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The Determination of Bank Interest Rate Margins - Is There a Role for Macroprudential Policy?

E Philip Davis, Dilruba Karim and Dennison Noel[1]

Abstract

The advent of macroprudential policy alongside monetary policy raises the issue whether macroprudential policy has an additional effect on bank interest rate margins to that of monetary policy, and if so, whether it accentuates or offsets the interest rate effect. In light of this, we estimate combined effects of macroprudential policies and monetary policies on bank interest margins for up to 3,723 banks from 35 advanced countries over 1990-2018. In the short run, tightening of both types of policy tends to narrow the margin, while in the long run, monetary policy typically widens the margin while effects of macroprudential policies are mostly zero or positive, suggestive of countervailing action by banks. There are also significant interactions between macroprudential and monetary policy for several macroprudential policies; a tighter monetary stance is widely found to offset the negative effect of macroprudential policies on margins while a loose monetary policy leaves the negative effects intact, with potential consequences for financial stability. These results are of considerable relevance to policymakers, regulators and bank managers, not least when monetary policies are tight to reduce inflationary pressures.

Classification: E44, E52, E58, G21, G28

Keywords Macroprudential policy, monetary policy, short-term interest rate, yield curve, bank interest margin

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1. Introduction

The bank interest rate margin is defined as net interest receipts as a percentage of average assets. Levels and changes in the margin are an important determinant of banks' profitability and influence their ability to accumulate capital, with implications for financial stability. They also determine interest rates for depositors and lenders, with broader macroeconomic implications.

Monetary and macroprudential policies, in seeking together to maintain monetary and financial stability, will both influence the margin and indeed, the margin is a key aspect of the transmission mechanism of macroeconomic policy. This effect of monetary policy on the margin is a consequence of its impact on the interest-rate structure, as well as on wider macroeconomic conditions. Meanwhile, macroprudential policy may also affect the margin, for example tighter loan demand/supply measures will alter portfolio decisions on earning assets by affecting credit supply and demand. In this overall context, there is considerable interest in whether macroprudential policy and monetary policy are complementary or conflicting in their effects, both on banks and the wider economy, given both are vital in order to maintain monetary and financial stability (Constâncio 2015).

There is a quite an extensive literature on the determination of bank margins, with a particular focus on the effects of monetary policy operating through interest rates (such as Alessandri and Nelson (2015), Borio et al (2017), Bikker and Vervliet (2017) and Claessens et al (2018)). The literature on the effects of macroprudential policy, which initially focused mainly on macroeconomic data, now extensively employs individual bank data as well, with consideration inter alia of effects on bank lending (Claessens et al (2013), Andries et al (2018)) and on bank risk (Altunbas et al (2018), Meuleman and Vander Vennet (2020), Chan et al (2023)).

These streams of literature on margin determination and effects of macroprudential policy, however, have tended to be separate and not brought together. In particular, the effect of macroprudential policies on banks' margins, either separately or in the context of monetary policies, has barely been explored in the literature to date. Davis et al (2022) did examine effects of macroprudential policy on banks' aggregate profitability (return on average assets and on equity) but not margins per se. In a work focused on the effects of macroprudential policy on risk, Meuleman and Vander Vennet (2022) provided some results for macroprudential policy effects on bank profitability in the context of monetary policy, but their results for the margin as opposed to franchise value are often insignificant. As discussed further below, their work is focused on a relatively short time period in the Eurozone, when margins for the most part changed rather little, which may help explain their results.

Neglect of effects of macroprudential policy on bank margins is a paradox in light of their potential relevance to authorities in evaluating risks to financial stability and in the overall assessment of the stance of macroeconomic policy. A related point is that there is little empirical evidence of whether the effect of macroprudential policy is conditional on the stance of monetary policy. Most work assessing whether there is complementarity or conflict is based on calibrated DSGE models. Equally, there has been little testing of short versus long-run effects of macroprudential policy. Given scope for banks to adjust their strategies in response to macroprudential policies in line with their risk appetite, we would expect the long-run effects to be smaller and often negligible or of opposite sign to the short-run effects.

To cast further light on these issues, we explore the effects of macroprudential policies alongside interest rates and other control variables on bank margins, using a model of banks' net interest margin drawn from the above-mentioned literature. We use a sample of up to 3,723 banks from 35 advanced countries over 1990-2018. Alongside data on short rates and the yield curve[1], and drawing on the literature on effects of macroprudential policy, we use the data from the IMF iMaPP database of macroprudential policy actions (IMF 2020), also accumulated to show the policy stance and stringency.

To summarise our main results, we find that tighter monetary policy tends to reduce the margin in the short run, whereas in the long run it boosts the margin. Concerning macroprudential policies, a key finding is that loan-demand and loan-supply targeted macroprudential policies have a negative short-run impact on the margin, while capital- and liquidity-based measures typically do not affect the margin in the short run. It is suggested that the latter are primarily aimed at ensuring that banks can cope in the event of a systemic crisis, not at altering portfolio decisions on earning assets, and hence should have more limited impact on interest margins. Meanwhile, long-run effects on margins from all types of macroprudential policy are typically zero or positive, suggestive of countervailing action by banks. There are also significant interactions between macroprudential and monetary policy for several macroprudential policies; a tighter monetary stance is widely found to offset the negative effect of macroprudential policies on margins while a loose monetary policy stance leaves the negative effects intact, with potential consequences for financial stability.

Besides the extensive and detailed testing of effectiveness of macroprudential policy on margins, our advances on earlier literature include assessment of both short- and long-run macroprudential policy effects, a more extensive range of control variables than in previous work on margin determination, and empirical as opposed to theoretical assessment of the interactions of monetary and macroprudential policies, casting light on the potential for complementarity or conflict in the specific context of effects on bank margins.

We contend that these results are of considerable relevance to policymakers, regulators and bank managers, not least when monetary policies are tight to reduce inflationary pressures. For example, if both monetary and loan supply/demand focused macroprudential policies are tightened together, banks will have less net interest income from which to accumulate capital, at least in the short run.

The paper is structured as follows: Section 2 provides a literature survey, focusing on work on margin determinants and macroprudential policy effects which form the background for our work. Section 3 introduces the analytical framework, the data and descriptive statistics. Section 4 presents the results and Section 5 shows robustness checks, while Section 6 concludes.

[1] Note that due to lack of data on long-term interest rates, we are unable to cover developing countries.

2. Literature Survey

As noted above, our work brings together two streams in the empirical literature on bank behaviour, which have to our knowledge not been related to date. First, in order to provide an empirical framework for testing of macroprudential effects, we survey empirical work on the determination of the bank margin, which focuses in particular on the effect of short- and long-term interest rates. Second, we examine empirical work on the effects of macroprudential policy, a growing subset of which uses bank-by-bank data, but which has not to date focused on the bank interest rate margin. Our coverage of these is complemented by suggestions as to how macroprudential policies could affect margins and a short section relating our work to extant analyses of the interrelation of macroprudential and monetary policy.

Before our survey of empirical work, we consider it useful to introduce some key features of the margin itself. As noted by Freriks and Kakes (2021), the net interest margin can be seen as the sum of the funding margin (risk free swap rate less rate on interest bearing liabilities) and lending margin (rate on interest bearing assets less the risk-free swap rate). Along with fee and other noninterest income, the margin provides the bank with income to cover the costs of providing financial services and expected losses. Margins also reflect other markups such as risk appetite and the expected return to shareholders. Banks are able to set deposit and lending rates to some degree given their role in mitigating informational frictions, which gives them pricing power vis-à-vis counterparties, particularly those without access to securities markets. Furthermore, the margin will reflect earnings from maturity transformation, that in turn depend on exposure to interest rate risk, the slope of the yield curve and use of risk management techniques, including derivatives (For theoretical modelling work on the margin see, for example, Ho and Saunders (1981) and Alessandri and Nelson (2015).)

2.1 Determinants of the bank interest margin

Turning to recent empirical work on determinants of the margin, Demirguc-Kunt and Huizinga (1999) using bank-level panel data for 80 countries over 1988-95 found a positive effect of the level of the short rate on banks' margins. However, they did not test for an effect of the yield curve or for first differences. In a study using aggregate data for banking sectors in 10 industrialized countries over the period 1981–2003, Albertazzi and Gambacorta (2009) found the long rate to be significant in the determination of margins but not the short rate.

Alessandri and Nelson (2015) estimated determinants of the margin for a sample of 44 UK bank groups with quarterly data from 1992-2009. Independent variables were the current level and difference of the short rate and the yield curve, and also bank leverage, balance-sheet growth and GDP growth, together with a profit-volatility measure and sector concentration. They found that the levels of the short rate and the slope of the yield curve are positively related to the margin, while differences (level or lag) are significant and negative. This was suggested to show repricing frictions for banks in the short term which are eliminated in the long term.

Another recent study by Borio et al (2017) used data on 109 major international banks from 1995-2012. They also allowed for non-linearities in the relation of interest rates to bank profitability by means of squared terms for both short rates and the yield curve. Again, the short rate and yield curve slope had a positive levels effect, while each of the quadratic terms were negative, implying a disproportionate effect on the margin when rates are low. The link of the short rate to the margin was suggested to be partly related to the "retail deposits endowment effect" which is linked to imperfect adjustment of deposit rates, which benefits banks when inflation and hence short rates are high, but limits profitability when they are low. On the other hand, there may also be quantity effects on the margin when rates rise, which are negative if loans are more price-elastic than deposits. Changes in the yield curve slope may also have quantity effects via the volume of fixed rate mortgages.

Bikker and Vervliet (2017) sought to investigate the effect of low interest rates since the subprime crisis on the profitability of US banks, including the interest rate margin. Consistent with the above papers, they found that low short rates reduce the interest rate margin and there are also concavities increasing the effect at very low rates. A low long rate also reduces the margin, albeit less powerfully than the short rate.

Claessens et al (2018) also looked at the effects of "low for long" interest rates over the period since 2008, with a sample of 3385 banks from 47 countries over 2005-2013. They found that low interest rates have a significantly greater effect on bank margins than high interest rates, an effect that could be missed by estimating for a full period rather than separately for periods with low and high rates. Interest income (lending) margins are more affected than interest expense (funding) margins, and banks with short maturity balance sheets are more affected than those with long maturity ones.

Looking specifically at effects of the policy of adopting negative interest rates over 2012-16 on 7359 banks in 33 OECD countries, Molyneux et al (2019) found that banks in countries adopting such a policy had significantly lower margins and the effect was greater inter alia for small banks and in countries with more competitive banking systems and floating exchange rates. Freriks and Kakes (2021) found that margins of banks in the euro area over 2007-19 that were more reliant on deposit funding declined compared to that of other banks as interest rates fell, as they were unwilling to reduce deposit rates below zero, but were also unwilling or unable to compensate this by boosting their lending margins.

2.2 The effects of macroprudential policy

There is empirical evidence which suggests that macroprudential policy is effective in reducing the build-up of financial system imbalances. Underlying research historically tended to focus on macro data for measures such as credit growth and house prices, as shown for example in Akinci and Olmstead-Rumsey (2018), Carreras et al (2018) and Cerutti et al (2017). These studies generally show that macroprudential policy reduces credit growth and house price growth at a macro level.

More recently, there have also been a growing number of bank-level studies of the effects of macroprudential policy, and these inform the approach adopted in our work. Claessens et al (2013), for example, looked at the effectiveness of macroprudential policy in reducing banking system vulnerabilities in 48 countries and 1,920 banks. They found that policies aimed at borrowers were effective in (indirectly) reducing asset growth. Measures aimed at banks' assets and liabilities were very effective, but countercyclical buffers as a group showed less promise.

The study also focused on effects of policies on bank leverage and found credit limits, debt-to-income and loan-to-value policies to be effective.

In a more recent paper, which is one of the few to assess separately short- and long-run effects, Andries et al (2022) with a sample of 414 banks and 61 countries, found that in the short run, macroprudential policy, especially borrower-related instruments, reduces credit growth, while in the long run there is a tendency for tight macroprudential policy to raise credit growth. This is the case both at a country and bank level. They also found that the impact of macroprudential policies varies between types of banks, banking systems, policy regimes and countries.

Several recent papers also focus on the effect of macroprudential policies on risk for individual banks. Altunbas et al (2018) assessed the impact of macroprudential policy on two measures of individual bank risk, the change in the expected default frequency and the change in the Z score. The sample covered 3,177 individual banks in 61 countries over 1990-2012. They found a significant negative effect of macroprudential policies on risk, which is greatest in an upturn and for banks that are small, poorly capitalized and with more wholesale funding.

Meuleman and Vander Vennet (2020) investigated the impact of macroprudential policies on systemic risk as measured by the Marginal Expected Shortfall for EU banks from 2000-2017. They found that whereas macroprudential policies – notably controls on credit expansion and exposure limits - do reduce the component of systemic risk related to individual bank risk, the component related to risks arising from systemic linkages is aggravated by some policies. It was suggested that some retail banks may be incentivised to undertake activities with a lower regulatory burden, which may entail offsetting increased risk-taking.

Chan et al (2023) assessed the effect of macroprudential policy on bank risk for banks in East Asian countries, while controlling for bank competition and allowing for interaction between competition and policy. Notably in the developing and emerging East Asian countries, the interactions between competition and macroprudential measures often showed a lesser response to such measures in terms of risk reduction for banks with more market power. They suggested that this links in turn to ability of such banks to undertake risk-shifting in response to macroprudential policy.

