Bank of Finland Research Discussion Papers
4 • 2019

Saara Tuuli

Model-based regulation and firms' access to finance

Bank of Finland
Research

Bank of Finland Research Discussion Papers
Editor-in-Chief Esa Jokivuolle

Bank of Finland Research Discussion Paper 4/2019
15 February 2019

Saara Tuuli
Model-based regulation and firms' access to finance

ISBN 978-952-323-261-7, online
ISSN 1456-6184, online

Bank of Finland
Research Unit

PO Box 160
FIN-00101 Helsinki

Phone: +358 9 1831

Email: research@bof.fi
Website: www.suomenpankki.fi/en/research/research-unit/

Model-based regulation and firms' access to finance

Saara Tuuli

February 15, 2019

Abstract

This paper investigates the impact of the model-based approach to bank capital regulation (i.e. the Internal Ratings Based Approach; IRBA) on firms' access to finance. A difference-in-differences methodology is used given that the IRBA, introduced as part of Basel II, was adopted by different banks in different times. The results suggest that firms indirectly affected by the new regulation via their main bank adopting the IRBA faced a 6-7 percentage point higher probability of facing a deterioration in their access to finance. When the sample is adjusted for the demand for credit, this estimate increases to 12-13 percentage points. The impact is found to come via increases in the cost of credit and to a smaller extent, reductions in the volume or size of loans. Around three-quarters of the effect is attributed to the sensitivity of the IRBA capital requirements to economic conditions, with adopting banks also found to specialize in low-risk lending.

Keywords: banks, capital regulation, firm-level data, borrowing constraints

JEL Codes: G21, G28, D25, E51

1 Introduction

The determination of bank capital requirements is an important and particularly contentious topic in financial regulation. One of the main goals in the past decade has been to better orient banks' capital requirements towards the underlying risks associated with their assets. Basel II made an important step in this direction by introducing a model-based approach or Internal-Ratings Based Approach (IRBA) to estimating credit risk, with the approach meant to encourage banks to adopt stronger risk management practices. Concerns over the potential impact of the IRBA on lending conditions have, however, been raised in the literature. For example, as hypothesised by Repullo and Suarez (2004)(57), banks could be encouraged to specialise in particular types of lending: given a lower capital requirement for low-risk loans, banks adopting the IRBA could be encouraged to concentrate their portfolios in low-weighted assets at the expense of other types of lending; this could contribute to a misallocation of capital in the economy. Furthermore, the procyclicality of the IRBA could intensify this effect. If measures of asset risk are responsive to economic conditions, capital requirements for banks using the approach will increase in a downturn, potentially leading them to deleverage by reducing lending further, particularly relatively bank capital-intensive (i.e. riskier) customers.

This paper aims to answer the following questions. What was the impact of Basel II's model-based regulation (i.e. the IRBA) on firms' credit conditions? To what extent were changes driven by procyclicality and what other dynamics, such as specialisation, were at play? Using a panel data set created by merging an annual survey of firms' credit conditions in Finland over 2000-2010 with data from firms' financial statements, this paper attempts to answer these questions by exploiting the institutional details of the Finnish implementation of the reform in 2007. The use of the approach was phased in across the Finnish banking industry, with the timing of banks' adoption of the approach depending on the timing of banks' applications for permission to use the approach and the granting of that permission by the regulator. The banks that were granted permission to use the IRBA during the period under study did so before the onset of the crisis and hence under an expectation of favourable economic conditions. The coexistence of the

IRBA and a simpler "Standardised approach", which in practice is very similar to the Basel I approach, allows for the identification of firms affected by the regulation via their banking relationships and an unaffected group against which the former can be compared.

The results suggest that the impact of the IRBA on firms' credit conditions was negative over 2007-2010. Firms primarily funded by banks that adopted the IRBA were associated with a 6.2 to 6.7 percentage point higher likelihood of facing credit constraints compared to their peers primarily funded by banks using the Standardised approach. This estimate rises to 12.2 to 13.1 percentage points when the sample is adjusted for the demand for bank credit. More specifically, the results suggest that much of the negative impact of the approach is likely to have been felt via the cost of credit (i.e. in terms of higher margins or fees), with a more modest impact on the volume of lending (including maturity) and little impact on other loan terms and conditions. Around three-quarters of the impact of the IRBA is attributed to procyclicality, while the results suggest that banks adopting the approach shifted their portfolios towards low-risk assets and away from riskier customers. These results are robust to a battery of tests including those that account for the potential effects of i) possible changes in the composition of firms over the sample, ii) firms' secondary banking relationships, iii) potential biases arising from large banks being more likely than smaller banks to be early adopters and iv) potential differences in the affected and unaffected group based on observed firm characteristics. The results are also tested against a placebo (nonexistant) reform one and two years before Basel II was implemented, as well as the potential effect of the strong interlinkages between the Nordic banking sectors.

There is a growing number of empirical papers studying the impact of bank shocks on lending, with many focusing on the effects of the global financial crisis and others on the impact of the regulatory reforms subsequently introduced to improve the resilience of the banking sector. Two other papers focus on the variation in capital requirements arising from the use of Basel II's IRBA. This paper is closest to Behn et al. (2016)(7), which studies the impact of German banks' use of the IRBA using German credit register loan-level data for 2008-2011 and find that the credit risk shock induced by the collapse

of Lehmans led to an increase in capital charges and in turn a higher reduction in the amount of granted loans where capital charges were calculated under the IRBA. Fraisse et al. (2017)(29) study IRBA banks' capital requirements and their variation among corporate exposures by risk rating over 2008-2011. Aggregating to firm level a sample of "active" loans and credit lines extended by six large French banks to French firms over 2008-2011, the authors show that a one percentage point increase in capital requirements reduces bank lending but this can, in part, be offset by increased lending from other banks. This paper departs from Behn et al. (2016)(7) and Fraisse et al. (2017)(29) in important ways. First, this paper uses a much longer time series based on survey data and hence demand is controlled for directly via firms' self-reported demand for external finance. Second, this paper looks beyond loan volumes: given that the effect of the reform is found to mostly come through changes in the cost of credit in this study, studies focused on loan volumes is likely to underestimate the effect of the IRBA. Third, this paper studies the mechanisms through which the IRBA affects firms' access to finance and, in particular, the role of specialisation in certain types of lending as hypothesised by Repullo and Suarez (2004)(57).

While this paper and those by Behn et al. (2016)(7) and Fraisse et al. (2017)(29) focus on an inherent feature of Basel II that led to variation in the capital requirements of banks, other studies focus on the variation in bank capital requirements directly imposed by the regulator. Prior to the implementation of the current regulatory framework (Basel III), regulators in most countries imposed a uniform capital requirement for all banks and hence variation among banks in terms of level of capital held by banks as a result of the regulatory framework is a fairly recent phenomenon. The lack of historical data means that empirical studies are scarce and studies of the impact of Basel III generally rely on the use of dynamic stochastic general equilibrium models (see e.g. BIS 2011(5) for a review). Exceptions include the regulatory frameworks of Spain and the UK, where bank capital requirements have varied across banks and/or over time (see e.g. Jimenez et al. 2017(45) and DeMarco and Wieladek 2015(23)).

A key challenge in studying the impact of bank shocks is being able to isolate the effect

of changes in supply to those in demand as many factors, such as economic downturns, will effect both. Unique in the study of the impact of banking regulation, this paper controls for demand based on firms' self-reported demand for finance. The loan-level studies of Behn et al. (2016)(7) and Fraisse et al. (2017)(29) rely on firm-time fixed effects to control for credit demand (as pioneered by Kwhaja and Mian 2008(49)) and hence only cover firms with multiple banking relationships. This method is also used in related papers on the impact of the financial crisis on lending (e.g. Iyer et al. 2014(43)) and real economy outcomes (e.g. Cingano et al. 2016)(17). As discussed in Degryse et al. (2018)(21), this applicability of this method (and those using large firms in studying real economy outcomes of the financial crisis as in Campello et al. 2010(12), Ivashina and Scharfstein 2010(42) and Chodorow-Reich 2014(15)) is limited since multiple-relationship (and large) firms represent a minority of firms in many countries. A notable exception is Jimenez et al. (2017)(45) and Puri et al. (2011)(56) who use loan applications to control for demand in studying an early Spanish form of macroprudential policy (dynamic provisioning) on lending and the effects of the financial crisis on retail lending, respectively. The use of loan applications identifies which firms applied for a loan, but is not able to capture informal constraints (i.e. firms being discouraged from applying for credit), which can lead to biased results (see e.g. Popov 2016)(54). Other strategies used to isolate the effects of credit supply from demand include i) the use of exogenous shocks (e.g. Japanese stock market decline in Peek and Rosengren 1997(53); the Russian financial crisis in Chava and Purnanandam 2011(14); unanticipated nuclear tests in Khwaja and Mian 2008(49)); ii) the estimation of demand and supply equations using data that includes firm-level characteristics in a disequilibrium model (e.g. Kremp and Sevestre 2013(50), Carbo-Valverde et al. 2016(13)); and iii) bank lending standards as gauged by bank surveys (e.g. the ECB's Bank Lending Survey as in Ciccarelli et al 2015(16); van der Veer and Hoebericts 2016(62); Kuchler 2012(48); Blaes 2011(11); Del Giovane 2011(22)).

A few recent papers use surveys of firms to control for demand albeit in a different context. For example, Ferrando, Popov and Udell (2017(30), 2018(31)) use the ECB's Survey on Access to Enterprises (SAFE) to study the impact of sovereign stress and the

ECB's unconventional monetary policy measures on euro area small and medium-sized enterprises (SMEs) and Popov and Udell (2012)(55) use the EBRD's BEEPS survey to study the impact of average banking conditions on SME credit supply in 16 emerging European countries. There are some important differences between the surveys used in these studies and that used in this paper. First, unlike the dataset used here, which identifies firms' main funding sources (whether a particular bank or another external provider of finance), these surveys do not identify the key banking relationship or other funding source of firms; only Ferrando et al. (2018)(31) identifies bank-firm relationships using the Bureau an Dijk's Amadeus database, which is mute over the relative importance of different relationships when more than one is reported. Second, there are major differences in terms of the coverages of the surveys. The dataset used here is an unbalanced panel of all firms over the 2000-2010 period with the same firms interviewed in the post- and pre-reform period, whereas the ECB's SAFE survey covers only SMEs in the post-crisis period, with firms generally only appearing once (at least in the six and four waves utilized in Ferrando et al. 2017(30) and 2018(31) respectively). The BEEPS data covers both SMEs and larger firms but the data generally is not presented in panel form and in Popov and Udell (2012)(55) only the years 2005 and 2008 are included.

Another benefit of using firm-level surveys is the amount of available outcome variables (credit constraints in terms of volumes, margins, fees and other terms and conditions). The loan-level studies (e.g. Behn et al. 2016(7), Fraisse et al. 2017(29), Iyer et al. 2014(43), Puri et al. 2011(56)) generally are unable to look beyond loan volumes. Furthermore, in papers by Behn et al. (2016)(7) and Fraisse et al. (2017)(29), for example, the extensive margin (banks ending an existing borrower relationship) is captured by observing a loan existing and then ceasing to exist in a later period. It is unclear, however, that this method adequately captures decisions by banks as distinct from decisions by firms to end a borrowing relationship due to factors such as changes in demand. Other outcome variables (e.g. the cost of credit or other lending terms and conditions) are hardly discussed due to lack of reliable data.

Other related papers include earlier research on the impact of Basel II's IRBA focused

on simulations to estimate its impact in terms of absolute changes in capital requirements, with some of those studies then extrapolating the impact of those changes onto individual portfolios. For example, the results of the Quantitative Impact Study 5 of the Committee of European Banking Supervisors (2006)(18) suggest a significant fall in the minimum required capital for EU banks under Basel II (under the assumption of favourable economic conditions) compared to the previous regime, with a much sharper fall predicted for banks adopting the IRBA compared to those adopting the Standard approach. This relatively large fall is mostly due to a fall in capital requirements against mortgage assets, but also - to a lesser extent - SME retail assets. Other papers such as Altman and Sabato (2005)(4) and Saurina and Trucharte (2004)(59) develop models of the probability of default associated with different types of firms. These authors find that the difference in capital requirements under the IRB, Standardised and Basel I approaches depends on the extent to which corporate sector lending is categorised as corporate as opposed to retail, since the latter attracts a favourable risk weight.

