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Abstract

We use data on UK banks' minimum capital requirements to study the interaction of monetary policy and capital requirement regulation. UK banks were subject to both time-varying capital requirements and changes in interest rate policy. Tightening of either capital requirements or monetary policy reduces the supply of lending. Lending by large banks reacts substantially to capital requirement changes, but not to monetary policy changes. Lending by small banks reacts to both. There is little evidence of interaction between these two policy instruments. The differences in the responses of small and large banks, and the lack of interaction between capital requirement changes and monetary policy, have important policy implications. Our results confirm the theoretical consensus view that monetary policy should focus on price stability objectives and that capital requirement changes are a more effective tool to achieve financial stability objectives related to loan supply. We also identify important distributional consequences within the financial system of these two policy instruments. Finally, our findings do not corroborate theoretical models that raise concerns about complex interactions between monetary policy and macroprudential variation in capital requirements.

Key words: Loan supply, capital requirements, monetary policy, macroprudential regulation.

JEL classification: G21, G18, E51, E52, E44.

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Summary

Traditionally national authorities have regulated banks from the perspective of the safety and soundness of individual institutions. Such "microprudential" regulation has operated separately from the main policy instrument employed to smooth aggregate fluctuations in business activity, monetary policy. But following the recent global financial crisis, "macroprudential" regulation, such as varying banks' capital requirements countercyclically, has increasingly been viewed as a desirable instrument of policy. Changing banks' capital requirements countercyclically not only has the familiar aim of building up capital in good times to act as a buffer to absorb losses in bad times, it also can have the goal of stabilising the credit cycle itself, leaning against the cycle to reduce credit growth when the economy overheats, and mitigating disruptive credit crunches when the economy suffers a downturn. This latter goal is appropriately "macroprudential", since a shallower credit cycle should reduce the incidence of financial crises generated by imprudent lending and the mispricing of risk, thus enhancing the stability of the financial system. But higher capital requirements could also increase lending at banks with very low or negative net worth, in particular if they helped to overcome a so-called "debt overhang" problem.

There is already a substantial and rapidly growing theoretical literature on the expected credit supply impact of bank capital requirements (alongside the venerable literature on the credit supply impact of monetary policy). Moreover, some papers predict that monetary policy should interact with changes in bank capital requirements through various channels when the two instruments are deployed jointly. That is to say, a bank's lending response to a change in capital requirements may be different if there is a simultaneous change in monetary policy, and a bank's lending response to a change in monetary policy may be different if there is a simultaneous change in capital requirements. So far, however, there have been no empirical tests of whether or not this is the case, despite their evident and urgent relevance to policy.

This paper provides the first empirical estimate of how banks' credit supply responds to monetary policy and minimum capital requirements, when the two instruments are used together.

The analysis is made possible by an apparently unique policy experiment performed in the United Kingdom during the 1990s and 2000s, where the Financial Services Authority (FSA) varied individual banks' minimum risk-based capital requirements. The extent of this variation across banks was large (the minimum required capital ratio was 8%, its standard deviation was 2.2%, and its maximum was 23% of risk-weighted assets). The variation in the average minimum capital requirement over the business cycle was also large, and tended to be countercyclical, as envisaged under macroprudential regulation. This data set on individual banks' minimum capital requirements over time is combined with Bank of England data on lending by the same banks.

The empirical analysis suggests that tightening monetary policy and increasing banks' minimum capital requirements both have independent negative effects on banks' supply of loans to the non-financial private sector. Consistent with previous work it is found that lending by large banks does not react as much as the lending of small banks to changes in monetary policy, perhaps because large banks have greater flexibility in accessing non-deposit funding. Changes in capital requirements, on the other hand, have large effects on the loan supply of large and small banks alike, suggesting greater relative potency for this instrument in economies with banking systems comprised of a small number of large banks. Finally, contrary to existing theoretical perspectives on the interaction of monetary policy and capital requirement changes, no interaction effects are found between changes in monetary policy and capital requirements.