Davis et al (2022) analysed the effect of macroprudential policy on banks' overall profitability, as shown by the return on average assets and the return on average equity, using a sample of 7250 global banks in 93 countries over 1990–2018. A number of policy measures had a negative impact on profitability, such as capital requirements, limits on foreign currency lending and taxation measures, and in some estimates loan-loss provision measures. Other measures, such as limits on credit growth and loan measures tended to boost profitability. These effects varied according to countries' economic development, bank type and time period. Macroprudential policy also adversely affected profitability of small and highly capitalized banks more than larger and less capitalized banks.

Note, however, that we would not expect there to be identical effects of macroprudential policies on margins as on overall profitability, since the latter also includes non-interest income, provisioning and noninterest expenditures. All of these could also be influenced by macroprudential (and monetary) policies in contrasting ways; Genay and Podjasek (2014), for example, show how US banks substituted between these sources of profitability in the light of low interest rates.

Meuleman and Vander Vennet (2022) assessed the effects of macroprudential policy impulses, both separately and conditioned on stance of the Eurozone monetary policy, on aspects of bank performance for 204 banks in the Eurozone over 2008-2018. They found that macroprudential policies reduce credit growth and bank risk but also impact adversely and significantly on profitability as measured by the "franchise value" measure of the market to book ratio, especially for retail banks. Whereas tight monetary policy complements effects of macroprudential policy in respect of credit growth and risk, the effects on profitability are attenuated when the monetary stance is tight. On the other hand, although the authors do test for effects on the margin, they are less clear cut than for franchise values.[2]

In this context, we note that our own work is quite distinct from Meuleman and Vander Vennet (2022) for having a much larger sample of banks and countries, a longer data period which is not largely focused on the period of "low for long" short rates and quantitative easing, when margins were little changed, and a much more granular breakdown of macroprudential policies. Their narrower sample may help to explain the differences in results with our own estimates.

2.3 Potential effects of macroprudential polices on bank margins

Bringing the subject matter of the above sections together, estimation of the effect of macroprudential policy on banks' interest rate margins is the major contribution of this article. In general, we anticipate that, in line with results above of reduced risk and lower credit growth, the margin will shrink when macroprudential policy is tightened, at least in the short run. There follow specific suggestions regarding the potential effects on margins of macroprudential policies, developing in part from research cited above:

We suggest that loan demand/ supply measures should have more impact on loan volumes and margins that capital measures. The latter are primarily aimed at ensuring that banks can cope in the event of a systemic crisis by build-up of resilience, not at altering portfolio decisions on earning assets, and hence should have more limited impact on interest margins. Indeed, while loan supply/demand measures are focused on changing asset composition, the direct effect of capital measures is on liabilities. An intermediate position may be held by general measures such as reserve requirements and liquidity measures which do seek to affect assets, but aim to boost resilience, in common with capital requirements. We note that loan demand/supply measures have been shown by the literature cited above (Claessens et al (2013), Andries et al (2022)) to reduce credit growth. They have also been found to reduce risk (Meuleman and Vander Vennet (2020)). Both of these effects would be likely to narrow the margin.

Looking in turn at loan demand and loan supply policies, in the short run, loan demand-targeted policies such as the loan-to-value ratio limits and debt-to-income ratio limits might be expected to reduce the margin. This is because high LTV/DSTI loans whose volume is reduced (as shown inter alia by Acharya et al (2020)) would tend to have higher interest rates than other assets, thus entailing a reduction in risk and a narrowing of the margin. If balance sheet size is

[2] A significant negative effect of macroprudential policy on margins is found when tested separately from monetary policy, but the results when interacted with monetary policy are not significant.

maintained, the margin might shrink further if the portfolio shifted to lesser yielding assets (such as lower-leverage loans and liquid assets). If the balance sheet shrinks due to the policy (as found for example by Claessens et al (2013) cited above), it would also reduce the average return on it if higher-risk loans are excluded.

Meanwhile, loan-supply targeted measures such as limits on growth of total or foreign loans would also be likely to trigger negative effects on the margin as banks' portfolios would shift relatively to lower risk assets such as liquid assets which have lower returns. Loan-to-deposit limits' effects on the margin depend inter alia on the relative price of deposits and non-deposit liabilities.

Capital-based measures requiring banks to hold more capital will affect the liability side of the balance sheet, requiring more capital relative to deposits and other liabilities. The cost of capital in dividends is not a part of the calculation of margins. Indirect effects may be seen, however. Capital-based measures may induce banks to raise balance sheet risk by boosting commercial lending and small firm loans (as found by Auer et al (2019)) so as to regain previous levels of profitability and obtain sufficient reserves to build up resilience, thus raising the margin. Similar effects may arise from advance provisioning requirements. On the other hand, higher risk-adjusted capital requirements might tend to shrink margins as banks shift into lower-weighted assets in response.

General supply-based measures such as reserve requirement ratios and liquid asset requirements tend to be directed at resilience (as for capital-based measures) and not countercyclical policy (as for loan demand/supply targeted measures). They oblige banks to hold more low-return assets than they would otherwise, thus narrowing the margin, although this may be partly offset if they also oblige banks to shift from wholesale to cheaper retail funding (King 2013). Again, assuming the bank's risk appetite is unchanged, such policies may induce an offsetting rise in risk in the rest of the asset portfolio.

An overall tightening of macroprudential policy might accompany a fall in the margin if the overall aim of reducing high-margin lending growth is achieved, as the existing papers outlined above suggest, and as found by Meuleman and Vander Vennet (2022). But if there are offsetting results for the different types of measure, the effect could be zero.

All of these policies might have differing short- and long-run effects parallel with those for monetary policy outlined above, with a short-run adjustment phase as noted above and a long-run equilibrium effect, both of which we estimate in this paper. Given scope for banks to adjust their strategies in response to macroprudential policies in line with their risk appetite, we would expect the long-run effects to be smaller and often negligible or of opposite sign to the short-run effects.

Concerning such long-run effects, loan growth limits may reduce household lending if that is their focus but may also lead banks to raise corporate lending and securities holdings (Acharya et al 2020), thus raising risk on the loan portfolio. In each case, this may offset any negative impact on margins (Meuleman and Vander Vennet 2022). A further effect may be to shift financial activities outside regulatory parameters (Cizel et al 2016) such as to shadow banks, which banks may nonetheless finance and increase high-margin cross-border lending activity by domestic or foreign banks (Aiyar et al 2014; Cerutti et al 2017). Even in respect of loans per se, we note the result of Andries et al (2022) cited above, that while loan-targeted policy reduces loan growth in the short run, the long-run effect may be to increase it.

Building on the above, we outline two hypotheses for testing:

Hypothesis 1: Loan-targeted policies will have more impact on margins than general, liquidity or capital requirements.

Hypothesis 2: Due to countervailing policy shifts by banks, macroprudential policies will tend to have a zero or positive effect on margins in the long run.

We would also anticipate that the effect of macroprudential policy may vary with the stance of monetary policy. As shown, authors have typically found tightening of monetary policy reduces the margin in the short run and increases it in the long run. These effects may be expected to interact with the direct effects of macroprudential policy, whereby a tighter monetary policy stance may offset the impact of macroprudential policies on margins.

This gives rise to a further testable hypothesis:

Hypothesis 3: Adverse effects of macroprudential policies on margins will be attenuated when the monetary policy stance is tight.

2.4 Interaction of monetary and macroprudential policies

Our work brings together the two fields highlighted in Sections 2.1 and 2.2 above, namely estimates of the effects of macroprudential policies and determinants of bank margins. However, we contend that our work also casts light on a further field of work, namely the interaction of macroprudential policy with a range of other policies, especially monetary policy. It does, however, differ markedly in approach from the bulk of the work to date in this area which tends to use theoretical or calibrated models of the wider economy rather than empirical estimation (exceptions include Gambacorta and Murcia (2019), Revelo et al (2020) and Meuleman and Vander Vennet (2022)).

Such effects could be complementary (as, for example, in N'Diaye 2009) or potentially conflicting (Agur and Demertzis 2015)[3]: In the conflicting cases, policymakers may have to determine which policy is more effective in achieving the financial and economic objective of policy makers at the time. Our work casts further light on the potential for complementarity or conflict specifically in respect of the bank margin. In this overall context, the strong appetite by policy makers for the development and incorporation of macroprudential policy in the regulatory framework and its relationship with monetary policy makes its impact all the more important to evaluate.

[3] Other recent work in this area includes Beau et al (2012), Antipa and Matheron (2014) and Turdaliev and Zhang (2019).

3. Methodology and Data

3.1 Analytical framework

In light of the above, we first sought to establish the relationship between interest rates, other control variables and bank margins (defined as net interest revenue as a percentage of average assets), and then used it to test the effect of macroprudential policy on the margin, and also interactions between macroprudential and monetary policies.

Our baseline model for the net interest margin (NIM), to which we afterwards add macroprudential variables, was largely developed from the work of Alessandri and Nelson (2015). We used the central bank policy rate (CBR) as a measure of short rates, while the yield curve (YC) is calculated as the difference between a 10-year government bond rate and the policy rate.[4] We also include the difference of the policy rate (DCBR) and the yield curve slope (DYC) in the current period and at lag one, as well as the lagged dependent variable in the model. This permits a clear separation between short rate and yield curve slope effects, respectively. Hence our baseline model is:

$$NIM_{it} = \alpha_{it} + \beta_1 NIM_{it-1} + \beta_2 CBR_{jt} + \beta_3 DCBR_{jt} + \beta_4 DCBR_{jt-1} + \beta_5 YC_{jt} + \beta_6 DYC_{jt} + \beta_7 DYC_{jt-1} + \beta_8 Internal_{it-1} + \beta_9 Industry_{jt-1} + \beta_{10} Macro_{jt} + \varepsilon_{it} \quad (1)$$

where *i* denotes the individual bank, *j* refers to the country in which bank *i* operates, and *t* indicates time period. Note that we consider it appropriate to include current levels of the interest rate variables since the interest rate margin of an individual bank is not likely to affect central bank decisions, as argued also by Borio et al (2017), and hence issues of endogeneity are not likely to arise.[5]

We tested a wider range of non-interest controls than Alessandri and Nelson (2015), Borio (2017) or Claessens et al (2018), albeit comparable to Bikker and Vervliet (2017) and Molyneux et al (2019). These are drawn from the literature on bank profitability (see for example Goddard et al (2013) and Saona (2016) as employed in Davis et al (2022)). These controls come in three groups, denoted internal, industry and macro in equation (1). Individual bank variables are tested in lagged form given the potential issues of endogeneity.

The internal bank-level control variables are respectively; bank size (LNSIZE), which is the logarithm of total assets; leverage (LEV) the ratio of equity to total assets; credit risk (CRISK) measured by provisions divided by gross loans; liquidity risk (LRISK) shown by the ratio of deposits to liabilities[6]; management efficiency (COSTINC) as shown by the ratio of total operating expenses to total income; and diversification (DIVSIF) which is the ratio of non-interest income to gross revenue.

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[4] Borio et al (2017) also used a similar approach.

[5] Robustness tests detailed in Section 5 show that further allowance for potential endogeneity by forms of instrumentation make little difference to our results, thus lending support to this suggestion.

[6] As noted by Altunbas et al (2018), this is a measure of a bank's contractual strength. It is also a measure of liquidity risk because this ratio is also influenced by the existence of explicit or implicit deposit insurance, which makes this form of funding more stable and less exposed to the risk of a run.

In studies cited above, the size, liquidity, diversification and efficiency relations to the margin are typically negative while credit risk and a higher leverage ratio typically boost it. As noted, however, many existing studies find a much smaller range of bank variables to be significant (Molyneux et al (2019) is an exception). Following studies of bank activity such as Beck et al (2013), this vector of independent variables tested at a bank level characterizes aspects of a banking sector's weighted average business model which contribute to profitability as well as risk.

The industry variable is LINDEX, the Lerner Index, a measure of competition which varies bank-by-bank. Since it is specific to each individual bank, the Lerner Index is also lagged like the internal variables. The Lerner index is a measure of the price-cost margin; it can be seen as a proxy for current and future profits stemming from pricing power, and it varies at the level of the individual bank. It is derived by estimation of a translog cost function as in Beck et al. (2013) and Davis and Karim (2019).The macro variables include the presence of a banking crisis (BCRISIS) as defined by Laeven and Valencia (2020). It is a dummy coded one in the year the crisis starts until the year it was over and is otherwise zero. The other macro variables are real GDP growth (GDPG) and CPI Inflation (INFL). These are all entered as current levels, in common with interest rates.

For the testing in this framework of effects of macroprudential policies, we used the 2020 version of the IMF's integrated Macroprudential Policy (iMaPP) Database, originally constructed by Alam et al (2019). This dataset of macroprudential instruments covers 134 countries monthly over 1990 to 2018 (IMF 2020). It is based on survey data collected from official reporting agencies to the IMF, such as central banks and financial sector regulatory authorities, and has been used in recent work such as Alam et al (2019), Bergant et al (2020), Davis et al (2022) and Chan et al (2023).There are 7 summary instruments derived from 17 individual instruments following Alam et al (2019), see Tables 1 and 2 for detail.

As noted by Alam et al (2019), the advantages of iMaPP over previous datasets include the fact it provides a comprehensive coverage in terms of instruments, countries, and time periods. It combines information from five existing databases, as well as the IMF's new Annual Macroprudential Policy Survey, and various additional sources, such as authorities' official announcements and IMF country documents. It includes policy instruments that can be macroprudential in nature but also serve other purposes (such as capital flow management- and monetary policy measures), noting that macroprudential policy instruments can overlap with other policies.