A strand of theoretical literature considers the coexistence of the IRB and Standardised approaches and its impact on the asset allocation among banks and/or competition between banks. In a theoretical analysis, Repullo and Suarez (2004)(57) hypothesise that banks specialise in certain types of lending as a result of the co-existence of the two approaches. IRBA adopters have a competitive advantage in the provision of low-risk loans because the IRBA involves a lower capital requirement for these loans. By contrast, non-adopters have a competitive advantage in high-risk lending because the 'flat rate' approach of lumping borrowers into categories effectively involves low-risk borrowers cross-subsidising high-risk borrowers, which increases the attractiveness of high-risk loans and raises the average credit risk of a bank's loan portfolio. The authors therefore expect low-risk firms to achieve reductions in loan rates by borrowing from banks adopting the IRBA and high-risk firms to avoid increases in their loan rates by borrowing from banks that adopt the Standardised approach. Rime (2005)(58), also using a theoretical model, comes to a similar conclusion. An empirical analysis of this specialism hypothesis should see the competitive advantage of different banks reflected in prices; lower prices

for low-risk customers of IRBA banks versus competitors and lower prices for high-risk customers of non-IRBA banks versus competitors. A reduction (increase) in the overall riskiness of customers of IRBA (non-IRBA) banks should also be expected. The only paper to directly test for the Repullo and Suarez (2004)(57) hypothesis is Benetton et al. (2017)(8); this paper considers only mortgage lending. The authors find that the coexistence of the IRB and Standardised approaches led banks to specialise and hence to a "systemic concentration of high-risk mortgages in lenders with less sophisticated risk management". Behn et al. (2016)(7) find that less profitable firms are likely to be more affected by the credit risk shock, implicitly providing support to the specialisation hypothesis.

Another strand of literature focuses on the procyclical effects of bank behaviour and lending in the economic cycle (see e.g. Goodhart 2005(32); Goodhart et al. 2004(33); Kashyap and Stein (2004)(47); Taylor and Goodhart 2004(61) and Gordy and Howell 2006(34)). Procyclicality in this context refers to the unintended consequence of risk-based capital requirements increasing the amplitude of economic cycles. Capital requirements increase during a downturn to the extent that measures of (perceived) asset risk are responsive to economic conditions. Banks can either raise new equity, which can be more difficult during a downturn than under favourable economic conditions, and/or banks can deleverage by reducing lending, exacerbating the downturn. The extent to which countercyclical capital charges effect loan volumes - particularly risky ones, which are likely to experience a relatively large impact due their relative capital-intensity - remains unclear (adjustments made by banks during the 2008 crisis in response to higher capital requirements are discussed, for example, in Cohen, 2013(19)).

More broadly, this paper contributes to the literature on the impact of bank liquidity or capital shocks on loan supply (e.g. Bernanke 1983(9); Bernanke, Lown and Friedman 1991(10); Peek and Rosengren 1995(52); and Kashyap and Stein 2000)(46).

Studying the Finnish case is interesting for at least three reasons. First, an aggressive use of the IRBA among some Finnish banks means that risk weights among mortgage exposures applied by these banks have recently, on average, been the lowest in Europe (IMF

2016)(40). This led to an intervention by the Finnish Financial Supervisory Authority, with a 15% minimum risk weight on residential mortgage loans effective from January 2018. Indeed, Herrala (2014)(37) documents a significant rise in mortgage lending in Finland as a result of the reform, while the other side of the coin (the impact on the corporate sector) has been less studied. Second, any effects on the corporate sector as a result of the IRBA are likely to have been heavily influenced by procyclicality. There was a steep decline in Finnish GDP following the start of the financial crisis and Finland's economy is also heavily bank-based;[1] therefore the procyclicality mechanism may have been more pronounced in Finland for a given fall in output relative to some other economies (see e.g. Heid 2007 (36), who argues that bank-based economies experience the bigger procyclical effects than financial markets-based economies). Third, the resilience of the Finnish financial sector over the financial crisis lessens the problem of disentangling the effects of the reform from other effects associated with the crisis. Banks were highly capitalised and benefited from flight-to-safety flows: banks' claims at the Bank of Finland increased from EUR3.8bn in December 2006 to EUR8.3bn in December 2009 as other euro area banks hoarded liquidity as interbank deposits with Finnish banks.

This paper is split into six parts. Section 2 provides an overview of the implementation of Basel II in Finland. Section 3 and Section 4 provides a description of the data and the empirical strategy used in this study. Section 5 discusses the main results, sensitives around them and robustness checks. The final section concludes.

2 Overview of Basel II implementation in Finland

An obligation for banks to continually meet an 8% risk-weighted capital ratio, defined as the ratio of capital to risk-weighted assets, was established as part of the Basel Accord of 1988 ('Basel I'). Weights were set depending on the institutional nature of the borrower: for example, a zero weight was assigned to an OECD government security, 50% to a loan fully secured by a residential mortgage and 100% for industrial and commercial loans.

[1]See e.g. Levine (2002)(51) for indicators of the extent to which Finland and other countries are bank-based economies.

A key objective of Basel Capital Accord ('Basel II'), introduced as a revision to the Basel I framework, was to better orient banks' capital requirements towards the actual credit risks associated with their assets. Released by the Basel Committee on Banking Supervision in 2004 and applied in the EU from 1 January 2007, banks were given two broad methodologies to choose from for calculating credit risk weights and hence capital charges: the IRBA and the Standardised approach (internal models for market risks arising from trading activities had been introduced as part of an amendment in 1996). Under the IRBA, the estimation of credit risk is (at least partially) delegated to banks themselves. The Foundation IRBA allowed banks to calculate the probability of default parameter based on self-collected quantitative and qualitative criteria, whereas the Advanced IRBA (not used in Finland during the period studied here) allowed banks to also calculate three additional parameters (loss given default, exposure at default and maturity). Under the Standardised approach, risk weights are either based on external rating institution's assessments or, where external ratings are unavailable, based on Basel I risk weights. With most firms being small and therefore unrated, including 75% of the firms of the dataset used here, the Standardised approach is in principle similar to that of Basel I (Hakenes and Schnabel, 2011(35)).

Within the five broad classes of assets with different underlying risk characteristics (sovereign, bank, corporate, retail and equity), the corporate and retail categories are most relevant for lending to firms. Criticism over the potentially excessively high risk weights for SMEs under Basel II led the Basel Committee (Basel Committee on Banking Supervision, 2004)(6) to allow banks to apply the more favourable retail risk weight of 75% to very small businesses, provided the bank's portfolio is diverse and the bank's loan to the SME borrower is less than 1 million euros. Favourable treatment is also applied to SME lending that falls under the corporate category: a special discount is applied for exposures to firms with under 50 million euros in sales (Basel Committee, 2004)(6).

In Finland, banks were invited to apply for permission from the Finnish Supervisory Authority to use the IRBA a minimum of a year before the intended adoption date,[2]

[2]Finnish Financial Supervisory Authority, 2005(25).

with banks allowed to apply it from the beginning of 2007 onwards. Banks needed to prove to authorities that "their rating and risk estimation systems and processes provide a meaningful assessment of borrower and transaction characteristics; a meaningful differentiation of risk; and reasonably accurate and consistent quantitative estimates of risk" (Basel Committee, 2004)(6). The adoption of the approach was therefore staggered among banks, depending on applications and permissions for its use. The approach was also implemented in a staggered way by each IRBA-adopting bank: permission to use the new approach was granted on a portfolio basis, with a gradual implementation plan agreed with the supervisor.[3] Non-adopters and late adopters of the IRBA moved to the Standardised approach over 2007.

The first Finnish adoptee of the IRBA, Nordea, received approval to use the IRBA for corporate and institutional exposure classes in Finland in June 2007 (in other words, before the crisis), followed by approval for their retail portfolio in December 2008.[4] As noted in Nordea's Annual Reports, 37% of Nordea's exposures were calculated using the IRBA in 2007, rising to 49% in 2010 and 74.4% in 2015.[5]

Another early adoptee of the IRBA was OP Financial Group, made up of around 180 credit institutions and their central organisation. OP was granted permission to use the IRBA for corporate and institutional customers within its corporate lending entity (at the time called Pohjola) in 2008.[6] Further permissions were granted in 2011 for retail and credit institution exposures.[7]

Apart from Handelsbanken, which received permission to use the IRBA in 2008,[8] no other banks were formally using it in their Finnish portfolios until after the period under review in this paper (that is, after 2010). For example, another large bank, Danske,

[3]Expecting a decrease in capital among IRBA adoptees, the financial supervisor also required the capital requirement of banks using the approach to not fall by more than 5% during the first year, 10% after the second year and 20% after the third year of using the IRBA compared to the Basel I capital adequacy calculation. See Finnish Financial Supervisory Authority, 2006(26). This was later extended to the end of 2011 (see Finnish Financial Supervisory Authority, 2009(27)

[4]See "Capital Adequacy and Risk Management Report (Pillar 3), Nordea Bank Group" 2007, 2008 and 2014 for announcements on IRBA adoption.

[5]Nordea Bank Finland Annual Reports 2007, 2010 and 2015.

[6]OP-Pohjola Group Annual Review, 2008.

[7]OP-Pohjola Group Report by the Executive Board and Financial Statements, 2011.

[8]Handelsbanken Risk and Capital Management – information according to Pillar 3, 2008.

received IRBA approval, for its Finnish corporate exposures, in 2015.[9] Ålandsbanken received IRBA approval in 2012 for its household portfolio and in 2016 for its corporate portfolio[10] and Aktia in 2015 for its household portfolio.[11]

Although only a small number of banks were IRBA certified before 2010, the high degree of concentration in the Finnish banking system means that 31% of private non-financial lending in Finland was undertaken by an IRBA-approved institution in end-2007, 69% in end-2008, 81% in end-2015 and 82% in end-2016.[12] Note that only the Foundation IRBA was in use in Finland during the period studied here and hence no distinction is made between the Foundation and Advanced IRB approaches.

Ahead of implementation and against the expectation of favourable economic conditions, the financial supervisor and banks expected the reform to lead to a fall in capital requirements across all banks, especially for those using the IRBA.[13] Indeed, for banks for which data is available, both corporate and retail exposures were associated with substantially lower risk weights under the IRBA.[14] While banks have incentive to move to the IRBA given the improved alignment between the banks' required capital and actual asset risk, the high fixed cost associated with meeting these minimum requirements (e.g. a large investment into risk management technologies) means that larger banks are likely to have been able to adopt the approach more quickly than smaller banks. Banks that did not adopt the approach pre-crisis would have faced reduced incentives to adopt the approach once the crisis hit.

While a reduction in capital requirements suggests a positive effect on corporate credit conditions, particularly for firms with relationships with IRBA adopters, portfolio affects and, under unfavourable economic conditions, the procyclicality of Basel II regulation, points to a potential negative impact on corporate credit conditions. Finnish banks'

[9]Danske Bank Group Annual Report, 2015. Note that Danske's Danish parent received approval from the Danish supervisor to use the IRBA in 2007 (Danske Bank Group Annual Report, 2007).

[10]Ålandsbanken Annual Report, 2011 and Ålandsbanken Interim Report, January-September 2016.

[11]Aktia Bank PLC Annual Report, 2015.

[12]Based on lending shares in 2010 (the final year of the sample used in this paper) as reported by Finance Finland (2010)(24).

[13]See e.g. Pohjola Bank plc Annual Review 2007, Nordea Bank Finland Annual Report 2005 and FSA Newline 4/2007.(28)

[14]See e.g. Handelsbanken Annual Report 2007 and Nordea Finland Capital Risk Management Reports 2008-2010.

financial statements point to some IRBA adopters shifting their portfolios towards safer assets, such as mortgages, as a result of the reform. Furthermore, Herrala (2014)(37), who studies the impact of Basel II on banks' credit policies in Finland, albeit only in terms of the household sector, finds that, as a result of the reform, banks' practices led to a 20-50% improvement in household credit availability, with banks shifting away from corporate credit in attempts to economise on capital charges.[15] Furthermore, procyclicality could exacerbate this effect given the sharp downturn experienced in Finland in 2009.