I. Introduction

By the middle of the twentieth century, both academic economists and policy makers advocated the use of counter-cyclical monetary policy to stabilise the economy. Bank regulatory policies, such as capital requirements, cash reserve requirements, and other prudential tools, were focused instead on microeconomic objectives, typically defined as individual banks' "safety and soundness." But following the recent global financial crisis, "macroprudential" regulation—which seeks to preserve the resilience of the financial system as a whole, including by managing aggregate bank credit flows over the cycle and thereby reducing the risks that large cyclical movements pose to individual institutions—has increasingly been viewed as a desirable instrument of policy. Changing banks' minimum capital requirements countercyclically not only has the familiar aim of building up capital in good times to act as a loss-absorbing buffer in bad times, it also can have the goal of stabilizing the credit cycle itself, leaning against the cycle to reduce credit growth when the economy overheats, and mitigating disruptive credit crunches when the economy suffers a downturn. This latter goal is appropriately "macroprudential", since a shallower credit cycle should reduce the incidence of financial crises generated by imprudent lending and the mispricing of risk, thus enhancing the stability of the financial system.

Under Basel III, regulators have agreed to vary minimum capital requirements over time as part of the cyclical mandate of macroprudential policies.[1] Anecdotal evidence from Colombia suggests that, during the 2007-2008 credit boom, macroprudential policy was a more powerful

[1] Basel III envisages a "counter-cyclical capital buffer" of up to 2.5% of risk-weighted assets, which would be subject to the priciniple of reciprocity. Thus, for example, if the UK raised system-wide minimum capital requirements by 2.5%, other regulators would also raise capital charges on the UK assets of banks under their jurisdiction by this amount (UK regulators could raise capital requirements by more than 2.5%, but the reciprocal increase by other jurisdictions would only apply up to the 2.5% ceiling). In addition to cyclical variation of minimum capital ratios, macroprudential policy could entail other cyclical variation in policy instruments (e.g., liquidity and provisioning requirements) as well as "structural" interventions to promote financial stability. For more details, see Tucker (2009, 2011), Galati and Moessner (2011), Bank of England (2011), and Aikman, Haldane and Nelson (2011).

instrument to manage aggregate credit than monetary policy.[2] But to our knowledge, no previous work[3] documents the relative effectiveness of these two tools for managing bank lending, or examines the extent to which the two tools magnify or lessen each other's impact. This paper aims to fill this gap by providing the first empirical examination of the independent effects and potential interactions of monetary and capital requirements policy on bank lending.

Our analysis is made possible by an apparently unique policy experiment performed in the UK during the 1990s and 2000s. As we explain more fully in Section II, the Financial Services Authority (FSA) varied individual banks' minimum risk-based capital requirements substantially. The extent of this variation across banks in the minimum required risk-based capital ratio was large (the minimum required capital ratio was 8%, its standard deviation was 2.2%, and its maximum was 23%). The variation in the average capital requirement over the business cycle was also large, and tended to be counter-cyclical, as envisaged under Basel III.

In earlier studies, Aiyar, Calomiris and Wieladek (2014a, 2014b), and Aiyar, Calomiris, Hooley, Korniyenko and Wieladek (2014), showed that changes in minimum capital requirements had large effects on the supply of credit by UK banks that were subject to UK capital regulation during the sample period of 1998 to 2007. Apparently, equity finance was sufficiently costly for banks that increases in capital requirements imposed important constraints on the supply of bank credit. Due to the unique aspects of the UK database on regulated banks, that paper was able to identify moments of exogenous changes in capital requirements, and control for changes in loan demand (made possible by detailed information on the sectoral specialization of lenders), and thus, isolate the effects of changes in minimum capital requirements on *loan supply*. But it is important to emphasize that these effects were based on observed sample averages during that period. In theory,

[2] Indeed, in the case of Colombia, macroprudential policy was used only after repeated efforts to reduce credit with increases in interest rates (which had resulted in a cumulative 400 basis point increase in the policy rate) had failed to achieve the desired objective during the credit boom of 2007-2008 (Uribe 2008).

