaller banks. With respect to non-performing loans, the market may assess that smaller banks with more non-performing loans raise sufficient provisions to offset the associated credit risk. With respect to trading assets, the absence of a significant relationship with bond issue spreads is unsurprising, because the smaller banks in the sample generally have low allocations to trading assets (averaging 4.9 per cent of total assets over the sample period).

The results are different for systemically important banks. The coefficients on the interaction terms between the D-SIB dummy variable and the default risk measures are negative and significant in all of the regressions (table 3.5, columns 1 to 5). For each risk variable that exhibits a positive coefficient on the main effect, that coefficient is offset by the coefficient on the corresponding interaction term. These results are consistent with the notion that bond investors downplay the risks of systemically important banks due to perceptions of government support. This finding is in line with the finding of Acharya,

Table 3.5: The effect of being systemically important on the relations between bank risk and equity capital and bond issue spreads

This table examines the effect of being systemically important on the relations between bank risk and equity capital and bond issue spreads. The sample period is January 2004 to December 2017. Discount margin is the difference (expressed in percentage) between the internal rate of return on the bond cash flows and the reference rate, assuming that the reference rate does not change over the life of the bond. DSIB is a zero-one dummy variable which equals one if the bank is a domestic systemically important bank. Risk is a measure of bank risk (-MDD, SIGE, VROA, NPL or TRADB). -MDD is the negative distance-to-default, calculated using the Merton model, plus 8. SIGE is the standard deviation of daily equity returns over the past twelve months. VROA is the standard deviation of the accounting return on assets over the past five years. NPL is the ratio of non-performing loans to total loans. TRADB is the ratio of trading assets to total assets. Equity ratio is the book value of equity divided by the book value of assets. All regressions include the same set of control variables as in table 3.4. Robust *t*-statistics in parentheses are based on standard errors clustered at the bank level. *, ** and *** indicate significance at the 10%, 5% and 1% levels.

	Dependent variable: Discount margin				
Independent variables	**(1) -MDD**	**(2) SIGE**	**(3) VROA**	**(4) NPL**	**(5) TRADB**
DSIB (α_2)	-0.0224	-0.0536	-0.0258	0.0672	0.2796
	(-0.38)	(-0.68)	(-0.15)	(0.42)	(1.12)
Risk (β_1)	0.0716***	0.0094*	0.1782**	-0.0001	-0.0027
	(4.99)	(2.09)	(2.69)	(-0.01)	(-0.65)
DSIB × Risk (β_2)	-0.0481***	-0.0073**	-0.6031**	-0.1767**	-0.0136*
	(-3.37)	(-2.64)	(-2.59)	(-2.94)	(-1.92)
$\beta_1 + \beta_2$	0.0235*	0.0021	-0.4249*	-0.1768**	-0.0164**
	(2.13)	(0.66)	(-1.98)	(-2.82)	(-2.69)
Equity ratio (γ_1)			-0.0137**	-0.0086	-0.0079
			(-3.03)	(-1.28)	(-1.37)
DSIB × Equity ratio (γ_2)			-0.0156	-0.0235	-0.0727*
			(-0.73)	(-1.29)	(-2.07)
$\gamma_1 + \gamma_2$			-0.0293	-0.0320*	-0.0806**
			(-1.35)	(-1.98)	(-2.31)
Control variables	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes
Adj. R-square	0.88	0.87	0.87	0.87	0.87
Observations	359	359	359	359	359

Anginer and Warburton (2016) that, whereas bondholders are sensitive to the risks of most financial institutions, they are less sensitive to the risks of the largest financial institutions. Furthermore, the sum of the coefficients on the main effect and interaction terms relating to bank risk are negative and significant in the regressions using the accounting-based risk measures (columns 3 to 5). These results suggest that, all else being equal, bond issue spreads are lower for D-SIBs with higher ROA volatility, more non-performing loans or larger trading books. These results are unexpected, but could arise from the market's assessment that provisions raised by D-SIBs with lower quality loan portfolios are more than adequate to compensate for portfolio credit risk or that trading assets provide diversification benefits which reduce the probability of a D-SIB's insolvency.

There is limited evidence that a bank's systemic importance affects investors' sensitivity to the capital adequacy of the bank when pricing its bond issues. The coefficient on the main effect of the equity ratio is negative in the regressions in which it is included (columns 3 to 5), suggesting that investors take account of the capital adequacy of smaller banks when pricing their bond issues. The coefficient on the interaction term between the D-SIB dummy variable and the equity ratio is negative in these regressions and is significant at the 10 per cent level when trading assets is used as the risk measure (column 5). Furthermore, the sum of the coefficients on the main effect and interaction terms involving the equity ratio is negative in the regressions in which these terms are included. Based on this analysis, there is no indication that investors are any less concerned about the bank's capital adequacy when they assess the bond issues of systemically important banks than when they assess the bond issues of smaller banks.

The analysis reported in this subsection suggests that lower borrowing costs in wholesale debt markets realised by D-SIBs relative to smaller banks can be attributed to expectations by investors that the government will shield D-SIB bondholders from potential future losses. Such expectations are evidenced by a diminished responsiveness of bond issue prices to the risks of systemically important banks relative to those of other banks. In each of the regressions that control for differences in the risk-yield premium relationship between D-SIBs and other banks (table 3.5), the coefficient on the D-SIB dummy variable is less negative and less statistically significant than in the regressions that do not control for these differences (table 3.4). The results suggest that the borrowing costs of D-SIBs would be raised if investors priced the bonds issued by these banks on a stand-alone basis.

3.4.4 Impact of the Basel III capital reforms

In this subsection, I examine the impact of the Basel III capital reforms on the disparity in borrowing costs between systemically important banks and smaller banks. For this purpose, I test whether the credit spreads on bonds issued in the Basel III period are different from the credit spreads on bonds issued prior to the Basel III period and whether any such differences are specific to systemically important banks. The specification of the regression is as follows:

$$\begin{aligned} SPREAD_i = {} & \alpha_1 + \alpha_2 DSIB_i + \alpha_3 BASELIII_i + \alpha_4 DSIB_i \times BASELIII_i + \beta RISK_i \\ & + \gamma EQUITY_i + \delta_1 CASH_i + \delta_2 ROA_i + \delta_3 MTB_i + \delta_4 LOGTTM_i \\ & + \delta_5 LOGIS_i + \delta_6 DEF_i + \delta_7 TERM_i + \varepsilon_i \end{aligned}$$

where $BASELIII_i$ is a zero-one dummy variable which equals one for bonds issued when increased requirements for the quality and level of capital are implemented under the Basel III framework from 1 January 2013.

The regression results are presented in table 3.6. The coefficient on the D-SIB dummy variable is negative and statistically significant in all of the regressions. The estimations indicate that bond issue spreads for D-SIBs are about 26-30 basis points lower than for non-D-SIBs prior to the implementation of the Basel III reforms. The coefficient on the Basel III dummy variable is positive and significant in three of the regressions (columns 1, 3 and 4), suggesting that the issue spreads on bonds are higher for the banking industry as a whole after the implementation of the regulatory changes. This coefficient may reflect tighter credit market conditions after the 2007-2009 financial crisis, which are not completely captured by the default risk premium and term structure premium variables in the regressions. Furthermore, the coefficient on the interaction term between the D-SIB dummy variable and the Basel III dummy variable is positive and significant in all five of the regressions. This result suggests that the borrowing cost advantage of D-SIBs is reduced after the implementation of the Basel III reforms. As measured by the coefficient on the interaction term, the disparity in credit spreads between D-SIBs and non-D-SIBs is pared back by around

Table 3.6: The effect of the Basel III capital reforms on the borrowing costs of D-SIBs

This table examines the effect of the Basel III capital reforms on the borrowing costs of D-SIBs. The sample period is January 2004 to December 2017. Discount margin is the difference (expressed in percentage) between the internal rate of return on the bond cash flows and the reference rate, assuming that the reference rate does not change over the life of the bond. *DSIB* is a zero-one dummy variable which equals one if the bank is a domestic systemically important bank. *Basel III* is a zero-one dummy variable which equals one for bonds issued when increased requirements for the quality and level of capital under the Basel III framework are implemented from 1 January 2013. *Risk* is a measure of bank risk (-MDD, SIGE, VROA, NPL or TRADB). *-MDD* is the negative distance-to-default, calculated using the Merton model, plus 8. *SIGE* is the standard deviation of daily equity returns over the past twelve months. *VROA* is the standard deviation of the accounting return on assets over the past five years. *NPL* is the ratio of non-performing loans to total loans. *TRADB* is the ratio of trading assets to total assets. *Equity ratio* is the book value of equity divided by the book value of assets. *Cash holdings* is the ratio of cash and liquid assets to total assets. *Return on assets* is pre-tax profit divided by average assets. *Market-to-book ratio* is the market value of equity divided by the book value of equity minus 1. *Log tenor* is the logarithm of the time-to-maturity of the bond in years. *Log issue size* is the logarithm of the amount issued of the bond in millions of constant 2017 Australian dollars. *Default premium* is the default risk premium, measured by the yield spread between bonds in the S&P/ASX corporate bond 1-5 year index and Australian Government bonds with nearest average time-to-maturity. *Term spread* is the term structure premium, measured by the yield spread between 10-year Australian Government bonds and 90-day bank accepted bills. Robust *t*-statistics in parentheses are based on standard errors clustered at the bank level. *, ** and *** indicate significance at the 10%, 5% and 1% levels.

	Dependent variable: Discount margin				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Independent variables	**-MDD**	**SIGE**	**VROA**	**NPL**	**TRADB**
Constant (α_1)	-0.0778	0.0331	0.0893	0.0267	0.1214
	(-0.99)	(0.45)	(1.25)	(0.35)	(1.44)
DSIB (α_2)	-0.2599***	-0.2970***	-0.2609***	-0.3041***	-0.3040***
	(-5.03)	(-5.12)	(-5.44)	(-6.16)	(-8.54)
Basel III (α_3)	0.1277**	0.0633	0.1136**	0.0883*	0.0680
	(2.89)	(1.43)	(2.50)	(1.93)	(1.68)
DSIB $\times$ Basel III (α_4)	0.1128**	0.1321**	0.1314**	0.1221**	0.1313***
	(2.48)	(2.96)	(3.00)	(2.68)	(3.45)
$\alpha_2 + \alpha_4$	-0.1472***	-0.1649**	-0.1295**	-0.1819***	-0.1726***
	(-3.08)	(-2.89)	(-2.79)	(-4.48)	(-5.51)
Risk (β)	0.0239*	-0.0038	0.2100***	0.0236*	-0.0067*
	(2.01)	(-0.98)	(4.42)	(2.10)	(-1.81)
Equity ratio (γ)			-0.0170***	-0.0114*	-0.0104**
			(-4.13)	(-2.12)	(-2.30)
Cash holdings (δ_1)	-0.0117**	-0.0104**	-0.0147***	-0.0129***	-0.0098***
	(-2.85)	(-2.71)	(-3.09)	(-4.54)	(-3.68)
Return on assets (δ_2)	-0.0879***	-0.0920**	-0.0442	-0.0417	-0.0684*
	(-3.30)	(-2.83)	(-1.75)	(-1.28)	(-1.98)
Market-to-book ratio (δ_3)	-0.0999***	-0.1015***	-0.1580***	-0.1136**	-0.1404***
	(-3.36)	(-3.12)	(-4.73)	(-2.81)	(-3.99)
Log tenor (δ_4)	0.3710***	0.3819***	0.3687***	0.3738***	0.3800***
	(35.87)	(32.34)	(35.20)	(35.92)	(38.39)
Log issue size (δ_5)	0.0186**	0.0190**	0.0197**	0.0198**	0.0199**
	(2.43)	(2.55)	(2.70)	(2.68)	(2.99)
Default premium (δ_6)	0.3946***	0.4738***	0.4046***	0.4259***	0.4359***
	(11.98)	(9.97)	(14.30)	(13.33)	(13.83)
Term spread (δ_7)	0.0712**	0.0864***	0.0610*	0.0799**	0.0781**
	(2.50)	(4.03)	(2.03)	(2.54)	(2.27)
Adj. R-square	0.82	0.82	0.83	0.82	0.83
Observations	359	359	359	359	359

11-13 basis points after the implementation of the regulatory reforms.[38,39]

The results reported in table 3.6 suggest that the borrowing cost advantage of D-SIBs is reduced, but *not* eliminated, after the implementation of the Basel III reforms. The sum of the coefficients on the main effect of the D-SIB dummy variable and on the interaction term between the D-SIB dummy variable and the Basel III dummy variable is negative and significant in all of the regressions. As measured by the sum of these coefficients, D-SIBs continue to realise a cost advantage of around 13-18 basis points relative to non-D-SIBs when they raise senior unsecured debt funding after the implementation of the reforms.

A potential concern with the analysis is that the results may capture pre-existing divergent trends in borrowing costs between D-SIBs and other banks, which are unrelated to the more stringent capital requirements under the Basel III framework. In unreported analysis, I investigate the trends in borrowing costs between the two types of banks surrounding the implementation of the Basel III reforms. For this purpose, I include a linear time trend in the regression analysis, as a main effect and as part of two-way and three-way interaction terms with the D-SIB dummy variable and the Basel III dummy variable. Before the reforms, the bond issue spreads increased for both types of banks (see figure 3.1). However, allowing for changes in the risks of individual banks and the deterioration in credit market conditions following the onset of the financial crisis, the issue spreads increased by a smaller amount for D-SIBs than for non-D-SIBs. This finding contradicts the conjecture that the diminished borrowing cost advantage of D-SIBs after the implementation of the regulatory reforms is a consequence of pre-existing trends in borrowing costs between D-SIBs and other banks. After the implementation of the reforms, the issue spreads increased at a slower rate than before the reforms and the time trend in issue spreads was not significantly different between D-SIBS and other banks. The trend analysis supports my conclusion that the pricing of bonds issued by D-SIBs relative to those issued by other banks changed after the implementation of the Basel III reforms.

The results pertaining to the impact of the Basel III capital reforms on the borrowing

[38] The results are similar if I use the logarithm of total assets in constant 2017 Australian dollars, instead of D-SIB status, to measure a bank's systemic importance. About half of the borrowing cost advantage associated with greater bank size disappears after the implementation of the Basel III capital reforms.

[39] The results are similar if I include a variable representing the standalone credit rating of the bank, assigned by Moody's Investors Service, as an additional control variable in the regressions.

costs of systemically important banks are economically significant. Based on the estimated coefficient in table 3.6, column 1, the cost advantage realised by a D-SIB in the yield that it pays to investors over the life of a bond is reduced by 0.1128 per cent per annum. According to APRA aggregate statistics, the four D-SIBs have long-term wholesale borrowings worth 532.2 billion Australian dollars at the end-2017. If the cost advantage in servicing all of their long-term borrowings is reduced to the extent indicated by my regression results, my estimates suggest that the implementation of the Basel III capital reforms in Australia will reduce the cost advantage of systemically important banks by approximately 0.1128 per cent per annum yield $\times$ 532.2 billion dollars' worth of long-term borrowings = 600 million Australian dollars per annum (from 1.4 billion to 0.8 billion dollars per annum). The full impact of the reforms on banks' debt-servicing costs will not take effect until the banks have refinanced all of their long-term borrowings under the new regulatory regime. However, my estimate of the economic impact is conservative, because it disregards any reduction in the cost advantage that potentially applies to 233.2 billion Australian dollars' worth of short-term wholesale borrowings, with residual maturities of 12 months or less, currently being serviced by the D-SIBs.

There are two possible explanations for observing a reduction in the borrowing cost advantage of D-SIBs relative to non-D-SIBs in the Basel III period. A first possible explanation relates to a regulatory initiative, announced in late-2011, to introduce resolution plans ('living wills') for Australian banks.[40] A living will comprises two elements: recovery planning, where a financial institution sets out the actions it would take to survive a severe crisis without public sector intervention; and resolution planning, which focusses on cost-effective resolution of the institution by the authorities where recovery is not possible (see APRA chairman John Laker's address to the Finsia Financial Services Conference, 'APRA's regulatory priorities – An update', delivered on 25 October 2011). Living wills are intended to minimise the costs to taxpayers associated with the failure of a large and complex financial institution and reduce risks to the financial system. They are expected to include contingency plans for breaking up the assets of a failed institution and preserving the operation of essential market infrastructure. If investors foresee that living wills make it more feasible to impose losses on uninsured creditors in the event of a failure, bond pricing

[40] The initiative to introduce living wills for Australian banks is based on the recommendations of the Basel Committee on Banking Supervision (see the BCBS's publication, *Report and Recommendations of the Cross-border Bank Resolution Group*, released in March 2010).

may become more sensitive to the risks of systemically important banks. A second possible explanation is that increases in equity capital mandated under the Basel III framework may be less effective in reducing the borrowing costs of larger banks compared with those of smaller banks. The credit spreads on the bond issues of larger banks will be relatively unaffected by higher capital buffers, if the default protection derived from those buffers substitutes for the protection derived from implicit government guarantees.

3.4.5 The effects of bank risk and equity capital on a D-SIB's cost of debt under the Basel III framework

I perform additional analysis to determine whether: (i) bond investors are more sensitive to the risks of systemically important banks after the establishment of living wills; or (ii) a weaker relationship between equity capital and credit spreads for systemically important banks than for other banks has the effect of reducing the funding cost advantage of systemically important banks after the implementation of the Basel III framework. To answer these questions, we extend the regression analysis by including two-way interaction terms between the D-SIB dummy variable, the Basel III dummy variable and bank risk and between the D-SIB dummy variable, the Basel III dummy variable and a bank's equity ratio. The regressions also include three-way interaction terms between the same sets of variables. The three-way terms allow us to identify the incremental impact of bank risk and equity capital on a D-SIB's cost of issuing senior debt after the implementation of the Basel III framework.

Table 3.7 presents the regression results. The results do not reconcile with the idea that bond investors are more sensitive to the risks of systemically important banks after the establishment of living wills for Australian banks. For each risk variable that has a significantly positive coefficient on the main effect, that coefficient is offset by the coefficient on the two-way interaction term between the D-SIB dummy variable and bank risk (columns 1 and 3). Hence, there is no evidence of a positive risk-spread relationship for the bond issues of systemically important banks prior to the implementation of the regulatory reforms. The two-way interaction term between the Basel III dummy variable and bank risk does not have a significantly positive coefficient in any of the regressions. There is no evidence that the yield premium demanded by bond investors for bearing the risks of smaller banks increased

Table 3.7: The effect of the Basel III capital reforms on the pricing of D-SIB bond issues

This table examines the effect of the Basel III capital reforms on the relations between bank risk and equity capital and the pricing of bonds issued by D-SIBs relative to those issued by other banks. The sample period is January 2004 to December 2017. *Discount margin* is the difference (expressed in percentage) between the internal rate of return on the bond cash flows and the reference rate, assuming that the reference rate does not change over the life of the bond. *DSIB* is a zero-one dummy variable which equals one if the bank is a domestic systemically important bank. *Basel III* is a zero-one dummy variable which equals one for bonds issued when increased requirements for the quality and level of capital under the Basel III framework are implemented from 1 January 2013. *Risk* is a measure of bank risk (-MDD, SIGE, VROA, NPL or TRADB). *-MDD* is the negative distance-to-default, calculated using the Merton model, plus 8. *SIGE* is the standard deviation of daily equity returns over the past twelve months. *VROA* is the standard deviation of the accounting return on assets over the past five years. *NPL* is the ratio of non-performing loans to total loans. *TRADB* is the ratio of trading assets to total assets. *Equity ratio* is the book value of equity divided by the book value of assets. All regressions include the same set of control variables as in table 3.6. Robust *t*-statistics in parentheses are based on standard errors clustered at the bank level. *, ** and *** indicate significance at the 10%, 5% and 1% levels.

	Dependent variable: Discount margin				
Independent variables	**(1) -MDD**	**(2) SIGE**	**(3) VROA**	**(4) NPL**	**(5) TRADB**
DSIB (α_2)	0.0834	-0.0512	-0.0674	-0.3114	-0.0087
	(0.46)	(-0.33)	(-0.35)	(-1.69)	(-0.03)
Basel III (α_3)	0.3308*	-0.0947	0.1628	0.2493*	0.2832*
	(2.00)	(-0.56)	(1.22)	(1.81)	(2.09)
DSIB × Basel III (α_4)	-0.1247	-0.0715	-0.3436	-0.0262	-0.1190
	(-0.70)	(-0.35)	(-1.71)	(-0.11)	(-0.29)
Risk (β_1)	0.0751**	-0.0016	0.3631***	0.0223	-0.0009
	(2.28)	(-0.26)	(5.66)	(1.07)	(-0.10)
DSIB × Risk (β_2)	-0.0650*	-0.0107*	-0.5357**	0.1082	-0.0091
	(-2.04)	(-2.01)	(-2.36)	(1.28)	(-0.60)
$\beta_1 + \beta_2$	0.0101	-0.0123**	-0.1726	0.1305	-0.0099
	(1.04)	(-2.81)	(-0.88)	(1.45)	(-1.13)
Basel III × Risk (β_3)	-0.0296	0.0078	-0.2576**	-0.0104	-0.0116
	(-1.01)	(1.29)	(-2.41)	(-0.46)	(-0.96)
$\beta_1 + \beta_3$	0.0455**	0.0062	0.1056	0.0118	-0.0125**
	(2.81)	(1.33)	(0.86)	(0.91)	(-2.30)
DSIB × Basel III × Risk (β_4)	0.0300	0.0089	-0.4433	-0.2048**	0.0056
	(0.89)	(1.06)	(-1.02)	(-2.62)	(0.35)
$\beta_2 + \beta_4$	-0.0350*	-0.0018	-0.9790	-0.0966*	-0.0035
	(-2.05)	(-0.30)	(-1.75)	(-1.79)	(-0.48)
$\beta_1 + \beta_2 + \beta_3 + \beta_4$	0.0105	0.0043	-0.8734	-0.0847	-0.0159**
	(0.86)	(1.10)	(-1.68)	(-1.57)	(-2.31)
Equity ratio (γ_1)			-0.0239***	-0.0043	-0.0012
			(-4.43)	(-0.80)	(-0.30)
DSIB × Equity ratio (γ_2)			-0.0093	-0.0177	-0.0353
			(-0.35)	(-0.97)	(-0.92)
$\gamma_1 + \gamma_2$			-0.0332	-0.0220	-0.0365
			(-1.24)	(-1.21)	(-0.96)
Basel III × Equity ratio (γ_3)			0.0047	-0.0122	-0.0161**
			(0.65)	(-1.60)	(-2.24)
$\gamma_1 + \gamma_3$			-0.0192***	-0.0165***	-0.0173**
			(-4.45)	(-3.15)	(-2.85)
DSIB × Basel III × Equity ratio (γ_4)			0.0643**	0.0503**	0.0263
			(2.50)	(2.33)	(0.51)
$\gamma_2 + \gamma_4$			0.0550*	0.0327	-0.0090
			(1.79)	(1.17)	(-0.23)

$\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4$			0.0358	0.0161	-0.0263
			(1.18)	(0.59)	(-0.66)
Control variables	Yes	Yes	Yes	Yes	Yes
Adj. R-square	0.83	0.83	0.84	0.83	0.83
Observations	359	359	359	359	359

after the implementation of the regulatory reforms. The three-way interaction term between the D-SIB dummy variable, the Basel III dummy variable and bank risk does not have a significantly positive coefficient in any of the regressions. Hence, there is no evidence that the yield premium for bearing the risks of systemically important banks increased relative to that for other banks. Furthermore, the sum of the coefficients on the two-way interaction term between the D-SIB dummy variable and bank risk and the three-way interaction term between the D-SIB dummy variable, the Basel III dummy variable and bank risk is significantly negative when the negative distance-to-default or non-performing loans is used as the risk measure (columns 1 and 4). These results suggest that investors are less concerned about the risks of systemically important banks than about the risks of smaller banks after the introduction of living wills. There is no evidence of a significantly positive risk-spread relationship for the bond issues of systemically important banks after the implementation of the regulatory reforms (indicated by the sum of the four beta coefficients on the main effect and interaction terms involving bank risk). Investors may doubt the effectiveness of living wills in facilitating the resolution of a large financial institution in such a way that uninsured creditors are subject to losses.

The results support the conjecture that a weaker relationship between equity capital and credit spreads for systemically important banks than for smaller banks has the effect of reducing the borrowing cost advantage of systemically important banks under the Basel III framework. The coefficient on the main effect of the equity ratio is significantly negative in the regression with ROA volatility as the risk measure (table 3.7, column 3). This coefficient suggests that, before the implementation of the Basel III reforms, smaller banks with higher equity ratios realise lower spreads on bond issues. The coefficient on the two-way interaction term between the D-SIB dummy variable and the equity ratio is insignificant in the same regressions. Hence, there is no evidence that bond investors treat the equity ratios of systemically important banks differently to those of smaller banks before the reforms. The coefficient on the two-way interaction term between the Basel III dummy variable and the equity ratio is statistically insignificant, except in the regression with trading assets as the risk measure. However, the coefficient on the three-way interaction term between the D-SIB dummy variable, the Basel III dummy variable and the equity ratio is significantly positive in two regressions (columns 3 and 4). This result suggests that the bond issue spreads of systemically important banks become relatively less sensitive to the capital resources of the bank after the regulatory reforms. Furthermore, as indicated by the sum of the four gamma coefficients on the main effect and interaction terms involving the equity ratio, there is no evidence of a significantly negative relationship between the equity ratio and bond issue spreads for systemically important banks after the implementation of the regulatory reforms. A lack of responsiveness of bond issue spreads to equity capital is a source of disadvantage for systemically important banks when they seek to raise wholesale debt funding.

3.4.6 Further analysis

To test the robustness of my results, I undertake further analysis. First, I repeat the empirical analysis for 413 senior unsecured fixed-rate bonds issued by Australian banks in the local currency over the 2004-2017 period. The available sample of fixed-rate bonds is unbalanced, consisting of 378 bonds issued by D-SIBs and 35 bonds issued by other banks. For the fixed-rate bonds, the credit spread at issuance is computed as the difference between the yield on the bond and the yield on the Treasury bond with the closest maturity date. Despite the unbalanced nature of the sample, the results are similar to those obtained using floating-rate bonds. The credit spreads at issuance are lower for D-SIBs than for smaller banks and the credit spreads for D-SIBs are significantly less sensitive to three measures of the default risk for individual banks (the negative Merton distance-to-default, equity volatility and ROA volatility). Before the implementation of the Basel III capital reforms, the credit spreads on fixed-rate bonds at issuance are about 64-97 basis points lower for D-SIBs than for smaller banks and, after the implementation of the reforms, the disparity is reduced by about two-thirds.