3 Data description

The data used in this study is based on a merger of survey data and data from firms' financial statements. The survey is based on an annual survey of credit conditions conducted since 1994 on behalf of a number of organisations including the Bank of Finland and what are now called the Confederation of Finnish Industries and the Ministry of Employment and the Economy. Over the sample used in this study, covering 2000-2010 (excluding 2005),[16] participating firms numbered around 1,000 per year and covered different (non-financial) industries and locations in Finland. The number of observations total 10,705 and cover 3,372 individual firms. Earlier and later years are excluded due to issues around the comparability of surveys[17] and in order to avoid issues associated with the confounding effects of major changes affecting the Finnish banking sector e.g. the adoption of the euro. Statistics Finland's data on firms' financial statements is comprehensive: it covers the period from 1986 onwards and includes all key financial statement variables e.g. turnover, assets, equity, profit, personnel, wages, rent, etc.[18]

The panel is unbalanced (see Table 1) in part due to a particular percentage of firms being dropped out of the survey intentionally each year. The response rate varied between

[15]Herrala (2014)(37) also argues that banks reacted to regulation in a forward-looking manner, with banks changing credit policies as early as seven years ahead of Basel II implementation. The analysis here is not at odds with that of Herrala, but suggests that adjustments were (also) made once implementation took place. Herrala's analysis suggests that the total impact of Basel II could be underestimated here if some of the impact came through as early as 2000.

[16]Data for the year 2005 was unavailable.

[17]In particular, the data available after 2010 excludes information about the particular bank that the firm is predominantly funded by.

[18]The list of variables is available on Statistics Finland's website(60).

70 and 80% over the period utilised in this study. The 20 to 30% of firms not responding to the survey include those that were initially included in the survey but then not contacted due to reasons such as a merger leading to a double count of a firm, the firm no longer being in operation, bankruptcy, etc. Also contributing to the non-response rate was the inclusion of subsidiaries with financing arrangements determined at group level: where group and subsidiary respondents were the same, the respondent was only interviewed once.

3.1 *Dependent variables*

Descriptive statistics for the variables utilised in this study are presented in Table 2 . As discussed below, the key dependent variables for testing the impact of IRBA adoption on credit conditions relate to various difficulties firms reported to have experienced in accessing finance. The key dependent variable is an aggregate term, $Constrained_{ijt}$, which equals 1 if firm i with a key relationship with bank j at time t reported to have seen a deterioration in their access to credit over the past 12 months and zero otherwise. This is a broad category, which includes issues around the ***cost*** of lending (the firm reporting increases in margins and fees for existing or new credit), the ***volume*** of lending (firms reporting having their loan application denied, being granted a loan of a smaller size and/or with a shorter maturity than they had applied for) and ***firms reporting harsher other terms and conditions*** (such as a tightening in collateral requirements). The aggregate term is broken down into dummy variables $Cost_{ijt}$, $Volume_{ijt}$ and $Conditions_{ijt}$ respectively, with these disaggregated variables also used as dependent variables in the equations outlined below.[19] In aggregate, firms experiencing a deterioration in their access to credit varied between 5% and 10% ahead of the crisis, followed by a doubling to over 20% in 2009 (Figure 1). While the pattern of the time series is similar across the disaggregated variables, the evolution of the aggregate term, $Constrained_{ijt}$,

[19]Behn et al. (2016)(7), Fraisse et al. (2017)(29) and Jimenez et al. (2012(44) and 2017(45)) distinguish between the 'extensive margin' i.e. the decision to initiate or stop a lending relationship and the 'intensive margin' i.e. conditional on lending, the volume of credit granted. These two terms relating to the volume of lending are aggregated into one term here, given the small number of cases in which these apply.

is predominantly driven by developments in the cost of credit, particularly a widening in margins. The number of firms denied credit altogether (1.1%), awarded a smaller loan than applied for (1.3%) or with a shorter maturity (0.5%) or experiencing a tightening in other conditions (1.2%) is of a small magnitude relative to changes in margins (6.1%) and fees (3%).

In testing for the Repullo and Suarez (2004)(57) hypothesis of specialisation, a credit metric based on the Altman (1968)(2) Z-score for predicting bankruptcy is used as the dependent variable.[20] The Z-score - used as a prototype for many IRBA models (Altman et al., 2017)(3) - is based on a number of financial ratios. The version used here, based on the estimates of the Z-score in a cross-country context in Altman et al. (2017)(3), includes four of them: i) working capital to total assets (as a measure of net liquid assets relative to total capitalisation; ii) retained earnings to total assets (as a measure of earned surplus of a firm over its life); iii) earnings before interest and taxes to total assets (as a measure of the productivity or the profitability of the assets of the firm); and iv) the market value of equity to the book value of total liabilities (as an indicator of the extent to which assets of a firm can decline in value before the liabilities exceed the assets and the firm becomes insolvent). An average of the four best performing models (out of 8) for Finland is used. As discussed in Altman et al. (2017)(3), the Z-score (or logit) has a probability representation but does not represent an empirical probability of default (PD) and does not have a PD interpretation. Instead, it is used here as general metric of the creditworthiness of a firm, where the higher the number between 0 and 1, the more likely the firm is to go bankrupt.

3.2 *Independent variables*

The key independent variables are the dummy variables IRB_j and $Reform_{jt}$. The variable IRB_j equals 1 if the firm declares their main external financier to be a bank that adopted the IRBA and zero otherwise.[21] The variable $Reform_{jt}$ represents the time pe-

[20] Other recent empirical studies that use the Z-Altman score include, for example Ippolito et al (2016)(41).

[21] The survey was conducted in Finnish and translates into "Who is your main financier (select only one)?" or "What is your most important source of external finance?". Two options are then presented

riod from the reform onwards and equals 1 on the date the main financing bank moving to the new regulatory regime (be it the IRB or the Standardised approach) and all subsequent periods. The variable $Reform_{it}$ can therefore only equal 1 from 2007 onwards and only from 2008 onwards for some firms. The interaction term ($IRB_j X Reform_{jt}$) is the key variable interest, given that its coefficient estimates the impact of the reform.

One issue associated with these independent variables is that the dataset only identifies the banking relationship the firm declares to be their main one in any given year. Many firms have more than one banking relationship, particularly large ones. Firms in Finland, like those in other Nordic countries, tend to have a small number of banking relationships as opposed to those in for example southern Europe (Degryse et al., 2009)(20), however. Indeed, around 45% of firms used in this survey had only one banking relationship and around 75% had two or fewer. These percentages change to 50% and 85% when only SMEs are considered. As discussed further below, the sample can be narrowed to firms with only a small number of banking relationships to investigate the extent to which the presence of multiple relationships might affect the results.

Another issue associated with these independent variables are a number of mergers that took place over the sample period (e.g. the merger of Sampo Bank and Leonia Bank in 2001 and its subsequent acquisition by Danske Bank). Data for banks that ended up as part of another banking group are merged with data for other entities in the group. While this is problematic in the sense that competitors banks, with different business models, are likely to be quite different in terms of their lending strategies as separate entities than as a merged bank, these mergers occurred before the adoption of the IRBA. Therefore, although this might affect bank-level fixed effects, it does not affect the key dependent variables – IRB_j and $Reform_{jt}$ or the coefficient estimates associated with them.

The remaining variables relate to a number of firm-level controls (Table 2) widely used in the literature on firms' access to credit. These include dummy variables for the

'bank' or 'other', with the former question leading to another multiple choice question with the option of ticking one of around 14 Finnish banks or filling in an open field for a bank not on the list. The market share of banks implied by survey responses closely reflects the market share of banks based on banks' own financial statements.

size of the firm (using the EU staff headcount-based definition[22]), as well as industry and geographical location. The Z-score or the ratios used in its calculation are not directly used as controls where the dependent variable relates to credit conditions because their inclusion could involve a loss of useful information (the baby out with the bathwater problem discussed in Angrist and Pischke (2009)(1)).[23] Financial statement variables such as logs of the firms' turnover and profit are nevertheless used to control for balance sheet size and as a measure of firm performance, respectively. Other measures of financial health and performance used here include equity ratio (%), liquidity ratio (%), return on capital invested (%), return on investment (%) and return on equity (%).[24]

One shortcoming of this dataset is the lack of data on banks: sources such as SNL only report bank balance sheet data from 2005 onwards for Finnish banks. Indeed, many relevant series are only available from 2007 given the Basel II Pillar 3 disclosure requirements. In any case, the number of mergers makes other metrics difficult to utilise on a consistent basis. Other technical features of the Finnish banking sector, such as the illiquidity of the secondary market for Finnish bank bonds also makes it difficult to estimate funding costs in a meaningful way.

4 Empirical strategy

The key difficulty in all empirical papers that study the effects of different reforms is selection bias. In the context of this study, for example, it could be that firms selected into being affected by the reform by their choice of their main financier (the anticipation effect). The survey used here nevertheless suggests that borrowers did not chose a particular bank because of its IRBA or non-IRBA status. In the 2006 survey, firms were asked about their expectations regarding the impact of Basel II on their access to credit. Around three-quarters of firms were unaware of the upcoming changes to banking

[22]The European Commission defines firm sizes as follows: micro (<10 staff), small (<50 staff) and medium-sized (<250).

[23]Estimates of the effect of the reform are, however, little changed when the Z-score is included as a dependent variable (see model 25).

[24]All metrics are reported by Statistics Finland, except for the liquidity ratio, which has been calculated as current over total assets.

regulation. Out of the firms that were aware, 78% expected no changes in their ability to obtain credit and 60% expected no changes to their margins. Across the survey, firms cited that the reason behind their selection of a particular bank was due to their existing relationship with the bank (55%), existing prices (21%), available services (11%), location (8%), etc.

Another important potential source of selection bias arises from banks' decisions to apply to use the IRBA and over the borrowers to whom they extend credit. A type of bank more likely than others to apply for the IRBA may also have responded to the crisis differently in terms of their lending practices than non-IRBA adopting banks due to reasons unrelated to the reform or procyclicality. Indeed, as discussed in e.g. Hakenes and Snabl (2011)(35), large banks are likely to have been early adopters of the reform, given the high fixed cost of risk management technologies. Large banks may have also been more heavily exposed to the interbank markets than their smaller counterparts, with the financial crisis playing a relatively large role in their balance sheet decisions. If so, the OLS coefficient associated with the key variable of interest, the interaction term, would reflect selection bias as well as causal effects. The results outlined below suggest that riskier firms could have been more affected than their less risky counterparts; the negative correlation between selection of firms post reform (lower risk ones) and the dependent variable (more significant deterioration in access to credit) implies a negative bias, working against the findings presented here.

Selection bias arising from banks' decisions may be less problematic in Finland than in other jurisdictions for at least two reasons. Firstly, the Finnish banking sector is highly concentrated and dominated by a few large institutions including groups of credit unions and savings banks. While the adoption of the IRBA was determined by banks (along with the financial supervisory authority), suggesting that banks 'self-select' into being affected by the policy, many of the banks (and most of overall business lending) included in the control group in this study eventually moved under the IRBA suggesting that banks not adopting the IRBA during the period under study were not fundamentally unable to adopt it (and hence fundamentally different to IRBA banks) but were just slower to do

so. Indeed, IRBA adopting banks applied for permissions before the onset of the crisis and in the expectation of favourable economic conditions and hence lower risk weights and capital charges that could be achieved under the Standardised approach. Given the recession and the sensitivity of risk weights to the economic environment, capital charges ended up being higher than anticipated by early adopters, reducing incentives among later adopters to speedily apply for permission to adopt the IRBA. Second, the Finnish banking system faired the global financial crisis well due to strong capital buffers and limited exposures to opaque structured products or vulnerable countries (see e.g. IMF 2010(38) and IMF 2012(39)). Banks became safe havens, overly liquid and hence any differences in e.g. interbank exposures between IRBA and non-IRBA banks are unlikely to have a major effect on large banks' lending decisions. The group of IRBA and non-IRBA banks also do not widely differ, on average, in terms of key metrics such as capital ratios. The issue of differences between these banks is nevertheless discussed further below given that large banks with more sophisticated risk management practices were more likely than other banks to adopt the IRBA before 2010 and may have reacted to the crisis differently in ways that matter for the results of this study.