[3] The few other relevant studies that examine the impact of capital requirements on credit conditions include BCBS (2010) and MAG (2010) who focus on the effect on lending spreads and Nadauld and Sherlund (2009) who study the impact on sub-prime credit. See Bank of England (2011) for a survey of the existing evidence.

higher capital requirements could increase lending at banks with very low or negative net worth; if capital ratio requirements help to prevent or overcome a so-called "debt overhang" problem, which can occur at very low capital ratios, then in principle, higher capital could encourage lending.

As elaborated further below, the theory of the bank lending channel of monetary policy (e.g., Bernanke and Gertler 1995) predicts that contemporaneous changes in capital requirements should affect the transmission of monetary policy to loan supply. Additionally, Thakor (1996) argues that the sign of this interaction will depend on the change in the term premium associated with a given change in monetary policy. If the term premium increases (falls), government bonds become a more (less) attractive investment opportunity, given their zero risk weight relative to lending, leading banks to reallocate their portfolio towards (away) from government securities. A contemporaneous increase in the capital requirement will reinforce (weaken) this effect. These theories may have important implications for the coordination of monetary and macroprudential policy.[4] To our knowledge, ours is the first paper to test these theories and compare the effects of the two instruments on individual bank lending side by side. During this time, the FSA and the Bank of England were mutually independent organisations, with the former focused on individual bank regulation and supervision and the latter primarily responsible for price stability. Formally, Her Majesty's Treasury (HMT), The Bank of England and the FSA met as part of a tripartite group to discuss matters of financial stability. But to the best of our knowledge, UK monetary policy did not

[4] Most previous work on the question of interaction focuses on the welfare consequences of macroprudential and monetary policy in DSGE modelling frameworks, and posits important interactions between macroprudential and monetary policies. For example Angelini, Neri and Panetta (2011) find that coordination among monetary and macroprudential policy is beneficial if financial and housing market shocks dominate the economy. Similarly, Beau, Clerc and Mojon (2011) find that monetary policy can be more effective in reaching its goals if it takes into account the effects of macroprudential policy on the economy. But the conclusions of these early studies are mainly hypothetical, as they rely on calibration without empirical evidence regarding the actual interaction between monetary and macroprudential policies. See also Dell'Ariccia, Laeven and Marquez (2010), Angelini, Nicoletti-Altimari and Visco (2012), Gelain and Ilbas (2013), International Monetary Fund (2012, 2013). Interestingly, Gelain and Ilbas (2013) argue that coordination of monetary policy and capital policy may not be desirable, particularly if the main objective of the latter is to safeguard financial stability.

explicitly[5] take into account capital requirements of individual banks. Similarly, while there was a memorandum of information sharing between the FSA and the Bank of England, the framework used by regulators (ARROW) does not explicitly mention monetary policy. This institutional setup provides an ideal framework to examine the individual and joint effects of these two independent policy instruments on loan supply.

Our paper also investigates the extent to which the responses of bank loan supply to changes in monetary policy and capital requirements vary by type of bank. There is a large literature documenting that the effect of monetary policy on loan supply – measured either by the quantity of lending or by credit spreads on bank loans – depends on bank characteristics related to the cost of finance, particularly bank size (Kashyap and Stein 1995, 2000; Ehrmann, Gambacorta, Martinez-Pages, Sevestre and Worms 2003; Jimenez, Ongena, Peydro, and Saurina 2008; Dell'Ariccia, Laeven and Suarez 2013) . Owing to the unique policy environment of the UK, we are able to investigate the differential effects of changes in both capital requirements and monetary policy on the loan supply responses of different types of banks.