Table 1: Instruments in the IMF IMAPP Dataset of Macroprudential Policies (2020)

Survey Instrument	Abbreviation	Description
Countercyclical buffer	CCB	A requirement for banks to maintain a countercyclical capital buffer. Implementations at 0% are not considered as a tightening in dummy-type indicators.
Conservation buffer	CONSERVATION	Requirements for banks to maintain a capital conservation buffer, including the one established under Basel III.
Capital requirements	CAPITAL	Capital requirements for banks, which include risk weights, systemic risk buffers, and minimum capital requirements. Countercyclical capital buffers and capital conservation buffers are captured in the above measures respectively and thus not included here.
Leverage requirements	LVR	A limit on leverage of banks, calculated by dividing a measure of capital by the bank's non-risk-weighted exposures (e.g., Basel III leverage ratio).
Provisioning requirements	LLP	Loan loss provision requirements for macroprudential purposes, which include dynamic provisioning and sectoral provisions (e.g. housing loans).
Credit growth limits	LCG	Limits on growth or the volume of aggregate credit, the household-sector credit, or the corporate-sector credit by banks, and penalties for high credit growth.
Loan restrictions	LOANR	Loan restrictions, that are more tailored than those captured in "LCG". They include loan limits and prohibitions, which may be conditioned on loan characteristics (e.g., the maturity, the size, the LTV ratio and the type of interest rate of loans), bank characteristics (e.g., mortgage banks), and other factors.
Limits on Foreign Currency Loans	LFC	Limits on foreign currency (FC) lending, and rules or recommendations on FC loans.
Loan to deposit limits	LTD	Limits to the loan-to-deposit (LTD) ratio and penalties for high LTD ratios.
Loan to value limits	LTV	Limits to the loan-to-value ratios, including those mostly targeted at housing loans, but also includes those targeted at automobile loans, and commercial real estate loans.
Debt to income limits	DSTI	Limits to the debt-service-to-income ratio and the loan-to-income ratio, which restrict the size of debt services or debt relative to income. They include those targeted at housing loans, consumer loans, and commercial real estate loans.
Levy/Tax on Financial Institutions	TAX	Taxes and levies applied to specified transactions, assets, or liabilities, which include stamp duties, and capital gain taxes.
Liquidity measures	LIQUIDITY	Measures taken to mitigate systemic liquidity and funding risks, including minimum requirements for liquidity coverage ratios, liquid asset ratios, net stable funding ratios, core funding ratios and external debt restrictions that do not distinguish currencies.
Limits on FX operations	LFX	Limits on net or gross open foreign exchange (FX) positions, limits on FX exposures and FX funding, and currency mismatch regulations.
Reserve requirements	RR	Reserve requirements (domestic or foreign currency) for macroprudential purposes. This category may currently include those for monetary policy as distinguishing those for macroprudential or monetary policy purposes is often not clear-cut.
SIFI surcharges	SIFI	Measures taken to mitigate risks from global and domestic systemically important financial institutions (SIFIs), which includes capital and liquidity surcharges.
Other macroprudential measures	OTHER	Macroprudential measures not captured in the above categories—e.g., stress testing, restrictions on profit distribution, and structural measures (e.g., limits on exposures between financial institutions).

Notes: Sources are Alam et al (2019) and IMF (2020). The database covers a sample from 1990 to 2018, with monthly data which we have annualized (for policy action) and cumulated over time and annualized (for the policy stance/stringency).

Table 2: Summary measures derived from the IMF IMAPP Dataset of Macroprudential Policies (2020)

Derived and summary instruments	Abbreviation	Definition
All measures	MAPP-INDEX	Sum-total of the instruments listed in Table 2
Loan-targeted measures	LOAN-TARGETED	Sum of the "Demand" and the "Supply-loans" instruments.
Demand-targeted measures	DEMAND	Sum of loan to value limits and debt to income limits
Loan-supply targeted measures	SUPPLY-LOANS	Sum of provisioning requirements, credit growth limits, loan restrictions limits to the loan to deposit ratio, and limits to foreign currency loans
General supply targeted measures	SUPPLY-GENERAL	Sum of reserve requirements, liquidity requirements, and limits to FX positions.
Capital related supply measures	**SUPPLY-CAPITAL**	**Sum of leverage, countercyclical buffers, conservation buffers, and capital requirements.**

Notes: see Table 1. In common with Alam et al (2019) we omit SIFI surcharges from any summary category (except MAPP-index) since they include capital and liquidity surcharges.

The database of individual macroprudential tools is in the form of dummy-style instruments These dummy indices are based on the effective date when it differs from the announcement date, because the effective date is more widely available. The dummies show tightening (+1), no-change (0) and loosening (-1) and has accordingly only categorical as opposed to numerical values for the macroprudential policies.[7] In other words, they show simply whether the policy is tightened, unchanged or loosened, not the severity of application or easing. They are summed for calculating the summary instruments. The fact that we have categorical measures means we are estimating the impact of an average policy action, in line with the rest of the literature on macroprudential policy.

Besides using the difference-data on tightening and loosening directly from the database (indicated DMPP, the change in macroprudential policy), we have also cumulated the observations into levels from the start of the dataset in 1990 (indicated MPP, the stance of macroprudential policy), following the approach of Bergant et al (2020) working with this dataset. Thereafter, we annualized the data in line with the frequency of the banking data. Besides giving an indicator of policy tightening or loosening as provided in the database (DMPP), we thus provide an approximate measure of the stance and stringency of macroprudential regulation at each point in time (MPP), with a higher index showing a tighter stance.

As noted by Meuleman and Vander Vennet (2020), cumulation is important since macroprudential measures can have effects not just initially but also subsequently, not least since it cannot be shown at what point the policy is binding (Cerutti et al (2017) and Akinci and Olmstead-Rumsey (2018)). Cumulative measures are also less likely to be subject to issues of endogeneity, as they are mostly predetermined (Bergant et al 2020). The cumulated and policy-action measures of macroprudential policies, respectively, can be seen as parallel to the monetary policy measures on the level and difference of the interest rate (showing the policy stance and tightening/easing, respectively). Extending the baseline, the estimation equation for

[7] As noted by Alam et al (2019), although calculating measures of policy intensity for all instruments would in principle be preferable, it would be difficult, and possibly not feasible, to construct such measures, given that the designs of instruments of interest are diverse. In fact, many policy instruments are implemented differently across countries, with different definitions of regulated variables, so that the numerical information provided in regulations is often not comparable across countries.

testing macroprudential policies is thus as follows, where as for monetary policy, we enter the macroprudential policy as a current level, a current difference and a lagged difference:

$$NIM_{it} = \alpha_{it} + ß_1 NIM_{it-1} + ß_2 CBR_{jt} + ß_3 DCBR_{jt} + ß_4 DCBR_{jt-1} + ß_5 YC_{jt} + ß_6 DYC_{jt} + ß_7 DYC_{jt-1} + ß_8 Internal_{it-1} + ß_9 Industry_{jt-1} + ß_{10} Macro_{jt} + ß_{11} MPP_{jt} + ß_{12} DMPP_{jt} + ß_{13} DMPP_{jt-1} + \varepsilon_{it} \quad (2)$$

Macroprudential policies are introduced into the baseline model one by one. This is in line with the standard approach in the literature on macroprudential policy such as Cerutti et al (2017), Akinci and Olmstead-Rumsey (2018), Carreras et al (2018) and Gaganis et al (2020). We consider effects of summary measures which combine individual instruments, and then the individual instruments themselves. As for monetary policy, it can be argued that, the degree of endogeneity of macroprudential policy applied to the banking sector vis-a-vis the margin of an individual bank is low, and so a current level and current difference terms may be acceptable. However, as a robustness check, we do include a variant where the current policy-related variables (current level and difference of the policy rate, yield curve and macroprudential policies) are instrumented prior to estimation by two lags of the variable concerned and also estimates using System GMM (Section 5).

Our regressions show the effectiveness of tools at each point in time, as applied in practice across the countries concerned, given the typical intervention undertaken. As argued in Akinci and Olmstead-Rumsey (2018) and Bergant el al (2020), measurement imprecision, common to virtually all existing work on macroprudential policy, should bias the analysis against finding significant effects associated with macroprudential regulation rather than generate spurious evidence.

An important further step is to allow for interactions between interest rates and macroprudential tools in their effect on the margin. The equation is as follows:

$$NIM_{it} = \alpha_{it} + ß_1 NIM_{it-1} + ß_2 CBR_{jt} + ß_3 DCBR_{jt} + ß_4 DCBR_{jt-1} + ß_5 YC_{jt} + ß_6 DYC_{jt} + ß_7 DYC_{jt-1} + ß_8 Internal_{it-1} + ß_9 Industry_{jt-1} + ß_{10} Macro_{jt} + ß_{11} MPP_{jt} + ß_{12} DMPP_{jt} + ß_{13} DMPP_{jt-1} + ß_{14} MPP_{jt}{*}CBR_{jt} + ß_{15} DMPP_{jt}{*}CBR_{jt} + ß_{16} DMPP_{jt-1}{*}CBR_{jt-1} \quad (3)$$

We use leveraged coefficients for the combined relationship (monetary and macroprudential policies) to see whether their effects differ from the mean. We leverage all three macroprudential policy tools, namely the level, the difference and the lagged difference by the level of the relevant short-term interest rate as shown in equation (3). This should provide an accurate estimate of the effects of macroprudential policy at different levels of interest rates.[8]

[8] We also considered to leverage the difference terms in MPP by the difference of the relevant short rate. However, this formulation does not give the effects that are required since it becomes positive both in the case of tightening of both policies (as would be expected) but also if both policies are eased (multiplying minus by minus gives plus). The expression is only negative if one policy is tightened and the other is eased. Accordingly, we rejected that approach.

3.2 Estimation

As is common in the literature on individual banks, all variables except BCRISIS and MPP are winsorized at 99% to avoid an impact of outliers. Annual data are used, in line with the frequency of the banking data. Accordingly, interest rates and macroprudential policy show year-averages. The Hausman test suggested that a bank fixed-effects model is appropriate, while time fixed effects were also significant. As noted by Meuleman and Vander Vennet (2020), inclusion of time dummies to capture global macroeconomic and financial conditions affecting margins, as well as local macro variables (GDP growth and inflation) should also control for endogenous changes in monetary (and macroprudential) policies.

We cluster standard errors at a country level, given that the policy variables of interest are on the country level, as in Altunbas et al (2018). Accordingly, estimation is by panel OLS with country-clustered standard errors and bank and time fixed effects, and we used cluster-robust standard errors. A robustness check shows results using bank-level clustering. Bikker and Vervliet (2017) similarly used a panel OLS approach with fixed effects, as did Alessandri and Nelson (2015) in the bulk of their regressions.

Given use of lags for bank-specific variables to avoid issues of endogeneity, we contend that this approach is more appropriate and reliable than GMM. As noted by Kok et al (2019), dynamic panel data models which use GMM estimators are only asymptotically efficient and have poor finite sample properties when the time-dimension T is small.[9] Hence we prefer to retain GMM as a robustness check only.

3.3 Data and descriptive statistics

Empirical testing of the model was undertaken using data from the Fitch-Connect database for banks in up to 35 advanced countries, as shown in Appendix Table A1. We are unable to cover developing and emerging market countries since they typically lack long-term interest rate data for the yield curve. The types of banks included are universal commercial banks, retail and consumer banks and universal wholesale banks. Investment banks and private banks are excluded due to different balance sheet and income structures, as are bank holding companies, to avoid double counting. As in Claessens et al (2013), the number of banks for each country covers at least the top 100 banks based on total assets, or less if fewer banks exist on the Fitch-Connect database.[10] The banking data collected are unconsolidated (where available), which also allows for the reporting of foreign bank subsidiaries in each country. All financial statement data are annual and in US dollars. The period of coverage for the banking data is 1990 to 2018, annually, in line with the IMAPP database. We estimated with the 3-month interbank rate instead of the central bank policy rate as a robustness check. The macro variables are from the IMF-IFS and OECD.

[9] As also argued by Mirzaei et al (2013), the use of lagged instrumental variables for GMM would imply further loss of degrees of freedom that would vitiate our results by markedly reducing the size of the unbalanced panel dataset. However, this issue can be reduced by use of forward orthogonal deviations transform (Arellano and Bover 1995), as in our robustness check.

[10] For countries with more than 100 banks, we selected the top 100 in 1995, 2005 and 2015 so as to obtain a spread over the full time period. All these banks are included in the data for the years they existed in order to capture the top 100 banks over the sample as far as possible, and to avoid the loss of data points.

Table 1 shows the descriptive statistics of the baseline model variables for the period 1990-2018. Note that the bank level data typically has fewer observations than the macroeconomic data since the underlying series of individual bank balance sheets and profit and loss are typically not complete over the full data period. The net interest margin as a proportion of average assets (NIM) has a mean of 2.57% of total assets with a sizeable variance. It is far larger than non-interest income, whose ratio to average assets is 1.24%. Credit risk (CRISK), provisions/gross loans, is on average 8.8%, with a large variation between banks. Unadjusted capital adequacy (LEV) averages 10.9%. Our measure of liquidity risk, deposits/liabilities (LRISK) averages 64%. Management efficiency (COSTINC) averages 64% of total income, while non-interest income (DIVSIF) represents about 32.5% of gross revenue. The Lerner Index (LINDEX) is positive, suggesting some degree of market power for banks. At just over 0.2, it is comparable in average levels with other studies such as Davis and Karim (2019) and Davis et al (2022). Average GDP growth over the period was about 2.5% and the inflation rate was about 3.0%. The average short rate in the sample is 3.55%, while the yield curve is 1.25% implying an average long rate of 4.8%.