Another reason why selection effects arising may not be overly problematic in this study is that studying the evolution of the key variables suggests that the group of firms not financed by IRBA banks is likely to be a reasonable counterfactual for those that were. For example, a time series of the key dependent variable, $Constrained_{ijt}$ suggests that, pre-reform, firms financed by IRBA-adopting banks were not more credit constrained than those not affected by the IRBA (Figure 2) nor were there any major divergences in the evolution of credit conditions among firms financed by IRBA adopters versus other banks. Indeed, the difference in the averages of these groups in terms of the $Constrained_{ijt}$ variable is close to zero but then increases once the reform is implemented (Figure 3). This is also broadly true when the average Z-score is compared among the two groups (Figure 4). That is, the evolution of the riskiness of IRBA banks' borrowers were broadly similar to that of non-IRBA banks' borrowers pre-reform.

While the affected and unaffected groups need not be identical in their composition in

terms of observables in order for the unaffected group to be used as a valid counterfactual for the affected group, similar characteristics could suggest that firms are also more likely than not to be similar in terms of unobservables. Studying the characteristics of firms (Table 3) ahead of the reform (i.e. the period of 2000-2006) suggests that firms were indeed broadly similar in terms of their main characteristics, particularly in terms of their financials (equity ratio, profit, return on capital invested, return on investment and return on equity), geography and industry. The affected group nevertheless has a slightly higher liquidity ratio, higher turnover and a slightly higher proportion of small firms. The magnitudes of these differences are small, but statistically significant. A regression with IRB_j as the dependent variable suggests that these characteristics are unable to help predict whether a firm belongs to the affected group or not (Table 4). This is with the exception of the liquidity ratio and the dummy variables for micro and small firms. The effect of the size dummies disappears if these are merged together into one wider group of micro and small firms. One way to test for the importance of these differences is to narrow the sample such that the groups of unaffected and affected firms are identical in their composition in terms of observable characteristics using a technique called matching. This is discussed further below.

Using the basic difference-in-differences set up, the first set of models involve the dependent variable being regressed on the key policy variables. In particular, the following linear probability model is estimated:

$$y_{ijt} = \alpha_i + \alpha_t + \beta_1 IRB_j + \beta_2 Reform_{jt} + \beta_3 IRB_j \mathrm{X} Reform_{jt} + X'_{it}\gamma + u_{ijt}$$

where y_{ijt} is the outcome variable for firm i, with a key relationship with bank j at time t. These outcome variables include $Constrained_{ijt}$, $Cost_{ijt}$, $Volume_{ijt}$ and $Conditions_{ijt}$. The α terms are firm and time fixed effects and X_{it} are firm-level control variables. As discussed above, the variables IRB_j and $Reform_{jt}$ are indicator dummies for the adoption of the IRBA approach by bank j and the timing of the reform (i.e. when banks transitioned to either the IRB or Standardised approach). The coefficient on the interaction term (β_3) is the key estimate of interest. Standard errors are clustered at the

firm level, given the relatively small number of banks.

Testing for specialisation hypothesis of Repullo and Suarez (2004)(57) involves estimating the following equation:

$$Zscore_{ijt} = \alpha_i + \alpha_t + \beta_1 IRB_j + \beta_2 Reform_{jt} + \beta_3 IRB_j \text{X} Reform_{jt} + u_{ijt}$$

The sample used to test the Repullo and Suarez (2004) hypothesis is of course narrower, as it only includes firms that were awarded credit by IRBA and non-IRBA banks and not just those that applied for it.

5 Regulation and changes in firms' access to credit

5.1 *Main regression results*

The results of the main regression, which uses $Constrained_{ijt}$ as the dependent variable, is shown in Table 5. The results are reported for different combinations of firm fixed effects and control variables. Furthermore, two different samples are used: i) the whole sample and ii) a sample that adjusts for demand by including only firms that both applied for credit and are externally funded, as opposed to their main funding source being internal funds, a parent company, etc.

The results using the whole sample (model 1 and 2) suggests that firms affected by the IRBA by their main external financier being an IRBA adopter were 6.2 to 6.7 percentage points more likely to face financing constraints following the reform. The result is significant at 1% level across different specifications of the model using the whole sample of firms. The results suggest that firms banking with IRBA adopters did not face less favourable credit conditions pre-reform: the estimate of β_1 is around zero. Instead, less favourable access to credit only kicked in once IRBA practices had been adopted. Controlling for year effects, the post-reform period was generally associated with fewer problems in accessing credit, although this result is not statistically significant.

Predictably, a higher proportion of firms included in the sample adjusted for demand

faced problems in their access to credit: coefficient estimates puts this proportion at around 40% as opposed to around 10% of all firms in the whole sample (model 4 and 5). Furthermore, firms reporting an IRBA bank as their main lender faced a 12.2 to 13.1 percentage point higher likelihood of being credit constrained. The confidence interval is wide and includes the estimate for the full sample. One explanation for this higher estimate is that the pool of firms used in the sample includes firms at different ends of the spectrum in terms of their prospects: both firms seeking finance beyond internal funds only to invest or expand operations (around 50% over the survey period) and those seeking finance only to deal with cash flow issues (around 23%). The estimate of β_1 is statistically significant using the smaller sample: firms banking with IRBA adopters faced a smaller probability of being credit constrained pre-reform. This, coupled with the higher estimate of β_3, suggests that firms reliant on external credit faced a much more economically significant deterioration in their access to credit once the reform kicked in if they banked with IRBA adopters instead of non-IRBA adopters.

The models without firm fixed effects (models 3 and 6) both point to affected firms being 8.5 percentage points more likely to face problems in accessing credit. The estimate of β_1 (the coefficient associated with IRB_j) is relatively large and statistically significant at 1% in model 6 (with only firms that applied for credit): it could be that the fixed effect of IRBA banks absorbs some of the firm-level fixed effects excluded in this version of the model: a small number of banks in the sample and a small number of changes by firms to their main funder could translate into a high degree of correlation between the IRB_j variable and firm fixed effects. Indeed, survey reports a 2008 peak amount of firms reporting that they had changed their main financier over the past three years being less than 10% compared to around 7 to 9% in other years. Furthermore, only around a third of the 7-10% of firms switching banks switched from their main external financier being an IRBA adopter to a non-IRBA adopter or vice versa (in other words, switched from being in the affected group to the unaffected group or vice versa). The coefficient estimate of β_1 is nevertheless not significant with the whole sample included (model 3) and re-estimating the other models (1, 2, 4 and 5) without firm fixed effects

makes negligible difference to the results.

The results of the disaggregated outcomes – $Cost_{ijt}$, $Volume_{ijt}$ and $Conditions_{ijt}$ – are presented in Table 6 and shed light on the way in which the impact of the reform was felt by firms. Contrary to those of Behn et al. (2016)(7)[25], the results suggest that the impact from the reform came predominantly through changes in costs, that is, through increases in the margins or fees charged by the bank. Indeed, the economic significance of the reform on the cost of credit, at 6.5 to 8.7 percentage points using the two different samples, is broadly the same as that associated with the aggregate term $Constrained_{ijt}$. The estimate of the impact using the smaller sample is nevertheless imprecise, with a wide confidence interval of -0.031 to 0.205. The impact of the reform was also felt, albeit to a much smaller extent, via a reduction in terms of the volume of lending (including maturity). The results suggest that affected firms were 1 to 1.5 percentage points less likely to have their desired volume of lending granted. Results for the estimate of the impact of the reform on other lending conditions is probably close to zero.

5.2 *Sensitivity analysis and robustness checks*

This section considers the various issues identified above and the extent to which they are relevant for the interpretation of the results. First, results are presented for five difference samples (see Tables 7 and 8) and regressions with the key independent variables modified as "placebo" tests are considered.

First, the sample is reduced to exclude firms that appear only in the pre-reform or only in the post-reform sample (model 14). While this cuts the number of observations in half, it allows for a test of the extent to which the results are skewed by firms that drop out of the survey pre-reform or are introduced into the survey post-reform. The result remains significant at 1% level using this smaller sample, with the estimate of the impact of the reform (at 0.093) being somewhat higher than under the full sample.

Second, the sample is restricted to only firms that stick with their main funder in case

[25]Behn et al. (2016) infers the payment structure from quarterly loan amounts given a lack of data on interest rates and finds the impact of the reform to have come through changes in the volume of lending as opposed to other loan conditions, including interest rates

firms seeking external finance from different sources over time means that the composition of the affected and unaffected groups changes following the reform: unaffected firms become affected firms and vice versa (model 15). As discussed above, restricting the sample in this way involves a loss of only 10% of observations, with little change to the estimate of the impact of the reform.

Third, since the dataset does not capture the potential offsetting effect of secondary relationships, the sample is restricted to firms reporting that they only have one or two banking relationships. Since a firm facing a negative change to their terms of credit could substitute lending from their main financier to other banks, as discussed in Fraisse et al. (2017)(29), the impact of the reform could be overstated in the results presented above. In line with evidence that Finnish firms tend to have few banking relationships, the sample is reduced by around one-fifth. The smaller sample (model 16) leads to a smaller estimate of β_3 (in other words, the impact of the reform is smaller among firms with few relationships). It is possible that the strength of the borrower-lender relationship is stronger among these firms than on average across the sample: 63% of firms with one or two relationships reported having selected their main external financier due to their existing relationship compared with 57% of firms with three or more. As discussed in, for example, Degryse et al. (2009), empirical evidence suggest that relationship borrowers tend to have better access to credit. If borrowers with few relationships are more likely than other firms to be relationship borrowers, they could have better access to credit and therefore could have been less affected by the reform.

Fourth, as discussed above, it is possible that the estimated impact of the reform could be coming from another source: the difference in the way in which IRBA-adopting banks, which are argued to tend to be large banks, reacted to the crisis compared to non-adopters. As discussed above, most of the non-IRBA adopters in the survey adopted the IRBA after 2010 and hence the difference is mostly one of readiness or speed to adopt rather than an ability or inability to adopt the approach. Restricting the sample to firms that applied for credit from top six largest banks, as determined by the size of their balance sheet, reduces the sample size to about a fifth. While the estimated economic

significance of the impact (model 17) is similar to that implied by the main regression results (see models 4 and 5), the result is imprecise with a wide confidence interval of -0.027 to 0.299.

Fifth, a reduced form of the model is considered using matched data. That is, the sample is reduced so that, in each year, the two groups are composed of an identical set of firms based on a number of observed characteristics such as size, geography and industry. This calculation tests whether or not observed differences between the two groups - such as the affected group containing more small firms than the unaffected group - can explain the different impact of the reform on these two groups. The reduced form estimate using matched data is 0.128 compared with a reduced form estimate of 0.099 using (the whole sample of) unmatched data (Table 8). Stripping out year and fixed effects and then calculating the reduced form based on the residuals makes little change to the results. This supports that any bias in the results is likely to be negative, as posited above.

A placebo reform is considered for two different periods, a period of one year and two years before the reform took place. These placebo periods are in 2006 or 2007, depending on the firm, for the one-year ahead test and for 2004 and 2006 or 2006-2007, depending on the firm, for the two-years ahead test. A significant result would suggest that, ahead of the reform, credit conditions were already different between firms with relationships with IRBA banks and non-IRBA banks, calling into question whether the differences in the post-reform period were due to the reform as opposed to other factors. The coefficient estimate on the interaction term is small and negative for the one-year test and is close to zero for the two-year test, with neither estimate being statistically significant.

Another concern relates to the strong banking interlinkages between the Nordic countries. For example, Nordea and Danske, which make up a large share of lending in Finland, were both owned by their respective Nordic banking groups under the period under review. Each banking group had to request permission from the Finnish Financial Supervisory Authority to apply the IRBA to their Finnish portfolios, but it is possible that the strategy and lending behaviour of these banks shifted with permissions granted elsewhere in the group; the timing of these permissions from abroad did not coincide

with the timing of those granted in Finland. If IRBA approval from a foreign supervisor had the same effect on Finnish corporate or SME portfolios as that from the Finnish supervisor, this would bring one of the large banks in the sample into the IRBA group in the sample and shift the IRBA approval date by a year for one other. A regression with a new indicator variable for these permissions granted elsewhere leaves the estimate of the reform based on Finnish permissions broadly the same as in the baseline model (model 1). The estimate of the impact of non-Finnish Nordic permissions is small and not significant.