Second, I repeat the empirical analysis for 86 subordinated floating-rate bonds issued by Australian banks in the local currency over the same period (comprising 37 bonds issued by D-SIBs and 49 bonds issued by other banks). The credit spreads on subordinated bonds at issuance are lower for D-SIBs than for smaller banks and the credit spreads for D-SIBs are less sensitive to two of the default risk measures for individual banks (non-performing loans and trading assets). However, the number of subordinated bonds issued after the implementation of the Basel III capital reforms (9 by D-SIBs and 9 by other banks) is insufficient to determine whether the disparity in issue spreads between the two types of banks is reduced after the reforms.

3.5 Summary

Using primary bond market data for Australian banks in the period from January 2004 to December 2017, this study examines whether systemically important banks realise an implicit subsidy when raising wholesale debt funding and evaluates the effectiveness of the Basel III capital reforms in reducing the subsidy. The results reported in this chapter indicate that expectations of government support are embedded in the credit spreads of bonds issued by systemically important banks. This hypothesis is supported in two ways: (i) the credit spreads are lower for bonds issued by systemically important banks than for bonds issued by other banks after allowing for bank risk; and (ii) the credit spreads are less sensitive to conventional measures of bank risk for bonds issued by systemically important banks than for bonds issued by other banks. The estimations reported in this chapter suggest that, before the implementation of the Basel III capital framework, systemically important banks realise an implicit subsidy of around 26-30 basis points when they raise senior unsecured borrowings.

Utilising the advanced phase-in timeline for the Basel III capital reforms in Australia, this study examines the impact of the new regulatory regime in reducing the implicit subsidy of systemically important banks. The results suggest that the implicit subsidy is reduced by approximately one-half after the implementation of the Basel III capital reforms. Increases in the equity capital base mandated under the Basel III rules serve to reduce the borrowing costs of smaller banks, but they are less effective in reducing the borrowing costs of larger banks. This pattern is consistent with the proposition that the default protection provided by a stronger capital position substitutes for the protection provided by implicit government guarantees in shoring up investor confidence in a systemically important bank.

Chapter 4

Do the Basel III bail-in rules increase investors' incentives to monitor banking risks? Evidence from the subordinated debt market

4.1 Introduction

The empirical study reported in this chapter examines the impact of the Basel III discretionary point of non-viability trigger mechanism on the pricing of subordinated debt securities issued by Australian banks. Australian banks began to issue bail-in subordinated debt securities with the point of non-viability trigger from May 2013, while the conventional subordinated debt securities that they issued previously continue to trade in the secondary market until they are redeemed and phased-out by January 2023. This transition timetable enables an assessment of whether investors demand a bail-in risk premium when pricing subordinated debt securities issued with the Basel III discretionary point of non-viability trigger compared with the old-style securities without the trigger. This trigger provides a mechanism to help resolve a gone-concern bank, when the regulator uses its discretion to activate the non-viability trigger and convert to common equity or write off the holdings of tier 2 subordinated debt investors, to absorb the losses of the bank. This study examines the impact of the Basel III gone-concern bail-in mechanism on the pricing of subordinated debt and whether the regulatory discretionary point of non-viability trigger mechanism increases the sensitivity of subordinated debt prices to the risk profile of the issuing bank.

The remainder of this chapter is organised as follows. Section 4.2 describes the Basel III loss absorbency requirements for tier 2 capital instruments. Section 4.3 describes the data and methodology for this study. Section 4.4 reports the empirical results on the impact of the Basel III discretionary point of non-viability trigger mechanism on the pricing of bank-issued subordinated debt securities. The findings of this study are summarised in section 4.5.

4.2 Basel III bail-in rules for bank subordinated debt

As part of initiatives to improve the loss absorbing capacity of non-common equity capital instruments, the Basel III reforms introduced new loss absorbency requirements for subordinated debt securities to qualify as tier 2 regulatory capital instruments. In the previous versions of the Basel Accord, eligible subordinated debt securities had been allowed to be included as gone-concern tier 2 regulatory capital. However, the 2007-2009 financial crisis highlighted significant shortcomings in the arrangements by which subordinated debt capital would be used to resolve an insolvent bank, as well as moral hazard problems caused by government support for systemically important financial institutions. In many countries, subordinated debt holders were spared from the contractual requirements to absorb bank losses according to the juniority of their claims because governments intervened to recapitalise the banks before they were subject to bankruptcy proceedings. The Basel III loss absorption mechanism introduced for tier 2 subordinated debt securities requires them to be issued with a loss absorbency feature, such that the securities are converted to common equity or have their principal values written-down once a point of non-viability trigger is activated. The responsibility to decide whether a bank is non-viable is exercised by the national banking regulator. This bail-in feature represents an additional risk, over and above the risks to which conventional subordinated debt investors are exposed.

In Australia, the domestic prudential regulator, the Australian Prudential Regulation Authority (APRA) began the implementation of the Basel III capital reforms from January 2013. The new loss absorbency requirements were introduced for tier 2 subordinated debt according to a phase-in timeline running from 2013 to 2023. Australian banks were generally in a strong position to meet the Basel III rules and started to issue Basel III bail-in subordinated debt in both domestic and offshore markets from May 2013. Bail-in subordinated debt securities are mostly traded over the counter, except a small number that are listed and traded on public securities exchanges including the Australian Securities Exchange (ASX). Any subordinated debt issued since 1 January 2013 must include a regulatory discretionary point of non-viability trigger to be eligible to be included as part of tier 2 capital under the Basel III regime. There is no specific guidance provided to the market about how the local supervisor, APRA, will assess and decide when a bank is to be declared non-viable. The assessment could potentially be based on a high proportion of non-performing loans, a lack of sufficient liquidity or a weakened capital position. The uncertainty associated with the issuing bank's regulatory standing in relation to the non-viability provisions and the lack of transparency about how the regulator will assess the bank's condition contribute to the risk profile of the bail-in subordinated debt securities. Under the Basel III rules, the pre-defined mechanical 5.125% CET1 capital ratio trigger applies to additional tier 1 capital instruments, but it does not apply to tier 2 capital instruments (including subordinated debt).

Transitional arrangements have been implemented for the old-style subordinated debt securities issued under the Basel I and Basel II regimes. These securities can continue to be counted towards tier 2 regulatory capital, but will be phased out from their first available call date (if any), or as determined by APRA. The proportion of the transitional instruments included in the base amount of tier 2 capital is to be reduced over a ten-year period from 2013 to 2023, with a 10 per cent reduction each year. The regulatory discretionary loss absorption mechanism only applies to new issues of bail-in subordinated debt from 1 January 2013. If the point of non-viability trigger is activated by the regulator, Basel III bail-in subordinated debt is to be written off or converted to common equity. However, the old-style subordinated debt securities issued under Basel I and Basel II frameworks will not be converted or written off in this case. This, in turn, gives the old-style subordinated debt securities a higher effective ranking in the hierarchy of claims on the bank. During the period that both the old-style and Basel III bail-in subordinated debt securities are trading in the market place, it is expected that the bail-in mechanism will be taken into account by investors when they price the subordinated debt securities issued with the Basel III bail-in feature.

4.3 Empirical implementation

4.3.1 Data and sample

This study focuses on 75 subordinated debt securities issued by 9 Australian banks and traded in the secondary market from January 2013 to December 2017. The sample bonds included in the study comprise 28 old-style subordinated bonds (i.e. subordinated debt issued under the Basel I and Basel II regimes) and 47 bail-in subordinated bonds (i.e. Basel III tier 2 subordinate debt) issued since 1 January 2013, that is, the start date of Basel III implementation in Australia. Table 4.1 presents the sample Australian banks, the number of subordinated bonds and number of monthly observations involved in the analysis. Observations for subordinated bonds with less than one year remaining to effective maturity are excluded from the sample data. As can be seen from the table, the sample comprises a reasonably balanced number of observations for subordinated bonds issued with and without the Basel III point of non-viability trigger. Subordinated bonds represents a more junior claim on the bank than senior bonds and are issued with an offer to compensate investors with periodic interest payments, which are relatively higher compared with senior bonds and can be either fixed or floating rate. The higher yields that investors demand can be attributed to the higher risks associated with subordinated bonds, which include interest rate risk and default risk, but also the potential for conversion into common equity or write down for bonds issued under the Basel III rules.

The subordinated bonds in the sample are issued in eight different currency denominations. I collect issue-level information on the subordinate debt securities from Bloomberg, including their issue dates, maturity types, contractual maturity dates, coupon rates, coupon types, coupon frequency, par value, issue amounts, call features and the Basel III loss absorbency treatment of each individual bond. To determine the effective maturity date of a subordinated bond, I consider both the call schedule and maturity type of the bond. Because the market convention is such that all callable subordinated bonds issued by Australian banks are called by the issuing bank at the first call date, I use the first call date as the effective maturity date for all subordinated bonds that are callable bonds. For

Table 4.1: Sample banks with subordinated debt observations

This table presents the sample Australian domestic banks included in the analysis. The sample period is January 2013 to December 2017. This table presents the number of subordinated bonds and month-end observations for the subordinated bonds with the Basel III point of non-viability trigger and for those without the point of non-viability trigger.

Fixed-rate bonds

Bank name	No. of subordinated bonds		No. of observations	
	Without trigger	**With trigger**	**Without trigger**	**With trigger**
Westpac Banking Corporation	3	10	126	153
Commonwealth Bank of Australia	4	6	208	135
National Australia Bank Limited	3	4	148	74
Australia and New Zealand Banking Group Limited	2	9	85	238
Macquarie Bank Limited	3	2	170	62
All banks	15	31	737	662

Floating-rate bonds

Bank name	No. of subordinated bonds		No. of observations	
	Without trigger	**With trigger**	**Without trigger**	**With trigger**
Westpac Banking Corporation	2	3	81	116
Commonwealth Bank of Australia	0	2	0	57
Australia and New Zealand Banking Group Limited	3	2	136	69
National Australia Bank Limited	3	3	120	60
Bendigo and Adelaide Bank Limited	1	2	25	55
Bank of Queensland Limited	3	1	50	20
MyState Bank Limited	0	1	0	27
Auswide Bank Limited	1	2	22	62
All banks	13	16	434	466

bonds that are not callable, I use the contractual maturity date as the bond's effective maturity date. I collect daily prices for the subordinated bonds from Capital IQ and Bloomberg, then select calendar month-end observations and calculate credit spreads for the subordinated debt securities.[41] For fixed-rate subordinated bonds, I obtain the maturity dates and monthly yields-to-maturity of government bonds in the eight relevant currencies from Bloomberg to be used as the benchmark risk-free interest rates. For floating-rate subordinate bonds, I collect bank bill swap rates from the Australian Financial Markets Association to be used as the benchmark risk-free interest rate.[42]

To construct bank risk measures and control variables that can be used in the analysis

[41] End of day prices of subordinated debt securities are the mid-price of the bid and ask quote prices. I use Capital IQ as the first source for pricing data due to better data quality and coverage. For bonds with no pricing data from Capital IQ, I use data from Bloomberg to calculate credit spreads.

[42] The floating-rate subordinated bonds in the sample are all Australian dollar-denominated bonds.

to disentangle the effect of the point of non-viability trigger from other possible factors that may impact the credit spreads of banks' subordinated bonds, I collect data from a variety of sources. I collect daily data on bank equity returns and market capitalisation from Thomson Reuters Datastream. Semi-annual data from banks' financial reports are obtained from Worldscope, including the total assets, total liabilities, shareholders' equity, net income, non-performing loans, total loans, trading assets and cash and liquid assets of the bank. For macroeconomic factors, interest rates on bank accepted bills and generic Australian Government bonds of different maturities are collected from the Reserve Bank of Australia. Average redemption yields for bonds in the S&P/ASX Australian Corporate Bond Index are obtained from Thomson Reuters Datastream. The values of the S&P/ASX 200 VIX index are collected from Bloomberg.

4.3.2 Point of non-viability trigger, bank risk and control variables

The key variable of interest is the gone-concern loss absorption feature for a subordinated debt security. Bloomberg reports whether a subordinated debt instrument qualifies as Basel III tier 2 capital, and the trigger type and trigger action under the Basel III rules. Banks are required under APRA's prudential standard APS330, to disclose the main features of instruments included in their regulatory capital. Combining the information from Bloomberg and from banks' disclosure documents, I determine whether a subordinated debt security issued by an Australian bank meets the Basel III loss absorbency requirement. In the capital disclosure document, the bank specifies if a tier 2 subordinate debt instrument has the regulatory discretionary point of non-viability trigger. Alternatively, if a subordinated debt security is specified as 'Tier 2' capital under 'Post-transitional Basel III rules', the security is designated as a bail-in subordinated debt instrument, i.e., one issued with the Basel III gone-concern loss absorption feature, otherwise, the security is designated as an old-style subordinated debt instrument, i.e., one issued without the loss absorption feature.

Table 4.2 lists the bank risk measures, subordinated debt security characteristics, bank-level characteristics and macroeconomic variables and the anticipated effects on credit spread levels. I employ five alternative proxies to measure bank default risk. Following

Table 4.2: List of risk measures, subordinated-debt characteristics, bank-characteristics and macroeconomic variables

	Proxy for	Expected effect on credit spreads
Panel A: Bank risk variables		
Negative Merton distance-to-default (*-MertonDD*)	Bank default risk	Positive
Common equity volatility (*Equity volatility*)	Bank equity risk	Positive
Common equity idiosyncratic volatility (*Idiosyncratic volatility*)	Bank idiosyncratic equity risk	Positive
Non-performing loan/Toal loans (*NPL*)	Bank asset risk	Positive
Trading assets/Total assets (*Trading Assets*)	Bank asset risk	Positive
Panel B: Subordinated bond characteristics		
Logarithm of issue size (*Log issue size*)	Counterparty availability	Negative
Logarithm of time-to-maturity (*Log TTM*)	Interest rate risk	Positive
Callable feature (*Callable*)	Bond callable by issuer	Positive
Panel C: Other bank-level variables		
Return on assets (*ROA*)	Profitability/Operational efficiency	Negative
Common equity to total assets ratio (*Common equity ratio*)	Bank solvency position	Negative
Cash holdings to total assets ratio (*Cash holdings*)	Bank liquidity position	Negative
Panel D: Macro variables		
10 year government bond yield - 90-day bank bill rate (*Term premium*)	Term premium	Positive
S&P/ASX corporate bond index yield spread (*Default premium*)	Default premium	Positive
S&P/ASX 200 VIX (*VIX*)	Equity market volatility	Positive

Hillegeist, Keating, Cram and Lundstedt (2004), Duffie, Saita and Wang (2007) and Acharya, Anginer and Warburton (2016), the first risk variable used is the distance-to-default value calculated using the Merton (1974) structural default model. The Merton distance-to-default is shown in previous studies to have significant explanatory power in generating a term structure of bank default probabilities (Duffie, Saita and Wang, 2007). The Merton model is an application of option pricing theory, which treats a firm's equity as a European call option on the firm's assets, where the value of the firm's liabilities represents the strike price. The number of standard deviations away from the default point, i.e., the point at which the assets of the bank are just equal to its liabilities, is the distance-to-default value estimated for the bank. If the market value of the bank's total assets falls below the book value of its total liabilities, the call option is out of the money and will be left unexercised. The insolvent bank will be passed over to its debt holders (Hillegeist, Keating, Cram and Lundstedt, 2004). To enhance the readability of the regression results, I use the negative value of the Merton distance-to-default as the risk measure (following Gropp, Vesala and Vulpes, 2006). In this way, a higher value of the negative Merton distance-to-default indicates a bank with higher default risk.

As Campbell, Hilscher and Szilagyi (2008) identify limitations of the Merton distance-to-default measure in predicting bank default risk, I use two additional market-based risk measures, common equity volatility and idiosyncratic common equity volatility. Atkeson, Eisfeldt and Weill (2017) demonstrate theoretically that one can estimate a firm's distance-to-default using data on the inverse of the volatility of that firm's equity returns. Following Acharya, Anginer and Warburton (2016), I use equity return volatility ($Equity\ volatility$) as a risk measure. This measure transcends the assumptions underpinning the Merton structural model. Equity volatility is computed using daily stock return data over the past 12 months. Also, as substitute risk measure, I use idiosyncratic equity volatility (following Balasubramnian and Cyree, 2011 and Balasubramnian and Cyree, 2014). It is documented by Campbell and Taksler (2003) that idiosyncratic equity volatility has a direct relationship with the credit spreads on corporate bonds. Using their method, idiosyncratic equity volatility ($Idiosyncratic\ volatility$) is calculated as the residual standard error obtained by estimating a rolling market index model, that is, by regressing excess returns on the bank's common equity against excess returns on the market index over the past 130 trading days. I use the S&P ASX 200 total return index and the 90-day bank bill swap rate as the equity market index and the risk-free rate respectively.

To the extent that investors anticipate government support for distressed firms in the banking industry, the distance-to-default and other equity market-based measures of bank risk may understate the risks inherent in their business models (Gandhi and Lustig, 2015; Kelly, Lustig and Van Nieuwerburgh, 2016). To address this concern, I use two accounting-based risk measures to test the robustness of my results. Following previous studies examining banks' bond spreads, including Sironi (2003), Brewer and Jagtiani (2013) and Balasubramnian and Cyree (2014), I use non-performing loans (*NPL*) as a risk measure. Morgan and Stiroh (2001) find evidence that bond investors price the risks implicit in banks' trading assets. Thus, I use the relative size of a bank's trading book ($Trading\ assets$) as an additional risk measure.

To allow for other factors that could potentially impact on the pricing of subordinated debt securities, I control for specific characteristics of the securities, bank profitability and financial strength, and macroeconomic factors. As debt securities with larger issue sizes and shorter maturities can be expected to be more liquid and have lower yield spreads, I compute the logarithm of the amount issued of the bond in constant 2017 dollar terms (*Log issue size*), i.e., adjusted using the historical consumer price index, and the logarithm of the term-to-maturity of the bond (*Log* TTM) to assess the influence of these factors on the pricing of subordinated bonds. I also use a zero-one dummy variable to identify callable bonds. A subordinated bond is callable if the issuer has the option to call the security on one or more pre-defined dates. This option is valuable to the issuer and can be expected to result in higher yield spreads on the securities. Following Acharya, Anginer and Warburton (2016), I consider variables relating to the financial strength and profitability of the bank when it issues a bond: the common equity to total assets ratio ($Common\ equity\ ratio$), cash holdings to total assets ratio ($Cash\ holdings$) and the return on assets (*ROA*). A bank with a higher common equity ratio, and a higher level of cash holdings is a bank that is financially sounder and is expected to be associated with lower credit spreads. A bank with a higher return on assets is one that operates more efficiently and is expected to be associated with lower credit spreads. I include three macroeconomic variables in the analysis. *Term Spread* is calculated as the yield spread between 10-year Australian Government bonds and 90-day bank bills. $Default$ *Premium* is the yield spread between bonds in the S&P/ASX corporate bond index and Australian Government bonds with the nearest average time to maturity, and is used as a proxy for default risk. The S&P/ASX 200 VIX index (VIX) is used to measure the aggregate uncertainty in the securities market, which is calculated by the index provider using the 30-day implied volatilities of S&P/ASX 200 put and call options.

4.4 Results

4.4.1 Descriptive statistics

Table 4.3 reports descriptive statistics of key variables for the sample subordinated bond monthly observations used in the analysis.[43] Descriptive statistics for characteristics of the fixed-rate bonds and floating-rate bonds are reported separately. The average credit spreads in the secondary market are 178 bps and 196 bps for fixed-rate and floating-rate bonds respectively from January 2013 to December 2017. The average term to effective maturity for the sample subordinated bonds trading in the secondary market is around 5 years for fixed-rate bonds and 3 years for floating-rate bonds. The average issue size of the sample subordinated bonds is around 720 million and 640 million Australian dollars for fixed-rate and floating-rate bonds respectively.

Figures 4.1 and 4.2 illustrate the average credit spreads and total amount outstanding of subordinated debt securities issued by Australian banks quarter-by-quarter over the sample period, displayed for fixed-rate bonds (Panel A) and floating rate bonds (Panel B). The grey bars represent the old-style subordinated debt issued under the Basel I and Basel II regimes (without the point of non-viability trigger), while the gold bars represent bail-in subordinated debt issued under the Basel III regime (with the point of non-viability trigger). Regarding the average credit spreads in figure 4.1, except in the September and December quarter of 2017 when most of the old-style floating-rate subordinated debt securities have been redeemed, in every quarter for which comparable data are available, there is a higher credit spread on

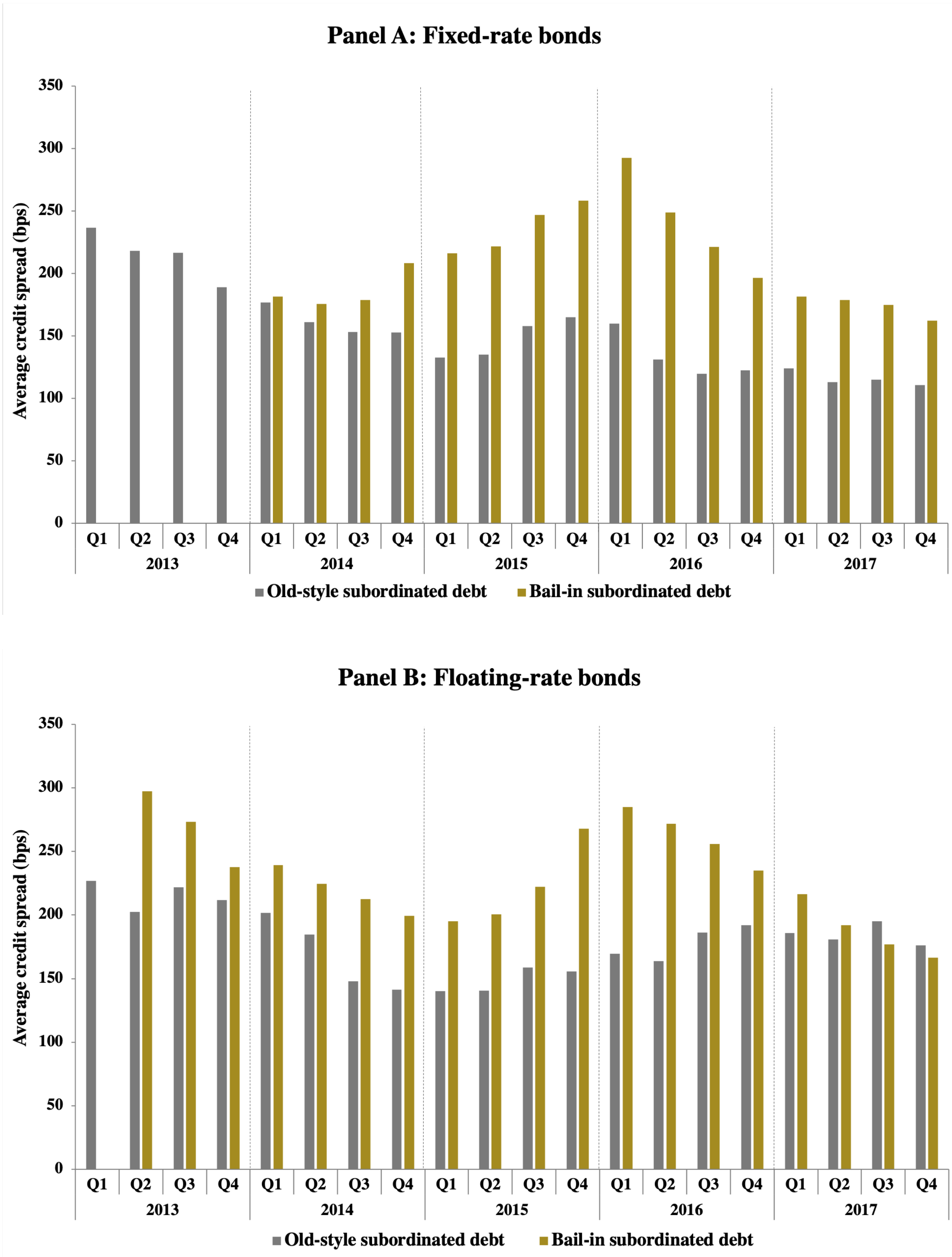
[43] For the bank-level and macroeconomic variables, the descriptive statistics are based on the fixed-rate bond monthly observations. The descriptive statistics based on the floating-rate bond monthly observations are similar and are omitted for brevity.

Table 4.3: Descriptive statistics for bank subordinated debt observations

This table presents summary statistics for bank subordinated debt observations. The sample period is from January 2013 to December 2017. *Issue size* is the issue size of the subordinated debt security in constant 2017 dollars. *Time-to-maturity* is the the time-to-effective maturity of the subordinated debt security. For fixed-rate securities, *Credit Spread* is the difference in yields between the subordinated debt security and the nearest maturity government bond. For floating-rate securities, *Credit Spread* is the discount margin, which is the difference between the internal rate of return on the subordinated debt cash flows and the reference bank bill swap rate, assuming that the reference rate does not change over the life of the security. *Merton distance-to-default* is the distance-to-default calculated using the Merton model. *Equity volatility* is the standard deviation of daily equity returns over the past twelve months. *Idiosyncratic volatility* is the residual standard error estimated for the bank's common equity using a rolling market index model over the past 130 trading days. *Non-performing loans* is non-performing loans divided by total loans. *Trading assets* is the bank's trading book to total assets ratio. *Total assets* is the book value of total assets. *Common equity ratio* is the book value of common equity divided by the book value of assets. *Cash holdings* is cash holdings divided by total assets. *Return on assets* is the return on assets, computed as net income divided by average assets. *Term spread* is the term structure premium, measured by the yield spread between 10-year Australian Government bonds and 90-day bank accepted bills. *Default premium* is the default risk premium, measured by the yield spread between bonds in the S&P/ASX corporate bond index and Australian Government bonds with nearest average time-to-maturity. *S&P ASX 200 VIX* is the level of the S&P/ASX 200 VIX index.