Table 3: NIM baseline model variables, descriptive statistics for the period 1990-2018

Abbreviation	Mean	Median	Max	Min	Std. Dev.	Obs
NIM (%)	2.570	2.030	26.458	-1.990	2.620	50516
LNSIZE (log)	21.804	21.818	27.117	16.054	2.252	55143
LEV	0.109	0.074	0.900	0.002	0.134	54888
CRISK	0.876	0.360	18.752	-3.150	2.040	45430
LRISK	0.636	0.702	0.992	0.001	0.290	49857
COSTINC (%)	63.678	62.510	241.794	0.706	29.273	55140
DIVSIF	0.325	0.283	1.268	-0.542	0.288	53973
LINDEX	0.206	0.212	0.645	-0.962	0.187	46059
BCRISIS	0.113	0.000	1.000	0.000	0.316	108953
GDPG (%)	2.457	2.420	11.467	-8.669	2.635	108333
INFL (%)	3.056	2.098	376.746	-0.923	13.344	108577
CBR (%)	3.549	2.792	29.350	-0.267	3.424	100872
YC (%)	1.250	1.241	7.155	-4.809	1.388	91618

Notes: Data sources are Fitch-Connect, the IMF, the OECD and author calculations. NIM is the net interest margin as a proportion of average assets, LNSIZE is the logarithm of total assets, LEV is unadjusted capital adequacy (equity/total assets), CRISK is credit risk (provisions/gross loans), LRISK is liquidity/contractual risk, (deposits/total liabilities), COSTINC is management efficiency (total operating expenses/ total income), DIVERSIF is diversification (non-interest Income/gross revenue), LINDEX is the Lerner Index, BCRISIS is a dummy variable for banking crises and it is coded one in the year the crisis starts until the year it was over and is otherwise zero (Laeven and Valencia 2020). GDPG is economic growth, the real GDP growth rate (annual %), INFL is the CPI inflation rate (annual %), CBR is the central bank policy rate (%) and YC is the 10-year bond yield less CBR (%). The values are a ratio unless otherwise stated. Except BCRISIS, the variables are winsorized at 99% and in levels.

As shown in Appendix Table A2., none of the variables are highly correlated except for the negative correlation between management efficiency (COSTINC) and the Lerner Index (LINDEX) at -0.632. Focusing on the correlations with the dependent variable, these are quite low. Only the correlation with capital adequacy, credit risk and the short rate are over 0.3 in absolute terms.

As noted, for macroprudential data, we used the iMaPP dataset (IMF 2020). The descriptive statistics for the cumulated and change indices are shown in Appendix Table A3.[11] We note that the correlation of the cumulative index and the level of policy rates (Appendix Table A4) is typically negative, albeit quite small (below -0.3). The overall measure for levels of all 17 policies (MAPP-INDEX) has a correlation with policy rates of -0.249, for example. Besides suggesting that policies have been used as substitutes, this pattern may reflect the greater use of macroprudential policies in recent years when policy rates were low. Meanwhile, the correlation of policy changes with interest rate changes is very low, albeit typically positive. The change in the overall measure (MAPP-INDEX) has a correlation of 0.132 with interest rate changes, suggesting a low degree of policy coordination. Also shown in Appendix Table A4 is that the correlation of the net interest margin with macroprudential tools varies across policies. The correlation of the margin with the cumulated overall measure (MAPP-INDEX) is positive, while it is negative for the corresponding overall policy action measure.

4. Empirical Results

4.1 Baseline model

Table 4 reports the empirical results for the baseline model of the net interest margin (equation (1) above). The lagged dependent variable of 0.63 is highly significant, which implies that there is persistence in levels of margins, and the long-run effect of each level variable is somewhat greater than the levels coefficients shown in the table. The lagged difference terms are negative both for the policy rate (CBR) and the yield curve (YC) while the corresponding levels effects are significant and contribute positively to banks' net interest margin (NIM).

The interest-rate effects are consistent with our expectation and the research literature of Section 2.3.[12] A negative short-run impact of interest rate changes suggests the presence of repricing frictions/price stickiness as in Alessandri and Nelson (2015). Also, in an increasingly competitive banking market, banks competing on interest rate margins to attract customers may not move first, especially when there is a rise in policy rates. Furthermore, the significant negative effect of a change in the term structure suggests that long-term debt might reprice faster than long-term loans.

The positive long-run short rate effect, holding the yield curve constant, can be seen alongside the positive inflation effect (INFL) as showing the "endowment effect", as argued above.[13] The

[11] Although the raw data for individual policies is limited to the values -1, 0 and +1, the indices can be larger in absolute terms because we are summing actions over 12 monthly periods, and there can be more than one action per period. Summary instruments aggregate across individual policies as well.

[12] Given that monetary policy can change during the year, the coefficient estimates show an average effect.

[13] Note that we also tested separately for an additional effect of zero or negative interest rates on the margin, using a dummy variable that is one for interest rates less than or equal to zero and zero otherwise, and found that there was no significant additional effect.

significant and positive effect of the current yield curve slope (YC) on the margin suggests the positive impact declines when the steepness of the curve is low as with quantitative easing. The implicit effect of the long rate is also positive, which is indicative of banks' market power in loan markets.

Among the banking and macro variables, only the log of bank assets (LNSIZE), the liquidity risk measure (LRISK) and the macro variable for inflation (INFL) were found to be significant. The liquidity risk proxy (LRISK) shows that bank margins increase when lower interest deposits form the bulk of total liabilities. Bank size (LNSIZE) shows larger banks have narrower margins, as in Bikker and Hu (2017) and Molyneux et al (2019). This may be possibly due to a more competitive environment (De Bandt and Davis 1999), although they may also have more scope to benefit from non-interest income to compensate for lower margins. The positive effect of inflation is in line with the "endowment effect" highlighted by Borio et al (2017).

Insignificant variables were excluded except for the current difference of CBR and YC (for congruence with the Alessandri and Nelson (2015) structure). We note that Alessandri and Nelson (2015) and Borio et al (2017) also found limited effects of bank-specific variables on the margin once interest rates were included, although Bikker and Vervliet (2017), estimating a static model without lagged dependent variable, found a wider range of these variables significant. In our work, the insignificance of GDP growth suggests that the direct effect of interest rates is sufficiently strong to not leave scope for any indirect effect of monetary policy via the real economy, at least within our sample. Meanwhile, the bank-level fixed effects capture a range of bank-specific factors while the time dummies capture global macroeconomic and financial conditions affecting margins. Looking again at Appendix Table A2, we find that the variables in the parsimonious equation have low correlations.

Table 4: Regression results for the net interest margin for the period 1990-2018

Dependent variable	NIM
NIM (t-1)	0.63*** (12.3)
LNSIZE(t-1)	-0.0743*** (3.2)
LRISK(t-1)	0.347** (2.6)
INFL(t)	0.0302** (2.2)
CBR(t)	0.0289** (2.8)
DCBR(t)	0.00821 (0.5)
DCBR(-1)	-0.0436** (2.2)
YC(t)	0.0406** (2.1)
DYC(t)	-0.00823 (0.5)
DYC(t-1)	-0.0725*** (3.6)
R-squared	0.868
R-squared (adj.)	0.856
Standard error	0.77
Periods included	27
Cross sections included	2878
Observations	35400

Notes: The equation is estimated by panel OLS with country-clustered standard errors and bank level and time fixed effects, and using cluster-robust standard errors. NIM is the net interest margin on average assets, LNSIZE is the log of total assets, LRISK is liquidity/contractual risk, measured as deposits/total liabilities, and INFL CPI Inflation, CBR is the central bank policy rate, and YC is the yield curve measured as the 10-year rate less the policy rate. D shows a difference effect. All variables are winsorized at 99%. The t-values are in parentheses. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

4.2 Results for summary macroprudential instruments

The summary macroprudential instruments (as shown in Table 2) were tested one by one using the extension of the baseline model shown in equation (2).[14] As noted above, the coefficients on the difference terms (DMPP) reflect policy implementation or adjustment, while the levels term (MPP) depict the stance of policy.

[14] Accordingly, all the control variables in Table 4 are included in each regression. We do not include full details of estimation for each policy for reasons of space. Details are available from the authors on request.

Table 5: Coefficients for summary and individual macroprudential instruments

Coefficient for	MPP(t)	DMPP(t)	DMPP(t-1)
Summary macroprudential Instruments			
MAPP-INDEX	-0.00463 (0.8)	-0.00742 (0.9)	-0.00428 (0.9)
LOAN-TARGETED	-0.00431 (0.5)	-0.0287*** (3.0)	0.00032 (0.1)
DEMAND	0.00704 (0.6)	-0.0416*** (3.9)	-0.00864 (0.3)
SUPPLY-ALL	-0.0089 (1.3)	0.00357 (0.4)	-0.00536 (0.4)
SUPPLY-LOANS	-0.0213* (1.7)	-0.0317 (1.6)	0.00847 (0.3)
SUPPLY-GENERAL	-0.0153 (0.9)	0.0259** (2.1)	-0.0192 (1.3)
SUPPLY-CAPITAL	-0.0017 (0.2)	0.00885 (0.8)	-0.0102 (0.5)
Individual macroprudential Instruments			
Capital-based measures			
CCB	-0.0489** (2.6)	0.0198 (0.8)	0.0347 (1.3)
CONSERVATION	-0.0298 (1.3)	0.0163 (0.7)	-0.00101 (0.1)
CAPITAL	0.00594 (0.4)	0.00479 (0.3)	0.00567 (0.2)
LVR	-0.0246 (0.4)	0.0542 (1.4)	-0.059 (1.6)
Loan-supply targeted measures			
LLP	-0.0487 (1.5)	-0.0679 (1.3)	0.0532 (1.1)
LCG	0.344 (1.6)	-0.609*** (3.2)	-0.375 *** (4.4)
LOANR	-0.0392 (0.9)	-0.0356 (0.9)	0.0264 (0.7)
LFC	-0.01 (1.4)	0.0294 (1.3)	-0.0166 (0.6)
LTD	-0.00862 (0.2)	-0.398*** (12.9)	-0.157*** (3.1)
Demand targeted measures			
LTV	-0.00525 (0.3)	-0.051*** (3.2)	0.00783 (0.2)
DSTI	0.0515** (2.2)	-0.0726*** (4.5)	-0.0652 (1.6)
General measures			
TAX	0.0252 (0.9)	-0.00704 (0.2)	0.00001 (0.1)
LIQUIDITY	-0.0257 (0.9)	-0.00262 (0.5)	-0.023 (0.5)
LFX	0.198***(16.2)	-0.00854 (0.4)	0.00203 (0.2)
RR	-0.0121 (0.7)	0.0476*** (3.9)	-0.0195 (1.1)
SIFI	-0.0581 (1.5)	0.004 (0.1)	0.0546 (1.4)

OTHER	0.0044 (0.3)	-0.0118 (0.4)	-0.012 (0.6)

Notes; Each row shows results from an individual equation, and each equation includes all the control variables shown in Table 4 (not shown in detail for reasons of space). Macroprudential variables are employed one at a time. MPP shows the levels effect of policy (the cumulated value for each policy) and DMPP the difference effect of policy (tightening or easing). For variable definitions, see Tables 1 and 2. The t-values are in parentheses. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

As shown in Table 5, a key result is that there are highly significant negative short-run effects of policy tightening across demand measures (LTV and DSTI) and loan-targeted measures (demand plus supply-loans). On the other hand, there is a positive short-run effect for changes in supply-general measures (reserve requirements, liquidity requirements, and limits to FX positions) and zero effect for supply-capital measures.

We also find a negative long-run effect of the supply-loans measure (comprising the sum of loan growth limits, provision measures, loan measures, limits to the loan to deposit ratio, and limits to foreign currency loans). For demand-targeted policies, supply-general and supply-capital measures there is no long-run effect.

These results imply that loan-targeted forms of macroprudential policy have a considerable adverse effect in margins of banks in the short term, which if reflected in overall profitability can in turn affect their ability to build up resilience by accumulating capital. A likely channel for these effects of loan-targeted measures is via reduction in asset growth as found by Claessens et al (2013) and Andries et al (2022), as well as the reduction in individual bank risk on the portfolio from credit-growth tools as found by studies such as Meuleman and Vander Vennet (2020). On the other hand, supply-general measures that include liquidity measures and reserve requirements are found to boost the margin in the short run, while capital-based measures have no effect. This last result is again consistent with Altunbas et al (2018) who found that unlike other measures, tightening of capital-based measures did not entail a reduction in risk.

These results differ from the study of effects of macroprudential policy on bank profitability in Davis et al (2022), who found no significant effects of the summary measures. One reason may be that the latter study only examined the long-run effects which we also find generally insignificant. But it may also be the case that pressure on margins from macroprudential policy leads to offsetting upward pressure on noninterest income (largely fees and net trading gains).

The short-run effects of demand and loan-targeted measures, zero effect of capital-based measures and positive effect of supply-general policies are broadly in line with Hypothesis 1 in Section 2.2. This is consistent with the suggestion that loan-targeted policies operate by altering portfolio decisions with negative effects on the margin, while resilience-targeted policies such as those on capital and liquidity are primarily aimed at ensuring that banks can cope (in terms of capital and liquidity) in the event of a systemic crisis and should have less effect on the margin.

For all policy types, the largely insignificant long-run effects suggest countervailing action by banks against any short-term effects on margins such as shifting to higher-risk assets in the context of loan-demand measures. This is in line with Hypothesis 2 of Section 2.1. The exception is the long-run negative effect on the margin from loan-supply measures, effects of which on the margin are thus shown to be hard to evade (although we also note that in practice the coefficient is only significant at 90%).