5.3 *Procylicality*

A key question is the extent to which the impact of the reform came through the procyclicality mechanism (which makes lending relatively bank capital-intensive for IRBA adopters) as opposed to other effects, such as IRBA-adopting banks deciding to "specialise" i.e. shift their portfolios towards low-risk lending (to make their lending less capital-intensive). Inspired by a technique used in Behn et al. (2016)(7), one way to study the impact of the procyclicality in isolation is by focusing on SMEs. As discussed above, a special discount is applied for exposures to firms with under 50 million euros in sales and hence an increase in the probability of default of these firms induces a smaller increase in the associated risk weight compared to firms with sales over 50 million euros. Capital charges for IRBA loans to SMEs are thus less affected than other firms under the IRBA. The greater the difference in estimates of the impact of IRBA adoption for these types of SMEs versus other firms, the bigger the role for procyclicality in explain the impact of the reform during 2007-2010.

Coefficient estimates are reported for three different samples: firms with turnover[26] of less than 25 million euros, less than 50 million euros and more than 50 million euros (Table 9). The coefficient estimates for firms with less than 50 million euros at 3.76 percentage points is significantly lower than the 6.24 percentage points estimated for

[26]Statistics Finland reports data on turnover as opposed to sales and hence the former is used. Statistics Finland describes turnover as being "comprised of sales income from products and services belong to the enterprise's operations proper from which any granted discounts, value added tax, and other direct taxes based on sales volume have been deducted".

the whole sample (model 18 and 19). This difference is starker (3.65 versus 13.37 basis points) when the estimated impact in a sample of firms earning less than 25 million euros in turnover is compared with firms earning more than 50 million in turnover (models 20 and 21). If the estimate for large corporates is assumed to encompass the net effect of the reform and the estimate for those earning less than 25 million euros is taken to encompass the net effect of only changes not related to procyclicality, the results suggest that a large chunk, perhaps close to three-quarters, of the deterioration in lending conditions among firms was driven by the procyclicality mechanism. In other words, of the 13 percentage point higher effect felt by large corporates, just under 10 percentage points can be attributed to procylicality and another 3 percentage points can be attributed to other effects.

5.4 *Specialisation hypothesis*

In terms of the existing pool of borrowers, the market share of IRBA banks and non-IRBA banks is remarkably stable over the period under review, consistent with the market shares discussed in Section 2. Around 40-50% of all firms, around 80% of firms financed by banks and around 60-65% of all applicants for external finance reported their main external financier to be an IRBA bank. To gauge the extent to which banks expanded or reduced their exposures to particular types of borrowers, the sample is restricted only to firms that were actually awarded new credit by an IRBA bank or a non-IRBA bank (in other words, borrowers with new or renewed lines of credit from banks).

A number of regressions are considered to estimate the effect of the reform on the riskiness of customers on the balance sheet of IRBA versus non-IRBA banks. The results are remarkably consistent whether all firms awarded new credit by banks are included or whether this group is reduced further to only include firms that appear in the pre- and post-reform periods or reduced even further to only include customers of the largest six banks (models 22-24). The post-reform period is characterised by firms being, on average, less creditworthy. Another statistically significant result is that the pool of IRBA banks' customers were on average riskier pre-reform. The reform nevertheless is

associated with a reduction in the level of IRBA banks' customers' credit risk: coefficient estimates suggest a 3.7 to 3.8 percentage point reduction in the average Z-score.[27] In models without firm fixed effects (models 25-27), this result is slightly more modest at between -2.5 to -3.1 percentage points.

The results provide evidence of the specialisation mechanism at play in the Finnish banking sector following the reform. The average creditworthiness of all borrowers (as proxied by the Z-score) is overall lower post-reform, which is predictable given the sharp fall in GDP following the financial crisis. Despite IRBA banks having less creditworthy borrowers than other banks pre-reform, the riskiness of their customer base - while increasing somewhat - remains fairly stable following 2007. By contrast, the creditworthiness of the customers of banks' borrowers decreases post-reform, with a spike in the Z-score metric. This suggests that, in line with the Repullo and Suarez (2004) hypothesis, IRBA banks expanded their exposures to low-risk customers post-reform, while others to higher-risk ones. The deterioration in credit conditions among firms banking with IRBA-adopting banks could - in addition to procyclicality - be attributed to the specialisation mechanism i.e. banks' making a decision to shift their portfolios towards safer assets within the corporate portfolio, in addition to shifting their portfolio towards mortgages as documented by Herrala (2014)(37).

6 Conclusion

In this paper, a difference-in-differences approach is used to estimate the impact of Basel II's model-based capital regulation via bank-firm relationships on firms' access to finance. The results suggest that the reform had a negative impact on firms whose main external financier was an IRBA-adopting bank, with these firms facing a higher likelihood of facing a deterioration in their access to credit once the reform kicked in compared to firms externally financed by non-adopters. This impact comes mostly through higher margins and fees, but also through changes in the volume of lending extended to firms. The results

[27] As discussed above, the Z-score metric, while representing a likelihood of bankruptcy, does not translate into a probability of default, making magnitudes difficult to interpret.

suggest that much of the result can be attributed to procyclicality, with evidence also found for the hypothesis that model-based approach adopters shifted to low-risk lending and hence, by tightening credit policies, reduced their exposures to riskier firms.

References

[1] Angrist, J D and J-S Pischke (2009), *Mostly Harmless Econometrics An Empiricist's Companion*. Princeton University Press, Princeton.

[2] Altman, E (1968), "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy", *Journal of Finance,* pp.189-209.

[3] Altman, E, Iwanicz-Drozdowska, M, Laitinen, E and A Suvas (2017), "Financial Distress Prediction in an International Context: A Review and Empirical Analysis of Altman's Z-Score Model", *Journal of International Financial Management and Accounting,* Vol. 28, No. 2, pp.131-171.

[4] Altman, E I and G Sabato (2005), "Effects of the New Basel Capital Accord on Bank Capital Requirements for SMEs", *Journal of Financial Services Research,* Vol. 28, No. 1, pp. 15-42.

[5] Bank for International Settlements (2011), "Basel III: Long-term impact of economic performance and fluctuations", *BIS Working Papers* No. 338.

[6] Basel Committee on Banking Supervision (2004), "International Convergence of Capital Measurement and Capital Standards – a revised framework", Bank of International Settlements, Basel, Switzerland.

[7] Behn, M, Haselmann, R and P Wachtel (2016b), "Pro-cylical capital regulation and lending", *Journal of Finance,* Vol. 71, No.2, pp. 919-956.

[8] Benetton, M, Eckley, P, Garbarino, N, Kirwin, L and G Latsi (2017), "Specialisation in mortgage risk under Basel II", *Bank of England Working Paper* No. 639.

[9] Bernanke, B (1983), Nonmonetary effects of the financial crisis in the propagation of the Great Depression, *American Economic Review,* Vol. 73, pp. 257–276.

[10] Bernanke, B, Lown, C and B Friedman (1991), "The credit crunch", *Brookings Papers on Economic Activity,* Vol. 22, No. 2, pp. 205–247.

[11] Blaes, B (2011), "Bank-related loan supply factors during the crisis: An analysis based on the German bank lending survey," *Deutsche Bundesbank Discussion Paper Series 1: Economic Studies* No. 31.

[12] Campello, M, Graham, J R and R H Campbell (2010), "The real effects of financial constraints: Evidence from a financial crisis", *Journal of Financial Economics,* Vol. 97, No. 3, pp. 470-487.

[13] Carbó-Valverde, S, Rodríguez-Fernández, F and G Udell (2016), "Trade Credit, the Financial Crisis, and SME Access to Finance", *Journal of Money, Credit and Banking,* Vol. 48, No. 1, pp. 113-143.

[14] Chava S and A Purnanandam (2010), "The real effect of a banking crisis on bank-dependent borrowers", *Journal of Financial Economics,* Vol. 99, No. 1, pp. 116-135.

[15] Chodorow-Reich, G (2014), "The Employment Effects of Credit Market Disruptions: Firm-level Evidence from the 2008-09 Financial Crisis", *Quarterly Journal of Economics,* Vol. 129, No. 1, pp. 1-59.

[16] Ciccarelli, M, Maddaloni, A, and J-L Peydro (2015), "Trusting the bankers: a new

look at the credit channel of monetary policy", *Review of Economic Dynamics* Vol. 18, No. 4, pp. 979-1002.
[17] Cingano, F, Manaresi, F and E Sette (2016), "Does Credit Crunch Investment Down? New Evidence on the Real Effects of the Bank-Lending Channel", *The Review of Financial Studies,* Vol. 29, No. 10, pp. 2737–2773.
[18] Committee of European Banking Supervisors (2006), "Quantitative Impact Study 5, Overview on the Results of the EU countries".
[19] Cohen, B H (2013), "How have banks adjusted to higher capital requirements", *BIS Quarterly Review* September 2013.
[20] Degryse, H, Kim, M and S Ongena (2009), *Microeconometrics of Banking.* Oxford University Press, New York.
[21] Degryse, H, De Jonghe, O, Jakovljevic, S, Mulier, K and G Schepens (2018), "Identifying credit supply shocks with bank-firm data: methods and applications", *National Bank of Belgium Working Paper* No. 347.
[22] Del Giovane, P, Eramo, G and A Nobili (2011), "Disentangling demand and supply in credit developments: a survey-based analysis for Italy", *Journal of Banking and Finance,* Vol. 35, pp. 2719-2732.
[23] De Marco, F and T Wieladek (2015), "The real effects of capital requirements and monetary policy: evidence from the United Kingdom", *Bank of England Staff Working Paper* No. 573.
[24] Finance Finland (2010), "Suomen rahalaitosten taseissa olevat euromääräiset lainat ja talletukset pankeittain/pankkiryhmittäin, joulukuu 2010." (see link)
[25] Finnish Financial Supervisory Authority (2005), "Press Release" (see link).
[26] Finnish Financial Supervisory Authority (2006), "Press Release" (see link).
[27] Finnish Financial Supervisory Authority (2009), "Press Release" (see link).
[28] Finnish Financial Supervisory Authority (2007), "FSA Newsline 4/2007" (see link).
[29] Fraisse, H, LÉ, M and D Thesmar (2017), "The Real Effects of Bank Capital Requirements", *European Systemic Risk Board Working Paper Series* No. 47.
[30] Ferrando, A, Popov A and G Udell (2017), "Sovereign stress and SMEs' access to finance: Evidence from the ECB's SAFE survey", *Journal of Banking and Finance,* Vol. 81, pp. 65-80.
[31] Ferrando, A, Popov A and G Udell (2018), "Do SMEs Benefit from Unconventional Monetary Policy and How? Microevidence from the Eurozone", *Journal of Money, Credit and Banking (forthcoming).*
[32] Goodhart, C (2005), "Financial regulation, credit risk and financial stability", *National Institute Economic Review,* No. 192.
[33] Goodhart, C, Hofmann, B and M Segoviano (2004), "Bank regulation and macroeconomic fluctuations", *Oxford Review of Economic Policy,* Vol. 20, No. 4.
[34] Gordy, M and B Howells (2006), "Procyclicality in Basel II: Can we treat the disease without killing the patient?", *Journal of Financial Intermediation,* Vol.15, pp. 395-417.
[35] Hakenes, H and I Schnabel (2011), "Bank size and risk-taking under Basel II", *Journal of Banking and Finance,* Vol. 35 No. 6, pp. 1436-1449.
[36] Heid, F (2007), "The cyclical effects of the Basel II capital requirements", *Journal of Banking and Finance,* Vol. 31 No. 12, pp. 3885-3900.
[37] Herrala, R (2014), "Forward-Looking Reaction to Bank Regulation", *ECB Working Paper Series* No. 1645.
[38] International Monetary Fund (2010), "Finland – Financial System Stability Assess-