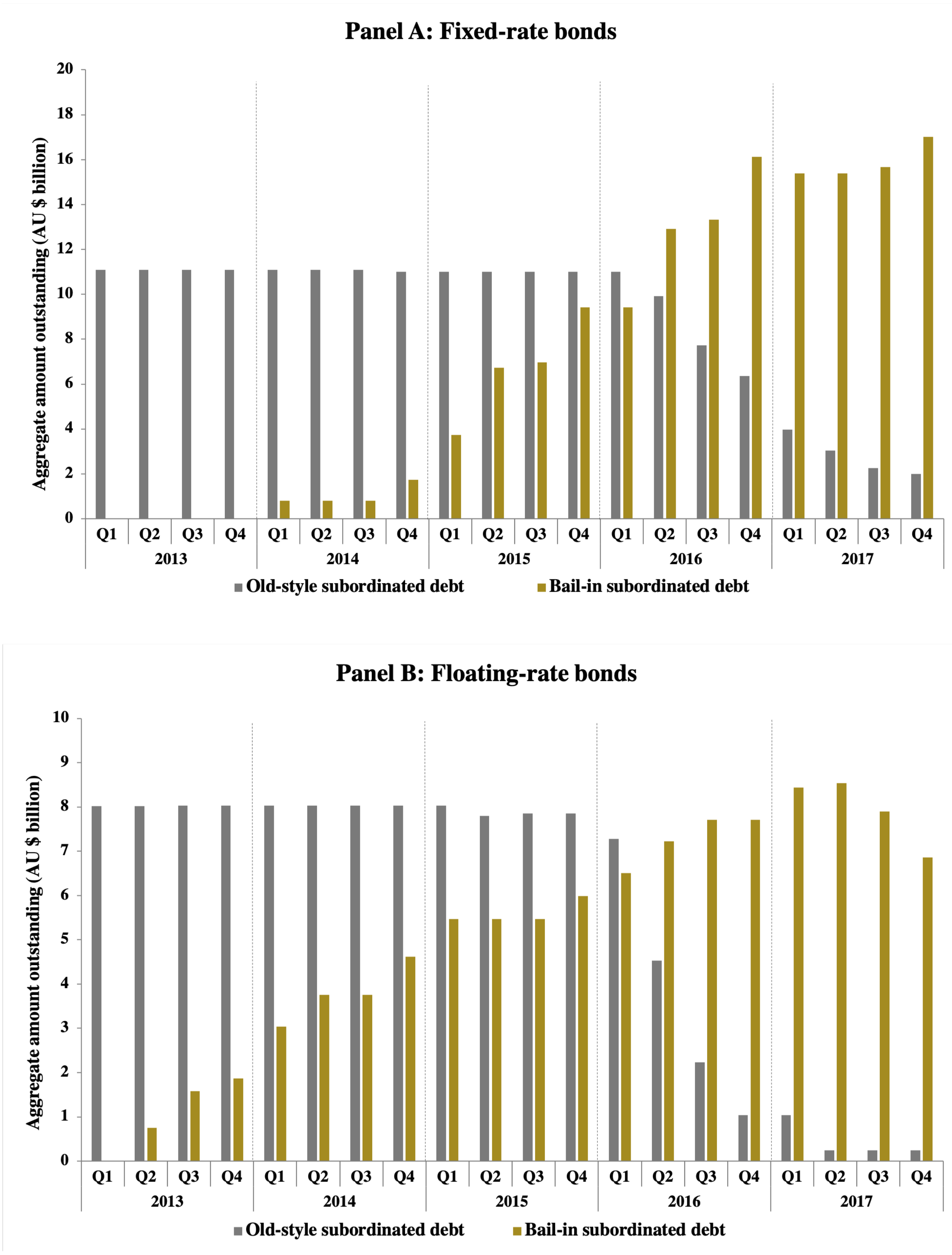
Data item	**Mean**	**Standard deviation**	**Lower quartile**	**Median**	**Upper quartile**
Subordinated bond characteristics					
– Fixed rate bonds					
Issue size $mil	720.4	436.0	355.1	777.0	1034.1
Time to maturity years	5.3	2.3	3.6	5.0	6.9
Credit spread bps	178	62	136	174	213
– Floating rate bonds					
Issue size $mil	641.4	476.4	256.3	566.8	887.1
Time to maturity years	3.2	1.2	2.2	3.2	4.1
Credit spread bps	196	72	143	180	229
Bank risk variables					
Merton distance-to-default	4.9	1.3	3.8	5.0	5.9
Equity volatility % pa	19.3	5.2	15.3	17.8	23.4
Idiosyncratic volatility % pa	12.3	7.5	9.4	10.8	12.8
Non-performing loans %	1.71	1.00	0.71	2.05	2.60
Trading assets %	7.6	3.9	4.9	6.0	10.4
Other bank-level variables					
Total assets $bil	764.3	264.9	788.8	856.1	923.3
Common equity ratio %	6.5	0.7	6.1	6.5	6.9
Cash holdings %	6.1	3.9	3.1	5.2	8.2
Return on assets % pa	1.3	0.2	1.1	1.4	1.5
Macro variables					
Term spread bps	66	40	36	66	94
Default premium bps	107	23	86	111	121
S&P ASX 200 VIX %	13.3	3.4	10.9	12.3	15.1

Figure 4.1: Average credit spreads for old-style and bail-in subordinated debt



This figure shows the quarterly average credit spreads of subordinated debt securities issued by the sample Australian banks, presented for fixed-rate bonds (panel A) and floating-rate bonds (panel B). *Credit Spread* (y-axis) is in basis points. For fixed-rate subordinated debt, *Credit Spread* is the difference in yields between the subordinated debt security and a maturity-matched government bond. For floating-rate subordinated debt, *Credit Spread* is the discount margin, which is the difference between the internal rate of return on the subordinated debt cash flows and the reference bank bill swap rate, assuming that the reference rate does not change over the life of the subordinated debt security. The time period (x-axis) is from quarter 1 2013 to quarter 4 2017. The gold bars represent the credit spreads of bail-in securities, which are subordinated debt securities issued under the Basel III regime, i.e., with the point of non-viability trigger. The grey bars represent the credit spreads of conventional subordinated debt securities, which are issued under the Basel I and II regimes, i.e., without the trigger.

Figure 4.2: Total market size for old-style and bail-in subordinated debt



This figure shows the aggregate amount on issue of subordinated debt securities for the sample Australian banks in billions of Australian dollars, presented for fixed-rate bonds (panel A) and floating-rate bonds (panel B). The time period (x-axis) is from quarter 1 2013 to quarter 4 2017. The gold bars represent the total amount outstanding of bail-in debt, which are subordinated debt securities issued under the Basel III regime, i.e., with the point of non-viability trigger. The grey bars represent the amount outstanding of conventional subordinated debt securities, which are issued under the Basel I and II regimes, i.e., without the trigger.

Table 4.4: Pearson correlation coefficients for key variables of the sample bank subordinated debt observations

PONV is a dummy variable which equals to 1 if a subordinated debt security is issued with the Basel III loss absorption feature, i.e. a point of non-viability trigger. *LOGT* is the logarithm of the term to effective maturity of the subordinated debt security. *LOGS* is the logarithm of the issue size of the subordinated debt security in constant 2017 dollars. *-MDD* is the negative distance-to-default calculated using the Merton model. *SIGE* is the standard deviation of daily equity returns over the past twelve months. *IDIO* is the residual standard error estimated for the bank's common equity using a rolling market index model over the past 130 trading days. *NPL* is non-performing loans divided by total loans. *TRAD* is bank's trading book to total assets ratio. *CEQU* is the book value of common equity divided by the book value of assets. *CASH* is cash holdings divided by total assets. *ROA* is the return on assets, computed as net income divided by average assets. *TERM* is the term structure premium, measured by the yield spread between 10-year Australian Government bonds and 90-day bank accepted bills. *DEF* is the default risk premium, measured by the yield spread between bonds in the S&P/ASX corporate bond index and Australian Government bonds with nearest average time-to-maturity. *VIX* is the level of the S&P/ASX 200 VIX index. ***, **, and * indicate significance at 1%, 5% and 10% levels, respectively.

	PONV	LOGT	LOGS	-MDD	SIGE	IDIO	NPL	TRAD	CEQU	ROA	CASH	TERM	DEF
LOGT	0.54***												
LOGS	-0.22***	0.20***											
-MDD	0.05	0.06*	0.14***										
SIGE	0.04	0.04	0.12***	0.94***									
IDIO	-0.11***	0.17***	0.16***	0.39***	0.38***								
NPL	0.21***	-0.07*	0.12***	0.01	-0.08**	-0.23***							
TRAD	-0.23***	0.05	0.34***	0.25***	0.24***	0.37***	-0.01						
CEQU	0.12***	0.22***	-0.03	0.15***	0.27***	0.41***	-0.59***	0.26***					
ROA	-0.09**	-0.09***	-0.09***	-0.20***	0.02	-0.07**	-0.39***	0.01	0.39***				
CASH	-0.02	0.15***	0.26***	0.26***	0.23***	0.23***	0.09***	0.56***	0.16***	-0.16***			
TERM	-0.02	0.09**	-0.08**	-0.32***	-0.35***	0.10***	-0.22***	-0.12***	0.11***	-0.12***	-0.05*		
DEF	0.01	-0.11***	0.09***	0.62***	0.65***	0.00	0.16***	0.11***	-0.09***	0.10***	0.07*	-0.78*	
VIX	-0.09**	-0.07**	0.10***	0.61***	0.63***	0.06*	0.12***	0.13***	-0.15***	0.12***	0.08**	-0.45***	0.68***

bail-in subordinated debt issued with the point of non-viability trigger than on the old-style subordinated debt. The wider credit spreads can be expected to be contributed to by the additional risk premium required by investors in bail-in subordinated debt due to the point of non-viability trigger. However, it may also be a consequence of other factors that have an impact on the yield spreads of subordinated bonds. As illustrated in figure 4.2, the amount outstanding of bail-in subordinated debt increased steadily from 2013, while that of old-style subordinate debt declined from the second quarter of 2016. By the end of the sample period, the amount outstanding of fixed-rate subordinated debt issued with the Basel III point of non-viability trigger is greater than that of floating-rate subordinated debt issued with the trigger.

Table 4.4 presents the correlations between key explanatory variables included in the analysis. The key variable of interest, *PONV*, is a dummy variable used to identify whether a subordinated debt security is issued with the Basel III point of non-viability trigger. As shown in the correlation table, the *PONV* dummy variable is positively correlated with the ratio of non-performing loans to total loans, suggesting that banks with lower quality credit portfolios may have raised subordinated debt funding to buttress their regulatory capital positions under the Basel III rules. However, the *PONV* dummy variable is negatively correlated with idiosyncratic equity volatility and the proportion of trading assets to total assets, suggesting that banks that have issued the new-style securities have a safer profile overall. The *PONV* dummy variable is positively correlated with the issuing bank's common equity ratio, indicating that the pricing observations for subordinated debt with the point of non-viability trigger are for banks with generally stronger capital positions compared with the pricing observations for the old-style subordinated debt without the trigger.

4.4.2 Impact of the point of non-viability trigger on subordinated debt pricing

To determine whether investors may be concerned about the possibility of being bailed-in to support the resolution of a gone-concern bank, this subsection examines whether credit spreads are wider for subordinated debt issued with the Basel III regulatory discretionary point of non-viability trigger, relative to subordinated debt issued without the trigger. I regress the secondary market credit spreads of subordinated bonds on the indicator variable for the Basel III point of non-viability trigger mechanism, alternative bank risk variables, subordinated bond characteristics, the issuing bank's profitability and financial strength, and macroeconomic factors (following the modelling strategy of Flannery and Sorescu, 1996 and Krishnan, Ritchken and Thomson, 2005). Using a panel regression approach, I include year fixed effects and bank fixed effects to control for any omitted variables at these levels and cluster the standard errors in the estimations by security and month-end date to allow for heteroskedasticity and panel-related correlation in the regression residuals.[44]

The specification of the regression is as follows:

$$\begin{aligned}
Spread_{i,t} = &\alpha_1\ PONV_i + \beta_1\ Bank\ risk_{i,t-1} + \gamma_1\ Common\ equity\ ratio_{i,t-1} \\
&+ \delta_B\ Bank\ control\ factors_{i,t-1} + \delta_S\ Subordinated\ bond\ characteristics_{i,t} \\
&+ \delta_M\ Macroeconomic\ factors_t + YearFE + BankFE + \varepsilon_{i,t}
\end{aligned}$$

where, for fixed-rate subordinated bonds, $Spread_{i,t}$ is the spread between the month-end yield-to-effective-maturity of the bank subordinated bond traded in month t, and the month-end yield-to-maturity of the benchmark government bond with the same currency-denomination and nearest maturity date. As the observation month t changes, the benchmark government bond for a fixed-rate subordinated bond can, in some cases, be replaced by another newly-issued government bond with a closer maturity date. For floating-rate subordinated bonds, $Spread_{i,t}$ is the discount margin, which is the difference between the internal rate of return on the bond cash flows and the reference bank bill swap rate, assuming that the reference rate does not change over the life of the bond. *PONV* is a dummy variable which equals 1 if the subordinated debt security has the Basel III point of the non-viability trigger; and equals 0 if the subordinated debt security was issued under the Basel I or Basel II regimes, i.e., without the Basel III point of non-viability trigger. Five alternative measures are used to capture bank risk (*Bank risk*), which are the negative of the Merton distance-to-default ($-MertonDD$), common equity volatility ($Equity\ volatility$), the residual standard error ($Idiosyncratic\ volatility$) estimated for the bank's common equity, the ratio of non-performing loans to total loans (*NPL*), and the ratio of trading assets to total assets

[44] There are insufficient clusters to cluster the standard errors by bank and year.

(*Trading assets*). The regression model controls for the bank's profitability, liquidity position and common equity position (*Bank control factors*) using the return on assets (*ROA*), the ratio of cash and liquid assets to total assets (*Cash holdings*) and the ratio of the book value of common equity to total assets (*Common equity ratio*). To control for subordinated debt characteristics (*Subordinated bond characteristics*), I include the logarithm of the amount issued of the security in millions of constant 2017 Australian dollars (*Log issue size*), the logarithm of the time-to-maturity in years (*Log TTM*), and a dummy variable which equals 1 if the security is callable by the issuer (*Callable*). Considering that macroeconomic factors could also result in credit spread differences between old-style and bail-in subordinated bonds, I further control for the default risk premium in the corporate bond market in general (*Default premium*), the term structure premium (*Term premium*) and the level of S&P/ ASX 200 VIX index (*VIX*).

If investors anticipate the possibility of being exposed to potential future bank loses on account of the Basel III loss absorbency mechanism for tier 2 capital instruments when pricing bail-in subordinated debt, it is expected that the coefficient on the *PONV* dummy variable will be significantly positive. The regression results for fixed-rate and floating-rate subordinated bonds are reported in panels A and B of table 4.5. Consistent with the prior expectation, the coefficient on the *PONV* dummy variable in all regressions, applying the different risk proxies, is positive and statistically significant. The regression results provide evidence that investors in the Basel III bail-in subordinated bonds take account of the Basel III point of non-viability trigger when making their pricing decisions. The coefficient on the *PONV* dummy variable suggests that investors demand an additional risk premium of approximately 73 basis points and 45 basis points for fixed-rate and floating rate securities respectively when investing in the Basel III bail-in subordinated debt, relative to the risk premium they demand for investing in the old-style subordinated bonds. The results are consistent across all regressions, which use bank fixed effects to control for omitted bank-specific factors and use year fixed effects to control for any other factors that are common to all sample banks.

If investors in subordinated debt securities demand higher compensation for trading securities issued by riskier banks, the coefficients on the five alternate variables for measuring bank risk are expected to be positive and significant. In panel A, the significantly positive

Table 4.5: Impact of the point of non-viability trigger on subordinated debt pricing

This table presents regression results for the specification, $Spread_{i,t} = \alpha_1 PONV_i + \beta_1 Bank\ risk_{i,t-1} + \gamma_1 Common\ equity\ ratio_{i,t-1} + \delta_B Bank\ control\ factors_{i,t-1} + \delta_S Subordinated\ bond\ characteristics_{i,t} + \delta_M Macroeconomic\ factors_t + YearFE + BankFE + \varepsilon_{i,t}$. The sample period is from January 2013 to December 2017. For fixed-rate securities, *Spread* is the difference in yields between the subordinated debt security and the nearest maturity government bond. For floating-rate securities, *Spread* is the discount margin, which is the difference between the internal rate of return on the subordinated debt cash flows and the reference bank bill swap rate, assuming that the reference rate does not change over the life of the security. *PONV* is a dummy variable which equals 1 if a subordinated debt security is issued with the Basel III loss absorption feature, i.e. a point of non-viability trigger. *-MertonDD* is the negative distance-to-default calculated using the Merton model. *Equity volatility* is the standard deviation of the bank's equity returns over the past twelve months. *Idiosyncratic volatility* is the residual standard error estimated for the bank's common equity using a rolling market index model over the past 130 trading days. *NPL* is non-performing loans divided by total loans. *Trading assets* is the bank's trading book to total assets ratio. *Common equity ratio* is the book value of common equity divided by the book value of assets. *ROA* is the return on assets, computed as net income divided by average assets. *Cash holdings* is cash holdings divided by total assets. *Log issue size* is the logarithm of the issue size of the subordinated debt security in constant 2017 dollars. *Log TTM* is the logarithm of the term-to-effective maturity of the subordinated debt security. *Callable* is a dummy variable which equals 1 if the security is callable by the issuer on a pre-defined date. *Term spread* is the term structure premium, measured by the yield spread between 10-year Australian Government bonds and 90-day bank accepted bills. *Default premium* is the default risk premium, measured by the yield spread between bonds in the S&P/ASX corporate bond index and Australian Government bonds with nearest average time-to-maturity. *VIX* is the level of S&P/ASX 200 VIX index. Robust t-statistics in parentheses are based on standard errors clustered at both the security and month-end date levels. ***, **, and * indicate significance at 1%, 5% and 10% levels, respectively.

Panel A: Fixed-rate bonds

	Dependent variable: Credit spread				
Independent variables	**(1)** **- MertonDD**	**(2)** **Equity volatility**	**(3)** **Idiosyncratic volatility**	**(4)** **NPL**	**(5)** **Trading assets**
PONV (α_1)	0.732***	0.732***	0.743***	0.756***	0.752***
	(3.48)	(3.48)	(3.50)	(3.43)	(3.54)
Bank risk (β_1)	0.057**	0.016***	0.021	-0.059	-0.022
	(2.47)	(3.14)	(0.55)	(-0.89)	(-1.26)
Common equity ratio (γ_1)				-0.028	-0.016
				(-0.38)	(-0.23)
ROA (δ_1)	-0.583***	-0.619***	-0.643***	-0.708***	-0.661***
	(-3.69)	(-4.07)	(-3.96)	(-3.76)	(-4.22)
Cash holdings (δ_2)	0.002	0.002	0.002	0.001	0.002
	(0.52)	(0.45)	(0.42)	(0.16)	(0.56)
Log TTM (δ_3)	0.022	0.022	0.020	0.018	0.016
	(0.60)	(0.61)	(0.54)	(0.46)	(0.44)
Log issue size (δ_4)	-0.029	-0.029	-0.026	-0.028	-0.025
	(-0.48)	(-0.48)	(-0.43)	(-0.46)	(-0.42)
Callable (δ_5)	0.410***	0.411***	0.411***	0.404***	0.404***
	(4.70)	(4.72)	(4.70)	(4.65)	(4.61)
Term premium (δ_6)	0.039	0.033	0.078	0.065	0.083
	(0.42)	(0.38)	(0.79)	(0.64)	(0.86)
Default premium (δ_7)	0.728***	0.701***	0.837***	0.825***	0.857***
	(3.60)	(3.48)	(4.01)	(3.87)	(4.17)
VIX (δ_8)	0.023***	0.022***	0.032***	0.032***	0.032***
	(3.74)	(3.64)	(3.99)	(3.97)	(3.83)
Observations	1,389	1,389	1,389	1,389	1,389

No of banks	5	5	5	5	5
No of subordinated bonds	46	46	46	46	46
Year FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.571	0.571	0.567	0.568	0.569

Panel B: Floating-rate bonds

	Dependent variable: Credit spread				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Independent variables	**- MertonDD**	**Equity volatility**	**Idiosyncratic volatility**	**NPL**	**Trading assets**
PONV (α_1)	0.446***	0.447***	0.449***	0.454***	0.485***
	(3.47)	(3.50)	(3.52)	(3.40)	(3.74)
Bank risk (β_1)	0.015	0.007	0.079	-0.063*	-0.017
	(0.50)	(0.96)	(0.53)	(-1.92)	(-0.78)
Common equity ratio (γ_1)				-0.164***	-0.133**
				(-3.60)	(-2.40)
ROA (δ_1)	-0.667***	-0.679***	-0.674***	-0.634***	-0.507**
	(-3.31)	(-3.51)	(-3.38)	(-3.19)	(-2.26)
Cash holdings (δ_2)	0.004	0.003	0.004	0.005	0.006***
	(1.07)	(1.03)	(0.97)	(1.51)	(9.17)
Log TTM (δ_3)	0.086*	0.087*	0.084*	0.087*	0.087*
	(1.77)	(1.78)	(1.78)	(1.87)	(1.91)
Log issue size (δ_4)	-0.407**	-0.406**	-0.406**	-0.421***	-0.390**
	(-2.51)	(-2.49)	(-2.51)	(-2.61)	(-2.58)
Callable (δ_5)	-0.738***	-0.731***	-0.732***	-0.735***	-0.775***
	(-3.57)	(-3.47)	(-3.52)	(-3.50)	(-3.85)
Term premium (δ_6)	0.374***	0.361***	0.377***	0.386***	0.389***
	(4.38)	(4.35)	(5.02)	(5.33)	(5.52)
Default premium (δ_7)	0.965***	0.926***	0.973***	1.048***	1.120***
	(4.34)	(3.94)	(4.35)	(4.87)	(5.09)
VIX (δ_8)	0.013**	0.012*	0.015**	0.015**	0.016***
	(2.16)	(1.95)	(2.30)	(2.35)	(2.67)
Observations	861	861	861	861	800
No of banks	8	8	8	8	8
No of subordinated bonds	29	29	29	29	29
Year FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.812	0.812	0.812	0.817	0.771

coefficients in front of two of the risk measures (columns 1 and 2), namely, $-MertonDD$ and $Equity\ volatility$, provide support for the idea that subordinated debt investors demand higher compensation for investing in banks with a higher risk of insolvency, as captured by the negative distance-to-default and common equity volatility. However, the estimated coefficients on the other risk measures are statistically insignificant or negative (columns 3 to 5 in panel A and columns 1 to 5 in panel B). There is no evidence that investors price subordinated bonds based on bank risk captured by idiosyncratic equity volatility, non-performing loans or trading assets. Analysis on whether the Basel III point of non-viability trigger may result in an increased sensitivity of credit spreads to bank risk is reported in the next subsection.

To disentangle the effect of the Basel III bail-in mechanism from other factors that might impact on the credit spreads of subordinated debt securities, the model includes variables to control for other subordinated debt characteristics, bank-level characteristics and macroeconomic conditions. With regard to variables measuring subordinated debt security characteristics, the significant and negative coefficient on *Log issue size* in the floating-rate security regressions (panel B) is consistent with a benefit of larger issues to subordinated debt investors, derived from better liquidity in the secondary market. However, the coefficient on this variable is insignificant in the fixed-rate subordinated debt regressions (panel A). This may reflect institutional investors' preference to hold fixed rate subordinated bonds until maturity, especially the bonds issued by higher quality banks. The estimated coefficient on $Log\ TTM$ is positive and significant at the 10% level in all of the floating-rate subordinated debt regressions, which suggests that the default premiums are higher for floating-rate subordinated debt securities with longer times remaining to maturity. The results indicate a significantly positive relationship between credit spreads and the dummy variable $Callable$ in the fixed-rate security regressions. With bonds that have a call option, the issuer may buy back the bonds from investors at a pre-defined call date, which is valuable to the issuer when interest rates go down and bond prices increase. However, the coefficient on $Callable$ in the floating-rate security regressions is significantly negative. This result is unexpected, but likely arises from the unbalanced sample, with almost all of the floating-rate bonds being callable by the issuer.

In relation to characteristics of the bank that has issued the subordinated bond, the regressions include the ratio of common equity to total assets to control for the bank's solvency position, the return on assets to control for the bank's profitability and the ratio of cash holdings to total assets for the bank's liquidity position. The book value of the bank's total assets is excluded from the regressions, due to its high collinearity with the issue size of the subordinated bonds and with the bank fixed effects. Also, to avoid collinearity with the bank risk measures, the common equity ratio is omitted as an explanatory variable if the risk measure incorporates the bank's capital adequacy (as is the case for $-MertonDD$, $Equity\ volatility$ and $Idiosyncratic\ volatility$). It is expected that the coefficient on the $Common\ equity\ ratio$ will be negative and significant if the credit spreads for the subordinated bonds are sensitive to the bank's capital position. The results show a significant and negative coefficient on the $Common\ equity\ ratio$ in the floating-rate bond regressions having NPL and $Trading\ assets$ as the risk variables, which suggests that the credit spreads are sensitive to the banks' common equity position. If investors take account of a bank's profitability and operating efficiency, I expect to observe a negative coefficient on the bank's lagged return on assets. The negative and significant coefficient on ROA in all of the regressions for both fixed-rate and floating-rate subordinated bonds suggests that investors view banks with better profitability and greater operating efficiency as less likely to become financially distressed. The coefficient on cash holdings is expected to be negative if investors in subordinated bonds perceive that banks with more liquid assets have greater capacity to meet future payment obligations. However, the coefficient on $Cash\ holdings$ is not significantly negative in any of the regressions.

To allow for changes in credit market conditions over the sample period, the regressions include the term premium, the default premium and the level of S&P/ASX 200 VIX index. It is expected that the credit spreads for subordinated debt securities will be positively related to the slope of the yield curve. Consistent with this expectation, in all of the floating-rate bond regressions, the coefficient on the $Term\ premium$ variable is positive and significant. The coefficient on the $Default\ premium$ variable is positive and significant in all of the regressions in both panel A and panel B. This suggests that changes in credit spreads for banks' subordinated bonds are closely related with conditions prevailing in the Australian corporate bond market. The regression results for both fixed-rate and floating-rate securities indicate a significantly positive relationship between the credit spreads for bank subordinated bonds and the level of S&P/ASX 200 VIX index, which suggests that aggregate uncertainty in the securities market has a significant influence on the pricing of bank subordinated debt.

4.4.3 Impact of the point of non-viability trigger on the relation between bank risk and subordinated debt pricing

One explanation for the results reported in table 4.5 is that investors in Basel III bail-in subordinated debt securities demand an additional risk premium compared with old-style securities because they anticipate being exposed to potential future bank losses if the bank breaches the discretionary point of non-viability trigger. However, previous studies argue that the additional risk premium might be attributable to the uncertainty associated with the way in which the regulator will exercise its discretion in relation to the non-viability trigger, rather than to an increased exposure to potential bank losses (see for example, Davis and Saba, 2016). If investors in Basel III bail-in subordinated bonds have greater exposure to potential bank losses than those in conventional securities issued without the loss absorption feature, they can be expected to be more sensitive to the bank's risk profile when pricing the securities. To address this question, the analysis reported in this subsection examines whether the Basel III bail-in feature affects the risk-sensitivity of the credit spreads for subordinated bonds. The pricing regression model is augmented with an interaction term between the *PONV* dummy variable and the measure of bank risk, as well as an interaction term between the *PONV* dummy variable and the equity capital ratio. Using this approach, the main effects of the risk variable and the equity capital ratio capture the sensitivity of credit spreads to bank risk and equity capital for investors in the old-style subordinated bonds, while the interaction terms capture the incremental sensitivity of credit spreads to bank risk and equity capital for investors when investing in bail-in subordinated bonds with the Basel III point of non-viability trigger. Investors are expected to be better incentivised to monitor bank risks if the loss absorbing capacity of the subordinated bonds is improved, which would be reflected in an increased sensitivity of security credit spreads to bank risk and equity capital. If investors are more sensitive to bank risk, I expect to observe positive and significant coefficients on the interaction terms between the *PONV* dummy variable and bank risk and between the *PONV* dummy variable and equity capital.