4.3 Results for individual macroprudential instruments

The individual measures also shown in Table 5 show which instruments are most important in driving the results for the aggregate measures.

For example, again in line with Hypothesis 1, we find highly significant negative short-run effects for both subcomponents of the demand-targeted index, namely loan to value measures (LTV) and debt-service-to-income limits (DSTI). This is again consistent with the effectiveness of borrower-related policies in reducing asset growth as found in Claessens et al (2013). Concerning the loan-supply targeted policies, we find a short-term negative effect credit growth limits (LCG) and loan-to-deposit limits (LTD). These overall effects are again consistent with effects on credit growth tools on risk as found by Meuleman and Vander Vennet (2020). Other subcategories such as loan measures (LOANR) and provision measures (LLP) are not significant in the short run, however.

Underlying the positive short-run effect from the supply-general measure we find significant positive effects of tightening of reserve requirements (RR) but not liquidity measures (LIQUIDITY) or limits on FX positions (LFX). This result arises despite the fact that reserves are typically less remunerated that other assets banks can hold. We suggest that higher reserves may give more confidence to wholesale depositors, as well as giving better access to central bank liquidity, thus allowing cheaper funding of banks.

Again, consistent with the aggregate results and with Hypothesis 2, we find there are fewer significant results for the levels of macroprudential instruments (denoted MPP) showing long-run effects, than for differences showing short-run effects. We do find a significant positive effect for cumulated limits on foreign exchange positions (LFX), which may imply a focus on higher-risk domestic assets when such a policy is applied. A positive long-run effect is also found for debt-service-to-income limits (DSTI), consistent with the results of Andries et al (2022) of credit growth being stimulated by macroprudential measures in the long term. Meanwhile the countercyclical buffer (CCB) is negative in the long run, possibly reflecting pressure to reduce overall asset size. We note that no individual instrument underlying the loan-supply measure is significant in the long run.

Combining insights of Tables 4 and 5, a number of macroprudential policies accentuate the effect of increases in interest rates to narrow the margin in the short run. Notably, the introduction of loan demand/supply targeted macroprudential policies has a negative short-run effect in line with prior expectations (Section 2.3). Short-run effects are more widespread across the policies than long run ones; concerning the latter, positive signs for debt-service-to-income ratio and limits on FX positions complement the long-run positive effect of monetary policy on the margin while the negative effect of the countercyclical buffer and of supply-general measures runs counter to it.

4.4 Interaction between monetary and macroprudential policy

We now go on to look at the interaction between macroprudential policies and central-bank rates in respect of banks' margins, since both are important for financial system stability. This will also help to understand further whether macroprudential policy offsets or complements the effect of monetary policy.

4.4.1 Does the monetary policy effect change with inclusion of macroprudential policies?

First, we looked at whether the estimated policy rate (CBR) and the yield curve slope (YC) vary when the effect of macroprudential policy is included/excluded from the model. Table 6 shows the coefficients and confidence intervals for the interest rate effects in Table 4. As noted, the difference (short run) effect is negative, and the levels (long run) effect is positive.

Examining the underlying estimates[15] summarized in Table 5, inclusion of the macroprudential instruments did not in any case shift the coefficients on the monetary policy rate or yield curve outside the confidence interval where the macroprudential policies are excluded. The significant difference terms for the policy rate and the yield curve are generally close to the levels without macroprudential policies, with the differenced policy rate effect lying between -0.04 and -0.045, while the differenced yield curve is between -0.069 and -0.074.

Table 6: Confidence intervals for the significant interest rate effects

Variable	Coefficient	95% confidence interval
CBR(t)	0.0289	0.0083 to 0.0495
DCBR(t-1)	-0.0436	-0.083 to -0.004
YC(t)	0.0406	0.0019 to 0.079
DYC(t-1)	-0.0725	-0.11 to -0.03

Notes; Based on estimates in Table 4. CBR is the central bank policy rate, and YC is the yield curve measured as the 10-year rate less the policy rate. D shows a difference effect.

Concerning long run results, the lowest level of the policy rate levels coefficient (CBR) was 0.0259 in the case where the summary variable for supply-loans is included and the highest was 0.0322 for supply-general. The level of the yield curve (YC) is also lowest for supply-loans at 0.037, and highest for limits on FX positions (LFX) at 0.0426. The long-run beneficial effect of interest rates on the margin is thus reduced in the case of such as supply-side measures, but the effect is not sizeable. This suggests overall that the interest rate terms are capturing complementary effects on the margin from macroprudential policy.

[15] We do not show results in detail for reasons of space.

4.4.2 How do effects of macroprudential policies vary with levels of interest rates?

We now go on to look at the interacted relationship effect between levels of policy interest rate (CBR) and macroprudential policy actions (DMPP) and stance (MPP), and the impact it has on net interest margin as shown in equation (3), further extending the NIM model in Table 4.

Table 7: Coefficients for summary macroprudential instruments and leveraged coefficients with policy rates)

Coefficient on	MPP(t)	DMPP(t)	DMPP(t-1)	MPP(t)*CBR(t)	DMPP(t)*CBR(t)	DMPP(t-1)*CBR(t-1)
MAPP-INDEX	-0.00418 (0.7)	-0.0241*** (3.6)	-0.0006 (0.1)	0.00162 (0.6)	0.0117*** (3.6)	-0.00366 (0.9)
LOAN-TARGETED	-0.005 (0.5)	-0.0323** (2.6)	0.0106 (0.4)	0.00013 (0.1)	0.00241 (0.3)	-0.00701 (1.2)
DEMAND	0.00564 (0.5)	-0.0354* (2.0)	0.00475 (0.1)	0.0004 (0.1)	-0.00547 (0.5)	-0.00847 (0.8)
SUPPLY-ALL	-0.00622 (0.9)	-0.0221** (2.4)	-0.00304 (0.2)	0.00189 (0.7)	0.0154*** (4.0)	-0.0026 (0.6)
SUPPLY-LOANS	-0.0202 (1.7)	-0.0472** (2.4)	0.0159 (0.5)	-0.0019 (0.1)	0.0148* (1.8)	-0.0053 (0.6)
SUPPLY-GENERAL	-0.014 (0.8)	-0.0256 (0.9)	0.00874 (0.3)	0.00376 (0.9)	0.0176*** (3.0)	-0.0094 (1.0)
SUPPLY-CAPITAL	0.000173 (0.1)	-0.00208 (0.2)	-0.0316* (1.9)	0.00332 (0.4)	0.0102 (1.3)	0.0164* (1.8)

Notes: Each row shows results from an individual equation, and each equation includes all the control variables shown in Table 4 (not shown in detail for reasons of space). Macroprudential variables and leveraged coefficients are employed one at a time. MPP shows the levels effect of policy (the cumulated value for each policy), DMPP the difference effect of policy (tightening or easing), MPP*CBR shows the levels effect times the central bank policy rate (denoted CBR) and DMPP*DCBR is the difference effect times the difference of the policy rate. For variable definitions see Tables 1 and 2. The t-values are in parentheses. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 8: Coefficients for individual macroprudential instruments and leveraged coefficients with policy rates

Coefficient on	MPP(t)	DMPP(t)	DMPP(t-1)	MPP(t)*CBR(t)	DMPP(t)*CBR(t)	DMPP(t-1)*CBR(t-1)
Capital-based measures						
CCB	-0.0356** (2.3)	-0.00603 (0.4)	0.0085 (0.4)	-0.0393 (1.6)	0.0719** (2.6)	0.0836** (2.1)
CONSERVATION	-0.0365 (1.5)	0.00152 (0.1)	0.00117 (0.4)	0.021 (1.1)	0.0377 (1.3)	-0.0341 (0.8)
CAPITAL	0.0068 (0.5)	-0.00288 (0.1)	-0.0251 (0.9)	0.00257 (0.2)	0.00702 (0.7)	0.0186* (1.8)
LVR	-0.0525 (1.3)	0.0995*** (2.9)	0.0155 (0.5)	0.0736* (1.7)	-0.078 (1.6)	-0.0681*** (3.7)
Loan-supply targeted measures						
LLP	-0.0597 (1.6)	-0.0784 (1.1)	0.00441 (0.1)	0.0304*** (3.6)	0.00471 (0.3)	0.0058 (0.2)
LCG						
LOANR	-0.00955 (0.2)	-0.0618 (1.4)	0.00878 (0.2)	-0.0321** (2.3)	0.014 (1.4)	0.00546 (0.3)
LFC	-0.0118* (1.7)	-0.0397 (1.0)	-0.00022 (0.1)	0.0189 (1.1)	0.0258 (1.2)	-0.0283** (2.4)
LTD						
Demand Targeted measures						
LTV	-0.00855 (0.4)	-0.0372 (1.5)	0.029 (0.4)	0.001 (0.1)	-0.009 (0.7)	-0.0108 (0.7)
DSTI	0.0631** (2.2)	-0.123** (2.7)	-0.0546 (1.0)	-0.0069 (0.4)	0.05* (1.8)	-0.0122 (0.5)
General measures						
TAX	0.0305 (0.5)	0.00654 (0.1)	-0.0383 (0.5)	0.00057 (0.1)	-0.0069 (0.2)	0.0255 (0.4)
LIQUIDITY	-0.0377 (1.1)	-0.00827 (0.3)	0.0116 (0.2)	0.00637* (1.8)	0.00175 (0.2)	-0.0255* (2.0)

LFX	0.594*** (20.0)	0.00731 (0.2)	0.0288 (1.1)	-0.215*** (12.7)	-0.0154 (0.7)	-0.00798 (0.5)
RR	-0.00729 (0.4)	-0.0451 (0.9)	0.0108 (0.2)	0.00149 (0.3)	0.0235** (2.4)	-0.00654 (0.6)
SIFI	-0.0499 (1.2)	-0.0254 (0.9)	0.0466 (1.1)	0.0271 (1.2)	0.0518 (1.3)	-0.0172 (0.3)
OTHER	0.000964 (0.1)	-0.0139 (0.4)	-0.0126 (0.6)	0.0115 (0.7)	0.00471 (0.2)	-0.0021 (0.1)

Notes: Each row shows results from an individual equation, and each equation includes all the control variables shown in Table 4 (not shown in detail for reasons of space). Macroprudential variables and leveraged coefficients are employed one at a time. MPP shows the levels effect of policy (the cumulated value for each policy), DMPP the difference effect of policy (tightening or easing), MPP*CBR shows the levels effect times the central bank policy rate (denoted CBR) and DMPP*DCBR is the difference effect times the difference of the policy rate. For variable definitions see Tables 1 and 2. The t-values are in parentheses. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

The interaction effects (MPPt*CBRt), (DMPPt*CBRt) and (DMPP(t-1)*CBR(t-1)) in Tables 7 and 8 allow us to investigate the effect of macroprudential policy over time at different levels of interest rates. As can be seen in Tables 7 and 8, there are indeed several significant results for interacted effects of macroprudential instruments and central-bank policy rates, and some additional macroprudential policies become significant when the leveraged terms are included. Note, however, that the equations for credit growth limits (LCG) and loan/deposit limits (LTD) could not be estimated as the leveraged difference terms are all zero.

Looking first at the summary variables in the first three columns of Table 7, unleveraged policy effects come through difference (policy-introduction) terms and not levels (policy-stance) terms. The main differences from Table 5 where leveraged effects were omitted, are that the levels effect of supply-loans and the difference effect of supply-general are not significant, while we find additional negative effects from the current difference of supply-all and supply-loans, as well as the first lagged difference of supply-capital. Such effects would be missed if estimating without the leveraged terms.

As regards leveraged effects shown in fourth to sixth columns of Table 7, there are no long-run levels effects from the summary variables, in parallel to the lack of unleveraged effects and in line with Hypothesis 2. Accordingly, the long-run effect of summary measures is zero. As regards leveraged difference effects (i.e., from macroprudential policy introduction or adjustment, DMPP*CBR and its lag), loan-targeted policies and demand policies have no leveraged difference effects, so negative short-run effects are the same at all levels of interest rates. However, for the total index, the supply-all and supply-loans aggregates, the negative unleveraged short-run effects are offset by significant positive leveraged difference terms, meaning the negative effect is partly or wholly offset at higher interest rates. A similar pattern arises for supply-capital at the first lag of the difference. For supply-general there is only a positive leveraged term at current levels of interest rates, meaning that the positive effect rises with the level of interest rates. The effect of interest rates on the margin in combination with macroprudential policy is of course in addition to the direct effect of interest rates. Our findings are partly consistent with those found by Meuleman and Vander Vennet (2022), who find that tight monetary policy mitigates the negative effect of macroprudential policy on profitability as measured by the market to book ratio. As noted above however, they do not find significant effects of macroprudential policy on the margin when interacted with monetary policies.

The result of offsetting of effects of macroprudential policy by tighter monetary policy is despite the fact that tight monetary policy is also likely to enhance downward pressure on lending growth from macroprudential policies, as shown by Gambacorta and Murcia (2017). It suggests that banks may be shifting to higher risk assets to compensate when interest rates are high, which Revelo et al (2020) highlight as one of the adverse effects of tighter monetary policy on financial stability. This is nonetheless also in some ways a favourable outcome for financial stability as it enables banks to build up capital more readily. The environment of the 2010s with restrictive macroprudential policies and loose monetary policies, on the other hand, was adverse for bank profitability (as well as offering a lesser limit on credit growth) and hance posed risks for financial stability.