ment Update" (see link).
[39] International Monetary Fund (2012), "Finland 2012 Article IV Consultation", (see IMF Country Report No. 12/253).
[40] International Monetary Fund (2016), "Finland Financial System Stability Assessment", (see IMF Country Report No. 16/370).
[41] Ippolito, F, Peydro, J-L, Polo, A and E Sette (2016), "Double bank runs and liquidity management", *Journal of Financial Economics,* Vol. 122, No. 1, pp. 135-154.
[42] Ivashina, V and D Scharfstein (2010), "Bank lending during the financial crisis of 2008", *Journal of Financial Economics,* Vol. 97, No. 3, pp. 319-338.
[43] Iyer, R, Da-Rocha-Lopes, S, Peydro, J-L and A Schoar (2014), "Interbank liquidity crunch and the firm credit crunch: Evidence from the 2007-2009 crisis", *Review of Financial Studies,* Vol. 27, No. 1, pp. 347-372.
[44] Jiménez, G, Ongena, S, Peydró J L and J Saurina (2012), "Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications", *American Economic Review,* Vol. 102 No. 5, pp. 2301-2326.
[45] Jiménez, G, Ongena, S, Peydró J L and J Saurina (2017), "Macroprudential Policy, Countercyclical Bank Capital Buffers, and Credit Supply: Evidence from the Spanish Dynamic Provisioning Experiments", *Journal of Political Economy,* Vol. 125, No. 6, pp. 2126-2177.
[46] Kashyap, A and J Stein (2000), "What do a million observations on banks say about the transmission of monetary policy?", *American Economic Review,* Vol. 90, No. 3, pp. 407-428.
[47] Kashyap, A K and J C Stein (2004), "Cyclical implications of the Basel II capital standards", *Economic Perspectives,* 1Q/2004, Federal Reserve Board of Chicago.
[48] Kuchler, A (2012) "The interplay between credit standards and credit demand; microeconometric evidence from Denmark", *Danmarks Nationalbank Working paper 82.*
[49] Khwaja A and A Mian (2008), "Tracing the impact of bank liquidity shocks: evidence from an emerging market", *American Economic Review,* Vol. 98, No. 4, pp. 1413-1442.
[50] Kremp E amd P Sevestre (2013), "Did the crisis induce credit rationing for French SMEs?", *Journal of Banking and Finance,* Vol. 37, pp. 3757-3772.
[51] Levine, R (2002), "Bank-based or market-based financial systems: which is better?", *NBER Working Paper Series* No. 9138.
[52] Peek, J and E Rosengren (1995), "The capital crunch: Neither a borrower nor a lender be", *Journal of Money, Credit and Banking,* Vol. 27, No. 3, pp. 625-638.
[53] Peek, J and E Rosengren (1997), "The international transmission of financial shocks", *American Economic Review,* Vol. 87, No. 4, pp. 495-505.
[54] Popov, A (2016), "Monetary policy, bank capital, and credit supply: a role for discouraged and informally rejected firms", *International Journal of Central Banking* Vol. 12, No. 1, pp. 95-141.
[55] Popov, A and G Udell (2012), "Cross-border banking, credit access and the financial crisis" *Journal of International Economics,* Vol. 87, No. 1, pp. 147-161.
[56] Puri, M, Rocholl, J and S Steffen (2011), "Global retail lending in the aftermath of the U.S. financial crisis: Distinguishing between supply and demand effects", *Journal of Financial Economics,* Vol. 100, No. 3, pp. 556-578.
[57] Repullo, R and J Suarez (2004), "Loan pricing under Basel capital requirements", *Journal of Financial Intermediation,* Vol. 13, pp. 496-521.

[58] Rime, B (2005), "Will Basel II lead to a specialization of unsophisticated banks on high-risk borrowers?", *International Finance,* Vol. 8, No.1, pp. 29-55.
[59] Saurina, J and C Trucharte (2004), "The Impact of Basel II on Lending to Small- and Medium-Sized Firms: A Regulatory Policy Assessment Based on Spanish Credit Register Data", *Journal of Financial Services Research,* Vol. 26, No. 2, pp. 121-144.
[60] Statistics Finland, "Financial statement panel data" (see link).
[61] Taylor, A and C Goodhart (2006), "Procyclicality and volatility in the financial system: the implementation of Basel II and IAS39", in S Gerlach and P Gruenwald (eds) *Procyclicality of financial systems in Asia.* IMF and Hong Kong Institute for Monetary Research, Palgrave MacMillan, New York.
[62] Van der Veer, K and M Hoeberichts (2016), "The level effect of bank lending standards on business lending", *Journal of Banking and Finance,* Vol. 66, pp. 79-88.

Figures

Figure 1: Firms reporting a deterioration in their access to credit (mean)

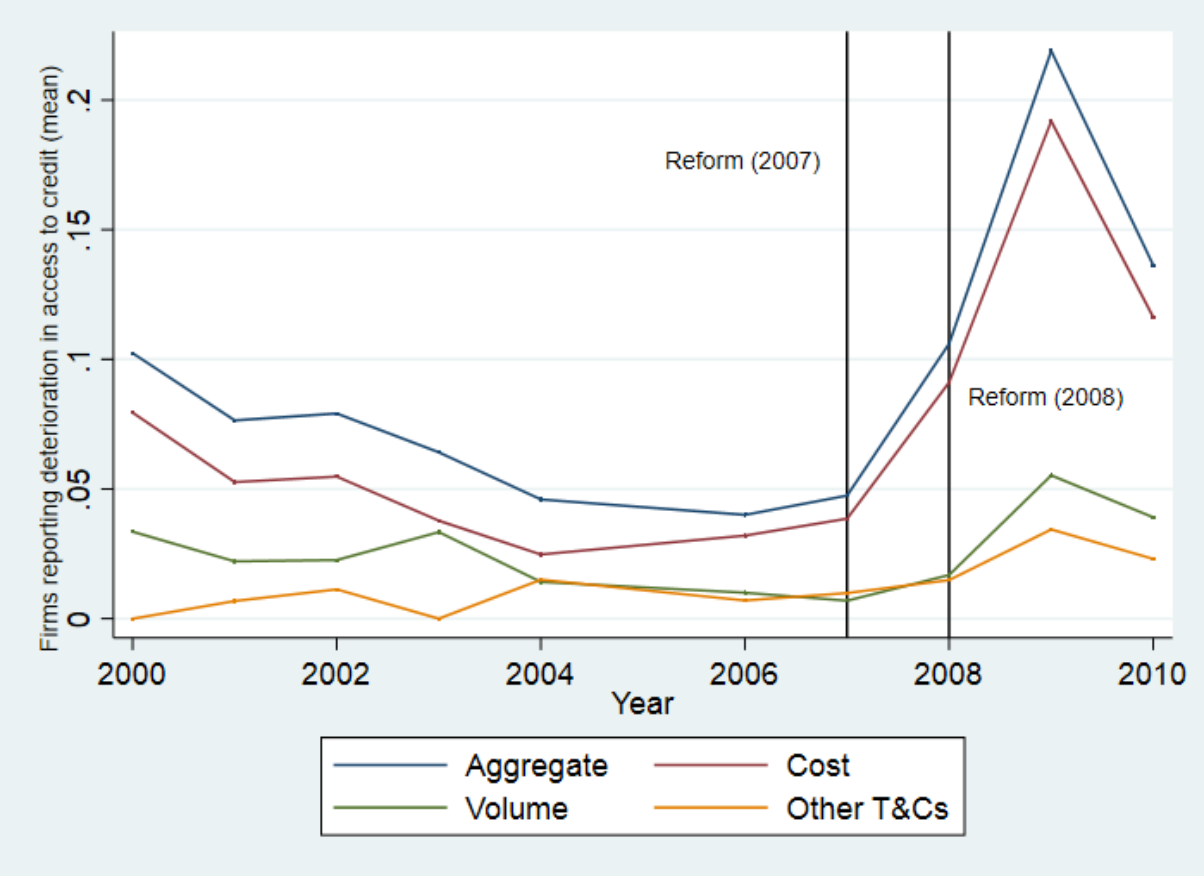


Figure 2: Firms reporting a deterioration in their access to credit (mean), by group

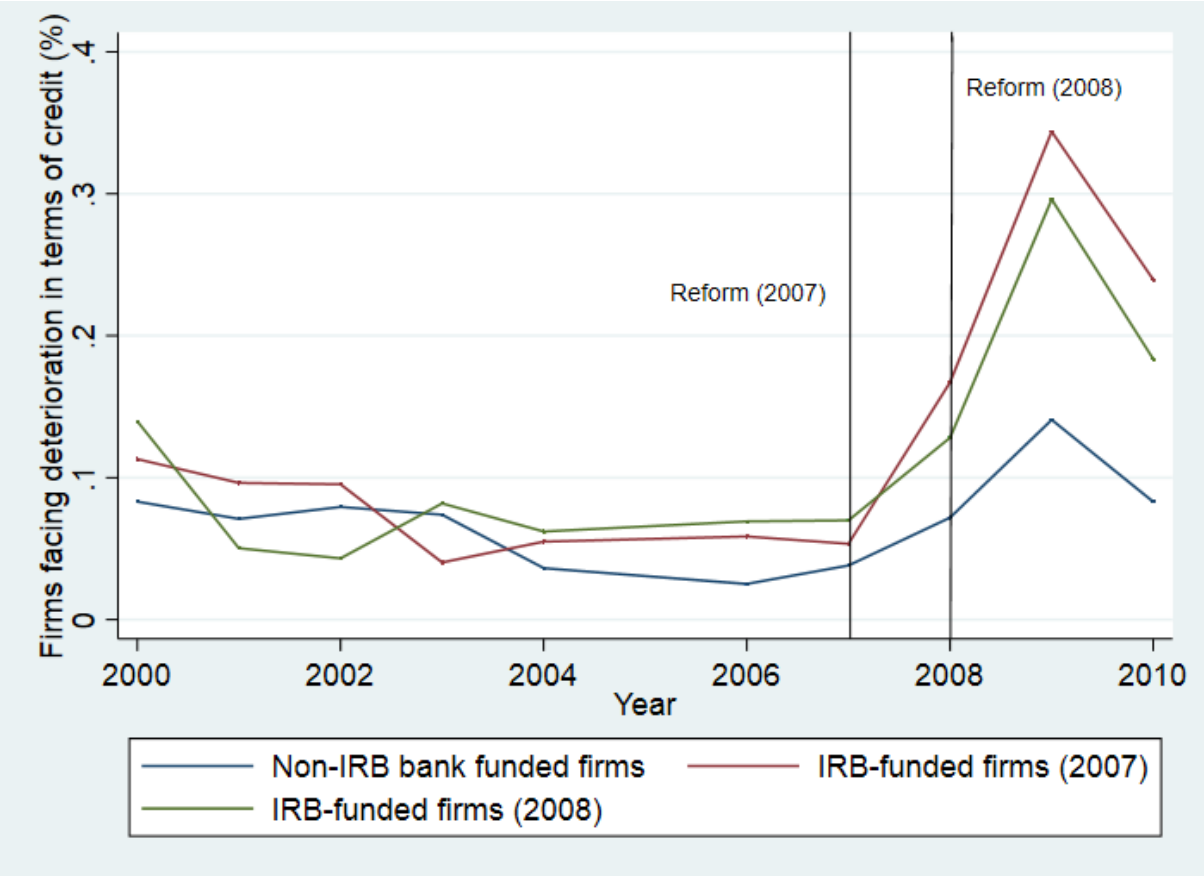


Figure 3: Difference in the mean of IRBA and non-IRBA bank funded firms reporting a deterioration in their access to credit (matched data)