Our results suggest that changes in monetary policy and banks' capital requirements have substantial and independent effects on loan supply. Consistent with previous work (e.g., Kashyap and Stein 2000), we find that the amount of lending by large banks does not react as much as the lending of small banks to changes in monetary policy. In a concentrated banking system like that of the UK, this implies that monetary policy faces limitations in influencing aggregate bank loan supply. Changes in capital requirements, on the other hand, have large effects on the loan supply of large and small banks alike. Finally, contrary to existing theoretical perspectives on the interaction of monetary policy and capital requirement changes, we are unable to identify interaction effects between changes in monetary policy and capital requirements.

[5] There could be, of course, implicit coordination in form of feedbacks between the two instruments. In particular, if capital requirements affect credit conditions and credit conditions affect real activity, monetary policy would have responded to the impact on real activity.

In section II, we discuss the relevant economic theory that underpins the transmission to loan supply of changes in capital requirements, changes in monetary policy, and their interaction. Section III briefly describes the bank-specific UK data base that we employ to measure changes in capital requirements and changes in loan supply and loan demand. Section IV describes the regression framework that we will use in our investigation in greater detail. Sections V presents the results. Section VI discusses questions of robustness and endogeneity. Section VII concludes.

II. Theory

In this section we discuss the theory relevant for our empirical tests, starting first with the relevant transmission channels of monetary policy, then capital requirements, and finally theories about how they might interact.

Monetary policy (a change in the interest rate controlled by the central bank) may affect bank lending via several channels. The bank lending channel of monetary policy predicts a loan contraction following an interest rate increase, so long as cash reserve requirements are binding and banks are liquidity constrained (Bernanke and Gertler 1995). The bank capital requirement channel of monetary policy, presented in Van den Heuvel (2002), predicts that bank capital may fall following a monetary policy contraction as a result of unexpected losses due to interest rate risk. In that case, unless dividends are cut, loans will have to shrink to restore the targeted capital buffer. Finally, recent work emphasizes shifts in the risk-taking preferences of banks as a channel through which monetary policy can affect bank lending. Low interest rates can increase banks' net worth (Adrian and Shin 2010), reduce asset volatility and thereby reduce perceptions of risk (Borio and Zhu 2008), and make nominal target returns harder to achieve (Rajan 2005).[6] This may lead to an increase in banks' appetite for risk, and therefore, riskier lending. Empirical evidence for the bank lending, bank capital and risk-taking channel of monetary policy is provided in Kashyap and Stein

[6] See Dell'Ariccia et al (2010) for a review.

(1995, 2000), Gambacorta and Mistrulli (2004) and Altunbas, Gambacorta and Marques-Ibanez (2010), respectively.

Changes in capital requirements will have an independent impact on bank lending, so long as equity is costly and capital buffers are binding. Both of these conditions have been shown to hold empirically for our UK sample (see Aiyar, Calomiris and Wieladek 2014a, Bridges et al. 2012, Francis and Osborne 2009).

The standard story about the bank lending channel of monetary policy implies potentially important interactions between monetary policy changes and changes in capital requirements; both policy instruments affect lending through related contingencies involving bank balance sheets. The bank lending channel of monetary policy relies on the cost to banks of raising debt other than deposits – that is, debts that are not directly affected by reserve requirements – when reserve requirements are binding and banks are constrained in the amount of non-depository debt they can raise (Bernanke and Gertler 1995). An increase in a binding minimum capital requirement, and the implied limit on leverage, will, therefore, reduce the ability of a bank to access non-depository debt, and thus should strengthen the impact of monetary policy on lending.[7]

Alternative mechanisms for an interaction effect can be posited via a "time-varying risk-aversion" channel. For example, assume that low policy rates are associated with greater bank willingness to undertake risk, as supported by a substantial body of empirical evidence (Jiminez et al. 2008). In a low interest rate environment, banks become less risk averse, which implies that they may be willing to allow their capital buffers – defined as the proportion of capital relative to risk-weighted assets that the bank maintains in excess of its minimum capital ratio requirement – to fall by more in response to an increase in minimum capital requirements. If capital buffers shrink in a

[7] Francis and Osborne (2009) and Aiyar, Calomiris and Wieladek (2014a) show that minimum capital ratio requirements tend to be binding constraints on bank lending, which is, of course, a necessary condition for changes in minimum capital ratio requirements to affect lending. A binding capital ratio, however, does not imply that the capital ratio is equal to the minimum requirement, since banks will desire to maintain a positive capital buffer to ensure that they remain in compliance.

low interest rate environment, then a rise in capital requirements will have a smaller effect in shrinking credit supply than it would have during a time of higher interest rates.