Turning to the individual policies, the unleveraged effects are similar to Table 5, except that we now find a significant difference effect for leverage measures (LEV), and a significant levels effect for foreign currency lending (LFC), while difference effects of loan-to-value measures (LTV) and reserve requirements (RR) are no longer significant.

As regards leveraged terms in differences in the fifth and sixth columns of Table 8 (i.e., when the policy is introduced or adjusted - DMPP*CBR and its lag), we find positive effects for countercyclical buffers (CCB), debt-service-to-income policies (DSTI) and reserve requirements (RR). These are consistent with the outcomes of the summary measures cited above, with tight monetary policy mitigating negative or zero effects of macroprudential policy on the margin.

On the other hand, there are negative leveraged terms at the lagged difference of macroprudential policy for leverage measures (LVR), foreign currency lending restrictions (LFC) and liquidity measures (LIQUIDITY). These imply that the margin is reduced to a greater extent in the short run, the tighter is monetary policy, implying effects of such policies should be monitored carefully in the context of monetary tightening.

As regards leveraged levels of macroprudential policy in column 6 of Table 8 (MPP*CBR), the coefficients on leverage-based measures (LVR), loan loss provisions (LVR) and liquidity (LIQUIDITY) enter with a positive coefficient and other loan growth restrictions (LOANR) and foreign exchange position limits (LFX) with a negative sign. The results suggest that for the former policies there is a positive long-run effect that is higher, the higher the interest rate. Meanwhile for the latter the opposite is true (higher interest rates imply a lower margin in the long run). For foreign exchange position limits (LFX), a positive long-run effect applies only for rates below 2.8%, above which it is negative. This could be due to the trajectory of global interest rates over much of the sample.

Note that the leveraged coefficients in differences and levels only have a major effect on the margin when interest rates are positive. Accordingly, in the environment of low short rates that prevailed from 2009-21, the leveraged effect would not be sizeable, but our estimates suggest that it comes very much to the fore when rates are tightened to counter inflation.

In this context, we show in Table 9 a ready-reckoner based on the results shown in Tables 7 and 8, which depicts the net one-year, two-year and long-run effect of the macroprudential policy tools at three levels of interest rates, namely 6% (showing a markedly tight policy that may be required for counter-inflationary purposes, as at the time of writing), 3% (typical over the long term) and 0.5% (typical of the 2009-2021 period) and allowing for the interaction terms. It is assumed that there is no change to interest rates, so the table shows the initial effect on margins from the introduction of each macroprudential policy at a constant interest rate, the second-year effect including the lagged dependent effect from any levels term, and then the cumulative effect fed through the lagged dependent variable disregarding the difference terms. We only calculate for significant coefficients of individual policies. Recall that the macroprudential policy variables are +1 for a tightening of policy 0 for no change and -1 for an easing. Accordingly, we assume that the difference effect in macroprudential policy is for +1 in the first significant period only and the cumulative effect is +1 for the whole time.

Table 9: Effect on the margin of macroprudential policy introduction at constant interest rate (percentage points)

	First year effect of macroprudential policy: at different interest rates			Second year effect of macroprudential policy: at different interest rates			Cumulative effect of macroprudential policy: at different interest rates		
	CBR=0.50%	**CBR=3%**	**CBR=6%**	**CBR=0.50%**	**CBR=3%**	**CBR=6%**	**CBR=0.50%**	**CBR=3%**	**CBR=6%**
Summary macroprudential Instruments									
MAPP-INDEX	-0.018	0.011	0.046	0.000	0.000	0.000	0.000	0.000	0.000
LOAN-TARGETED	-0.023	-0.023	-0.023	0.000	0.000	0.000	0.000	0.000	0.000
DEMAND	-0.035	-0.035	-0.035	0.000	0.000	0.000	0.000	0.000	0.000
SUPPLY-ALL	-0.014	0.024	0.070	0.000	0.000	0.000	0.000	0.000	0.000
SUPPLY-LOANS	-0.040	-0.003	0.042	0.000	0.000	0.000	0.000	0.000	0.000
SUPPLY-GENERAL	0.054	0.098	0.151	0.000	0.000	0.000	0.000	0.000	0.000
SUPPLY-CAPITAL	0.000	0.000	0.000	-0.032	-0.023	0.018	0.067	0.000	0.000
Individual macroprudential Instruments									
Capital-based measures									
CCB	0.000	0.180	0.396	-0.016	0.193	0.444	-0.096	-0.096	-0.096
CAPITAL	0.000	0.000	0.000	0.093	0.558	1.116	0.000	0.000	0.000
LVR	0.136	0.320	0.541	0.026	0.156	0.311	0.099	0.597	1.194
Loan-supply targeted measures									
LLP	0.015	0.091	0.182	0.025	0.149	0.297	0.041	0.247	0.494

LOANR	-0.016	-0.096	-0.193	-0.026	-0.157	-0.314	-0.043	-0.260	-0.519
LFC	-0.012	-0.012	-0.012	-0.033	-0.104	-0.189	-0.032	-0.032	-0.032
Demand-targeted measures									
DSTI	-0.035	0.090	0.240	0.103	0.103	0.103	0.171	0.171	0.171
General measures									
LIQUIDITY	0.003	0.019	0.038	-0.008	-0.045	-0.091	0.009	0.052	0.103
LFX	0.487	-0.051	-0.696	0.793	-0.083	-1.135	1.318	-0.138	-1.886
RR	0.012	0.071	0.141	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Results shown are based on the significant estimates reported in Tables 7 and 8. The table shows the initial effect on the net interest margin, in percentage points, of introduction of macroprudential policies (year 1 and year 2 effect) and the cumulative effect of the maintenance of that policy (long-run effect). For variable definitions, see Tables 1 and 2. Each effect is shown at three different levels of the central bank policy rate CBR, namely 0.5%, 3% and 6%.

The table shows that for the key summary measures, loan-targeted policies and demand policies, there are no differences in first year effects at different levels of interest rates. This results from the lack of significant interaction effects, as noted above. On the other hand, for the MAPP index of all policies, for supply-all supply-loans and supply-capital (in the second year) there is a negative effect at low short rates of 0.5% but it becomes positive at 3% for MAPP-index and supply-capital, and at 6% for supply-loans. For supply-general, effects on the margin are positive and larger at higher interest rates. Due to lack of levels terms in the summary equations, the long-run effect of each group of policies is zero.

As discussed above, these results are consistent with considerable mitigation of initial negative effects of policy-types on the margin when interest rates are higher, except for loan-targeted and demand measures. To the extent that low profitability is a matter of concern to financial stability, consideration in the context of the stance of monetary policy should be given to choosing measures that do not reduce the margin, so long as they are effective in reducing credit growth and enhancing resilience.

For individual measures, we find quite a marked variation in the overall effect on the margin from the combination of different macroprudential policies at level and difference with a given interest rate. This result is driven by the significance for certain policies of the leveraged effects MPP*CBR, DMPP*CBR and/or DMPP(-1)*CBR(-1). Without going into detail on all the outcomes, some general points can be made:

First, effects of policy in terms of sign are generally consistent over the different time horizons, with a policy that has a negative or positive effect on the margin in the first year having a negative or positive effect in the long run also. Measures affecting portfolio decisions such as loan restrictions (LOANR) and credit growth limits (LCG) have consistent negative effects on the margin while resilience measures such as capital measures (CAPITAL), leverage limits (LVR) as well as liquidity measures (LIQUIDITY) and reserve requirements (RR) are consistently positive.

For measures with a consistent positive effect, the boost to the margin is greater the higher the interest rate. This is also the case for debt-service-to income policies (DSTI) where the initial effect at low rates is negative and for the countercyclical buffer (CCB) in the first two periods. These measures are thus favourable for resilience when monetary policy is tight. For those whose consistent effect is negative, on the other hand, higher interest rates lead to either an unchanged or a greater reduction in the margin. These policies should accordingly be used with an awareness of these effects if monetary policy is tightened.

Effects of the countercyclical buffer (CCB) are not monotonic, as its long-term effect is negative while the short-run effects are largely positive. The latter result should perhaps be taken with caution since the policy has only been used quite recently while short rates have remained low. A policy of limits on foreign exchange (LFX) shows a positive effect on the margin at low rates, while at higher rates the effect is negative over all three time horizons. We suggest this may reflect its use in countries such as those in East Asia at times when short rates were generally high.

4.4.3 Summary regarding policy interactions

We have found that macroprudential policy effects on the margin vary widely according to the level of interest rates and thus the tightness of monetary policy. The most common outcome is for the negative effects of macroprudential policies on the margin to be mitigated or offset when monetary policy is tight. This is despite results elsewhere in the literature that when both policies are tightened, they act as complements in reducing credit growth (Revelo et al 2020). During periods of loose monetary policy, on the other hand, tighter macroprudential policies are deleterious to margins and hence to potential to enhance resilience by building up capital, at least in the short run, even though the combined effects of both policies on credit growth is likely to be less. This is the case for the majority of the summary measures – and even where the effect on the margin is positive as for supply-general measures, it is more positive when rates are higher. These results are in line with Hypothesis 3.

For the most part, interactions for individual measures have a similar effect to the summary measures, although in this case some long-run effects are detected. The variation in the short- and long-run effects of the individual policy instruments shows that there are differing effects subsumed within the summary aggregates, but these net out in estimation of the latter, notably to zero in the long run.

Bear in mind that there is an effect of the interest rate, which is scaled by the level of the interest rate itself, and which is not included in Table 8. There is a one-off effect of tightening which is a lagged -0.0436 for each percentage point of tightening. Assuming that the yield curve differential is unchanged, the levels effect is roughly +0.0289 times the policy rate in the short run and +0.0762 times the policy rate in the long run.

Policy choices should take note of the differing effects of macroprudential policies on the margin, given their implications for profitability and hence capital accumulation. This is of particular importance when interest rates are low. There is a risk that policies which reduce both loan growth and measures of risk may be deleterious to scope for capital accumulation and hence financial stability, owing to their adverse effects on profitability, as also suggested by Meuleman and Vander Vennet (2022). However, unlike their work we are able to demonstrate significant interaction effects on the margin which we suggest relates to our wider range of banks and countries over a much longer time period, when there is significant movement in margins. This is unlike their sample of Eurozone banks over 2008-18, when for most of the period margins were little changed. Table 9 in this context, along with the above mentioned direct interest rate effects on the margin, offers some guidelines on the trade-offs involved in choice of macroprudential measures, subject to the stance of monetary policy.

5. Robustness Checks

We ran robustness checks to assess whether the results are stable to changes in variable definitions, estimation or specification. First, we replaced the central bank policy rate by the three-month interbank rate, second, we replaced country-level clustering with bank-level clustering as in Anginer et al (2018). Third, we instrumented each of the current-period policy variables prior to estimation by two lags of itself. Fourth, estimated by System GMM (Blundell and Bond 1998) that combines the original equation in levels and an equation in differences.

This estimator is designed for estimating models with a dynamic regressor and with independent variables that are not strictly exogenous. Both of the latter robustness checks seek to address the potential importance of endogeneity. Results of estimation of the baseline equations are shown in Appendix Table A5, while the results for macroprudential policies are included in Appendix Tables A6-A9.

Summarising the results of the baselines, most of the alterative estimates in Appendix Table A5 are close to those in Table 4. The lagged dependent, bank size (LNSIZE) and lagged difference of the yield curve (DYC(-1)) are always significant with the same sign. Liquidity risk (LRISK) is significant except for the bank clustering estimate and inflation (INFL). The main difference is that levels effects of the short rate (CBR) and yield curve (YC) as in the baseline are only present for the instrumented and GMM samples.

The replacement of the policy rate by the three-month interbank rate (column (1) of Tables A6 and A8) makes little difference to the results for macroprudential policy, with the same individual policies significant at both levels and differences as in Table 5. Meanwhile, bank clustering with country and time dummies in column (2) of Tables A6 and A8 gives a number of additional significant summary and individual policies, while retaining all the significant ones from Table 5. An overall pattern of predominantly negative short run and mostly zero or positive long-run effects of macroprudential policies on the margin again emerges.

For our third robustness check (column (3) of Tables A7 and A9), we see that the instrumentation of the current-period policy variables does not greatly change the principal results in Table 5, suggesting policy endogeneity issues for the baseline regressions vis a vis the margin of individual banks are not serious. The pattern of signs and significance for the summary measures are the same as in Table 5. For individual policies, the bulk of difference terms remain negative, while for long-run effects there is a balance, and there are less long-run than short-run effects.

The suggestion that endogeneity issues in the baseline are minor is further confirmed by the main results of final robustness check with System GMM (column (4) of Tables A7 and A9). We again find that the short-term effects of the summary variables for loan-targeted and demand variables are significant and negative as in Table 5. There are additional positive long-run effects for these variables and a negative short run effect of supply-loans as for bank clustering. Underlying, this, short-run effects of individual policies are largely negative, except for some positive effects from capital-based measures and reserve requirements, while long-run significant effects are mostly zero or positive as in the baseline.

On balance, we contend that the robustness checks tend to underpin the validity of the baseline results.