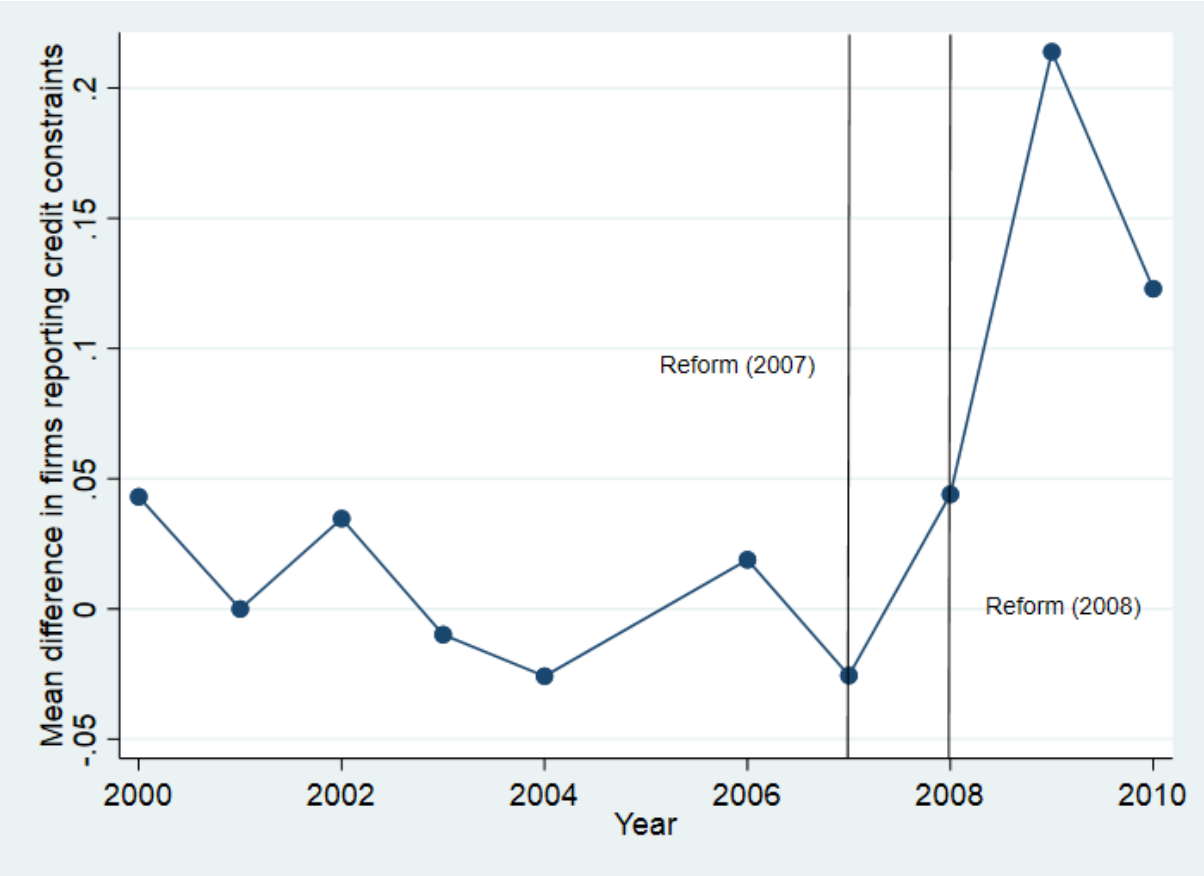
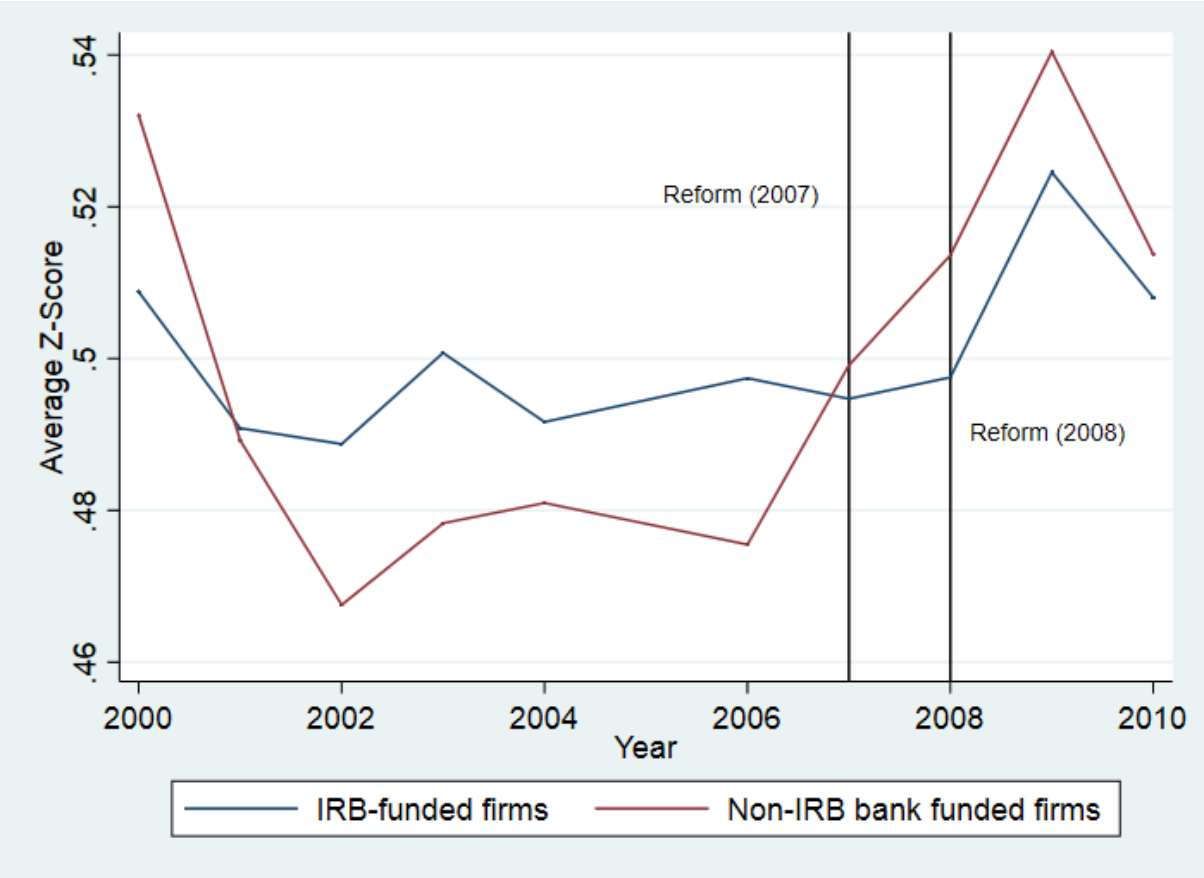


Figure 4: Z-score (mean), by group



Tables

Table 1: Panel structure

Observations	Frequency	Percent
1	971	9.07
2	1232	11.51
3	1692	15.81
4	1544	14.42
5	1885	17.61
6	936	8.74
7	875	8.17
8	576	5.38
9	504	4.71
10	490	4.58
Total	10,705	100

Table 2: Descriptive statistics

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
Constrained	1 if firm experienced a deterioration in their access to finance (as covered by variables, interest, volume and conditions); 0 otherwise.	10,705	0.09	0.29	0	1
Cost	1 if firm's margins or fees increased; 0 otherwise.	10,705	0.07	0.26	0	1
Volume	1 if a smaller-than-applied-for volume of lending was granted compared; 0 otherwise.	10,705	0.03	0.16	0	1
Conditions	1 if other loan terms and conditions became less favourable; 0 otherwise.	10,705	0.01	0.11	0	1
Z-score	Probability of bankruptcy as proxied by Altman Z-score.	10.364	0.49	0.11	N/A	N/A
IRB	1 if firm's reported main external financier is IRBA-adopting bank; 0 otherwise.	10,705	0.45	0.50	0	1
Reform	1 for bank-year observation if IRBA or Standardised approach is in use; 0 otherwise.	10,705	0.36	0.48	0	1
Equityratio*	Sum of equity, value adjustment and optional reserves as a percentage of balance sheet total (%).	10.364	41.97	34.18	0	1
Liquidityratio	Liquidity ratio calculated as current assets over total assets (%).	10.364	0.15	0.19	N/A	N/A
RoCI*,**	Return on capital investment, calculated as the sum of net profit, financial expenses and taxes as a percentage of balance sheet total (%).	10,705	14.78	41.43	N/A	N/A
RoI*,**	Return on investment, calculated as the sum of net profit, financial expenses and taxes as a percentage of the sum of equity, value adjustment, optional reserves and non-current creditors (%).	10,705	55.03	212.95	N/A	N/A
RoE*,**	Return on equity, calculated as net profit as a percentage of the sum of equity, value adjustment and optional reserves (%).	10,705	44.13	228.90	N/A	N/A
Log(turnover)	Log of turnover.	10,705	15.04	3.89	N/A	N/A
Log(profit)	Log of net profit.	10,705	9.22	5.91	N/A	N/A
Firm Size	1 if firm size is the following; 0 otherwise:					
Micro	*Fewer than 10 employees.*	10,705	0.25	0.44	0	1
Small	*Between 10-49 employees.*	10,705	0.21	0.41	0	1
Medium	*Between 50-249 employees.*	10,705	0.14	0.35	0	1
Geography	1 if firm located in the following; 0 otherwise:					
Helsinki	*Helsinki region.*	10,705	0.43	0.49	0	1
top5	*2nd to 5th largest cities by population after Helsinki region.*	10,705	0.10	0.30	0	1
top10	*5-10th largest cities by population.*	10,705	0.06	0.24	0	1
Industry	1 if firm main activity belongs to following industry; 0 otherwise:					
Industry1	*Agriculture, forestry and fishing.*	10,705	0.00	0.02	0	1
Industry2	*Manufacturing.*	10,705	0.35	0.48	0	1
Industry3	*Construction.*	10,705	0.09	0.29	0	1
Industry4	*Distributive trades, transport, accommodation and food services.*	10,705	0.30	0.46	0	1
Industry5	*Real estate, renting and business activities.*	10,705	0.17	0.37	0	1
Industry6	*Government and other services.*	10,705	0.06	0.24	0	1

Maximum and minimum values for some variables are unavailable due to Statistics Finland policy.
*Calculated by Statistics Finland
**Outliers have been removed.

Table 3: Descriptive statistics by group

Variable	Non-IRBA bank funded firms		IRBA-funded firms		p-value	St.Error
	Mean	St. Dev.	Mean	St. Dev.		
Equityratio	41.893	28.024	41.870	32.499	0.986	1.295
Liquidityratio	0.151	0.182	0.168	0.200	0.026	0.008
Log(profit)	9.448	5.840	9.322	5.633	0.579	0.228
Log(turnover)	15.199	3.868	14.831	3.444	0.010	0.142
RoCI	15.529	39.053	14.669	35.724	0.557	1.465
RoI	49.932	198.705	45.832	179.435	0.579	7.381
RoE	49.227	218.563	38.427	197.977	0.185	8.138
Size:						
Micro	0.233	0.423	0.274	0.446	0.020	0.018
Small	0.189	0.392	0.252	0.434	0.000	0.017
Medium	0.162	0.369	0.159	0.366	0.855	0.015
Geography:	0.488	0.500	0.475	0.499	0.510	0.201
Helsinki	0.412	0.492	0.376	0.485	0.069	0.020
top5	0.076	0.266	0.099	0.298	0.058	0.012
top10	0.056	0.229	0.066	0.248	0.295	0.010
Industry:						
Industry1	0.000	0.000	0.000	0.018	0.617	0.001
Industry2	0.328	0.470	0.361	0.480	0.082	0.019
Industry3	0.105	0.307	0.106	0.307	0.963	0.012
Industry4	0.334	0.472	0.300	0.458	0.068	0.019
Industry5	0.145	0.352	0.159	0.366	0.333	0.015
Industry6	0.051	0.219	0.047	0.211	0.647	0.009

Sample covers data for 2000-2006 and only for firms funded by banks.