Table 4.6 presents the regression results for fixed-rate bonds (panel A) and floating-rate

Table 4.6: Impact on the relation between bank risk and subordinated debt pricing

This table presents regression results for the specification, $Spread_{i,t} = \alpha_1 PONV_i + \beta_1 Bank\ risk_{i,t-1} + \beta_2 PONV_i \times Bank\ risk_{i,t-1} + \gamma_1 Common\ equity\ ratio_{i,t-1} + \gamma_2 PONV_i \times Common\ equity\ ratio_{i,t-1} + \delta_B Bank\ control\ factors_{i,t-1} + \delta_S Subordinated\ bond\ characteristics_{i,t} + \delta_M Macroeconomic\ factors_t + YearFE + BankFE + \varepsilon_{i,t}$. The sample period is from January 2013 to December 2017. For fixed-rate securities, *Spread* is the difference in yields between the subordinated debt security and the nearest maturity government bond. For floating-rate securities, *Spread* is the discount margin, which is the difference between the internal rate of return on the subordinated debt cash flows and the reference bank bill swap rate, assuming that the reference rate does not change over the life of the security. *PONV* is a dummy variable which equals 1 if the subordinated debt security is issued with the Basel III loss absorption feature, i.e. a point of non-viability trigger. *-MertonDD* is the negative distance-to-default calculated using the Merton model. *Equity volatility* is the standard deviation of the bank's equity returns over the past twelve months. *Idiosyncratic volatility* is the residual standard error estimated for the bank's common equity using a rolling market index model over the past 130 trading days. *NPL* is non-performing loans divided by total loans. *Trading assets* is the bank's trading book to total assets ratio. *Common equity ratio* is the book value of common equity divided by the book value of assets. *ROA* is the return on assets, computed as net income divided by average assets. *Cash holdings* is cash holdings divided by total assets. *Log issue size* is the logarithm of the issue size of the subordinated debt security in constant 2017 dollars. *Log TTM* is the logarithm of the term-to-effective maturity of the subordinated debt security. *Callable* is a dummy variable which equals 1 if the security is callable by the issuer on a pre-defined date. *Term spread* is the term structure premium, measured by the yield spread between 10-year Australian Government bonds and 90-day bank accepted bills. *Default premium* is the default risk premium, measured by the yield spread between bonds in the S&P/ASX corporate bond index and Australian Government bonds with nearest average time-to-maturity. *VIX* is the level of S&P/ASX 200 VIX index. Robust t-statistics in parentheses are based on standard errors clustered at both the security and month-end date levels. ***, **, and * indicate significance at 1%, 5% and 10% levels, respectively.

Panel A: Fixed-rate bonds

	Dependent variable: Credit spread				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Independent variables	**- MertonDD**	**Equity volatility**	**Idiosyncratic volatility**	**NPL**	**Trading assets**
PONV (α_1)	1.291***	0.107	0.502**	0.856	0.970*
	(3.81)	(0.47)	(2.02)	(0.65)	(1.70)
Bank risk (β_1)	0.022	0.005	0.019	-0.058	-0.016
	(1.03)	(0.88)	(0.51)	(-1.27)	(-0.81)
PONV × Bank risk (β_2)	0.122***	0.030***	0.331*	-0.006	-0.021
	(3.03)	(3.12)	(1.84)	(-0.04)	(-0.72)
$\beta_1 + \beta_2$	0.144***	0.035***	0.351*	-0.064	-0.037
	(4.52)	(4.68)	(1.89)	(-0.41)	(-1.31)
Common equity ratio (γ_1)				-0.026	-0.014
				(-0.35)	(-0.19)
PONV × Common equity ratio (γ_2)				-0.014	-0.003
				(-0.10)	(-0.03)
$\gamma_1 + \gamma_2$				-0.040	-0.017
				(-0.26)	(-0.15)
ROA (δ_1)	-0.668***	-0.733***	-0.680***	-0.704***	-0.568***
	(-4.19)	(-4.60)	(-4.12)	(-3.52)	(-3.20)
Cash holdings (δ_2)	0.000	0.000	0.001	0.001	0.003
	(0.05)	(0.10)	(0.36)	(0.14)	(0.67)
Log TTM (δ_3)	0.023	0.022	0.020	0.018	0.011
	(0.63)	(0.62)	(0.54)	(0.44)	(0.27)
Log issue size (δ_4)	-0.016	-0.022	-0.023	-0.028	-0.022
	(-0.26)	(-0.36)	(-0.38)	(-0.45)	(-0.36)
Callable (δ_5)	0.415***	0.411***	0.415***	0.404***	0.389***

	(4.66)	(4.68)	(4.73)	(4.75)	(4.83)
Term premium (δ_6)	0.034	0.037	0.075	0.065	0.094
	(0.39)	(0.44)	(0.77)	(0.66)	(0.98)
Default premium (δ_7)	0.635***	0.613***	0.807***	0.823***	0.900***
	(3.12)	(3.09)	(3.75)	(3.74)	(4.30)
VIX (δ_8)	0.022***	0.022***	0.031***	0.032***	0.031***
	(3.60)	(3.79)	(3.92)	(4.00)	(3.84)
Observations	1,389	1,389	1,389	1,389	1,389
No of banks	5	5	5	5	5
No of subordinated bonds	46	46	46	46	46
Adjusted R-squared	0.579	0.580	0.568	0.567	0.571

Panel B: Floating-rate bonds

	Dependent variable: Credit spread				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Independent variables	**- MertonDD**	**Equity volatility**	**Idiosyncratic volatility**	**NPL**	**Trading assets**
PONV (α_1)	0.962***	-0.118	0.343**	0.713	-0.833
	(4.70)	(-0.82)	(2.19)	(1.04)	(-0.89)
Bank risk (β_1)	-0.028	-0.006	0.021	-0.077**	-0.029
	(-1.36)	(-0.92)	(0.15)	(-2.14)	(-1.35)
PONV $\times$ Bank risk (β_2)	0.108***	0.029***	0.151	0.030	0.043*
	(3.73)	(4.21)	(0.84)	(0.38)	(1.89)
$\beta_1 + \beta_2$	0.080**	0.023**	0.172	-0.047	0.014
	(2.12)	(2.85)	(0.92)	(-0.73)	(0.55)
Common equity ratio (γ_1)				-0.160***	-0.223***
				(-2.88)	(-3.12)
PONV $\times$ Common equity ratio (γ_2)				-0.048	0.168
				(-0.46)	(1.20)
$\gamma_1 + \gamma_2$				-0.021**	-0.055
				(-2.27)	(-0.56)
ROA (δ_1)	-0.729***	-0.711***	-0.707***	-0.617***	-0.585**
	(-3.56)	(-3.59)	(-3.55)	(-3.13)	(-2.58)
Cash holdings (δ_2)	0.006*	0.006***	0.004	0.003	0.006**
	(1.91)	(3.43)	(1.38)	(0.09)	(1.99)
Log TTM (δ_3)	0.075	0.082*	0.082*	0.081*	0.080*
	(1.59)	(1.70)	(1.73)	(1.72)	(1.71)
Log issue size (δ_4)	-0.413***	-0.410***	-0.411**	-0.426**	-0.391***
	(-2.61)	(-2.58)	(-2.52)	(-2.53)	(-2.60)
Callable (δ_5)	-0.855***	-0.827***	-0.814***	-0.686**	-1.122***
	(-4.04)	(-3.72)	(-3.26)	(-2.48)	(-2.92)
Term premium (δ_6)	0.374***	0.373***	0.377***	0.381***	0.389***
	(4.58)	(4.75)	(5.04)	(5.27)	(5.43)
Default premium (δ_7)	0.931***	0.902***	0.959***	1.052***	1.110***
	(4.15)	(3.87)	(4.30)	(4.86)	(5.05)
VIX (δ_8)	0.014**	0.013**	0.015**	0.015**	0.018***
	(2.38)	(2.19)	(2.36)	(2.35)	(2.90)
Observations	861	861	861	861	800
No of banks	8	8	8	8	8
No of subordinated bonds	29	29	29	29	29
Adjusted R-squared	0.819	0.822	0.812	0.817	0.773

bonds (panel B). The estimated coefficients on the main risk variables are not positive and significant in any of these regressions for either fixed-rate or floating-rate subordinated bonds. There is no evidence that the credit spreads for conventional subordinated debt securities are sensitive to the risks captured by the market value-based measures ($-MertonDD$, $Equity\ volatility$ and $Idiosyncratic\ volatility$) or the accounting-based measures (NPL and $Trading\ assets$). This can possibly be explained by the fact that, before the Basel III reforms were implemented, subordinated debt investors were not required to absorb bank losses until a bank entered a formal bankruptcy process. The Basel III bail-in rule attempts to increase the exposure of subordinated debt investors to bank losses by applying a discretionary point of non-viability trigger mechanism to these securities. Among the interaction terms between the $PONV$ dummy variable and bank risk, those involving the negative distance-to-default and equity volatility are positive and significant in the regressions for both fixed-rate and floating-rate bonds (columns 1 and 2 in panel A and panel B). In addition, for fixed-rate bonds, the coefficient on the interaction term between the $PONV$ dummy variable and $Idiosyncratic\ volatility$ is positive and statistically significant at the 10% level. However, the coefficients on the interaction terms between the $PONV$ dummy variable and the accounting-based risk measures, NPL and $Trading\ assets$, are not statistically significant, which may be a consequence of less timely nature of the accounting data. The results based on the market-derived risk measures suggest that investors in the Basel III bail-in subordinated bonds are more responsive to banking risks in their pricing decisions than investors in the old-style subordinated bonds. This finding is consistent with the idea that the point of non-viability trigger is recognised by investors as giving them greater potential exposure to bank losses.

The regressions reported in columns 4 and 5 include the main effect of the $Common\ equity\ ratio$ and the interaction term between the $PONV$ dummy variable and $Common\ equity\ ratio$. The coefficient on the interaction term can be expected to be negative if the probability of the non-viability trigger being activated is lower for better capitalised banks. As reported in table 4.6 panel B, the coefficient on the main effect of the $Common\ equity\ ratio$ is negative and significant. However, the coefficient on the interaction term $PONV \times Common\ equity\ ratio$ is insignificant in all of the regressions for both fixed-rate and floating-rate bonds. Thus, there is no evidence that investors are more responsive in their pricing decisions to a bank's equity capital position on account of the gone-concern loss absorption mechanism.

In summary, the results reported in table 4.6 suggest that, compared with the conventional subordinated debt securities, the pricing of bail-in subordinated debt is more sensitive to bank default risk as captured by market-based measures i.e., the negative Merton distance-to-default, common equity volatility and idiosyncratic equity volatility. There is no evidence that the pricing of Basel III bail-in subordinated debt is more sensitive to the bank's common equity position. In general, the results provide evidence about the credibility assigned by investors to the Basel III point of non-viability trigger mechanism, which is consistent with investors anticipating that they have greater potential exposure to bank losses under the new regime.

4.5 Summary

To address the moral hazard problems highlighted by the 2007-2009 financial crisis and shortcomings in the resolution procedures for gone-concern banks, the Basel III reforms introduced a regulatory discretionary loss absorbency requirement for subordinated debt to qualify as tier 2 capital under international standards. Australian banks began transitioning to the new requirement from the beginning of 2013. If the regulator declares the bank to be non-viable, subordinated bonds with the non-viability trigger are converted to common equity or written-off, which gives the regulator greater flexibility in imposing losses on subordinated creditors. While Australian banks started to issue Basel III bail-in subordinated bonds, the conventional subordinated bonds, i.e., those without the point of non-viability trigger, are being phased out over a ten-year period to 2023. Using secondary market data for subordinated debt securities issued by Australian banks and traded by investors in the period from January 2013 to December 2017, this study examines the impact of the Basel III point of non-viability trigger on the credit spreads of the subordinated bonds. I find evidence suggesting that the loss absorption mechanism is taken into account by investors when they are pricing the Basel III bail-in debt securities. The results suggest that investors require a bail-in risk premium associated with the discretionary point of non-viability trigger mechanism. This pricing effect is evident when controlling for other debt security characteristics, bank profitability and financial strength, and macroeconomic factors. The average bail-in risk premium is estimated to be approximately 73 basis points for fixed-rate subordinated bonds and 45 basis points for floating-rate subordinated bonds.

To further elucidate about the credibility of the discretionary trigger mechanism for imposing potential bank losses on subordinated creditors, this study examines whether the Basel III discretionary bail-in feature has resulted in an increased sensitivity of the credit spreads on subordinated debt securities to bank risks. The results suggest that the pricing of Basel III bail-in subordinated bonds has become more sensitive to bank risk as captured by market-based measures, i.e., the negative Merton distance-to-default, common equity volatility and idiosyncratic equity volatility. These findings are consistent with the idea that investors in the Basel III bail-in subordinated bonds have greater potential exposure to banking losses than investors in the old-style subordinated bonds.

Chapter 5

Impact of the Basel III loss absorbency requirements on the pricing and liquidity of bank capital instruments

5.1 Introduction

The empirical study reported in this chapter examines the impact of the Basel III loss absorbency requirements on the pricing and liquidity of hybrid securities issued by Australian banks. Australian banks began to issue contingent convertible capital instruments (CoCos) with the Basel III loss absorption features from September 2011, while the conventional hybrid securities that they had issued previously continue to trade in the secondary market until they are phased-out by January 2023. This enables an assessment of whether investors demand an additional risk premium when pricing hybrid securities issued with the Basel III loss absorption triggers, i.e., a discretionary point of non-viability trigger and a mechanical 5.125% common equity tier 1 capital ratio trigger, compared with the old-style securities without the Basel III triggers. The two different triggers provide a mechanism for going-concern banks to be recapitalised when they reach a precariously low solvency position and a mechanism for CoCo investors to absorb losses to support the resolution of a gone-concern bank. Accordingly, this study tests whether the Basel III loss absorption features increase the sensitivity of hybrid security prices to the risk profile of the issuing bank. This study further examines the extent to which the Basel III loss absorption triggers influence the secondary market liquidity for banks' hybrid securities.

The remainder of this chapter is organised as follows. Section 5.2 describes the Basel III loss absorbency requirements. The data and methodology for the study are described in section 5.3. Section 5.4 presents the empirical results on the impact of the Basel III loss absorbency requirements on the pricing and liquidity of banks' hybrid securities. Section 5.5 summarises the findings of the study.

5.2 Basel III loss absorbency requirements

To address shortcomings in the existing bank capital regulation, the Basel III reforms proposed new rules for the quality and level of capital, but also for enhanced loss absorption features required for additional tier 1 and tier 2 capital instruments. For fixed-income investors, the new features are mandated for all non-common equity capital instruments issued since 1 January 2013. Previously, qualifying preferred equity and subordinated debt instruments had been allowed to be included as regulatory capital, within limits with respect to the amount of going-concern (tier 1) and gone-concern (tier 2) capital. However, the Basel II capital framework was criticised as not being sufficiently effective in restoring the tier 1 capital levels of distressed banks. In addition, the public bailout of systemically important financial institutions interrupted the contractual undertakings of private investors for absorbing bank losses according to the hierarchy of their claims. Investors were safeguarded by governments and central banks before they were wiped out as a consequence of bank failure. The Basel III loss absorbency requirements introduced contingent conversion features for non-common equity capital instruments, including a mechanical capital ratio trigger and a mandatory regulatory discretionary point of non-viability trigger. The latter feature applies to any non-common equity capital instruments issued by banks. Hybrid securities eligible to be included as additional tier 1 capital and reported as liabilities on the bank's balance sheet need to be issued with a pre-defined book-value based trigger point at 5.125 per cent common equity tier 1 (CET1) capital, which allows for the security to be converted into common equity or written-off if the trigger point is breached.

In Australia, the Basel III capital reforms were implemented from January 2013. The new loss absorbency requirements were implemented by the local prudential regulator, the Australian Prudential Regulation Authority (APRA). Earlier than the required phase-in, Australian banks started to issue Basel III CoCos in September 2011. There are also transitional arrangements for old-style additional tier 1 and tier 2 capital instruments issued under the Basel I and Basel II regimes. Such instruments will be phased out from their first available call date (if any), or as determined by APRA. The proportion of the transitional instruments in the base amount of additional tier 1 and tier 2 capital is to be reduced over a ten-year period from 2013 to 2023, with a 10 per cent reduction each year. This study focuses on CoCo capital instruments issued under the Basel III framework and uses those issued under the Basel I and Basel II frameworks as a control sample to help identify the impact of the loss absorption requirements on pricing and liquidity.

There are three types of CoCo instruments issued by Australian banks, 1) CoCos with only a gone-concern discretionary point of non-viability trigger; 2) CoCos with only a going-concern mechanical 5.125% CET1 capital ratio trigger; and 3) CoCos with both a point of non-viability trigger and a capital ratio trigger. The point of non-viability is not pre-defined and APRA has not provided clear instructions on the detailed assessment for it judging when the bank is deemed to be non-viable. The judgement on when the bank is "sailing too close to the wind" potentially could be based on high levels of past-due loans, insufficient liquidity or a weakened capital position. Whereas the regulatory discretionary point of non-viability trigger also applies to tier 2 subordinated debt instruments issued by banks in the Basel III period, the mechanical 5.125% CET1 capital ratio trigger is unique to additional tier 1 capital instruments. The uncertainty associated with the potential regulatory discretionary trigger event and the lack of transparency in relation to the prudential regulator's judgement contribute to the risk profile of Basel III CoCos with the discretionary trigger. If the triggers are activated, the Basel III Cocos are to be written off or converted to common equity. However, the old style hybrid securities issued under Basel I and Basel II framework will not be written off or converted. This, consequently, gives the old-style hybrid securities a higher ranking in the event the loss absorption triggers are activated for the new securities. During the period that both conventional hybrid securities and Basel III Cocos trade in the market place, the loss absorption features represent an important risk over and above the risks to which all hybrid security investors are exposed.

5.3 Empirical implementation

5.3.1 Data and sample

This study focuses on 41 floating-rate hybrid securities issued by 7 Australian banks and traded in the secondary market between January 2012 to December 2017. All the hybrid securities examined in this study are listed and traded on the Australian Securities Exchange. Table 5.1 presents the sample Australian banks involved in the analysis. The sample comprises 11 conventional hybrid securities (i.e. hybrid securities issued under the Basel I or Basel II regimes) and 30 Basel III Cocos (i.e. hybrid securities issued with one or both of the loss absorption triggers) issued since September 2011. There are 4 securities issued with only the point of non-viability trigger, 2 securities issued with only the common equity capital ratio trigger and 24 securities issued with both triggers. As the risk variables I use such as the *Merton distance-to-default*, *Equity beta* and *Idiosyncratic volatility*, rely upon equity market data, I exclude non-exchange listed banks from my sample. Observations for hybrid securities with less than one year remaining to maturity are excluded from the sample data. The hybrid securities have characteristics of both debt instruments and equity instruments. As described by the Australian Securities Exchange, hybrid securities are issued with an offer to compensate investors with periodic interest payments, which can be either fixed or floating rate (Australian Securities Exchange, 2017). However, this study only focuses on floating-rate hybrid securities. As a junior claim on the bank and senior only to ordinary shares, hybrid securities generally promise a higher yield compared with senior bonds. The higher yields can be attributed to the higher risks of hybrid securities, which include not only the interest rate risk and potential abandonment of interest payments to hybrid investors, but also the potential for conversion into common equity and early termination in the case of Basel III CoCos. The Basel III CoCos with both the discretionary and mechanical loss absorption triggers in my sample are classified as liabilities on banks' balance sheets, according to financial reporting standards. However, if the securities are issued as capital notes or preference shares, they are treated as equity securities by the Australian Taxation Office. Therefore, banks are permitted to distribute imputation tax credits with interest payments on the securities. Any imputation credits are included as part of the

Table 5.1: Sample banks with hybrid security observations

This table presents the sample Australian domestic banks included in the analysis. The sample period is January 2012 to December 2017. This table also presents the number of securities and month-end observations for hybrid securities 1) with no loss absorption triggers; 2) with only the point of non-viability (PONV) trigger; 3) with only the 5.125% common equity tier 1 (CET1) capital ratio trigger; and 4) with both the point of non-viability trigger and the capital ratio trigger.

	No. of hybrid securities				No. of observations			
Bank name	**No trigger**	**PONV trigger only**	**CET1 trigger only**	**Dual triggers**	**No trigger**	**PONV trigger only**	**CET1 trigger only**	**Dual triggers**
Westpac Banking Corporation	3	1	1	4	77	48	70	147
Commonwealth Bank of Australia	2	0	0	4	34	0	0	113
National Australia Bank Limited	1	1	0	4	48	10	0	159
Australia and New Zealand Banking Group Limited	3	0	1	5	114	0	72	152
Macquarie Bank Limited	0	2	0	1	0	80	0	39
Bendigo and Adelaide Bank Limited	2	0	0	4	50	0	0	132
Bank of Queensland Limited Adelaide Bank Limited	0	0	0	2	0	0	0	62
All banks	11	4	2	24	323	138	142	804

quoted spread above the reference floating interest rate for the securities.

Because of the combination of features of both debt and equity securities, the pricing of hybrid securities is more complex than for other claims on the bank. To calculate the credit spread of hybrid securities, I collect issue level information on the hybrid securities from Bloomberg, including their issue dates, maturity types, contractual maturity dates (where applicable), quoted margins, dividend frequency, par values, issue amounts, issuer call options and investor conversion options. I also hand collect information about whether a hybrid security is issued with one or both of the mechanical contingent conversion feature and the regulatory discretionary loss absorption feature (i.e. the Basel III triggers) from the hybrid security prospectus published by banks.

To determine the effective maturity date of a hybrid security, I consider the call feature, the maturity type and the mandatory conversion feature. First, if a hybrid security has a call feature at the bank's discretion, and there is a dividend step-up on the pre-specified call date, I apply the call date as the effective maturity date. Second, for a hybrid security that has no step-up feature but it has a contractual maturity date, the contractual maturity date is used as the effective maturity date. Third, if there is no dividend step-up on a pre-specified call date and no contractual maturity date, I use the mandatory conversion date as the effective maturity date for the security.

I collect end-of-day prices of hybrid securities from Bloomberg and select calendar month-end prices for calculating credit spreads. I obtain bank bill swap rates from the Australian Financial Markets Association as the benchmark interest rate for floating-rate hybrids. For testing the impact of the Basel III loss absorption features on the market liquidity of hybrid securities, I obtain intraday time and sales data from Thomson Reuters Tick History to calculate time-weighted bid-ask spreads across each trading day.

With regard to control variables, to disentangle the effects of the loss absorption features from the impact of other security characteristics, bank risk, profitability and liquidity and credit market conditions on banks' hybrid security credit spreads, I collect data from several sources. I collect daily data on bank equity returns and market capitalisation from Thomson Reuters Datastream. Semi-annual data are obtained from Worldscope on the total assets, total liabilities, shareholders' equity, net income, non-performing loans, total loans, trading assets, cash and liquid assets, and short-term debt for the sample banks. In addition, to control for credit market conditions, interest rates on bank accepted bills and the generic Australian Government bonds of different maturities are collected from the Reserve Bank of Australia. Average redemption yields for bonds in the S&P/ASX Australian Corporate Bond Index are obtained from Thomson Reuters Datastream. The data on the value-weighted bid-ask spread for all hybrid securities traded on the ASX are obtained from the Market Quality Dashboard.

5.3.2 Loss absorption features, bank risk and control variables

To determine whether a hybrid security issued by an Australian bank has the Basel III loss absorption features, I review the issue prospectus of each hybrid security and search for keywords in 'Regulatory treatment'. In the prospectus, if the security is specified as having the mechanical 5.125% common equity capital ratio trigger or regulatory discretionary point of non-viability trigger for conversion to common equity or write-off, the security is identified as a Basel III Coco instrument and a record is created of which triggers are relevant to the security. In addition, the prospectus will also specify under 'Post-transitional Basel III rules' that the security is counted towards 'Additional Tier 1' capital or 'Tier 2' capital for hybrid securities issued after the implementation of the Basel III capital reforms. All of the sample securities issued after the beginning of the Basel III phase-in period include either a gone-concern trigger feature or both the gone-concern and the going-concern trigger features. In other cases, if the security is specified as ineligible under 'Post-transitional Basel III rules', the hybrid security is an old style security, i.e. issued without the Basel III loss absorption features.

Table 5.2 lists the bank risk measures, bond characteristics, firm-specific and macroeconomic variables and the anticipated effects on credit spread levels. To measure the default risk of individual banks, seven different risk proxies are used in this study. Following previous studies such as Gropp, Vesala and Vulpes (2004, 2006); Hillegeist, Keating, Cram and Lundstedt (2004); Duffie, Saita and Wang (2007); Bharath and Shumway (2008); Acharya, Anginer and Warburton (2016), I employ the Merton (1974) structural

Table 5.2: List of risk measures, bond characteristics, firm-specific and macroeconomic variables used in the regression analysis

	Proxy for	Expected effect on credit spread	Expected effect on security illiquidity
Panel A: Bank risk variables			
Negative Merton distance-to-default (- *MertonDD*)	Bank default risk	Positive	Positive
Non-performing loans/total loans (*NPL*)	Bank asset risk	Positive	Positive
Trading assets/Total assets (*Trading Assets*)	Bank asset risk	Positive	Positive
Common equity beta (*Beta*)	Bank systematic equity risk	Positive	Positive
Common equity idiosyncratic volatility (*Idiosyncratic volatility*)	Bank idiosyncratic equity risk	Positive	Positive
Beta value of hybrid securities (*Hybrid beta*)	Bank systematic hybrid risk	Positive	Positive
Residual term of hybrid securities (*Hybrid residual*)	Bank idiosyncratic hybrid risk	Positive	Positive
Panel B: Hybrid security characteristics			
Logarithm of issue size (*Log issue size*)	Counterparty availability	Negative	Negative
Logarithm of remaining maturity (*Log tenor*)	Interest rate risk	Positive	Positive
Callable feature (*Callable*)	Bond callable by issuer	Positive	Positive
Convertible feature (*Convertible*)	Bond convertible by investors	Negative	Negative
Panel C: Bank-level variables			
Return on assets (*ROA*)	Profitability/Operational efficiency	Negative	Negative
Common equity to total assets ratio (*Common equity ratio*)	Bank solvency position	Negative	Negative
Cash holding to total assets ratio (*Cash holdings*)	Bank liquidity position	Negative	Negative
Panel D: Macro variables			
10 year bonds - 90-day bank bill rate (*Term premium*)	Term premium	Positive	
S&P/ASX corporate bond index spread (*Default premium*)	Default premium	Positive	
S&P/ASX 200 VIX (*VIX*)	Equity market volatility	Positive	Positive

default model to calculate the distance-to-default (*MertonDD*) of the bank. This model treats a firm's equity as a European call option where the underlying asset of the option is the firm's assets, while the value of the firm's liabilities represents the strike price. *MertonDD* measures the number of standard deviations away from the default point, where the default point is defined as the point at which the assets of the bank are just equal to its liabilities. If the market value of the firm's total assets drops below the book value of its total liabilities, the call option will be left unexercised and the defaulted firm will be passed over to its debt holders (Hillegeist, Keating, Cram and Lundstedt, 2004). As shown by Duffie, Saita and Wang (2007), the *MertonDD* measure has significant explanatory power in generating a term structure of default probabilities over time. For enhancing the readability of the regression results, I follow Gropp, Vesala and Vulpes (2006) by using the negative distance-to-default $-MertonDD$ as a risk measure. In this way, a higher value of $-MertonDD$ indicates a riskier bank.