6. Conclusion

We have assessed in detail and over an extensive sample the effect of macroprudential policies on banks' margins, and the interaction of macroprudential and monetary policies in the determination of such margins. We have also considered both short- and long-run impacts of macroprudential policies on the margin. We contend that the relative neglect in the literature of these effects on the margin is surprising, given their potential relevance to authorities in evaluating risks to financial stability and in the overall assessment of the stance of macroeconomic policy. We have employed an extensive dataset of up to 3,723 banks from 35 advanced countries over the extensive period 1990-2018, with typically around 35,000 observations and control variables similar to those in Alessandri and Nelson (2015). The results can be summarized as follows:

First, certain macroprudential policies do have an impact on banks' net interest margins. The main effect is a negative impact on the margin in the short run from demand-based policies, namely loan-to-value limits and debt-service-to-income limits, and also supply-loan based policies such as controls on credit growth, foreign currency lending and loan to deposit ratios. These policies are aimed to constrain banks' portfolio decisions in the interests of reducing lending and risk, and hence a negative effect on the margin is not surprising. In contrast, we find no short-run effects from capital-based policies and a positive one from general policies. We contend that these policies are primarily aimed at ensuring that banks can cope in the event of a systemic crisis by build-up of resilience, not at altering portfolio decisions on earning assets and hence should have more limited impact on interest margins. These results are in line with Hypothesis 1.

Second, we find no long-run effects for the summary measures of policy, apart from a weak negative effect from loan-supply targeted policies, although some are found for individual instruments. This is suggestive of countervailing action by banks against any short-run impact on margins from macroprudential policies and is in line with Hypothesis 2.

Third, there are significant interactions with monetary policy, as shown when the action and stance of macroprudential policy is leveraged in combination with the stance of monetary policy as shown by the level of the interest rate. Short-run positive interaction effects are detected for a number of summary and individual macroprudential policies, so that negative effects on the margin from macroprudential policies can be offset in many cases at higher levels of interest rates. Some long-term interaction effects are detectable for individual macroprudential instruments, implying a considerable difference in effects on the margins depending on the stance of monetary policy. These results are mostly in line with Hypothesis 3.

We contend that the robustness checks underpin the validity of the baseline results.

We suggest that the most important contributions of this study are the significant differential effects on the margin of different types of macroprudential policies, the different short- and long-run effects of macroprudential policies on the bank interest margin, and the significant monetary/macroprudential policy interactions. These have not been widely tested in the literature to date.

These results have important implications for policymakers seeking to assess the overall policy stance, not least when monetary policies are tightened to reduce inflationary pressures and macroprudential policies are tightened to reduce credit growth. For example, if both monetary and loan supply/demand focused macroprudential policies are tightened together, banks will initially have less net interest income from which to accumulate capital, with consequent risks to financial stability. On the other hand, these effects are mitigated if resilience-targeted forms of macroprudential policy such as capital and liquidity regulations are tightened along with monetary policy. In the long term, stringent monetary policies will tend to expand the margin while there is no offsetting effect from macroprudential polices except weakly in the case of loan-supply based policies. Loose monetary policies will however narrow the margin in the long run with risks to financial stability, especially if it leads banks to raise risk-taking to maintain profitability. More generally, since the effect of different macroprudential policy on margins varies across levels of interest rates, choice of macroprudential policy instruments needs to take this into account.

The results are also relevant for bank management, as they highlight the short-run challenge to profitability from a tightening of macroprudential policy, especially if it is combined with loose monetary policy. There may be an incentive to expand non-interest activity so that related income can compensate from loss of net interest income. While raising fee income may be risk neutral, other forms of non-interest income such as profits from portfolio trading may raise bank risk. On the other hand, the results suggest that in the longer term managers should be able to compensate for the initial impact of macroprudential policy on margins, which may, however, entail a shift to a higher-risk portfolio.

Further research could seek to investigate interest rate and macroprudential effects on margins in emerging market economies. This would however require a different specification for margin determination since such countries tend to lack long-term bond markets. It could also undertake further tests on advanced country banks, such as whether effects differ depending on bank size and capitalisation, by type of bank (retail or universal) and according to sub-periods. There could also be further work on macroprudential and monetary policy effects on other components of overall profitability, including provisions, noninterest expenses and noninterest income.

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Appendix

Table A1: List of countries and number of banks

Country	ISO Code	Region	Banks
Australia	AUS	Oceania	154
Austria	AUT	Europe	160
Belgium	BEL	Europe	129
Canada	CAN	North America	137
Cyprus	CYP	Europe	35
Czech Republic	CZE	Europe	66
Denmark	DNK	Europe	130
Estonia	EST	Europe	19
Finland	FIN	Europe	89
France	FRA	Europe	171
Germany	DEU	Europe	156
Greece	GRC	Europe	37
Hong Kong	HKG	Asia	129
Iceland	ISL	Europe	47
Ireland	IRL	Europe	93
Israel	ISR	Europe	24
Italy	ITA	Europe	177
Japan	JPN	Asia	158
Korea	KOR	Asia	142
Latvia	LVA	Europe	34
Lithuania	LTU	Europe	17
Luxembourg	LUX	Europe	172
Malta	MLT	Europe	27
Netherlands	NLD	Europe	91
New Zealand	NZL	Oceania	45
Norway	NOR	Europe	142
Portugal	PRT	Europe	131
Singapore	SGP	Asia	57
Slovak Republic	SVK	Europe	37
Slovenia	SVN	Europe	40
Spain	ESP	Europe	200
Sweden	SWE	Europe	132
Switzerland	CHE	Europe	181
UK	GBR	Europe	196
USA	USA	North America	168
Total	**92**		**3723**

Notes: Data sources: Fitch Connect and IMF.

Table A2: Correlation matrix for the period 1990-2018

	NIM	LNSIZE (log)	LEV	CRISK	LRISK	COSTINC	DIVERSIF	LINDEX	BCRISIS	GDPG	INFL	CBR	YC
NIM (NIR/TAA) (%)	1.000												
LNSIZE (log)	-0.247	1.000											
LEV	0.327	-0.365	1.000										
CRISK	0.372	-0.063	0.116	1.000									
LRISK	0.100	-0.281	0.021	-0.068	1.000								
COSTINC	-0.075	-0.129	-0.014	-0.028	0.098	1.000							
DIVSIF (%)	-0.191	0.052	0.118	0.049	-0.137	0.064	1.000						
LINDEX	0.227	-0.006	0.147	0.045	0.132	-0.632	-0.045	1.000					
BCRISIS	-0.035	0.089	-0.025	0.084	-0.034	0.013	-0.021	-0.029	1.000				
GDPG (%)	0.120	-0.103	0.061	-0.067	0.040	-0.046	0.022	0.025	-0.424	1.000			
INFL (%)	0.274	-0.075	0.118	0.167	-0.035	-0.040	0.048	-0.011	0.038	0.194	1.000		
CBR (%)	0.303	-0.107	0.066	0.171	-0.099	-0.035	0.015	-0.095	-0.063	0.256	0.793	1.000	
YC (%)	-0.106	0.007	-0.031	-0.024	0.023	0.024	-0.018	0.028	0.119	-0.253	-0.311	-0.486	1.000

Notes: Data sources are Fitch Connect, the IMF, the OECD and author calculations. For variable definitions, see Table 3. The values are a ratio unless otherwise stated. Except BCRISIS, the variables are winsorized at 99% and in levels.

Table A3: Descriptive statistics for the macroprudential variables

	(1) Cumulated indices					(2) Policy actions				
	Mean	Median	Max	Min	Std.Dev.	Mean	Median	Maximum	Minimum	Std. Dev.
MAPP-INDEX	1.211	0	42.41667	-7.75	5.896	0.515	0	10	-7	1.458
LOAN-TARGETED	0.977	0	21.83333	-6	2.856	0.151	0	6	-3	0.678
DEMAND	0.516	0	11	-3	1.771	0.081	0	4	-2	0.489
SUPPLY-ALL	0.165	0	26	-6	3.879	0.302	0	6	-6	1.014
SUPPLY-LOANS	0.460	0	12	-3	1.356	0.070	0	2	-2	0.343
SUPPLY-GENERAL	-1.009	0	9	-7	2.211	0.050	0	3	-5	0.554
SUPPLY-CAPITAL	0.714	0	13.41667	-3	1.671	0.182	0	4	-1	0.547
Capital-based measures										
CCB	0.032	0	3	-1	0.280	0.017	0	2	-1	0.157
CONSERVATION	0.205	0	4	-1	0.632	0.079	0	2	-1	0.286
CAPITAL	0.426	0	9	-3	0.986	0.070	0	4	-1	0.324
LVR	0.051	0	3	0	0.260	0.016	0	1	0	0.126
Loan-supply targeted measures										
LLP	0.106	0	5	-1	0.588	0.013	0	2	-1	0.152
LCG	0.008	0	1.25	0	0.092	0.002	0	2	-1	0.054
LOANR	0.224	0	5	-3	0.710	0.043	0	2	-2	0.251

LFC	0.114	0	5	0	0.626	0.012	0	2	0	0.122
LTD	0.008	0	1	-1	0.096	0.001	0	1	-1	0.049
Demand targeted measures										
LTV	0.315	0	8	-3	1.184	0.050	0	2	-1	0.341
DSTI	0.201	0	4.833333	0	0.705	0.031	0	2	-1	0.232
General measures										
TAX	0.119	0	6	0	0.588	0.029	0	3	-1	0.202
LIQUIDITY	0.137	0	9	-5	1.538	0.114	0	3	-1	0.386
LFX	-0.008	0	1	-2	0.164	0.000	0	1	-2	0.115
RR	-1.137	0	8	-7	1.917	-0.064	0	3	-5	0.383
SIFI	0.165	0	4	0	0.556	0.072	0	2	-1	0.261
OTHER	0.245	0	3	-1	0.581	0.032	0	2	-1	0.224

Notes: For variable definitions, see Tables 1 and 2. There are 108953 observations for each variable.

Table A4: Correlations for the macroprudential variables

	(1) Cumulated indices		(2) Policy actions	
	Correlation with CBR	Correlation with NIM	Correlation with CBR	Correlation with NIM
MAPP-INDEX	-0.249	0.019	0.132	-0.025
LOAN-TARGETED	-0.258	-0.026	0.045	-0.023
DEMAND	-0.206	-0.027	0.044	-0.028
SUPPLY-ALL	-0.178	0.034	0.127	-0.011
SUPPLY-LOANS	-0.273	-0.021	0.027	-0.009
SUPPLY-GENERAL	0.098	0.073	0.116	0.005
SUPPLY-CAPITAL	-0.321	-0.021	0.103	-0.027
Capital-based measures				
CCB	-0.096	-0.041	0.038	-0.033
CONSERVATION	-0.298	-0.066	0.083	-0.051
CAPITAL	-0.281	0.008	0.061	0.004
LVR	-0.183	0.007	0.055	0.011
Loan-supply targeted measures				
LLP	-0.116	0.066	0.032	0.018
LCG	-0.039	-0.045	-0.017	-0.011
LOANR	-0.286	-0.054	0.012	-0.017
LFC	-0.145	-0.029	0.018	-0.012
LTD	-0.079	0.030	0.010	0.003
Demand targeted measures				
LTV	-0.199	-0.035	0.028	-0.028
DSTI	-0.184	-0.004	0.051	-0.016
General measures				
TAX	-0.154	0.017	0.043	-0.008
LIQUIDITY	-0.186	0.031	0.123	-0.026
LFX	0.014	0.221	-0.009	0.067
RR	0.268	0.037	0.043	0.006
SIFI	-0.279	-0.055	0.096	-0.045
OTHER	-0.295	-0.002	0.044	-0.007

Notes: For variable definitions see Tables 1 and 2. There are 108953 observations for each macroprudential policy variable.

Table A5: Robustness checks: regression results for the net interest margin on average assets (NIM) for large and small banks, with the 3 month interbank rate, with bank clusters, with instrumented policy variables and System GMM, for the period 1990-2018

Dependent variable	**(1) NIM with 3-month rate**	**(2) NIM with bank clusters**	**(3) NIM with instrumented policy variables**	**(4) NIM with System GMM**
NIM (t-1)	0.628*** (12.2)	0.869*** (38.8)	0.634*** (11.8)	0.732*** (8.5)
LNSIZE(t-1)	-0.0741*** (2.2)	-0.0182*** (3.8)	-0.0729*** (3.1)	-0.0381** (2.2)
LRISK(t-1)	0.344** (2.7)	0.0414 (0.8)	0.334** (2.3)	0.253* (1.8)
INFL(t)	0.0376*** (2.8)	0.03** (2.6)	0.029** (2.2)	0.05* (1.9)
CBR(t)	0.00889 (0.6)	-0.00381 (0.3)	**0.0261**** **(2.3)**	0.0505* (1.9)
DCBR(t)	-0.00204 (0.1)	0.0296* (1.8)	**-0.009** **(1.1)**	0.0191 (0.8)
DCBR(-1)	-0.0277* (2.0)	-0.0269 (1.4)	-0.0388* (1.9)	-0.03 (1.6)
YC(t)	0.021 (1.3)	0.0186 (1.2)	**0.0335*** **(1.8)**	0.721* (1.9)
DYC(t)	-0.0192 (1.3)	0.0197 (0.7)	**-0.018** **(1.5)**	0.015 (0.6)
DYC(t-1)	-0.0546*** (4.0)	-0.0544*** (2.9)	-0.0627*** (3.2)	-0.0685*** (3.1)
R-squared	0.865	0.839	0.869	Na
R-squared (adj.)	0.853	0.838	0.857	Na
Standard error	0.785	0.817	0.771	Na
Periods included	27	27	26	27
Cross sections included	2891	2878	2870	2879
Observations	34701	35400	34556	35400