Table 4: Prediction of IRBA status

Dependent variable: IRB	
Equityratio	0.000
	(0.000)
Liquidityratio	0.093**
	(0.044)
Log(profit)	-0.001
	(0.001)
Log(turnover)	-0.006
	(0.005)
RoCI	0.000
	(0.000)
RoI	0.000
	(0.000)
RoE	-0.000
	(0.000)
Micro	0.017
	(0.031)
Small	0.050**
	(0.025)
Medium	0.046**
	(0.022)
Helsinki	-0.024
	(0.021)
top5	0.038
	(0.033)
top10	0.031
	(0.038)
Industry1	0.272
	(0.304)
Industry2	0.285
	(0.175)
Industry3	0.255
	(0.177)
Industry4	0.266
	(0.175)
Industry5	0.282
	(0.176)
Industry6	0.243
	(0.179)
Constant	0.586***
	-0.192
Cluster	None
Firm Fixed Effects	No
Year Fixed Effects	No
Observations	3,757
Number of firms	1,531
R-squared	0.006

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Main regression results

Sample	All			Externally-funded firms that applied for credit		
Dependent variable: Constrained						
Model	(1)	(2)	(3)	(4)	(5)	(6)
IRB	0.001	-0.002	0.010	-0.074*	-0.073*	-0.087***
	(0.010)	(0.010)	(0.007)	(0.043)	(0.044)	(0.027)
Reform	-0.023	-0.016	-0.027	-0.085	-0.078	-0.06
	(0.026)	(0.026)	(0.024)	(0.086)	(0.087)	(0.069)
IRB X Reform	0.062***	0.067***	0.085***	0.122**	0.131**	0.085**
	(0.018)	(0.018)	(0.012)	(0.062)	(0.064)	(0.041)
Constant	0.104***	0.136***	0.085	0.388***	0.459***	0.397
	(0.010)	(0.017)	(0.071)	(0.044)	(0.063)	(0.318)
Cluster	Firm	Firm	Firm	Firm	Firm	Firm
Firm controls	No	No	Yes	No	No	Yes
Firm fixed effects	Yes	Yes	No	Yes	Yes	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,705	10,364	10,364	2,485	2,429	2,429
Number of firms	3,372	3,268	3,268	1,200	1,172	1,172
R-squared	0.042	0.045	0.0415	0.191	0.198	0.1884

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 6: Results by disaggregated outcome

Sample	All			Externally funded, applied for credit		
Dependent variable	Cost	Volume	Conditions	Cost	Volume	Conditions
Model	(7)	(8)	(9)	(10)	(11)	(12)
IRB	0.004	-0.004	0.002	-0.046	-0.001	0.004
	(0.009)	(0.005)	(0.003)	(0.041)	(0.026)	(0.014)
Reform	-0.023	0.004	0.002	-0.045	0.026	-0.036
	(0.024)	(0.012)	(0.008)	(0.084)	(0.046)	(0.034)
IRB X Reform	0.065***	0.015*	-0.004	0.087	0.010	0.039
	(0.016)	(0.009)	(0.007)	(0.060)	(0.040)	(0.030)
2001	-0.032***	-0.006	0.007***	-0.100**	-0.008	-0.003
	(0.010)	(0.005)	(0.002)	(0.041)	(0.014)	(0.004)
2002	-0.033***	-0.006	0.011***	-0.106**	-0.009	0.012
	(0.010)	(0.006)	(0.003)	(0.045)	(0.021)	(0.011)
2003	-0.057***	0.006	0.000	-0.222***	0.009	-0.013*
	(0.010)	(0.006)	(0.002)	(0.043)	(0.021)	(0.007)
2004	-0.073***	-0.013**	0.012***	-0.257***	-0.010	0.017
	(0.011)	(0.006)	(0.004)	(0.044)	(0.019)	(0.011)
2006	-0.062***	-0.014*	0.007**	-0.235***	-0.008	0.014
	(0.012)	(0.007)	(0.004)	(0.047)	(0.025)	(0.013)
2007	-0.050**	-0.023*	0.009*	-0.207***	-0.044	0.023
	(0.024)	(0.013)	(0.005)	(0.072)	(0.033)	(0.018)
2008	0.009	-0.019	0.006	0.015	-0.027	0.017
	(0.028)	(0.015)	(0.008)	(0.088)	(0.040)	(0.032)
2009	0.112***	0.018	0.031***	0.372***	0.092**	0.090**
	(0.030)	(0.017)	(0.009)	(0.089)	(0.046)	(0.035)
2010	0.037	0.007	0.023***	0.162*	0.067	0.082**
	(0.029)	(0.016)	(0.009)	(0.092)	(0.046)	(0.038)
Constant	0.084***	0.028***	0.001	0.354***	0.054**	0.012
	(0.010)	(0.006)	(0.003)	(0.043)	(0.022)	(0.011)
Cluster	Firm	Firm	Firm	Firm	Firm	Firm
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,705	10,705	10,705	2,485	2,485	2,485
R-squared	0.046	0.010	0.007	0.200	0.041	0.031
Number of firms	3,372	3,372	3,372	1,200	1,200	1,200

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 7: Sensitivity analysis

Sample	All	Firms that appear in sample pre- and post-reform	Firms reporting no changes in external funder	Firms with small number of relationships	Firms funded by top 6 banks
Dependent variable:	Constrained				
Model	(13)	(14)	(15)	(16)	(17)
IRB	0.001	-0.003	-0.006	-0.004	-0.022
	(0.010)	(0.014)	(0.010)	(0.011)	(0.072)
Reform	-0.023	-0.043	-0.030	-0.030	-0.119
	(0.026)	(0.031)	(0.025)	(0.029)	(0.109)
IRB X Reform	0.062***	0.093***	0.065***	0.046**	0.136
	(0.018)	(0.020)	(0.018)	(0.020)	(0.083)
2001	-0.026**	-0.006	-0.030***	-0.045***	-0.110**
	(0.010)	(0.021)	(0.011)	(0.011)	(0.047)
2002	-0.028**	-0.017	-0.028**	-0.045***	-0.105**
	(0.011)	(0.020)	(0.012)	(0.013)	(0.053)
2003	-0.048***	-0.042**	-0.053***	-0.043***	-0.205***
	(0.011)	(0.018)	(0.012)	(0.012)	(0.050)
2004	-0.072***	-0.068***	-0.071***	-0.065***	-0.229***
	(0.011)	(0.017)	(0.012)	(0.013)	(0.053)
2006	-0.066***	-0.063***	-0.069***	-0.051***	-0.190***
	(0.013)	(0.018)	(0.013)	(0.016)	(0.057)
2007	-0.052**	-0.042	-0.050**	-0.029	-0.135
	(0.025)	(0.032)	(0.025)	(0.029)	(0.088)
2008	0.002	0.011	-0.002	-0.018	0.068
	(0.030)	(0.037)	(0.030)	(0.034)	(0.106)
2009	0.121***	0.148***	0.091***	0.072**	0.467***
	(0.031)	(0.039)	(0.031)	(0.034)	(0.104)
2010	0.041	0.048	0.024	0.018	0.241**
	(0.031)	(0.038)	(0.031)	(0.035)	(0.108)
Constant	0.104***	0.101***	0.107***	0.101***	0.346***
	(0.010)	(0.017)	(0.011)	(0.013)	(0.076)
Cluster	Firm	Firm	Firm	Firm	Firm
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	10,705	4,800	9,774	8,015	2,047
R-squared	0.042	0.068	0.033	0.023	0.207
Number of firms	3,372	888	3,254	3,023	1,036

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 8: Reduced form models

Non-matched data

Time:	Pre-reform	Post-reform	Difference
Group:			
IRB bank-funded firms	0.076	0.197	0.121
Non-IRB bank funded	0.062	0.083	0.022
Difference	0.015	0.114	0.099

Matched data

Time:	Pre-reform	Post-reform	Difference
Group:			
IRB bank-funded firms	0.057	0.193	0.136
Non-IRB bank funded	0.084	0.092	0.008
Difference	-0.028	0.100	0.128

Table 9: Test of procyclicality

Sample:	All	<50mn turnover	<25mn turnover	50mn+ turnover
Dependent variable: Constrained				
Model	(18)	(19)	(20)	(21)
IRB	0.001	-0.008	-0.010	0.010
	(0.010)	(0.010)	(0.010)	(0.026)
Reform	-0.023	-0.002	-0.007	-0.064
	(0.026)	(0.029)	(0.031)	(0.066)
IRB X Reform	0.062***	0.038*	0.037*	0.134***
	(0.018)	(0.021)	(0.022)	(0.036)
2001	-0.026**	-0.045***	-0.051***	0.052*
	(0.010)	(0.011)	(0.011)	(0.027)
2002	-0.028**	-0.045***	-0.053***	0.043
	(0.011)	(0.012)	(0.013)	(0.027)
2003	-0.048***	-0.052***	-0.050***	-0.022
	(0.011)	(0.013)	(0.013)	(0.027)
2004	-0.072***	-0.075***	-0.077***	-0.044*
	(0.011)	(0.013)	(0.014)	(0.026)
2006	-0.066***	-0.067***	-0.065***	-0.044*
	(0.013)	(0.015)	(0.016)	(0.026)
2007	-0.052**	-0.065**	-0.056*	-0.018
	(0.025)	(0.027)	(0.029)	(0.069)
2008	0.002	-0.053	-0.050	0.111
	(0.030)	(0.033)	(0.035)	(0.075)
2009	0.121***	0.037	0.037	0.279***
	(0.031)	(0.035)	(0.038)	(0.077)
2010	0.041	-0.015	0.001	0.113
	(0.031)	(0.036)	(0.038)	(0.074)
Constant	0.104***	0.119***	0.116***	0.076***
	(0.010)	(0.012)	(0.013)	(0.022)
Cluster	Firm	Firm	Firm	Firm
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	10,705	7,942	7,122	2,763
R-squared	3,372	0.022	0.022	0.105
Number of firms	0.042	2,703	2,468	892

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Test of specialisation hypothesis

Sample:	Firms awarded credit	of which, appear in sample pre- and post-reform	of which, funded by top 6 banks	Firms awarded credit	of which, appear in sample pre- and post-reform	of which, funded by top 6 banks
Dependent variable: Z-score						
Model	(22)	(23)	(24)	(25)	(26)	(27)
IRB	0.011*	0.019**	0.016	0.006	0.016**	0.011
	(0.006)	(0.009)	(0.011)	(0.005)	(0.008)	(0.009)
Reform	0.031**	0.037**	0.037**	0.016	0.025*	0.025
	(0.014)	(0.015)	(0.017)	(0.012)	(0.014)	(0.016)
IRB X Reform	-0.038***	-0.037***	-0.037***	-0.025***	-0.031***	-0.030**
	(0.011)	(0.010)	(0.012)	(0.010)	(0.010)	(0.012)
2001	-0.009*	-0.009	-0.003	-0.011**	-0.012	-0.008
	(0.005)	(0.008)	(0.008)	(0.005)	(0.008)	(0.008)
2002	0.002	-0.007	-0.002	0.001	-0.012	-0.008
	(0.005)	(0.008)	(0.008)	(0.005)	(0.008)	(0.008)
2003	-0.004	-0.004	0.004	-0.003	-0.007	-0.000
	(0.006)	(0.009)	(0.009)	(0.005)	(0.010)	(0.009)
2004	0.004	0.001	-0.000	0.002	-0.005	-0.006
	(0.006)	(0.008)	(0.009)	(0.005)	(0.008)	(0.009)
2006	0.003	-0.003	-0.003	0.001	-0.008	-0.008
	(0.008)	(0.010)	(0.011)	(0.007)	(0.010)	(0.010)
2007	-0.000	-0.012	-0.013	0.000	-0.013	-0.014
	(0.012)	(0.014)	(0.015)	(0.010)	(0.013)	(0.014)
2008	0.013	0.002	0.001	0.014	0.002	0.001
	(0.014)	(0.017)	(0.018)	(0.012)	(0.016)	(0.016)
2009	0.032**	0.020	0.023	0.036***	0.024	0.026
	(0.014)	(0.017)	(0.018)	(0.012)	(0.016)	(0.016)
2010	0.021	0.008	0.006	0.024*	0.010	0.008
	(0.014)	(0.017)	(0.018)	(0.012)	(0.016)	(0.016)
Constant	0.486***	0.482***	0.484***	0.490***	0.487***	0.493***
	(0.007)	(0.011)	(0.012)	(0.006)	(0.011)	(0.013)
Cluster	Firm	Firm	Firm	Firm	Firm	Firm
Firm fixed effects	Yes	Yes	Yes	No	No	No
Observations	2,159	991	904	2,159	991	904
R-squared	0.049	0.081	0.079			
Number of firms	1,077	384	363	1,077	384	363

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Bank of Finland Research Discussion Papers 2019

ISSN 1456-6184, online

1/2019 Marco Gallegati – Federico Giri – Michele Fratianni
Money growth and inflation: International historical evidence on high inflation episodes for developed countries
ISBN 978-952-323-257-0, online

2/2019 Francesco D'Acunto – Daniel Hoang – Maritta Paloviita – Michael Weber
IQ, Expectations, and Choice
ISBN 978-952-323-258-7, online

3/2019 Orkun Saka
Domestic banks as lightning rods? Home bias and information during Eurozone crisis
ISBN 978-952-323-260-0, online

4/2019 Saara Tuuli
Model-based regulation and firms' access to finance
ISBN 978-952-323-261-7, online