Campbell, Hilscher and Szilagyi (2008) discuss limitations of the Merton distance-to-default as a measure of bank default risk. As an alternative measure, I use idiosyncratic equity volatility, which is documented by Campbell and Taksler (2003) to have a direct relationship with the credit spreads on corporate bonds. Beltratti and Stulz (2012) find that a higher proportion of loans and other earning assets in banks' total assets is associated with higher idiosyncratic volatility, while a bank's tier 1 capital ratio is negatively correlated with idiosyncratic volatility. In addition to idiosyncratic equity volatility, I follow Fahlenbrach, Prilmeier and Stulz (2012) and Acharya, Pedersen, Philippon and Richardson (2017) by using the equity beta as a measure of a bank's systematic risk exposure, which is calculated as the covariance of a firm's stock returns with the market divided by the variance of market returns. To compute the equity beta (*Equity beta*) and idiosyncratic volatility (*Idiosyncratic volatility*), I estimate a rolling market index model by regressing excess returns on the bank's equity against excess returns on the market index over the past 130 trading days. The market portfolio is represented by the S&P ASX 200 total return index and the risk-free rate is represented by the 90-day bank bill swap (BBSW) rate. To obtain measures of systematic risk and idiosyncratic risk that are more directly relevant to hybrid securities, I further apply the market index model to the excess daily returns of hybrid securities, to calculate the beta value (*Hybrid beta*) and residual term (*Hybrid residual*) for hybrid security returns. In the same as way as the *Equity beta* and *Idiosyncratic volatility*, I use the S&P ASX 200 index to represent the market portfolio and the 90-day BBSW rate to represent the risk-free return.

A concern with the distance-to-default and other equity market-based measures of bank risk is that they may understate the risks to which banks are exposed, on account of government support for the banking industry (Gandhi and Lustig, 2015; Kelly, Lustig and Van Nieuwerburgh, 2016). To address this concern, I employ two accounting-based risk measures to test the robustness of the results. I use the ratio of non-performing loans to total loans (*NPL*) as a risk measure, which is widely applied in previous studies (Sironi, 2003; Demirgüç-Kunt and Huizinga, 2004; Elyasiani and Jia, 2008; Brewer and Jagtiani, 2013; Balasubramnian and Cyree, 2014). Further, Morgan and Stiroh (2001) find evidence that bond investors price the risks implicit in banks' trading assets. Thus, I use the relative size of a bank's trading book (*Trading assets*) as a risk measure.

My analysis also considers other factors that potentially have an impact on hybrid security credit spreads. Following previous banking and bond pricing literature, I employ several control variables related to bond characteristics, the strength and profitability of the issuing bank, and credit market conditions. First, I control for characteristics of the hybrid securities, including the logarithm of the amount issued in constant dollar terms (*Log issue size*) and term to effective maturity (*Log TTM*). Hybrid securities with larger issue sizes and shorter effective maturities can be expected to be more liquid and have lower yield spreads.

I include dummy variables, *Convertible* and *Callable* to control for the conversion option and call option of hybrid securities where applicable. As distinct from the Basel III loss absorbency requirements that require the hybrid securities to be converted into common equity or written off when the bank breaches a capital ratio threshold or is assessed to be non-viable by the regulator, in some cases a conversion option is provided to investors to convert the hybrid securities into ordinary shares after a pre-defined date at a pre-defined ratio. This conversion option is valuable to investors and can be expected to result in lower yield spreads. The callable feature of hybrid securities refers to the issuer's option to call the security on a pre-defined date. This option is valuable to the issuer and can be expected to result in higher yield spreads on the securities.

I consider three bank characteristic variables, namely, the common equity ratio (*Common equity ratio*), cash holdings (*Cash holdings*) and the return on assets (*ROA*). Higher common equity ratios and higher cash holdings indicate financially sounder banks and can be expected to produce lower credit spreads. A higher return on assets could reflect greater market power, or greater operating efficiency, and result in lower credit spreads. I also include three macroeconomic control variables in my model, which are the *Term Spread*, *Default Premium* and *VIX* index. *Term Spread* is the yield spread between 10-year Australian Government bonds and 90-day bank bills. *Default Premium* is the yield spread between bonds in the S&P/ASX corporate bond index and Australian Government bonds with the nearest average time to maturity, a proxy for default risk. The S&P/ASX 200 VIX index (*VIX*) is used to measure the aggregate uncertainty in the share market, which is calculated using the 30-day implied volatility of S&P/ASX 200 put and call options.

5.4 Results

5.4.1 Descriptive statistics

Table 5.3 presents descriptive statistics for the observations of bank hybrid securities and key variables involved in the analysis. The average issue size of the sample hybrid securities is close to one billion Australian dollars. The distributions on Australian tier 1 hybrid securities include franking credits, which are also known as imputation credits, which represent the amount of tax the bank has already paid. This means that investors receive a rebate for the tax paid by the company on profits distributed to investors. However, whether investors are entitled to claim the refund from the Australian tax office depends on their personal income levels and their taxation residency. As this study does not have access to data on investors' personal tax status, the credit spreads calculated in this study are based on the gross distribution rates, which include franking credits. The average credit spread is 317 basis points over the sample period from January 2012 to Dec 2017. The average round-tick transaction cost for bank hybrid securities, measured by the time-weighted bid-ask spread, is 22 basis points during the sample period.

Figure 5.1 presents the quarterly average credit spreads on hybrid securities issued by Australian banks over the sample period. The grey bars represent the credit spreads of conventional hybrid securities, which are issued under the Basel I and II regimes. The red bars represent credit spreads of hybrid securities issued with both Basel III loss absorption triggers (both a point of non-viability trigger and a 5.125% common equity capital ratio trigger). The yellow bars represent credit spreads of hybrid securities issued with only a point of non-viability trigger. The green bars represent credit spreads of hybrid securities issued with a 5.125% common equity capital ratio trigger. I observe that, in quarters for which comparable data are available, the credit spreads of CoCos with one or both triggers are generally higher than those of the conventional hybrid securities. The higher credit spreads for CoCos suggests a risk premium is required by investors due to the additional risks posed to investors by the loss absorption features. The average credit spreads of CoCos with the dual triggers are the highest in this comparison of the different security types. The average credit spreads of CoCos with only the point of non-viability trigger are in some quarters lower than those with only the capital ratio trigger, but the difference in credit spread between these security types is unstable. Detailed analyses are needed to provide evidence of an empirically significant correlation between the different loss absorption trigger mechanisms and the spread differences.

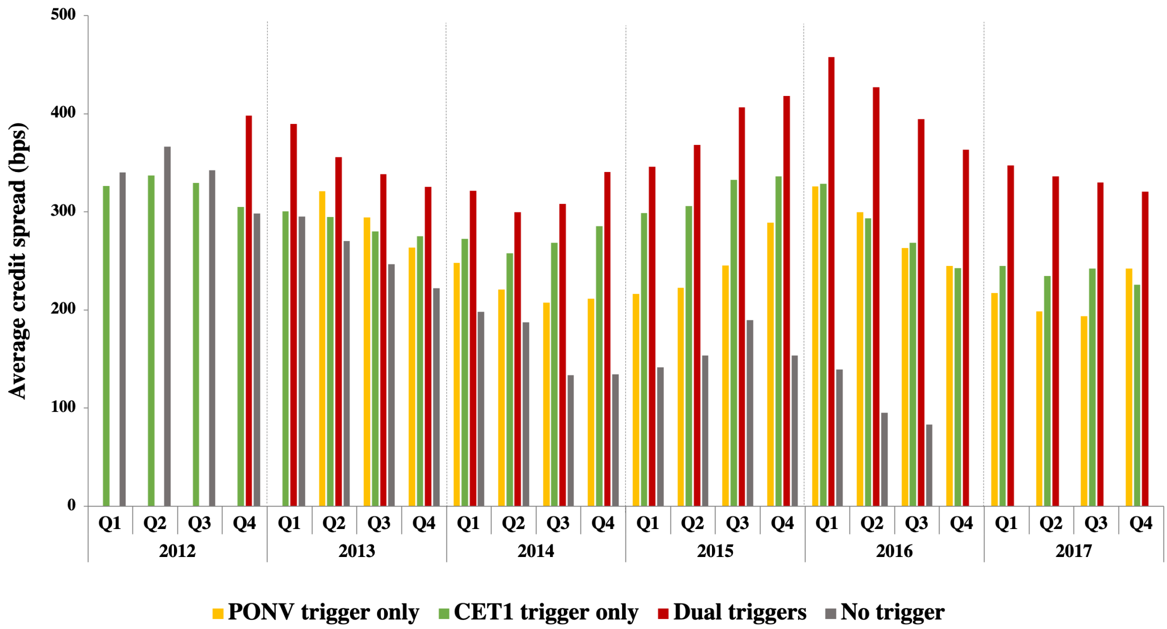
Figure 5.2 presents the total amount outstanding of hybrid securities issued by Australian banks in every quarter over the sample period. The grey bars represent the total amount outstanding of conventional hybrid securities, which are issued under the Basel I and II regimes. The red bars represent the total amount outstanding of hybrid securities issued with both Basel III loss absorption triggers (both a point of non-viability trigger and a 5.125% common equity capital ratio trigger). The yellow bars represent the total amount outstanding of hybrid securities issued with only a point of non-viability trigger. The green bars represent the total amount outstanding of hybrid securities issued with only a 5.125% common equity capital ratio trigger. As illustrated by figure 5.2, the amount outstanding of hybrid securities issued with the dual loss absorption features, i.e., with both triggers, is by the end of the sample period much higher than that of hybrid securities issued without the features. The hybrid security issuance by Australian banks has been particularly strong since 2013, with banks issuing the new instruments to meet the higher capital requirements under the Basel III reforms.

Table 5.3: Descriptive statistics for bank hybrid security observations

This table presents summary statistics for bank hybrid security observations. The sample period is from January 2012 to December 2017. *Issue size* is the issue size of hybrid securities in constant 2017 dollars. *Time-to-maturity* is the the term to effective maturity of hybrid securities. For floating-rate securities, *Credit spread* is the discount margin, which is the difference between the internal rate of return on the hybrid cash flows and the reference bank bill swap rate, assuming that the reference rate does not change over the life of the hybrid security. *Bid-ask spread* is the time-weighted bid-ask spread (difference between the ask price and bid price divided by the midpoint price for the hybrid security) averaged over the month. *Merton distance-to-default* is the distance to default calculated using the Merton model. *Non-performing loans* is non-performing loans divided by total loans. *Trading assets* is the bank's trading book to total assets ratio. *Equity beta* and *Idiosyncratic volatility* are the beta term and residual standard error estimated for bank common equity securities using a rolling market index model over the past 130 trading days. *Hybrid beta* and *Hybrid residual* are the beta term and residual standard error estimated for bank hybrid securities using a market index model over the past 130 trading days. *Total assets* is the book value of total assets. *Common equity ratio* is the book value of common equity divided by the book value of assets. *Cash holdings* is cash holdings divided by total assets. *Return on assets* is the return on assets, computed as net income divided by average assets. *Term spread* is the term structure premium, measured by the yield spread between 10-year Australian Government bonds and 90-day bank accepted bills. *Default premium* is the default risk premium, measured by the yield spread between bonds in the S&P/ASX corporate bond index and Australian Government bonds with nearest average time-to-maturity. *S&P ASX 200 VIX* is the level of the S&P/ASX 200 VIX index.

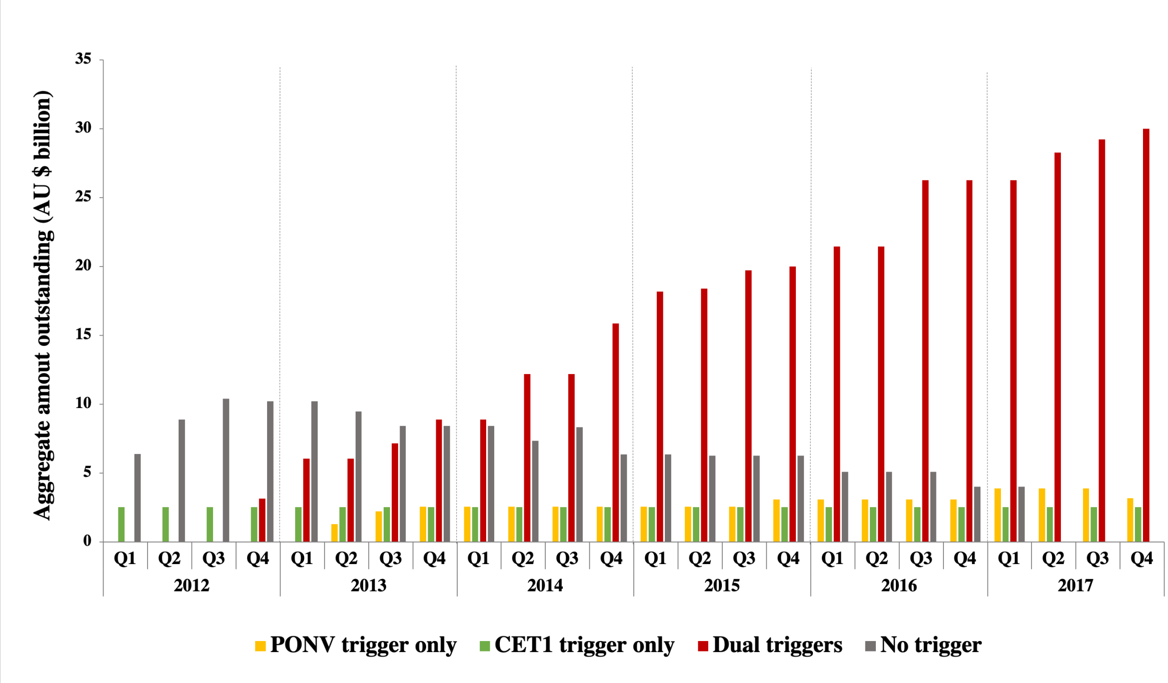
Data item	**Mean**	**Standard deviation**	**Lower quartile**	**Median**	**Upper quartile**
Hybrid security characteristics					
Issue size $mil	1038.5	601.8	531.0	1081.2	1450.0
Term to maturity years	7.7	1.6	7.0	8.0	8.3
Credit spread bps	317	106	261	327	383
Bid-ask spread bps	22	17	14	18	24
Bank risk variables					
Merton distance-to-default	4.8	1.2	3.9	4.8	5.8
Non-performing loans %	1.59	0.98	0.74	1.36	2.58
Trading assets %	7.2	3.4	5.0	6.1	9.1
Equity beta	1.12	0.17	1.00	1.11	1.23
Idiosyncratic volatility % pa	12.58	5.32	9.67	11.61	14.03
Hybrid beta	0.04	0.05	0.01	0.04	0.07
Hybrid residual % pa	5.97	2.10	4.68	5.32	6.61
Bank-level variables					
Total assets $bil	550.6	349.8	95.8	728.0	838.8
Common equity ratio %	7.4	2.7	6.2	6.5	7.2
Cash holdings %	5.0	3.8	2.0	3.9	6.8
Return on assets % pa	1.22	0.32	0.97	1.29	1.44
Macro variables					
Term spread bps	58	48	20	60	94
Default premium bps	114	36	87	111	127
S&P ASX 200 VIX %	14.8	3.5	12.4	14.2	16.3

Figure 5.1: Average credit spreads for hybrid securities with different triggers



This figure shows the quarterly average credit spreads of hybrid securities issued by the sample Australian banks. *Credit spread* (y-axis) is in basis points. For floating-rate hybrid securities, *Credit spread* is the discount margin, which is the difference between the internal rate of return on the hybrid cash flows and the reference bank bill swap rate, assuming that the reference rate does not change over the life of the hybrid security. The time period (x-axis) is from quarter 1 2012 to quarter 4 2017. The grey bars represent the credit spreads of conventional hybrid securities, which are issued under the Basel I and II regimes. The red bars represent credit spreads of hybrid securities issued with both Basel III loss absorption triggers (both a point of non-viability trigger and a 5.125% common equity capital ratio trigger). The yellow bars represent credit spreads of hybrid securities issued with only a point of non-viability trigger. The green bars represent credit spreads of hybrid securities issued with only a 5.125% common equity capital ratio trigger.

Figure 5.2: Total market size for Australian bank hybrid securities: old-style securities and Basel III CoCos



This figure shows the aggregate amount outstanding of hybrid securities for the sample Australian banks in billions of Australian dollars. The time period (x-axis) is from quarter 1 2012 to quarter 4 2017. The grey bars represent the total amount outstanding of conventional hybrid securities, which are issued under the Basel I and II regimes. The red bars represent the total amount outstanding of hybrid securities issued with both Basel III loss absorption triggers (both a point of non-viability trigger and a 5.125% common equity capital ratio trigger). The yellow bars represent the total amount outstanding of hybrid securities issued with only a point of non-viability trigger. The green bars represent the total amount outstanding of hybrid securities issued with only a 5.125% common equity capital ratio trigger.

Table 5.4: Pearson correlation coefficients for key variables of the sample bank hybrid security observations

PONV is a dummy variable which equals 1 if a hybrid security is issued with a point of non-viability trigger. *CET1* is a dummy variable which equals 1 if a hybrid security is issued with a 5.125% common equity capital ratio trigger. *LOGIS* is the logarithm of the issue size of hybrid securities in constant 2017 dollars. *LOGT* is the logarithm of the term to effective maturity of hybrid securities. *-MDD* is the negative of distance to default calculated using the Merton model. *NPL* is non-performing loans divided by total loans. *TRAD* is the bank's trading book to total assets ratio. *BETA* and *IDIO* are the beta term and residual standard error estimated for bank common equity securities using a rolling market index model over the past 130 trading days. *HBT* and *HRES* are the beta term and residual standard error estimated for bank hybrid securities using a market index model over the past 130 trading days. *CEQU* is the book value of common equity divided by the book value of assets. *CASH* is cash holdings divided by total assets. *ROA* is the return on assets, computed as net income divided by average assets. *TERM* is the term structure premium, measured by the yield spread between 10-year Australian Government bonds and 90-day bank accepted bills. *DEF* is the default risk premium, measured by the yield spread between bonds in the S&P/ASX corporate bond index and Australian Government bonds with nearest average time-to-maturity. *VIX* is the level of S&P/ASX 200 VIX index. ***, **, and * indicate significance at 1%, 5% and 10% levels, respectively.

	PONV	**CET1**	**LOGIS**	**LOGT**	**-MDD**	**NPL**	**TRAD**	**BETA**	**IDIO**	**HBT**	**HRES**	**CEQU**	**CASH**	**ROA**	**TERM**	**DEF**
CET1	0.56***															
LOGIS	-0.04	0.13***														
LOGT	0.63***	0.65***	0.19***													
-MDD	0.03	-0.05	-0.48***	-0.07*												
NPL	0.17***	0.31***	0.16***	0.12***	-0.07*											
TRAD	0.25***	-0.07*	-0.28***	0.14***	0.16***	0.13***										
BETA	0.21***	0.18***	0.02	0.05	0.34***	-0.06*	-0.04									
IDIO	0.20***	-0.01	-0.47***	0.08**	0.49***	-0.09**	0.28***	0.27***								
HBT	0.14***	0.17***	0.17***	0.23***	0.14***	0.01	0.00	0.04	0.02							
HRES	-0.04	-0.05	-0.53***	0.06*	0.57***	-0.12***	0.09**	0.02	0.25***	0.08**						
CEQU	0.25***	0.02	-0.61***	0.03	0.30***	-0.41***	0.12***	0.24***	0.48***	-0.08**	0.22***					
CASH	0.09**	-0.06*	0.25***	0.16***	-0.09**	0.22***	0.40***	0.10***	-0.02	0.13***	-0.19***	-0.17***				
ROA	-0.04	-0.15***	0.52***	0.07*	-0.36***	-0.38***	-0.14***	-0.00	-0.21***	0.14***	-0.30***	0.07*	0.18***			
TERM	0.18***	0.17***	0.04	0.11***	-0.30***	-0.06*	0.01	0.12***	0.00	-0.08**	-0.37***	0.10***	0.03	-0.05		
DEF	-0.26***	-0.23***	-0.09**	-0.16***	0.57***	-0.04	-0.04	-0.13***	0.07*	0.16***	0.49***	-0.08**	-0.07*	0.00	-0.84***	
VIX	-0.08**	-0.08**	-0.02	-0.05	0.39***	0.06*	0.03	0.02	0.12***	0.21***	0.26***	-0.12***	0.01	0.05	-0.41***	0.51***

Table 5.4 reports the Pearson correlation coefficients between the key explanatory variables included in my analysis. The dummy variable used to identify hybrid security observations with the point of non-viability trigger *PONV* is positively correlated with the issuing bank's non-performing loan ratio, the proportion of trading securities, and systematic risk measured by the beta terms estimated for bank common equity securities and hybrid securities, and bank common equity idiosyncratic volatility. The *PONV* dummy variable is also positively correlated with the issuing bank's common equity ratio and the ratio of cash holdings to total assets, suggesting that the hybrid security pricing observations with the discretionary trigger are for banks with generally stronger capital positions and liquidity positions compared with the pricing observations for the conventional hybrid securities without this trigger. The dummy variable used to identify hybrid security observations with the common equity capital ratio trigger $CET1$ is positively correlated with the issuing bank's non-performing loan ratio and systematic risk measured by the beta terms estimated for bank common equity securities and hybrid securities. However, it is negatively correlated with the issuing banks' proportion of trading assets and the ratio of cash holdings to total assets. These correlated factors will need to be controlled for when examining the impact of the loss-absorption triggers on hybrid security pricing and liquidity.

5.4.2 Impact of the loss absorption features on hybrid security pricing

In this subsection, I examine whether credit spreads are wider for hybrid securities issued with the Basel III loss absorption features, relative to hybrid securities without the features. Following the modelling strategy of Flannery and Sorescu (1996); Krishnan, Ritchken and Thomson (2005); Nguyen (2013) and Acharya, Anginer and Warburton (2016), the secondary market credit spread of a hybrid security is regressed on indicator variables for the two Basel III loss absorption features, bank risk measures, hybrid security characteristics, the issuing bank's financial characteristics, and macroeconomic conditions. I apply a panel regression model with year fixed effects and bank fixed effects and the standard errors in the estimations are double clustered by security and date to allow for heteroskedasticity and panel-based correlation in the regression residuals.[45]

[45] There are insufficient clusters to cluster the standard errors by bank and year.

The specification of the regression is as follows:

$$\begin{aligned} Credit\ spread_{i,t} = {} & \alpha_1 + \alpha_2\ PONV\ trigger_i + \alpha_3\ CET1\ trigger_i + \beta\ Bank\ risk_{i,t-1} \\ & + \gamma\ Common\ equity\ ratio_{i,t-1} + \delta_b\ Bank\ control\ factors_{i,t-1} \\ & + \delta_h\ Hybrid\ characteristics_{i,t} + \delta_m\ Macroeconomic\ factors_t \\ & + YearFE + BankFE + \varepsilon_{i,t} \end{aligned}$$

where, for floating-rate bonds, $Credit\ spread_{i,t}$ is the difference between the internal rate of return on the security cash flows and the bank bill swap rate specified as the reference interest rate in the original issue prospectus, assuming that the reference rate does not change over the life of the security. $PONV\ trigger_i$ is a dummy variable which equals 1 if a hybrid security has the discretionary point of non-viability trigger. $CET1\ trigger_i$ is a dummy variable which equals 1 if a hybrid security has the mechanical 5.125% common equity tier 1 capital ratio trigger. Seven alternative measures are used to capture bank risk (*Bank risk*) in this model. These measures are the negative of the Merton distance-to-default ($-MertonDD$), the ratio of non-performing loans to total loans (*NPL*), the ratio of trading assets to total assets (*Trading assets*), the beta term (*Beta*) and residual standard error (*Idiosyncratic volatility*) estimated for bank common equity securities, and the beta term (*Hybrid beta*) and residual standard error (*Hybrid residual*) estimated for bank hybrid securities. To control for hybrid security characteristics (*Hybrid charactoristics*), I include the logarithm of the amount issued of the hybrid security in millions of constant 2017 Australian dollars (*Log issue size*), the logarithm of the time-to-effective-maturity of the bond in years (*Log TTM*), a dummy variable which equals one if the security is convertible by investors (*Convertible*), and a dummy variable which equals one if the security is callable by the issuer (*Callable*). I also control for the bank's profitability, liquidity position and common equity position (*Bank control factors*) using the return on assets (*ROA*), the ratio of cash and liquid assets to total assets (*Cash holdings*) and the ratio of the book value of common equity to total assets (*Common equity ratio*).[46] Considering macroeconomic factors could also result in credit spread differences between CoCos and conventional hybrid securities, I control for the default risk premium in the corporate bond market in general (*Default premium*), the term structure premium (*Term premium*) and the level of the S&P/ ASX 200 VIX index (*VIX*).

[46] As the data on these bank characteristics variables are available at a semi-annual frequency, the values of the variables are carried forward until the next update.

Table 5.5: Impact of the Basel III loss absorption mechanisms on hybrid security pricing

This table presents regression results for the specification, $Credit\ spread_{i,t} = \alpha_1 + \alpha_2\ PONV\ trigger_i + \alpha_3\ CET1\ trigger_i + \beta\ Bank\ risk_{i,t-1} + \gamma\ Common\ equity\ ratio_{i,t-1} + \delta_b\ Bank\ control\ factors_{i,t-1} + \delta_h\ Hybrid\ characteristics_{i,t} + \delta_m\ Macroeconomic\ factors_t + YearFE + BankFE + \varepsilon_{i,t}$. The sample period is from January 2012 to December 2017. For floating-rate securities, *Credit Spread* is the discount margin, which is the difference between the internal rate of return on the hybrid cash flows and the reference bank bill swap rate, assuming that the reference rate does not change over the life of the hybrid security. *PONV trigger* is a dummy variable which equals 1 if a hybrid security is issued with a point of non-viability trigger. *CET1 trigger* is a dummy variable which equals 1 if a hybrid security is issued with a 5.125% common equity capital ratio trigger. *-MertonDD* is the negative distance to default calculated using the Merton model. *NPL* is non-performing loans divided by total loans. *Trading assets* is the bank's trading book to total assets ratio. *Equity beta* and *Idiosyncratic volatility* are the beta term and residual standard error estimated for the bank's common equity using a rolling market index model over the past 130 trading days. *Hybrid beta* and *Hybrid residual* are the beta term and residual standard error estimated for the bank hybrid security using a market index model over the past 130 trading days. *Common equity ratio* is the book value of common equity divided by the book value of assets. *Cash holdings* is cash holdings divided by total assets. *ROA* is the return on assets, computed as net income divided by average assets. *Log issue size* is the logarithm of the issue size of the hybrid security in constant 2017 dollars. *Log TTM* is the logarithm of the term-to-effective-maturity of the security. *Convertible* is a zero-one dummy variable which equals one if the security is convertible by the investor. *Callable* is a dummy variable which equals 1 if the security is callable by the issuer on a pre-defined date. *Term spread* is the term structure premium, measured by the yield spread between 10-year Australian Government bonds and 90-day bank accepted bills. *Default premium* is the default risk premium, measured by the yield spread between bonds in the S&P/ASX corporate bond index and Australian Government bonds with nearest average time-to-maturity. *VIX* is the level of S&P/ASX 200 VIX index. Robust t-statistics in parentheses are based on standard errors clustered at both the security and observations date levels. ***, **, and * indicate significance at 1%, 5% and 10% levels, respectively.