Notes: Equations (1) and (3) are estimated by panel OLS with country-clustered standard errors and bank level and time fixed effects, using cluster-robust standard errors. Equation (2) is estimated by panel OLS with bank-clustered standard errors and country level and time fixed effects, using cluster-robust standard errors. Equation (4) is estimated by System GMM with country-clustered standard errors and time fixed effects; the p-value for AR(1)=0.00, AR(2)=0.357, p=value for Hansen test=1.0. **Coefficients in bold** indicates a variable instrumented separately prior to estimation by two lags of itself. CBR is the central bank policy rate in equations (2), (3) and (4), and the three month interbank rate in equation (1), and YC is the yield curve measured as the 10-year rate less the policy rate in equations (2), (3) and (4), and the 10-year rate less the three month interbank rate in equation (1). For variable definitions, see Table 4. All variables are winsorized at 99%. The t-values are in parentheses. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table A6: Coefficients for summary macroprudential instruments with the 3 month interbank rate and with bank-clustered standard errors, entered individually

Dependent variable	Column (1) NIM with 3-month interbank rate instead of policy rate			Column (2) NIM with Bank-clustered standard errors		
Coefficient on	**MPP(t)**	**DMPP(t)**	**DMPP(t-1)**	**MPP(t)**	**DMPP(t)**	**DMPP(t-1)**
MAPP-INDEX	-0.00508 (0.9)	-0.00626 (0.8)	0.00118 (0.1)	0.0015 (0.5)	-0.0148*** (3.1)	-0.0141** (2.1)
LOAN-TARGETED	-0.00692 (0.6)	-0.026** (2.5)	0.00595 (0.3)	0.00652* (1.7)	-0.041*** (5.3)	-0.0146 (1.3)
DEMAND	0.00506 (0.4)	-0.0418*** (4.0)	0.00038 (0.1)	0.0174*** (3.2)	-0.0607*** (4.6)	-0.217 (1.2)
SUPPLY-ALL	-0.00884 (1.3)	0.00367 (0.4)	0.00167 (0.1)	-0.0005 (0.2)	-0.0013 (0.2)	-0.0188** (2.2)
SUPPLY-LOANS	-0.0264* (1.9)	-0.0229 (1.1)	0.014 (0.4)	-0.00376 (0.6)	-0.00436*** (3.9)	-0.0196 (1.5)
SUPPLY-GENERAL	-0.0142 (0.8)	0.0222* (1.7)	0.00074 (0.1)	-0.0028 (0.3)	0.0137 (1.1)	-0.0386* (1.8)
SUPPLY-CAPITAL	0.0017 (0.2)	0.00537 (0.5)	-0.0133 (0.7)	0.0235 (0.7)	0.011 (1.4)	-0.0133 (1.4)

Notes: Each row shows results from an individual equation, and each equation includes all the control variables shown in Table A5 columns (1) and (2) (not shown in detail for reasons of space).Macroprudential variables are employed one at a time. MPP shows the levels effect of policy (the cumulated value for each policy) and DMPP the difference effect of policy (tightening or easing). For variable definitions, see Table 2. The t-values are in parentheses. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table A7: Coefficients for summary macroprudential instruments with the 3 month interbank rate and with bank-clustered standard errors, entered individually

Dependent variable	**Column (3)** **NIM with instrumented policy variables**			**Column (4)** **NIM estimated by System GMM**		
Coefficient on	**MPP(t)**	**DMPP(t)**	**DMPP(t-1)**	**MPP(t)**	**DMPP(t)**	**DMPP(t-1)**
MAPP-INDEX	**-0.00409** **(0.7)**	**-0.00339** **(0.8)**	-0.00782 (0.6)	0.0126 (1.5)	-0.0172 (1.,6)	-0.0265 (1.2)
LOAN-TARGETED	**-0.0044** **(0.5)**	**-0.0149**** **(2.8)**	-0.00268 (0.1)	0.0308** (2.5)	-0.059*** (4.0)	-0.0453 (1.3)
DEMAND	**0.011** **(1.0)**	**-0.0277***** **(4.6)**	-0.0182 (0.5)	0.0522*** (2.8)	-0.0826*** (6.4)	-0.0592 (1.2)
SUPPLY-ALL	**-0.00894** **(1.5)**	**0.00402** **(0.7)**	-0.00726 (0.6)	0.0111 (0.9)	-0.0034 (0.3)	-0.0306 (1.3)
SUPPLY-LOANS	**-0.0254*** **(2.0)**	**-0.00811** **(0.8)**	0.0127 (0.4)	0.0419 (1.3)	-0.0722* (2.0)	-0.0788 (1.3)
SUPPLY-GENERAL	**-0.015** **(1.1)**	**0.0189*** **(1.9)**	-0.0176 (1.3)	0.0123 (0.9)	0.0196 (0.8)	-0.0176 (0.7)
SUPPLY-CAPITAL	**-0.0006** **(0.1)**	**0.00423** **(0.6)**	-0.011 (0.6)	-0.0087 (0.4)	0.0162 (1.1)	-0.0167 (0.6)

Notes: In column (3) results, current levels and changes of macroprudential policy variables, the central bank policy rate and the yield curve are instrumented separately prior to estimation by two lags of itself as shown by **bold figures** . Column (4) results show estimates generated using System GMM. Each row shows results from an individual equation, and each equation includes all the control variables shown in Table A5 columns (3) and (4) respectively (not shown in detail for reasons of space). Macroprudential variables are employed one at a time. MPP shows the levels effect of policy (the cumulated value for each policy) and DMPP the difference effect of policy (tightening or easing). For variable definitions, see Tables 1 and 2. The t-values are in parentheses. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table A8: Coefficients for individual macroprudential instruments with the 3 month interbank rate and with bank-clustered standard errors, entered individually

Dependent variable	**Column (1)** **NIM with 3-month interbank rate instead of policy rate**			**Column (2)** **NIM with Bank-clustered standard errors**		
Coefficient on	**MPP**	**DMPP**	**DMPP(-1)**	**MPP**	**DMPP**	**DMPP(-1)**
Capital-based measures						
CCB	-0.0525** (2.5)	0.017 (0.7)	0.0369 (1.3)	-0.0284* (1.8)	0.0339* (1.9)	0.0465* (1.9)
CONSERVATION	-0.0326 (1.2)	0.0158 (0.7)	-0.00035 (0.1)	-0.0061 (0.5)	0.0139 (0.8)	-0.0194 (1.1)
CAPITAL	0.0106 (0.7)	-0.00066 (0.1)	0.00313 (0.1)	0.00511 (1.0)	-0.00156 (0.1)	0.0005 (0.1)
LVR	-0.00773 (0.1)	0.0538 (1.5)	-0.0547 (1.5)	-0.0171 (0.9)	0.0532 (1.6)	-0.0686** (2.2)
Loan-supply targeted measures						
LLP	-0.045 (1.4)	-0.0687 (1.4)	0.0506 (1.0)	-0.0028 (0.1)	-0.101*** (3.4)	-0.0126 (0.5)
LCG	0.0934 (0.5)	-0.359** (2.0)	-0.274*** (3.3)	0.387** (2.0)	-0.0622*** (3.0)	-0.309** (2.1)
LOANR	-0.0522 (1.1)	-0.0235 (0.5)	0.0401 (1.0)	-0.0189 (1.6)	-0.0365* (1.9)	0.0105 (0.6)
LFC	-0.0126 (1.5)	0.0328 (1.5)	-0.00947 (0.4)	-0.0005 (0.1)	0.0007 (0.1)	-0.0612** (2.6)
LTD	0.0389 (1.1)	0.0177 (0.1)	-0.08* (2.0)	0.385*** (3.8)	-0.568*** (5.3)	-0.466*** (3.1)
Demand targeted measures						
LTV	-0.00848 (0.4)	-0.0542*** (3.4)	0.0208 (0.4)	0.0131* (1.7)	-0.072*** (3.9)	0.0041 (0.2)
DSTI	0.0494** (2.3)	-0.0685*** (4.1)	-0.0535 (1.4)	0.0539*** (3.8)	-0.103*** (4.1)	-0.112*** (2.9)
General measures						

TAX	0.0158 (0.5)	0.0114 (0.4)	0.0135 (0.4)	0.0261* (1.8)	-0.0243 (1.3)	-0.0249 (0.9)
LIQUIDITY	-0.0161 (0.6)	-0.0141 (0.6)	-0.032 (0.8)	-0.00652 (0.3)	-0.0328 (1.4)	-0.0519* (1.7)
LFX	0.199*** (18.3)	-0.00757 (0.4)	0.00742 (0.5)	0.328*** (4.1)	-0.0177 (0.2)	-0.0431 (0.5)
RR	-0.00867 (0.4)	0.0446*** (3.5)	0.0086 (0.3)	-0.00206 (0.2)	0.0462*** (2.8)	-0.0361 (1.3)
SIFI	-0.0563 (1.5)	0.00546 (0.2)	0.0538 (1.4)	-0.038** (2.0)	-0.0092 (0.5)	0.0492* (1.9)
OTHER	0.00507 (0.3)	-0.0126 (0.4)	-0.017 (0.8)	-0.0213* (1.7)	-0.00976 (0.4)	-0.0035 (0.2)

Notes: Each row shows results from an individual equation, and each equation includes all the control variables shown in Table A5 columns (1) and (2) (not shown in detail for reasons of space).Macroprudential variables are employed one at a time. MPP shows the levels effect of policy (the cumulated value for each policy) and DMPP the difference effect of policy (tightening or easing). For variable definitions, see Table 1. The t-values are in parentheses. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table A9: Coefficients for individual macroprudential instruments with the 3 month interbank rate and with bank-clustered standard errors, entered individually

Dependent variable	Column (3) NIM with instrumented policy variables			Column (4) NIM estimated by System GMM		
Coefficient on	**MPP**	**DMPP**	**DMPP(-1)**	**MPP**	**DMPP**	**DMPP(-1)**
Capital-based measures						
CCB	**-0.0442** (2.8)**	**0.0238* (1.8)**	0.0312 (1.3)	-0.037 (0.9)	0.0203 (0.6)	0.0261 (0.8)
CONSERVATION	**-0.0282 (1.3)**	**0.0187 (1.3)**	-0.00081 (0.1)	-0.0957* (1.7)	0.0762* (1.7)	0.0528 (1.1)
CAPITAL	**0.00714 (0.5)**	**-0.0014 (0.1)**	0.00055 (0.1)	-0.0125 (0.4)	-0.026 (1.0)	-0.0054 (0.1)
LVR	**-0.02 (0.5)**	**0.0348 (1.3)**	-0.0494 (1.5)	-0.027 (0.2)	0.194* (2.0)	0.027 (0.4)
Loan-supply targeted measures						
LLP	**-0.0348 (1.3)**	**-0.0254 (0.9)**	0.0433 (0.7)	0.13*** (2.8)	-0.157** (2.2)	-0.102 (1.2)
LCG	**0.584 (1.4)**	**-0.725* (1.8)**	-0.424** (2.7)	0.0819 (0.6)	-0.0524 (0.4)	-0.1 (1.2)
LOANR	**-0.0463 (1.2)**	**-0.00593 (0.2)**	0.0372 (1.0)	0.0156 (0.3)	-0.0326 (0.6)	0.00566 (0.1)
LFC	**-0.012 (1.5)**	**0.0186* (1.8)**	-0.0113 (0.4)	0.0342 (0.5)	-0.1167 (1.1)	-0.193 (1.4)
LTD	**-0.0166*** (5.3)**	**-0.0759*** (4.3)**	0.00178 (0.1)	0.854*** (3.5)	-0.659*** (7.1)	-0.878*** (3.6)
Demand targeted measures						
LTV	**-0.0013 (0.1)**	**-0.0309*** (3.9)**	-0.00367 (0.1)	0.0583* (1.9)	-0.0976*** (5.6)	-0.0361 (0.5)
DSTI	**0.0548** (2.8)**	**-0.0509*** (4.7)**	-0.0777** (2.2)	0.151*** (3.2)	-0.168*** (5.2)	-0.201** (2.3)
General measures						
TAX	**0.0353**	**-0.0131**	-0.0183	0.083	-0.111	-0.163

	(1.2)	**(0.7)**	(0.5)	(0.7)	(1.4)	(1.0)
LIQUIDITY	**-0.0278** **(1.5)**	**0.00943** **(0.6)**	-0.021 (0.6)	0.0553* (1.9)	-0.0497 (1.2)	-0.0924** (2.7)
LFX	**0.15***** **(17.7)**	**-0.0562***** **(4.9)**	0.0499*** (3.5)	0.615*** (4.5)	-0.426** (2.6)	-0.257*** (2.7)
RR	**-0.0107** **(0.6)**	**0.029**** **(2.5)**	-0.0214 (1.2)	-0.0067 (0.7)	0.0756** (2.3)	0.0111 (0.3)
SIFI	**-0.0524** **(1.5)**	**0.0192** **(0.9)**	0.0448 (1.0)	0.0071 (0.2)	0.0531 (1.0)	0.0628 (1.5)
OTHER	**0.00432** **(0.3)**	**-0.00616** **(0.3)**	-0.0124 (0.7)	- (00138 (0.1)	-0.0129 (0.4)	-0.0317 (1.0)

Notes: In column (3) results, current levels and changes of macroprudential policy variables, the central bank policy rate and the yield curve are instrumented separately prior to estimation by two lags of itself as shown by **bold figures** . Column (4) results show estimates generated using System GMM. Each row shows results from an individual equation, and each equation includes all the control variables shown in Table A5 columns (3) and (4) respectively (not shown in detail for reasons of space). Macroprudential variables are employed one at a time. MPP shows the levels effect of policy (the cumulated value for each policy) and DMPP the difference effect of policy (tightening or easing). For variable definitions, see Tables 1 and 2. The t-values are in parentheses. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.