	Dependent variable: Credit spread						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Independent variables	**- MertonDD**	**NPL**	**Trading assets**	**Equity beta**	**Idiosyncratic volatility**	**Hybrid beta**	**Hybrid residual**
PONV trigger (α_1)	0.500***	0.497***	0.503***	0.495***	0.514***	0.535***	0.597***
	(3.09)	(3.06)	(3.21)	(3.02)	(3.12)	(3.13)	(4.41)
CET1 trigger (α_2)	-0.355	-0.382	-0.387	-0.357	-0.359	-0.254	-0.160
	(-1.50)	(-1.60)	(-1.63)	(-1.50)	(-1.44)	(-1.04)	(-0.68)
Bank risk (β_1)	0.231***	0.088	0.042*	0.598**	-0.031	0.004	2.786***
	(4.19)	(1.55)	(1.89)	(2.31)	(-0.46)	(0.01)	(5.08)
Common equity ratio (γ_1)		0.193	0.236				
		(1.24)	(1.47)				
Cash holdings (δ_1)	0.003	0.004	0.005	-0.002	-0.001	-0.001	-0.004
	(0.70)	(0.78)	(0.86)	(-0.38)	(-0.30)	(-0.26)	(-0.65)
ROA (δ_2)	-0.201	-0.591**	-0.558*	-0.443*	-0.544**	-0.548	-0.313
	(-0.78)	(-2.25)	(-1.89)	(-1.72)	(-1.99)	(-1.44)	(-1.05)

Log issue size (δ_3)	-0.827**	-0.887**	-0.950***	-0.852**	-0.867**	-0.896**	-0.164
	(-2.40)	(-2.51)	(-2.76)	(-2.43)	(-2.43)	(-2.42)	(-0.59)
Log TTM (δ_4)	0.598***	0.600***	0.622***	0.610***	0.597***	0.580***	0.245
	(3.91)	(3.99)	(4.14)	(3.99)	(3.85)	(3.58)	(1.45)
Convertible (δ_5)	-0.724***	-0.720***	-0.764***	-0.722***	-0.752***	-0.780***	-0.550***
	(-3.32)	(-3.36)	(-3.74)	(-3.28)	(-3.44)	(-3.61)	(-3.23)
Callable (δ_6)	1.254***	1.282***	1.245***	1.240***	1.240***	1.195***	1.222***
	(4.95)	(4.98)	(5.13)	(4.86)	(4.75)	(4.99)	(5.95)
Term premium (δ_7)	-0.344***	-0.008	-0.028	-0.018	-0.011	-0.056	-0.100
	(-2.75)	(-0.07)	(-0.28)	(-0.20)	(-0.11)	(-0.54)	(-1.15)
Default premium (δ_8)	-0.256	0.421**	0.381*	0.447**	0.429**	0.398*	-0.031
	(-0.97)	(2.00)	(1.76)	(2.12)	(1.97)	(1.77)	(-0.15)
VIX (δ_9)	0.035***	0.046***	0.047***	0.039***	0.045***	0.047***	0.040***
	(5.09)	(6.18)	(6.19)	(5.28)	(6.02)	(6.89)	(7.64)
Observations	1,407	1,407	1,407	1,407	1,407	1,228	1,228
No of banks	7	7	7	7	7	7	7
No of hybrid securities	41	41	41	41	41	38	38
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.763	0.755	0.758	0.756	0.752	0.753	0.796

Table 5.5 reports the regression results. The dummy variables *PONV trigger* and *CET1 trigger* are the main variables of interest, which are expected to be positive and significant if Coco investors anticipate the Basel III loss absorption mechanisms increase their exposure to potential future bank losses. Consistent with this expectation, the coefficient on the *PONV trigger* dummy variable in all seven regressions, applying different risk proxies, is positive and statistically significant. The regression results provide evidence that CoCo investors take account of the Basel III point of non-viability trigger when trading bank hybrid securities. The results suggest that investors demand an additional risk premium of approximately 50-60 basis points when investing in Basel III CoCo capital instruments issued with the point of non-viability trigger mechanism. However, the coefficient on the *CET1 trigger* variable is not statistically significant in any of the regressions. These results indicate that the additional risk premium demanded by investors in Basel III CoCos can be attributed to the point of non-viability trigger mechanism rather than the capital ratio trigger mechanism. A breach of the 5.125% CET1 capital ratio trigger may only occur due to a massive jump down in the capital ratio. In this case, the PONV trigger could serve to marginalise the pricing of the CET1 trigger.The results are consistent across all regressions, which control for possible omitted bank-specific factors using bank fixed effects and any other effects that are common to all banks using year fixed effects.

If hybrid security investors demand higher compensation for investing in riskier banks, the coefficients on the seven alternate proxies for measuring bank risk are expected to be positive and significant. The significantly positive coefficients in front of three risk measures (columns 1, 3, 4, 7), namely, *-MertonDD, Trading assets, Equity beta* and *Hybrid residual*, provide support for the idea that hybrid investors demand a higher yield for investing in banks with a higher probability of default, a higher proportion of trading securities, more exposure to systematic risk and higher hybrid security-specific risk. However, the estimated coefficients on the other risk measures are statistically insignificant (columns 2, 5, 6). There is no evidence that investors price hybrid securities based on bank risk captured by non-performing loans, idiosyncratic equity volatility or the beta term for the hybrid security. I present analysis of whether the Basel III loss absorption features would increase the sensitivity of hybrid security credit spreads to changes in the various bank risk proxies in the next subsection.

Among the variables used to control for characteristics of the bank that has issued the security, I exclude the book value of the bank's total assets from the regressions due to its high collinearity with the hybrid security issue size and the bank fixed effects. It will be important to control for the bank's solvency position in the analysis. To avoid collinearity with the bank risk measure, the common equity ratio is omitted as an explanatory variable if the risk measure incorporates the bank's capital adequacy (as is the case for *-MertonDD, Equity beta, Idiosyncratic volatility, Hybrid beta* and *Hybrid residual*). In the regressions with *NPL* and *Trading assets* as the risk variables, I find an insignificant coefficient on the variable *Common equity ratio*, which suggests the credit spreads of hybrid securities, in general, are not sensitive to banks' common equity positions. The coefficient on cash holdings is expected to be negative if hybrid security investors perceive that banks with more liquid assets have a greater capacity to meet future payment obligations. However, the coefficient on *Cash holdings* is not statistically significant in any of the regressions. The negative and significant coefficient on *ROA* in four of the regressions suggests that investors view banks with better profitability and greater operating efficiency as less likely to become distressed.

To disentangle the effect of the Basel III loss absorption features from other factors that might impact on the credit spreads of hybrid securities, I include variables to control for other security characteristics, bank profitability and financial position and credit market conditions. With reference to the security characteristic variables, the significant and negative coefficient on *Log issue size* in all except one of the regressions is consistent with a benefit of larger issues to hybrid security investors, derived from better liquidity in the secondary market. The estimated coefficient on *Log TTM* is significant and positive in the same regressions, which is consistent with the default premium being higher for hybrid securities with longer residual terms to maturity. Furthermore, the coefficient on the dummy variable *Convertible* is negative and significant in all regressions, which suggests the option of the investor to convert the hybrid security into common shares increases the value of the security. The results indicate a significant positive relationship between the hybrid security credit spread and the *Callable* dummy variable in all seven regressions. This pattern reflects that the option of the issuer to buy back the securities from investors at a pre-defined call date. When credit spread goes down, the issuer will be more likely to call back the security.

I include the *Term premium* and *Default premium* variables in the regressions to control for changes in market conditions over time. As shown by the regression results, six of the coefficients on the *Term premium* variable are statistically insignificant and one is significantly negative, which could potentially be due to a lack of substantial variation in the term premium in the sample period for my study. In five of the regressions, the default risk premium has a significantly positive coefficient, indicating that changes in credit spreads for bank hybrid securities are influenced by conditions prevailing in the corporate bond market. I find a significantly positive relationship between the credit spreads of bank hybrid securities and the level of the S&P/ASX 200 VIX index, which suggests that the pricing of bank hybrid securities is affected by aggregate uncertainty in the equity market.

5.4.3 Impact of the loss absorption features on the relation between bank risk and hybrid security pricing

The significant and positive coefficient on the dummy variable *PONV trigger* in the regressions reported in table 5.5 suggests that investors in Basel III hybrid securities assign a non-zero probability to the regulator activating its discretionary trigger and exposing investors to potential future bank losses. However, as argued by previous studies (Flannery, 2014; Davis and Saba, 2016), this risk premium might be attributable to the uncertainty associated with the regulator's discretion to activate the non-viability trigger, rather than to increased exposure to potential bank losses. If Basel III hybrid security investors have greater exposure to potential bank losses than investors in non-Basel III hybrid securities, they can be expected to pay greater attention to the risk profile of the bank when pricing the securities. Therefore, in this subsection, I examine whether the Basel III loss absorption features affect the risk-sensitivity of hybrid security credit spreads. To address this question, interaction terms between both the *PONV trigger* dummy variable and the *CET1 trigger* dummy variable and the different measures of bank risk and equity capital are added to the baseline regressions. Using this approach, the main effects of the risk variables and equity capital capture the sensitivity of credit spreads to bank risk and equity capital for investors in the old-style hybrid securities, while the interaction terms capture the incremental sensitivity of credit spreads to bank risk and equity capital for hybrid investors when investing in Cocos with the different loss absorption trigger mechanisms. With the presence of the loss absorption features, investors' risk monitoring incentives are expected to be improved, which would be reflected in the increased sensitivity of hybrid security credit spreads to bank risk and equity capital. If Basel III Coco investors have greater exposure to bank risk as expected, I expect to see positive and significant coefficients on the interaction terms between the *PONV trigger* and/or *CET1 trigger* dummy variables and bank risk and between the dummy variables and equity capital.

Table 5.6 presents the regression results. The estimated coefficients on five of the main effect risk variables are positive and significant, which suggests that investors in conventional hybrid securities take into account bank risks as captured by *-MertonDD*, *Trading assets*, *Equity beta*, *Idiosyncratic volatility*, and *Hybrid residual*. The results signify a positive risk-spread relationship applicable to hybrid securities issued under the Basel I and Basel II regimes, i.e., without the loss absorption triggers. There is no evidence that the credit spreads of conventional hybrid securities are sensitive to the risks inherent in the non-performing loans or the estimated beta term for the hybrid security. Among the interaction terms between the *PONV trigger* dummy variable and bank risk, those capturing bank asset risk, common equity systematic risk or idiosyncratic risk are negative and significant (columns 2, 3, 4 and 5). To the contrary, the variable capturing the systematic risk of the hybrid security (column 6) is positive and statistically significant at the 1 per cent level. Among the interaction terms between the *CET1 trigger* dummy variable and bank risk, the coefficients on those involving the *-MertonDD* and the *Hybrid residual* are negative and significant (columns 1 and 7). However, in a similar pattern to the coefficient on *PONV trigger* $\times$ *Hybrid beta*, the coefficient on *CET1 trigger* $\times$ *Hybrid beta* is positive and significant at the 10% level (column 6). In column 6, the sum of the coefficients of the main risk variable and the interaction terms involving the individual trigger dummy variables ($\beta_1 + \beta_2$ and $\beta_1 + \beta_3$) are not significantly positive; however, the sum of the coefficients of the main risk variable and both interaction terms ($\beta_1 + \beta_2 + \beta_3$) is significantly positive. These results suggest that the combination of both the discretionary trigger and the mechanical trigger mechanisms leads investors in hybrid securities to adjust their pricing to take greater account of the issuing bank's systematic risk profile. In conclusion, these results suggest that investors price the Basel III hybrid securities more like equity securities, and less like fixed income instruments, than investors in the conventional hybrid securities. These results are consistent with the

Table 5.6: Impact of the loss absorption features on the relation between bank risk and hybrid security pricing

This table presents regression results for the specification $Credit\ spread_{i,t} = \alpha_1 + \alpha_2\ PONV\ trigger_i + \alpha_3\ CET1\ trigger_i + \beta_1\ Bank\ risk_{i,t-1} + \beta_2\ PONV\ trigger_i \times Bank\ risk_{i,t-1} + \beta_3\ CET1\ trigger_i \times Bank\ risk_{i,t-1} + \gamma_1\ Common\ equity\ ratio_{i,t-1} + \gamma_2\ PONV\ trigger_i \times Common\ equity\ ratio_{i,t-1} + \gamma_3\ CET1\ trigger_i \times Common\ equity\ ratio_{i,t-1} + \delta_b\ Bank\ control\ factors_{i,t-1} + \delta_h\ Hybrid\ characteristics_{i,t} + \delta_m\ Macroeconomic\ factors_t + YearFE + BankFE + \varepsilon_{i,t}$. The sample period is from January 2012 to December 2017. For floating-rate securities, *Credit Spread* is the discount margin, which is the difference between the internal rate of return on the hybrid cash flows and the reference bank bill swap rate, assuming that the reference rate does not change over the life of the hybrid security. *PONV trigger* is a dummy variable which equals 1 if a hybrid security is issued with a point of non-viability trigger. *CET1 trigger* is a dummy variable which equals 1 if a hybrid security is issued with a 5.125% common equity capital ratio trigger. *-MertonDD* is the negative distance to default calculated using the Merton model. *NPL* is non-performing loans divided by total loans. *Trading assets* is the bank's trading book to total assets ratio. *Equity beta* and *Idiosyncratic volatility* are the beta term and residual standard error estimated for the bank's common equity using a rolling market index model over the past 130 trading days. *Hybrid beta* and *Hybrid residual* are the beta term and residual standard error estimated for the bank hybrid security using a market index model over the past 130 trading days. *Common equity ratio* is the book value of common equity divided by the book value of assets. Robust t-statistics in parentheses are based on standard errors clustered at both the security and observations date levels. ***, **, and * indicate significance at 1%, 5% and 10% levels, respectively.

	Dependent variable: Credit spread						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Independent variables	**- MertonDD**	**NPL**	**Trading assets**	**Equity beta**	**Idiosyncratic volatility**	**Hybrid beta**	**Hybrid residual**
PONV trigger (α_1)	0.417	6.860***	7.151***	1.932**	1.584***	0.349**	0.511
	(0.73)	(3.54)	(4.94)	(2.17)	(2.96)	(2.04)	(1.34)
CET1 trigger (α_2)	-1.398***	1.634	1.526	-0.091	0.003	-0.268	1.168***
	(-3.10)	(1.21)	(1.39)	(-0.11)	(0.01)	(-1.16)	(3.12)
Bank risk (β_1)	0.363***	0.161	0.100***	1.769**	1.741**	-3.857***	4.575***
	(3.37)	(1.16)	(2.68)	(2.13)	(2.36)	(-2.63)	(8.61)
Bank risk × PONV trigger (β_2)	-0.005	-0.213***	-0.130***	-1.252*	-1.695**	4.393***	0.270
	(-0.04)	(-3.10)	(-3.32)	(-1.73)	(-2.27)	(3.87)	(0.27)
$\beta_1 + \beta_2$	0.358**	-0.051	-0.030	0.518	0.046	0.537	4.845***
	(3.18)	(-0.38)	(-0.96)	(0.92)	(0.45)	(0.40)	(4.35)
Bank risk × CET1 trigger (β_3)	-0.216**	0.033	0.001	-0.329	-0.461	2.256*	-3.876***
	(-2.19)	(0.28)	(0.04)	(-0.52)	(-1.34)	(1.66)	(-4.08)
$\beta_1 + \beta_3$	0.127	0.195**	0.101**	1.440**	1.280	-1.601*	0.699
	(1.53)	(2.84)	(2.60)	(2.19)	(1.58)	(-1.65)	(0.81)
$\beta_1 + \beta_2 + \beta_3$	0.146**	0.005	-0.036	0.255	-0.429	2.916***	1.007**
	(2.14)	(0.08)	(-1.60)	(0.92)	(-1.30)	(3.88)	(2.18)

Common equity ratio (γ_1)		1.180***	1.178***				
		(4.03)	(6.45)				
Common equity ratio × PONV trigger (γ_2)		-0.968***	-0.953***				
		(-3.25)	(-4.35)				
$\gamma_1 + \gamma_2$		0.212	0.225				
		(1.31)	(1.59)				
Common equity ratio × CET1 trigger (γ_3)		-0.317*	-0.285*				
		(-1.78)	(-1.73)				
$\gamma_1 + \gamma_3$		0.862**	0.893***				
		(2.48)	(3.26)				
$\gamma_1 + \gamma_2 + \gamma_3$		0.130	-0.115				
		(-1.44)	(-1.14)				
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,407	1,407	1,407	1,407	1,407	1,228	1,228
No of banks	7	7	7	7	7	7	7
No of hybrid securities	41	41	41	41	41	38	38
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.776	0.820	0.829	0.764	0.774	0.769	0.827

nature of the loss absorption mechanisms implemented under the Basel III regime: with the potential to be converted into common equity or written off if the triggers are activated, the securities bear a closer resemblance to equity securities than the old-style capital instruments.

The regressions reported in columns 2 and 3 include the main effect of the *Common equity ratio* and the interaction terms *Common equity ratio* × *PONV trigger* and *Common equity ratio* × *CET1 trigger*. A 5.125% common equity tier 1 capital ratio trigger applies to Basel III additional tier 1 hybrid securities. Consequently, it is expected that the pricing of the Basel III Cocos with the mechanical trigger will be more sensitive to changes in banks' common equity positions, which is represented in the regressions by the common equity ratio. Furthermore, a stronger common equity position can be expected to protect hybrid investors from the regulator activating the discretionary trigger. The coefficient on the interaction term *Common equity ratio* × *PONV trigger* is negative and significant in both regressions, however, the sum of the coefficients on the main effect and the interaction term is statistically insignificant. In addition, the coefficient on the interaction term *Common equity ratio* × *CET1 trigger* is significant and negative. However, the sum of the coefficients on the main effect and interaction terms is positive and significant. These results arise because hybrid security investors priced a higher credit spread for better-capitalised banks under the old regime, possibly because the common equity capital was allocated to protect against risks not adequately captured by the bank risk proxies used in the regressions. Under the Basel III regime, there is no evidence of a significant relationship between hybrid security credit spreads and the bank's common equity position.

In summary, the results reported in table 5.6 suggest that, compared with conventional hybrid securities, the pricing of Basel III Cocos is more sensitive to systematic bank risk as captured by the *Hybrid beta*, however, is less sensitive to the default risk applicable to the bank's fixed income securities, as captured by the negative value of the Merton distance-to-default, trading assets and idiosyncratic volatility. There is no evidence that the pricing of Basel III Coco instruments is sensitive to changes in the bank's common equity position. In general, the results provide evidence about investor expectations in relation to the Basel III loss absorption mechanisms, which is consistent with the bank's systematic risk profile taking a greater role in the pricing of hybrid securities under the new regime.

5.4.4 Impact of the loss absorption features on market illiquidity

In this subsection, I examine the impact of the Basel III loss absorption features on the secondary market liquidity for hybrid securities. For this purpose, I test whether the transaction costs for Basel III Cocos with the different loss absorption mechanisms are different from the transaction costs for hybrid securities issued prior to the Basel III reforms. To test the impact of the contingent convertible features on the secondary market illiquidity of Cocos, a dependent variable $Illiquidity_{i,t}$ is used in a panel regression specification:

$$\begin{aligned} Illiquidity_{i,t} = {} & \alpha_1 + \alpha_2\ PONV\ trigger_i + \alpha_3\ CET1\ trigger_i + \beta\ Bank\ risk_{i,t-1} \\ & + \gamma\ Common\ equity\ ratio_{i,t-1} + \delta_b\ Bank\ control\ factors_{i,t-1} \\ & + \delta_h\ Hybrid\ characteristics_{i,t} + \delta_m\ Macroeconomic\ factors_t \\ & + YearFE + BankFE + \varepsilon_{i,t} \end{aligned}$$

where $Illiquidity_{i,t}$ is measured by the monthly average time-weighted relative quoted bid-ask spread, *Time-weighted bid-ask spread*, for hybrid security i in month t. The relative quoted bid-ask spread after quote n within a given trading day for security i is:

$$Bid\text{-}ask\ spread_{i,n} = \frac{Ask_{i,n} - Bid_{i,n}}{(Ask_{i,n} + Bid_{i,n})/2}$$

where $Ask_{i,n}$ and $Bid_{i,n}$ are the best ask price and best bid price at time t of quote n for security i, while $(Ask_{i,n} + Bid_{i,n})/2$ is the mid-quote price. The relative quoted bid-ask spread represents the round-tick transaction cost for market orders that trade against limit orders at the best price levels. A commonly used way to calculate the relative quoted spread on a daily basis is using time weighting throughout the day. For each quote update in the trading day:

$$Time\ weighting_{i,n} = \frac{Time_{i,n+1} - Time_{i,n}}{\sum_{n=1}^{N}(Time_{i,n+1} - Time_{i,n})}$$

where $Time_{i,n}$ is the time of quote n for security i. Thus,

$$Time\text{-}weighted\ bid\text{-}ask\ spread_{i,d} = \sum_{n=1}^{N} Bid\text{-}ask\ spread_{i,n} \times Time\ weighting_{i,n}$$

As hybrid securities have characteristics of both common equity securities and fixed income securities, I apply the bid-ask spread to measure the transaction costs for hybrid securities. The bid-ask quoted spread is widely used not only in equity market studies but also in debt market studies. McInish and Wood (1992) is the first paper that shows the intraday pattern of quoted bid-ask spreads for equity securities by measuring the spread minute-by-minute, and documents an inverse relationship between quoted bid-ask spreads and trading volume. Subsequent studies adopt the time-weighted quoted bid-ask spread to measure illiquidity in the equity market (Chordia, Roll and Subrahmanyam, 2001; Chordia, Sarkar and Subrahmanyam, 2004; Hameed, Kang and Viswanathan, 2010; Hendershott, Jones and Menkveld, 2011; Foley and Putniņš, 2016). A recent study by Fong, Holden and Trzcinka (2017) uses the time-weighted quoted bid-ask spread as a benchmark illiquidity measure to compare against other low-frequency illiquidity proxies. Goyenko and Ukhov (2009) argue that the quoted bid-ask spread is a reliable measure for the Treasury security market and the measure is used by Chordia, Sarkar and Subrahmanyam (2004) to study the dynamic interaction of liquidity in stock and US Treasury bond markets. Chen, Lesmond and Wei (2007) use the proportional bid-ask spread as an illiquidity measure to examine the relationship between corporate bond credit spreads and market illiquidity. In the market illiquidity analysis, to address the concern that the broader hybrid market liquidity may change over time and influence bank hybrid liquidity, I add a control variable *Hybrid market illiquidity* that represents the hybrid market illiquidity in general. This variable is calculated as the value-weighted bid-ask spread of all of the hybrid securities traded on the Australian Securities Exchange.

The coefficients on the *PONV trigger* and *CET1 trigger* dummy variables are expected to be significantly positive if the market liquidity of hybrid securities issued by banks has deteriorated and there are higher transaction costs when trading Basel III CoCos with either a point of non-viability trigger or a capital ratio trigger. As it might be argued that inferior liquidity may be due to other factors that cause transaction costs to increase, I include relevant control variables to disentangle factors such as bond characteristics, bank risk and profitability, the general illiquidity condition of the hybrid security market and equity market volatility. The regression results are reported in table 5.7. From the results, there is no evidence that the transaction costs for hybrid securities issued with the Basel III loss absorption triggers are higher than for hybrid securities issued without the triggers.

Table 5.7: Impact of the loss absorption features on hybrid market illiquidity

This table presents regression results for the specification $Illiquidity_{i,t} = \alpha_1 + \alpha_2\ PONV\ trigger_i + \alpha_3\ CET1\ trigger_i + \beta\ Bank\ risk_{i,t-1} + \gamma\ Common\ equity\ ratio_{i,t-1} + \delta_b\ Bank\ control\ factors_{i,t-1} + \delta_h\ Hybrid\ characteristics_{i,t} + \delta_m\ Macroeconomic\ factors_t + YearFE + BankFE + \varepsilon_{i,t}$. The sample period is from January 2012 to December 2017. *Illiquidity* is the time-weighted bid-ask spread averaged over the month. *PONV trigger* is a dummy variable which equals 1 if a hybrid security is issued with a point of non-viability trigger. *CET1 trigger* is a dummy variable which equals 1 if a hybrid security is issued with a 5.125% common equity capital ratio trigger. *-MertonDD* is the negative distance to default calculated using the Merton model. *NPL* is non-performing loans divided by total loans. *Trading assets* is the bank's trading book to total assets ratio. *Equity beta* and *Idiosyncratic volatility* are the beta term and residual standard error estimated for the bank's common equity using a rolling market index model over the past 130 trading days. *Hybrid beta* and *Hybrid residual* are the beta term and residual standard error estimated for bank hybrid security using a market index model over the past 130 trading days. *Log issue size* is the logarithm of the issue size of the hybrid security in constant 2017 dollars. *Log TTM* is the logarithm of the term-to-effective-maturity of the security. *Convertible* is a zero-one dummy variable which equals one if the security is convertible by the investor. *Callable* is a dummy variable which equals 1 if the security is callable by the issuer on a pre-defined date. *Common equity ratio* is the book value of common equity divided by the book value of assets. *ROA* is the return on assets, computed as net income divided by average assets. *Hybrid market illiquidity* is the value-weighted average time-weighted bid-ask spread of all hybrid securities traded on the ASX. *VIX* is the level of S&P/ASX 200 VIX index. Robust t-statistics in parentheses are based on standard errors clustered at both the security and observations date levels. ***, **, and * indicate significance at 1%, 5% and 10% levels, respectively.

	Dependent variable: Time-weighted bid-ask spread						
Independent variables	**(1) - MertonDD**	**(2) NPL**	**(3) Trading assets**	**(4) Equity beta**	**(5) Idiosyncratic volatility**	**(6) Hybrid beta**	**(7) Hybrid residual**
PONV trigger (α_1)	-0.033	-0.032	-0.033	-0.034	-0.033	-0.040	-0.023
	(-1.06)	(-1.02)	(-1.06)	(-1.08)	(-1.05)	(-1.22)	(-1.37)
CET1 trigger (α_2)	-0.043	-0.043	-0.046	-0.044	-0.044	-0.046	-0.016
	(-1.05)	(-1.03)	(-1.08)	(-1.06)	(-1.05)	(-1.19)	(-0.75)
Bank risk (β_1)	0.010*	-0.005	0.003	0.045	-0.002	0.035	0.739***
	(1.66)	(-0.73)	(1.12)	(0.98)	(-0.15)	(0.36)	(5.80)
Common equity ratio (γ_1)		-0.002	0.000				
		(-0.11)	(0.02)				
Cash holdings (δ_1)	0.001*	0.001*	0.001*	0.001	0.001	0.001	0.000
	(1.90)	(1.73)	(1.66)	(1.34)	(1.38)	(1.22)	(0.09)
ROA (δ_2)	-0.001	-0.016	-0.008	-0.008	-0.016	-0.063	-0.005
	(-0.03)	(-0.43)	(-0.20)	(-0.23)	(-0.43)	(-1.51)	(-0.14)
Log issue size (δ_3)	-0.313***	-0.315***	-0.319***	-0.314***	-0.315***	-0.322***	-0.127***
	(-3.92)	(-3.91)	(-3.96)	(-3.91)	(-3.86)	(-3.95)	(-5.06)

Log TTM (δ_4)	0.060*	0.060*	0.062*	0.061*	0.060*	0.089**	-0.001
	(1.84)	(1.84)	(1.87)	(1.84)	(1.84)	(2.41)	(-0.07)
Convertible (δ_5)	-0.060	-0.063	-0.062	-0.059	-0.061	-0.058	0.004
	(-1.52)	(-1.55)	(-1.54)	(-1.49)	(-1.53)	(-1.43)	(0.15)
Callable (δ_6)	0.041	0.038	0.041	0.041	0.041	0.021	0.027
	(0.89)	(0.82)	(0.90)	(0.89)	(0.88)	(0.47)	(0.99)
Hybrid market illiquidity (δ_7)	0.847***	0.899***	0.900***	0.883***	0.900***	0.911***	0.554***
	(6.75)	(6.70)	(6.67)	(6.53)	(6.80)	(5.50)	(3.25)
VIX (δ_8)	-0.001	-0.000	-0.000	-0.000	-0.000	-0.000	-0.002
	(-1.31)	(-0.02)	(-0.07)	(-0.38)	(-0.03)	(-0.04)	(-1.26)
Observations	1,407	1,407	1,407	1,407	1,407	1,228	1,228
No of banks	7	7	7	7	7	7	7
No of hybrid securities	41	41	41	41	41	38	38
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.617	0.616	0.616	0.617	0.616	0.644	0.754

Table 5.8: Impact of the loss absorption features on the relation between hybrid market illiquidity and bank risk

This table presents regression results for the specification $Illiquidity_{i,t} = \alpha_1 + \alpha_2\ PONV\ trigger_i + \alpha_3\ CET1\ trigger_i + \beta_1\ Bank\ risk_{i,t-1} + \beta_2\ PONV\ trigger_i \times Bank\ risk_{i,t-1} + \beta_3\ CET1\ trigger_i \times Bank\ risk_{i,t-1} + \gamma_1\ Common\ equity\ ratio_{i,t-1} + \gamma_2\ PONV\ trigger_i \times Common\ equity\ ratio_{i,t-1} + \gamma_3\ CET1\ trigger_i \times Common\ equity\ ratio_{i,t-1} + \delta_b\ Bank\ control\ factors_{i,t-1} + \delta_h\ Hybrid\ characteristics_{i,t} + \delta_m\ Macroeconomic\ factors_t + YearFE + BankFE + \varepsilon_{i,t}$. The sample period is from January 2012 to December 2017. *Illiquidity* is the time-weighted bid-ask spread averaged over the month. *PONV trigger* is a dummy variable which equals 1 if a hybrid security is issued with a point of non-viability trigger. *CET1 trigger* is a dummy variable which equals 1 if a hybrid security is issued with a 5.125% common equity capital ratio trigger. *-MertonDD* is the negative distance to default calculated using the Merton model. *NPL* is non-performing loans divided by total loans. *Trading assets* is the bank's trading book to total assets ratio. *Equity beta* and *Idiosyncratic volatility* are the beta term and residual standard error estimated for the bank's common equity using a rolling market index model over the past 130 trading days. *Hybrid beta* and *Hybrid residual* are the beta term and residual standard error estimated for the bank hybrid security using a market index model over the past 130 trading days. *Common equity ratio* is the book value of common equity divided by the book value of assets. Robust t-statistics in parentheses are based on standard errors clustered at both the security and observations date levels. ***, **, and * indicate significance at 1%, 5% and 10% levels, respectively.

	Dependent variable: time-weighted bid-ask spread						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Independent variables	**- MertonDD**	**NPL**	**Trading assets**	**Equity beta**	**Idiosyncratic volatility**	**Hybrid beta**	**Hybrid residual**
PONV trigger (α_1)	-0.178*	1.043***	1.096***	0.155	0.235**	-0.059*	0.001
	(-1.90)	(3.10)	(3.99)	(1.33)	(2.41)	(-1.70)	(0.02)
CET1 trigger (α_2)	-0.153	0.091	0.126	-0.029	-0.029	-0.050	0.191**
	(-1.36)	(0.43)	(0.82)	(-0.42)	(-0.56)	(-1.38)	(2.05)
Bank risk (β_1)	0.035**	0.007	0.014**	0.187	0.413**	-0.410**	1.067***
	(1.99)	(0.56)	(1.97)	(1.49)	(2.54)	(-2.05)	(9.53)
Bank risk × PONV trigger (β_2)	-0.027*	-0.035*	-0.035***	-0.164	-0.420**	0.456**	-0.074
	(-1.80)	(-1.75)	(-3.75)	(-1.58)	(-2.57)	(2.10)	(-0.26)
$\beta_1 + \beta_2$	0.009	-0.028	-0.020***	0.022	-0.008	0.045	0.992***
	(0.57)	(-1.37)	(-3.59)	(0.45)	(-0.77)	(0.19)	(3.37)
Bank risk × CET1 trigger (β_3)	-0.022	0.008	0.013***	-0.025	-0.023	0.324	-0.602**
	(-1.16)	(0.51)	(3.10)	(-0.50)	(-0.40)	(1.38)	(-2.06)
$\beta_1 + \beta_3$	0.014	0.015	0.027***	0.161	0.390**	-0.086	0.464*
	(0.97)	(0.99)	(3.37)	(1.50)	(2.35)	(-0.42)	(1.67)
$\beta_1 + \beta_2 + \beta_3$	-0.013	-0.017	-0.008**	0.008	-0.033	0.387***	0.391***
	(-1.48)	(-1.44)	(-2.38)	(0.20)	(-0.57)	(3.26)	(4.69)

Common equity ratio (γ_1)		0.144***	0.150***				
		(3.31)	(4.33)				
Common equity ratio × PONV trigger (γ_2)		-0.163***	-0.151***				
		(-3.12)	(-4.05)				
$\gamma_1 + \gamma_2$		-0.019	-0.001				
		(-0.53)	(-0.06)				
Common equity ratio × CET1 trigger (γ_3)		-0.024	-0.042**				
		(-0.77)	(-2.32)				
$\gamma_1 + \gamma_3$		0.120**	0.108**				
		(2.23)	(2.57)				
$\gamma_1 + \gamma_2 + \gamma_3$		-0.046	-0.048*				
		(-1.52)	(-1.67)				
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,407	1,407	1,407	1,407	1,407	1,228	1,228
No of banks	7	7	7	7	7	7	7
No of hybrid securities	41	41	41	41	41	38	38
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.634	0.665	0.682	0.620	0.650	0.651	0.790

These results provide some evidence against the argument that the recent regulatory reforms negatively affect the liquidity of capital instruments during normal times, which potentially reduces the net benefit of the reforms in improving the capital adequacy and loss-absorbing capacity of banks (Adrian, Fleming, Shachar and Vogt, 2017). Uncertainty about how national regulators will assess a bank's non-viability and the potential conversion or write down in the value of the securities do not appear to make it more expensive for investors to participate in the market for bank hybrid securities.

With reference to the variables used to control for hybrid security characteristics, the coefficient on *Log TTM* is positive and significant in six of the regressions. The greater interest rate sensitivity contributes to greater bond price changes when the security is trading far from maturity, and this greater price risk is likely to make the market less liquid. The variable used to control for the counterparty availability for hybrid securities, *Log issue size*, has a significantly negative coefficient. The negative relationship with issue size suggests that the transaction costs are lower for hybrids issued in larger quantities. To promote a sufficient level of secondary market liquidity and minimise transaction costs, banks may choose to issue larger amounts of hybrid securities. The results with respect to the impact of firm-level and macro-level control variables are mixed. There is no evidence that the secondary market liquidity of hybrid securities is significantly related to bank profitability and the common equity ratio. The coefficient on the general hybrid market illiquidity variable is positive and significant in all of the regressions. This result indicates that the liquidity of hybrid securities issued by banks varies with the general liquidity condition of the entire hybrid securities market. However, the coefficient on the S&P/ASX 200 VIX index is insignificant in all of the regressions.

In relation to the seven alternative measures of bank risk, if the hybrid security market is less liquid for banks with higher risk profiles, the coefficients on the risk measures are expected to be positive and significant. Consistent with this expectation, the coefficients on the negative Merton distance-to-default and residual standard error estimated for the bank hybrid security are positive and significant. These positive coefficients may reflect higher transaction costs when the issuing banks for the hybrid securities are closer to default or the security returns exhibit higher idiosyncratic risk. However, the coefficients on the other five risk variables are not statistically significant. This pattern suggests that the secondary market liquidity level of hybrid securities is not particularly sensitive to the risks represented by non-performing loans, trading assets or systematic risk of the bank measured by the beta term for the bank's common equity or for the hybrid security.

In consideration of the mixed evidence on the relationship between hybrid security illiquidity and bank risk, I further examine whether the transaction costs for Basel III CoCos with the loss absorption features are more sensitive to bank risk and common equity capital than for the old-style securities. For this purpose, I interact the *Bank Risk* main effect with the *PONV trigger* and *CET1 trigger* dummy variables and the *Common equity ratio* main effect with the *PONV trigger* and *CET1 trigger* dummy variables. If the transaction costs for Basel III CoCos with the different trigger mechanisms are more sensitive to bank risk compared with conventional hybrid securities, significant and positive coefficients on the interaction terms are expected to be observed. In table 5.8 column 6, the coefficient on the $Bank\ risk \times PONV\ trigger$ term is positive and significant and the sum of the coefficients on the main effect and two interaction terms is significant. These coefficients suggest that the inclusion of the combination of the regulatory discretionary PONV trigger and the mechanical CET1 capital ratio trigger results in an increased sensitivity of security illiquidity to the systematic risk profile of the security. However, the results based on the other bank risk proxies indicate no such pattern. There is no evidence that the liquidity of bank hybrid securities becomes substantially more expensive in response to increases in bank default risk, as measured by the distance-to-default or idiosyncratic equity volatility. These results pertaining to the relationship between bank risk and security illiquidity may be specific to the relatively benign macroeconomic conditions examined in this study.

5.5 Summary

Since the 2007-2009 financial crisis, a lack of capacity within banks to absorb extraordinary losses and moral hazard problems caused by investors' perceptions of government guarantees have become a primary focus of industry observers and regulators. In Australia, the banking regulator implemented the Basel III capital reforms from the beginning of 2013, and Australian banks started to issue Basel III contingent convertible capital instruments from September 2011, with conventional hybrid securities being phased out over a ten-year period to 2023. There are three types of CoCo instruments issued by Australian banks, 1) CoCos with only a gone-concern discretionary point of non-viability trigger; 2) CoCos with only a going-concern mechanical common equity capital ratio trigger; and 3) CoCos with both a point of non-viability trigger and a capital ratio trigger. This study, to the best of my knowledge, is the first study to examine the impact of the different Basel III loss absorption trigger mechanisms on both the pricing and liquidity for bank hybrid securities. Using secondary market data for the period from January 2012 to December 2017 for hybrid securities issued by Australian banks, this study examines the impact of the Basel III loss absorption features and attempts to separately identify the effects of the different trigger mechanisms on the pricing and market liquidity of hybrid securities. The empirical analyses provide evidence to support the proposition that the gone-concern point of non-viability trigger is taken into account by investors when they are pricing Basel III CoCo instruments. An additional risk premium associated with the point of non-viability trigger continues to be evident when controlling for other security characteristics, bank-specific risk and solvency position, as well as macroeconomic factors. The average additional risk premium is estimated to be around 50-60 basis points.

To further investigate the effects of the regulatory reforms in restoring the credible loss-absorbing capacity of banks, this study examines whether the different Basel III loss absorption mechanisms result in an increased sensitivity of hybrid security credit spreads to bank risk. The results suggest that the pricing of Basel III CoCos issued with dual loss absorption triggers has become more sensitive to the systematic risk of the hybrid security, as measured by the beta term for the security; however, it has become less sensitive to measures of banking risk typically used to price debt securities, including the probability of default. The risk premium demanded by hybrid investors to compensate for systematic risk may be accentuated by the uncertainty about the regulators' ultimate declaration of non-viability and the way in which the regulator likely to exercise its power to impose losses on hybrid security investors.

I examine the impact of the Basel III loss absorption features on hybrid market liquidity and find no evidence that the market liquidity of bank hybrid securities has deteriorated overall with the inclusion of the loss absorption features. If the market liquidity for the securities had weakened, it may be counter-productive for banks and potentially cost them more to issue hybrid securities than to issue common equity, as they may need to compensate investors for the illiquidity by offering higher yields at issuance. The results suggest that the inclusion of the combination of the regulatory discretionary trigger and the mechanical capital ratio trigger are associated with an increased sensitivity of security illiquidity to the systemic risk of the hybrid security. However, there is no evidence that the liquidity of bank hybrid securities becomes substantially more expensive in response to increases in bank default risk. These results suggest that the securities issued with the gone-concern discretionary loss absorption mechanism have enhanced the loss-absorbing capacity of the bank, without damaging the liquidity of the capital instruments in the secondary market.

Chapter 6

Conclusion

In the years after the financial crisis of 2007-2009, a primary focus of regulatory reform has been to address the moral hazards and competitive distortions brought about by implicit government guarantees for systemically important financial institutions. Systemically important banks may be able to refinance on more favourable terms than other banks because creditors expect that systemically important banks will be supported by the public sector in the event that they become financially distressed. Using primary bond market data for Australian banks in the period from January 2004 to December 2017, the first empirical study presented in this thesis examines whether systemically important banks realise an implicit subsidy when raising wholesale debt funding and evaluates the effectiveness of the Basel III capital reforms in reducing the subsidy. Consistent with several previous studies (Penas and Unal, 2004; Brewer and Jagtiani, 2013; Beyhaghi, D'Souza and Roberts, 2014; Acharya, Anginer and Warburton, 2016), I find evidence that expectations of government support are embedded in the credit spreads of bonds issued by systemically important banks. This hypothesis is supported in two ways: (i) the credit spreads are lower for bonds issued by systemically important banks than for bonds issued by other banks after allowing for bank risk; and (ii) the credit spreads are less sensitive to conventional measures of bank risk for bonds issued by systemically important banks than for bonds issued by other banks. The estimations reported in this thesis suggest that, before the implementation of the Basel III capital framework, systemically important banks realise an implicit subsidy of around 26-30 basis points when they raise senior unsecured borrowings.

In Australia, the banking regulator implemented the Basel III capital reforms from the beginning of 2013, two years ahead of the international phase-in timeline, and banks raised the quality and level of their capital base to meet the new requirements earlier than banks in most other jurisdictions. These responses by the regulator and banks allow me to test the effectiveness of the reforms in reducing the implicit subsidy of systemically important banks. My analysis suggests that the implicit subsidy is reduced by approximately one-half since the implementation of the Basel III capital reforms. Increases in the equity capital base mandated under the Basel III rules serve to reduce the borrowing costs of smaller banks, but they are less effective in reducing the borrowing costs of larger banks. This pattern is consistent with the proposition that the default protection provided by a stronger capital position substitutes for the protection provided by implicit government guarantees in shoring up investor confidence in a systemically important bank.

Other features of the Basel III reform package have been introduced to improve the loss-absorbing capacity of banks and reduce the implicit subsidy of systemically important banks. New requirements for capital loss absorption at the point of non-viability can be expected to increase investors' incentives to monitor the risks of systemically important banks. The contractual terms for capital instruments, including tier 2 subordinated debt securities and additional tier 1 hybrid securities, are to include a clause that allows – at the discretion of the regulator – write-off or conversion to common shares if the bank is judged to be non-viable. The findings presented in this thesis suggest that the cost of funding sourced from senior debt markets is unresponsive to the risks of systemically important banks after the implementation of the Basel III capital framework. In this context, the new capital loss absorption requirements may perform an important function in limiting the extent to which the implicit subsidy for systemically important banks extends to funding sourced from subordinated debt markets and hybrid debt-equity markets.

The Basel Committee on Banking Supervision designates market discipline as one of the three pillars of banking regulation. Under the Basel III rules, to qualify as either going-concern or gone-concern bank capital, the issuances of any additional tier 1 hybrid securities and tier 2 subordinated debt securities must contain the regulatory discretionary point of non-viability trigger mechanism. There is also a mechanical 5.125% common equity tier 1 capital ratio trigger mechanism that applies to capital instruments classified as liabilities on the bank's balance sheet if they are to qualify as going-concern additional tier 1 regulatory capital. It is expected that additional tier 1 hybrid securities can function as contingent convertible capital instruments (CoCos) to facilitate the recapitalisation of a distressed bank, while tier 2 subordinated debt securities can function as bail-in debt instruments to better absorb bank losses when a bank fails. Australian banks started to issue new Basel III non-common equity capital instruments in October 2012, while old-style capital instruments continue to trade in the secondary market until they are phased out over a ten-year period to 2023. Taking advantage of the overlapping period, this research investigates whether the Basel III capital loss absorption features are priced by investors in bank's non-common equity capital instruments and whether the features increase investors' incentive to monitor banks' risk-taking activities.

Based on secondary market credit spreads on subordinated bonds of Australian banks from January 2013 to December 2017, the empirical results reported in this thesis provide evidence of a bail-in risk premium demanded by banks' subordinated debt investors that can be attributed to the newly-implemented Basel III gone-concern loss absorbency requirement for tier 2 capital. After controlling for other factors that can be expected to influence the credit spreads of subordinated bonds, the empirical results indicate significant credit spread differences between Basel III bail-in subordinated bonds and conventional bank subordinated bonds. The credit spreads of Basel III bail-in subordinated bonds are higher by approximately 73 basis points and 45 basis points for fixed-rate bonds and floating-rate bonds respectively, relative to bank subordinated bonds that do not include the loss absorption trigger. These results indicate that the Basel III loss absorption feature is priced when bank subordinated debt investors transact in the secondary market, which, accordingly, suggests that investors in bail-in subordinated debt anticipate being exposed to potential future losses if a bank is declared non-viable by the regulator. Motivated by previous research that provides mixed evidence about the risk-sensitivity of bank subordinated debt spreads and about the uncertainty associated with the discretionary loss absorption mechanism (see Krishnan et al. 2005; Balasubramnian and Cyree 2011; Davis and Saba 2016), this research tests whether the additional risk premium associated with the discretionary loss absorption mechanism can be attributed to a heightened sensitivity of bond pricing to bank risk characteristics. Testing differences in the sensitivity of credit spreads to bank risk between bonds with the Basel III discretionary loss absorption feature and those without the feature, I find a heightened sensitivity of banks' subordinated debt credit spreads to market-based measures of bank risk, i.e., the Merton distance-to-default, equity volatility and idiosyncratic equity volatility. This finding suggests that investors pay greater attention to the risk profile of the bank when pricing subordinated debt securities with the discretionary loss absorption feature and that they demand a higher expected yield premium for riskier banks under the new regime.

Since the 2007-2009 financial crisis, financial economists and practitioners have proposed new regulatory tools to mitigate the perceptions of implicit government guarantees and restore soundness and stability in the banking system (Sundaresan and Wang, 2015; Avdjiev, Kartasheva and Bogdanova, 2013) One such mechanism is a debt instrument that converts into common equity when a bank's capital position is weak but the bank is yet to become insolvent. This proposal attempts to make wholesale debt claims more like equity claims and incentivise wholesale debt holders to monitor banks' risk-taking activities by giving them greater exposure to underlying asset risks. The design of contingent convertible capital instruments (CoCos), including the determination of the trigger point and the conversion rate, has been widely debated in the past literature (Flannery, 2014; Berg and Kaserer, 2015). The treatment of CoCos within the Basel III capital framework includes newly defined additional tier 1 capital instruments that are issued with a mechanical loss absorption feature, with the loss absorption activated when a bank's common equity tier 1 capital ratio falls below 5.125%. Additional tier 1 capital instruments issued after the beginning of the Basel III phase-in period must also include the regulatory discretionary point-of-non-viability loss absorption feature.

Using secondary market transactions data for the ASX-listed hybrid securities of Australian banks in the period from January 2012 to December 2017, my empirical research examines the impact of the Basel III loss absorption features, both the going-concern mechanical trigger and the gone-concern discretionary trigger, on the pricing and liquidity of bank capital instruments. The results indicate that an additional risk premium is demanded by investors in Basel III CoCo securities relative to pre-Basel III hybrid securities, which supports the proposition that the Basel III gone-concern loss absorption feature is assessed by investors when they trade banks' hybrid securities. This risk premium demanded by investors can be attributed to the point of non-viability trigger, rather than the common equity capital ratio trigger mechanism. The average additional risk premium is estimated to be around

50-60 basis points after controlling for hybrid security characteristics, bank-specific risks and financial position, as well as macroeconomic factors. I further investigate whether the Basel III loss absorption features result in an increased risk sensitivity of hybrid security credit spreads. The results suggest that the pricing of bank hybrid securities with the dual loss absorption triggers has become more sensitive to the systematic risk of the hybrid security, as captured by the estimated beta term for the security; however, that it became less sensitive to measures of bank risk typically used to price debt securities, including the probability of default. These results are consistent with the idea that the Basel III loss absorption features have made banks' hybrid securities more like equity securities, with the pricing of the securities determined primarily with reference to the systemic risk profile of the bank.

The roles of the Basel III reforms in enhancing banks' loss-absorbing capacity and reducing the funding cost advantage of systemically important banks may be undermined if the new capital loss absorption requirements have a detrimental impact on the secondary market liquidity for banks' non-common equity capital instruments. Using secondary market quotations data for the ASX-listed hybrid securities of Australian banks, I examine whether the Basel III loss absorption features have had an adverse impact on hybrid security market liquidity. The combination of the going-concern and gone-concern trigger mechanisms is associated with reduced market liquidity for bank hybrid securities with greater systematic risk exposure. However, the implementation of the Basel III loss absorption features has not resulted in deteriorated market liquidity for bank hybrid securities overall. In general, the results of my study suggest that the Basel III loss absorption mechanisms have strengthened the loss-absorbing capacity of banks without disrupting the market liquidity of the capital instruments.

The empirical studies presented in this thesis focus on the effects of the Basel III capital framework in reducing the implicit subsidies realised by systemically important banks and in enhancing the loss-absorbing capacity provided by banks' non-common equity capital instruments. In a financial system in which banks take risks and authorities are prepared to tolerate the possibility of bank failure, the Basel III loss absorption requirements may provide a credible way to impose bank losses on creditors and to facilitate recovery planning and resolution planning. The empirical evidence reported in this thesis generally supports the vision of the Financial Stability Board, which has advocated for additional loss-absorbing capacity within systemically important banks, to reduce the frequency of banking crises and to support the resolution process for banks when crises occur (Austrlian Prudential Regulation Authority, 2018). The Basel III capital adequacy framework seeks to create additional loss-absorbing capacity within banks by modifying the contractual terms for existing capital instruments. The framework delineates between going-concern and gone-concern regulatory capital and mandates a mechanical capital ratio-based trigger and a regulatory discretionary trigger in each case. The efficiency with which these trigger mechanisms can be activated remains to be tested in stressed market conditions. However, the results presented in this thesis suggest that investors anticipate greater potential exposure to banking losses, with the inclusion of the Basel III discretionary bail-in trigger in particular.

With the early phase-in of the Basel III framework in Australia, the data available during the transitional period have allowed me to undertake research on the impact of key features of the reforms on the funding cost advantage of systemically important banks and on the pricing and liquidity of bank capital instruments, using the local banking industry as an experimental environment. Other countries have implemented the reforms in line with the international phase-in timeline, in many cases using the flexibility within the framework to allow for differences in local conditions. Future research can examine the impact of different approaches to implementing the Basel III capital reforms on the outcomes identified in this thesis. Recent events in other jurisdictions will also allow for an examination of the impact of the activation of the Basel III loss absorption mechanisms on market discipline. For example, the European Central bank deemed Banco Popular, a Spanish bank, as "failing or likely to fail" and the point of non-viability trigger was activated. Future research can investigate the impact of loss absorption trigger events on the pricing of bank capital instruments and the implications for the broader banking sector.

Other features of the regulatory capital framework can be expected to influence the effectiveness of market discipline in the banking industry. The extent to which countercyclical capital buffers reduce the funding cost advantage of systemically important banks at the onset of an economic downturn should be investigated. If countercyclical buffers protect systemically important banks at times of excess credit growth, they may reduce investor expectations of government support at a point in the business cycle when such perceptions are especially valuable. Recent revisions to the Basel III capital framework seek to improve the comparability of risk measurements produced using the internal models of internal ratings-based banks (Basel Committee on Banking supervision, 2017). Greater transparency about the way in which banks measure risk-weighted assets under the relevant standards can be expected to improve the accuracy with which investors price the capital instruments issued by the banks. Future research can examine the impact of the improved disclosure requirements on the pricing of banks' capital instruments and whether the requirements allow investors to better assess the risk profiles and financial positions of the banks.

References

Acharya, V. V., Anginer, D. and Warburton, A. J. (2016), 'The end of market discipline? Investor expectations of implicit government guarantees', working paper, New York University, May.

Acharya, V. V., Mehran, H. and Thakor, A. V. (2016), 'Caught between Scylla and Charybdis? Regulating bank leverage when there is rent seeking and risk shifting', *The Review of Corporate Finance Studies*, 5(1), 36–75.

Acharya, V. V., Pedersen, L. H., Philippon, T. and Richardson, M. (2017), 'Measuring systemic risk', *The Review of Financial Studies*, 30(1), 2–47.

Adrian, T., Fleming, M., Shachar, O. and Vogt, E. (2017), 'Market liquidity after the financial crisis', Federal Reserve Bank of New York Staff Reports No. 796.

Afonso, G., Santos, J. A. and Traina, J. (2014), 'Do'too-big-to-fail'banks take on more risk?', *Federal Reserve Bank of New York Economic Policy Review*, 20(2), 41–58.

Albul, B., Jaffee Dwight, M. and Tchistyi, A. (2015), 'Contingent capital debt and capital structure decisions', Working paper, Hass School of Business, UC Berkeley.

Allen, F. and Gale, D. (2000), 'Financial contagion', *Journal of Political Economy*, 108(1), 1–33.

Amihud, Y. and Mendelson, H. (1986), 'Asset pricing and the bid-ask spread', *Journal of Financial Economics*, 17(2), 223–249.

Atkeson, A. G., Eisfeldt, A. L. and Weill, P.-O. (2017), 'Measuring the financial soundness of us firms, 1926–2012', *Research in Economics*, 71(3), 613–635.

Australian Prudential Regulation Authority (2013), 'Domestic systemically important banks in Australia', APRA Information Paper, December.

Australian Securities and Investments Commission (2013), 'Hybrid securities', Report 365, August.

Australian Securities Exchange (2017), 'Understanding hybrid securities', ASX, July.

Austrlian Prudential Regulation Authority (2018), 'Increasing the loss-absorbing capacity of ADIs to support orderly resolution', APRA Discussion Paper.

Avdjiev, S., Kartasheva, A. V. and Bogdanova, B. (2013), 'CoCos: A primer', BIS Quarterly Review, September.

Avery, R. B., Belton, T. M. and Goldberg, M. A. (1988), 'Market discipline in regulating bank risk: New evidence from the capital markets', *Journal of Money, Credit and Banking*, 20(4), 597–610.

Balasubramnian, B. and Cyree, K. B. (2011), 'Market discipline of banks: Why are yield spreads on bank-issued subordinated notes and debentures not sensitive to bank risks?', *Journal of Banking and Finance*, 35(1), 21–35.

Balasubramnian, B. and Cyree, K. B. (2014), 'Has market discipline on banks improved after the dodd–frank act?', *Journal of Banking and Finance*, 41, 155–166.

Bank for International Settlements (1988), *International convergence of capital measurement and capital standards*, Basel: Basel Committee on Banking Supervision.

Bank for International Settlements (2006), *International convergence of capital measurement and capital standards: a revised framework - comprehensive version*, Basel: Basel Committee on Banking Supervision.

Bank for International Settlements (2010), *Basel III: A global regulatory framework for more resilient banks and banking systems*, Basel Committee on Banking Supervision.

Bank for International Settlements (2011), *Basel Committee issues final elements of the reforms to raise the quality of regulatory capital [Press release]*, Basel Committee on Banking Supervision.

Bank for International Settlements (2014), *Regulatory Consistency Assessment Programme (RCAP): Assessment of Basel III regulations – Australia*, Basel: Basel Committee on Banking Supervision.

Basel Committee on Banking supervision (2017), *Basel III: Finalising post-criss reforms*.

Beltratti, A. and Stulz, R. M. (2012), 'The credit crisis around the globe: Why did some banks perform better?', *Journal of Financial Economics*, 105(1), 1–17.

Benston, G. J. and Kaufman, G. G. (1994), The intellectual history of the federal deposit insurance corporation improvement act of 1991, *in* 'Reforming financial institutions and markets in the United States', Springer, pp. 1–17.

Benston, G. J. and Kaufman, G. G. (1997), 'FDICIA after five years', *Journal of Economic Perspectives*, 11(3), 139–158.

Berg, T. and Kaserer, C. (2015), 'Does contingent capital induce excessive risk-taking?', *Journal of Financial Intermediation*, 24(3), 356–385.

Berger, A., Davies, S. and Flannery, M. (2000), 'Comparing market and reg'ulatory assessments of bank performance: Who knows what when?', *Journal of Money, Credit and Banking*, 24, 641–670.

Berger, A. N. (1991), 'Market discipline in banking', Federal Reserve Bank of Chicago Proceedings No. 328.

Berger, A. N. and Bouwman, C. H. (2013), 'How does capital affect bank performance during financial crises?', *Journal of Financial Economics*, 109(1), 146–176.

Berger, A. N., Herring, R. J. and Szegö, G. P. (1995), 'The role of capital in financial institutions', *Journal of Banking and Finance*, 19(3-4), 393–430.

Beyhaghi, M., D'Souza, C. and Roberts, G. S. (2014), 'Funding advantage and market discipline in the canadian banking sector', *Journal of Banking and Finance*, 48, 396–410.

Bharath, S. T. and Shumway, T. (2008), 'Forecasting default with the merton distance to default model', *Review of Financial Studies*, 21(3), 1339–1369.

Bhattacharya, S., Boot, A. W. and Thakor, A. V. (1998), 'The economics of bank regulation', *Journal of Money, Credit and Banking*, 30(4), 745–770.

Billett, M. T., Garfinkel, J. A. and O'Neal, E. S. (1998), 'The cost of market versus regulatory discipline in banking', *Journal of Financial Economics*, 48(3), 333–358.

Birchler, U. W. and Facchinetti, M. (2007), 'Can bank supervisors rely on market data? A critical assessment from a swiss perspective', *Swiss Journal of Economics and Statistics*, 143(2), 95–132.

Black, F. and Cox, J. C. (1976), 'Valuing corporate securities: Some effects of bond indenture provisions', *The Journal of Finance*, 31(2), 351–367.

Bliss, R. R. and Flannery, M. J. (2002), 'Market discipline in the governance of US bank holding companies: Monitoring vs. influencing', *Review of Finance*, 6(3), 361–396.

Brewer, E. and Jagtiani, J. (2013), 'How much did banks pay to become too-big-to-fail and to become systemically important?', *Journal of Financial Services Research*, 43(1), 1–35.

Brunnermeier, M. K. and Pedersen, L. H. (2009), 'Market liquidity and funding liquidity', *Review of Financial studies*, 22(6), 2201–2238.

Calem, P. and Rob, R. (1999), 'The impact of capital-based regulation on bank risk-taking', *Journal of Financial Intermediation*, 8(4), 317–352.

Calomiris, C. W. and Kahn, C. M. (1991), 'The role of demandable debt in structuring optimal banking arrangements', *The American Economic Review*, pp. 497–513.

Campbell, J. Y., Hilscher, J. and Szilagyi, J. (2008), 'In search of distress risk', *The Journal of Finance*, 63(6), 2899–2939.

Campbell, J. Y. and Taksler, G. B. (2003), 'Equity volatility and corporate bond yields', *The Journal of Finance*, 58(6), 2321–2350.

Chen, L., Lesmond, D. A. and Wei, J. (2007), 'Corporate yield spreads and bond liquidity', *The Journal of Finance*, 62(1), 119–149.

Chen, N., Glasserman, P., Nouri, B. and Pelger, M. (2013), 'Cocos, bail-in, and tail risk', Office of Financial Research Working Paper No. 0004.

Chordia, T., Roll, R. and Subrahmanyam, A. (2001), 'Market liquidity and trading activity', *The journal of finance*, 56(2), 501–530.

Chordia, T., Sarkar, A. and Subrahmanyam, A. (2004), 'An empirical analysis of stock and bond market liquidity', *The Review of Financial Studies*, 18(1), 85–129.

Cook, D. O. and Spellman, L. J. (1994), 'Repudiation risk and restitution costs: Toward understanding premiums on insured deposits', *Journal of Money, Credit and Banking*, 26(3), 439–459.

Coval, J. D. and Thakor, A. V. (2005), 'Financial intermediation as a beliefs-bridge between optimists and pessimists', *Journal of Financial Economics*, 75(3), 535–569.

Dam, L. and Koetter, M. (2012), 'Bank bailouts and moral hazard: Evidence from germany', *The Review of Financial Studies*, 25(8), 2343–2380.

Davis, E. P. (1996), 'The role of institutional investors in the evolution of financial structure and behaviour', *The Future of the Financial System*, pp. 49–99.

Davis, K. and Saba, M. (2016), 'Hunting the BIRP: Is there a "bail-in risk premium" in australian bank hybrids', working paper.

Demirgüç-Kunt, A. and Detragiache, E. (2002), 'Does deposit insurance increase banking system stability? an empirical investigation', *Journal of Monetary Economics*, 49(7), 1373–1406.

Demirguc-Kunt, A., Detragiache, E. and Merrouche, O. (2013), 'Bank capital: Lessons from the financial crisis', *Journal of Money, Credit and Banking*, 45(6), 1147–1164.

Demirgüç-Kunt, A. and Huizinga, H. (2004), 'Market discipline and deposit insurance', *Journal of Monetary Economics*, 51(2), 375–399.

Demirgüç-Kunt, A. and Kane, E. J. (2002), 'Deposit insurance around the globe: Where does it work?', *Journal of Economic Perspectives*, 16(2), 175–195.

Demirgüç-Kunt, A., Kane, E. and Laeven, L. (2014), 'Deposit insurance database', IMF Working Paper.

Dewatripont, M. and Tirole, J. (2012), 'Macroeconomic shocks and banking regulation', *Journal of Money, Credit and Banking*, 44(s2), 237–254.

Diamond, D. W. (1984), 'Financial intermediation and delegated monitoring', *The Review of Economic Studies*, 51(3), 393–414.

Diamond, D. W. and Dybvig, P. H. (1983), 'Bank runs, deposit insurance, and liquidity', *The Journal of Political Economy*, pp. 401–419.

Diamond, D. W. and Rajan, R. G. (2001), 'Liquidity risk, liquidity creation, and financial fragility: A theory of banking', *Journal of Political Economy*, 109(2), 287–327.

Duffie, D. (2009), 'Contractual methods for out-of-court restructuring of systemically important financial institutions', Stanford University Working Paper.

Duffie, D. and Lando, D. (2001), 'Term structures of credit spreads with incomplete accounting information', *Econometrica*, 69(3), 633–664.

Duffie, D., Saita, L. and Wang, K. (2007), 'Multi-period corporate default prediction with stochastic covariates', *Journal of Financial Economics*, 83(3), 635–665.

Egan, M., Hortaçsu, A. and Matvos, G. (2017), 'Deposit competition and financial fragility: Evidence from the us banking sector', *American Economic Review*, 107(1), 169–216.

Eichberger, J. and Summer, M. (2005), 'Bank capital, liquidity, and systemic risk', *Journal of the European Economic Association*, 3(2-3), 547–555.

Ellis, D. M. and Flannery, M. J. (1992), 'Does the debt market assess large banks, risk?: Time series evidence from money center cds', *Journal of Monetary Economics*, 30(3), 481–502.

Ellis, L. (2016), 'Financial stability and the banking sector', presented in Sydney Banking and Financial Stability Conference, Sydney, July, Researve Bank of Australia.

Elyasiani, E. and Jia, J. J. (2008), 'Institutional ownership stability and bhc performance', *Journal of Banking and Finance*, 32(9), 1767–1781.

Evanoff, D. D., Jagtiani, J. A. and Nakata, T. (2011), 'Enhancing market discipline in banking: The role of subordinated debt in financial regulatory reform', *Journal of Economics and Business*, 63(1), 1–22.

Evanoff, D. D. and Wall, L. D. (2000), Subordinated debt and bank capital reform, *in* G. G. Kaufman, ed., 'Bank Fragility and Regulation: Evidence from Different Countries', Elsevier Science, Amsterdam, pp. 53–199.

Evanoff, D. and Jagtiani, J. (2004), 'Use of subordinated debt in the supervisory & monitoring process and to enhance market discipline'.

Fahlenbrach, R., Prilmeier, R. and Stulz, R. M. (2012), 'This time is the same: Using bank performance in 1998 to explain bank performance during the recent financial crisis', *The Journal of Finance*, 67(6), 2139–2185.

Fama, E. F. (1986), 'Term premiums and default premiums in money markets', *Journal of Financial Economics*, 17(1), 175–196.

Flannery, M. J. (1994), 'Debt maturity and the deadweight cost of leverage: Optimally financing banking firms', *The American Economic Review*, 84(1), 320–331.

Flannery, M. J. (1998), 'Using market information in prudential bank supervision: A review of the us empirical evidence', *Journal of Money, Credit and Banking*, pp. 273–305.

Flannery, M. J. (2001), 'The faces of "market discipline"', *Journal of Financial Services Research*, 20(2), 107–119.

Flannery, M. J. (2002), 'No pain, no gain? effecting market discipline via 'reverse convertible debentures'', working paper.

Flannery, M. J. (2005), No pain, no gain? effecting market discipline via "reverse convertible debentures.", *in* H. Scott, ed., 'Capital Adequacy Beyond Basel: Banking, Securities, and Insurance', Oxford Univ. Press, Oxford,UK, pp. 171–96.

Flannery, M. J. (2009), 'Market-valued triggers will work for contingent capital instruments', *Solicited Submission to US treasury working group on bank capital*, .

Flannery, M. J. (2014), 'Contingent capital instruments for large financial institutions: A review of the literature', *Annual Review of Financial Economics*, 6(1), 225–240.

Flannery, M. J. and Bliss, R. R. (2019), 'Market discipline in regulation: Pre-and post-crisis', Forthcoming, Oxford Handbook of Banking 3e.

Flannery, M. J. and Sorescu, S. M. (1996), 'Evidence of bank market discipline in subordinated debenture yields: 1983–1991', *The Journal of Finance*, 51(4), 1347–1377.

Foley, S. and Putniņš, T. J. (2016), 'Should we be afraid of the dark? Dark trading and market quality', *Journal of Financial Economics*, 122(3), 456–481.

Fong, K. Y., Holden, C. W. and Trzcinka, C. A. (2017), 'What are the best liquidity proxies for global research?', *Review of Finance*, 21(4), 1355–1401.

Gandhi, P. and Lustig, H. (2015), 'Size anomalies in US bank stock returns', *The Journal of Finance*, 70(2), 733–768.

Garcia, G. H. (1999), 'Deposit insurance: A survey of actual and best practices', IMF Working Paper No. 99/54.

Glasserman, P. and Nouri, B. (2016), 'Market-triggered changes in capital structure: Equilibrium price dynamics', *Econometrica*, 84(6), 2113–2153.

Glasserman, P. and Wang, Z. (2011), 'Valuing the treasury's capital assistance program', *Management Science*, 57(7), 1195–1211.

Goldberg, L. G. and Hudgins, S. C. (2002), 'Depositor discipline and changing strategies for regulating thrift institutions', *Journal of Financial Economics*, 63(2), 263–274.

Gorton, G. (2012), *Misunderstanding financial crises: Why we don't see them coming*, Oxford University Press.

Gorton, G. and Pennacchi, G. (1990), 'Financial intermediaries and liquidity creation', *The Journal of Finance*, 45(1), 49–71.

Gorton, G. and Santomero, A. M. (1990), 'Market discipline and bank subordinated debt: Note', *Journal of money, credit and Banking*, 22(1), 119–128.

Goyenko, R. Y. and Ukhov, A. D. (2009), 'Stock and bond market liquidity: A long-run empirical analysis', *Journal of Financial and Quantitative Analysis*, 44(1), 189–212.

Gropp, R., Hakenes, H. and Schnabel, I. (2010), 'Competition, risk-shifting, and public bail-out policies', *The Review of Financial Studies*, 24(6), 2084–2120.

Gropp, R., Vesala, J. M. and Vulpes, G. (2004), 'Market indicators, bank fragility, and indirect market discipline', *Economic Policy Review*, 10(2).

Gropp, R., Vesala, J. M. and Vulpes, G. (2006), 'Equity and bond market signals as leading indicators of bank fragility', *Journal of Money, Credit, and Banking*, 38, 299–428.

Grossman, R. S. (1992), 'Deposit insurance, regulation, and moral hazard in the thrift industry: Evidence from the 1930's', *The American Economic Review*, 82(4), 800–821.

Hakenes, H. and Schnabel, I. (2010), 'Banks without parachutes: Competitive effects of government bail-out policies', *Journal of Financial Stability*, 6(3), 156–168.

Hameed, A., Kang, W. and Viswanathan, S. (2010), 'Stock market declines and liquidity', *The Journal of Finance*, 65(1), 257–293.

Hannan, T. H. and Hanweck, G. A. (1988), 'Bank insolvency risk and the market for large certificates of deposit', *Journal of Money, Credit and Banking*, 20(2), 203–211.

Hart, O. and Zingales, L. (2012), Curbing risk on wall street, *in* 'Macroprudential Regulatory Policies: The New Road to Financial Stability?', pp. 313–330.

Hellmann, T. F., Murdock, K. C. and Stiglitz, J. E. (2000), 'Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough?', *American Economic Review*, pp. 147–165.

Hendershott, T., Jones, C. M. and Menkveld, A. J. (2011), 'Does algorithmic trading improve liquidity?', *The Journal of Finance*, 66(1), 1–33.

Hillegeist, S. A., Keating, E. K., Cram, D. P. and Lundstedt, K. G. (2004), 'Assessing the probability of bankruptcy', *Review of Accounting Studies*, 9(1), 5–34.

Himmelberg, C. P. and Tsyplakov, S. (2012), 'Pricing contingent capital bonds: incentives matter', working paper.

Holmstrom, B. and Tirole, J. (1997), 'Financial intermediation, loanable funds, and the real sector', *the Quarterly Journal of Economics*, 112(3), 663–691.

Hovakimian, A. and Kane, E. J. (2000), 'Effectiveness of capital regulation at US commercial banks, 1985 to 1994', *The Journal of Finance*, 55(1), 451–468.

International Monetary Fund (2012), 'Australia: Addressing systemic risk through higher loss absorbency - Technical note', IMF Country Report No. 12/311, November.

International Monetary Fund (2014), 'How big is the implicit subsidy for banks considered too important to fail?', *Global Financial Stability Report*, April, 101–32.

Jones, D. (2000), 'Emerging problems with the basel capital accord: Regulatory capital arbitrage and related issues', *Journal of Banking and Finance*, 24(1-2), 35–58.

Kelly, B., Lustig, H. and Van Nieuwerburgh, S. (2016), 'Too-systemic-to-fail: What option markets imply about sector-wide government guarantees', *American Economic Review*, 106(6), 1278–1319.

Koehn, M. and Santomero, A. M. (1980), 'Regulation of bank capital and portfolio risk', *The Journal of Finance*, 35(5), 1235–1244.

Krishnan, C., Ritchken, P. H. and Thomson, J. B. (2005), 'Monitoring and controlling bank risk: Does risky debt help?', *The Journal of Finance*, 60(1), 343–378.

Kroszner, R. S., Laeven, L. and Klingebiel, D. (2007), 'Banking crises, financial dependence, and growth', *Journal of Financial Economics*, 84(1), 187–228.

Kuritzkes, A. and Scott, H. (2009), 'Markets are the best judge of bank capital', *Financial Times*, 23.

Kwast, M. L., Covitz, D., Hancock, D., Houpt, J., Adkins, D., Barger, N., Bouchard, B., Connolly, J., Brady, T., English, W. and Evanoff, D. D. (1999), 'Using subordinated debt as an instrument of market discipline', Board of Governors of the Federal Reserve System, Staff Study (172).

Kyei, A. (1995), 'Deposit protection arrangements: a survey', IMF Working Paper No. 95/134.

Laeven, L., Ratnovski, L. and Tong, H. (2016), 'Bank size, capital, and systemic risk: Some international evidence', *Journal of Banking and Finance*, 69, S25–S34.

Leland, H. E. and Toft, K. B. (1996), 'Optimal capital structure, endogenous bankruptcy, and the term structure of credit spreads', *The Journal of Finance*, 51(3), 987–1019.

Llewellyn, D. T. (1996), ‘Banking in the 21st century: the transformation of an industry’, *Reserve Bank of Australia, The future of the financial system*, pp. 141–79.

Maechler, A. M. and McDill, K. M. (2006), ‘Dynamic depositor discipline in us banks’, *Journal of Banking and Finance*, 30(7), 1871–1898.

Matutes, C. and Vives, X. (1996), ‘Competition for deposits, fragility, and insurance’, *Journal of Financial intermediation*, 5(2), 184–216.

McInish, T. H. and Wood, R. A. (1992), ‘An analysis of intraday patterns in bid/ask spreads for NYSE stocks’, *the Journal of Finance*, 47(2), 753–764.

Mehran, H. and Thakor, A. (2011), ‘Bank capital and value in the cross-section’, *The Review of Financial Studies*, 24(4), 1019–1067.

Merton, R. C. (1974), ‘On the pricing of corporate debt: The risk structure of interest rates’, *The Journal of Finance*, 29(2), 449–470.

Miles, D., Yang, J. and Marcheggiano, G. (2013), ‘Optimal bank capital*’, *The Economic Journal*, 123(567), 1–37.

Modigliani, F. and Miller, M. H. (1958), ‘The cost of capital, corporation finance and the theory of investment’, *The American Economic Review*, 48(3), 261–297.

Morgan, D. P. and Stiroh, K. J. (2001), ‘Market discipline of banks: The asset test’, *Journal of Financial Services Research*, 20(2-3), 195–208.

Morgan, D. P. and Stiroh, K. J. (2005), ’Too big to fail after all these years’, Federal Reserve Bank of New York Staff Report No. 220, September.

Nguyen, T. (2013), ‘The disciplinary effect of subordinated debt on bank risk taking’, *Journal of Empirical Finance*, 23, 117–141.

Noss, J. and Sowerbutts, R. (2012), ‘The implicit subsidy of banks’, Bank of England Financial Stability Paper No. 15, May.

Park, S. and Peristiani, S. (1998), ‘Market discipline by thrift depositors’, *Journal of Money, Credit and Banking*, pp. 347–364.

Penas, M. F. and Unal, H. (2004), ‘Gains in bank mergers: Evidence from the bond markets’, *Journal of Financial Economics*, 74(1), 149–179.

Prescott, E. S. (2012), ‘Contingent capital: the trigger problem’, *FRB Richmond Economic Quarterly*, 98(1), 33–50.

Reinhart, C. M. and Rogoff, K. S. (2009), *This time is different: Eight centuries of financial folly*, Princeton University Press.

Repullo, R. (2004), ‘Capital requirements, market power, and risk-taking in banking’, *Journal of Financial Intermediation*, 13(2), 156–182.

Researve Bank of Australia (2013), ‘The basel iii capital reforms in australia’, *Financial Stability Review*, September, 36–8.

Rochet, J.-C. (1992), ‘Capital requirements and the behaviour of commercial banks’, *European Economic Review*, 36(5), 1137–1170.

Santos, J. A. (2014), ‘Evidence from the bond market on banks “too-big-to-fail” subsidy’, *Economic Policy Review, Forthcoming*, 20(2), 29–39.

Schäfer, A., Schnabel, I. and Weder di Mauro, B. (2016), ‘Bail-in expectations for european banks: Actions speak louder than words’, working paper.

Sironi, A. (2003), ‘Testing for market discipline in the european banking industry: Evidence from subordinated debt issues’, *Journal of Money, Credit, and Banking*, 35(3), 443–472.

Spiegeleer, J. D. and Schoutens, W. (2012), ‘Pricing contingent convertibles: A derivatives approach’, *The Journal of Derivatives*, 20(2), 27–36.

Squam Lake Working Group (2009), ‘An expedited resolution mechanism for distressed financial firms: Regulatory hybrid securities’, *Council on Foreign Relations*, 10.

Sundaresan, S. and Wang, Z. (2015), ‘On the design of contingent capital with a market trigger’, *The Journal of Finance*, 70(2), 881–920.

Treasury, H. M. (2009), *Risk, reward and responsibility: The financial sector and society*, London, December.

Ueda, K. and Weder Di Mauro, B. (2013), ‘Quantifying structural subsidy values for systemically important financial institutions’, *Journal of Banking and Finance*, 37(10), 3830–3842.

Von Thadden, E.-L. (2004), ‘Bank capital adequacy regulation under the new basel accord’, *Journal of Financial Intermediation*, 13(2), 90–95.

Wall, L. D. (1989), ‘A plan for reducing future deposit insurance losses: Puttable subordinated debt’, *Federal Reserve Bank of Atlanta Economic Review*, 74(4), 2–17.

Wall, L. D. (2010), ‘Too big to fail after FDICIA’, *Economic Review, Federal Reserve Bank of Atlanta*, 95.

Wheelock, D. C. and Wilson, P. W. (1995), ‘Explaining bank failures: Deposit insurance, regulation, and efficiency’, *The Review of Economics and Statistics*, pp. 689–700.

Williams, B. (2016), ‘The impact of non-interest income on bank risk in australia’, *Journal of Banking and Finance*, 73, 16–37.

Appendix 1

Calculation of Merton distance-to-default

We follow Hillegeist, Keating, Cram and Lundstedt (2004) in calculating Merton's (1974) distance-to-default. The market value of equity is modelled as a European call option on the value of the bank's assets:

$$V_E = V_A e^{-\delta T} N(d_1) - X e^{-rT} N(d_2) + (1 - e^{-\delta T}) V_A \quad \text{(A1)}$$

$$d_1 = \frac{log(\frac{V_A}{X}) + (r - \delta + \frac{\sigma_A^2}{2})T}{\sigma_A \sqrt{T}} \quad \text{(A2)}$$

$$d_2 = d_1 - \sigma_A \sqrt{T} \quad \text{(A3)}$$

where V_E is the market value of equity, V_A is the market value of the bank's assets, X is the face value of debt maturing at time T, r is the continuously compounded risk-free interest rate, δ is the continuously compounded dividend rate expressed in terms of V_A and σ_A is the standard deviation of asset returns. The values of V_A and σ_A are estimated by simultaneously solving equation (A1) and the optimal hedge equation:

$$\sigma_E = \frac{V_A e^{-\delta T} N(d_1) \sigma_A}{V_E} \quad \text{(A4)}$$

where σ_E is the standard deviation of equity returns. V_E is set equal to the current market value of equity and σ_E is computed as the annualised standard deviation of daily equity returns over the past twelve months. The strike price X is set equal to the book value of total liabilities at the most recent semi-annual reporting date. T equals one year and r is the 90-day bank bill rate. The dividend rate, δ, is the log return represented by the sum of the prior year's common and preferred dividends with respect to the approximate market value of assets (defined as the book value of total liabilities plus the book value of preferred stock plus the market value of common stock). The Newton method is used to solve the two equations. For starting values, we use $V_A = X + V_E$ and $\sigma_A = \sigma_E V_E/(V_E + X)$.

Finally, we calculate Merton's (1974) distance-to-default as:

$$Mertondd = \frac{log(\frac{V_A}{X}) + (\mu - \delta - \frac{\sigma_A^2}{2})T}{\sigma_A\sqrt{T}} \tag{A5}$$

where μ is the continuously compounded expected return on assets. We set μ equal to the natural logarithm of 1 plus after-tax profit before preferred dividends divided by the approximate market value of assets.

The default probability is the normal transform of the distance-to-default measure:

$$PD = N(-MertonDD) \tag{A6}$$