Thakor (1996) proposes a formal theory of the interaction between monetary and capital requirements policy, based on banks' portfolio reallocation decisions following a change in either policy instrument. In his model, when capital requirements rise, competition and screening costs prevent banks from passing on the increased cost to borrowers. The relative decline in expected profits from lending relative to holding government securities, which have a risk-weight of zero, leads banks to reallocate their portfolio from the former to the latter. The extent to which a capital requirement change interacts with monetary policy in this framework depends on the coinciding change in the interest rate term premium. If long rates rise (fall) by more than short rates, implying a positive (negative) term premium, government securities will become more (less) profitable. This will magnify (reduce) the effect of the rise in capital requirements. On the contrary, if the capital requirement declines, a positive (negative) term premium will reduce (increase) the effect of the change in the capital requirement on lending. In other words, this theory predicts that changes in capital requirements and monetary policy both affect banks portfolio choice between government securities and loans, but the sign of the interaction term depends on the change in the term spread.

To summarize: the literature on the credit supply response of monetary policy and bank minimum capital requirements is growing rapidly, in line with the perceived policy importance of the issue. But empirical work—especially on the impact of capital requirements on loan supply—remains scant.[8] The theoretical literature posits several distinct channels through which monetary policy and capital requirements could interact, with different implications for the sign and magnitude of the

[8] International Monetary Fund (2012) constructs a country panel study using aggregate data to measure the effects of monetary policy and capital requirements policy, as well as other macroprudential policy measures. The study finds statistically significant effects of capital requirements on credit growth, and finds that this effect is stronger during credit busts. The authors do not find any significant interaction effects between monetary policy and macroprudential policy (footnote 18, page 18). Such data, however, have various limitations, including various challenges of measurement, the non-comparability of policy instruments and enforcement of prudential regulation of capital across countries, as well as the problem of endogeneity of capital requirements and monetary policy and potential differences in endogeneity of those policy processes across countries.

potential interaction between the two instruments. Ultimately the nature of the interaction between instruments, if any, needs to be resolved empirically.

III. UK Capital Regulation 1998-2007

Our empirical analysis is made possible by a regulatory policy regime that set bank-specific, time-varying capital requirements. These minimum capital requirement ratios were set for all banks under the jurisdiction of the FSA – that is, all UK-owned banks and resident foreign subsidiaries. Bank capital requirements are not public information. We collect quarterly data on capital requirements, and other bank characteristics, from the regulatory databases of the Bank of England and FSA. Our sample comprises 88 regulated banks (48 UK-owned banks and 40 foreign subsidiaries). Bank mergers are dealt with by creating a synthetic merged data series for the entire period (e.g., if two banks merge in 1999, they are treated as merged in 1998 as well). The variables included in this study are listed and defined in Table 1, and Table 2 reports summary statistics.[9]

Discretionary regulatory policy played a much greater role in the UK's setting of minimum bank capital ratios than in the capital regulation of other countries. A key focus of regulation was the so-called "trigger ratio": a minimum capital ratio set for each bank that would trigger regulatory intervention if breached. For more details on the manner in which trigger ratios were set, and the consequences for banks of that variation, see Francis and Osborne (2009) and Aiyar, Calomiris, and Wieladek (2014a).

As Table 2 and Figure 1 show, the variation in minimum capital requirements as a share of risk-weighted assets over the sample period was large. The mean capital requirement ratio was 10.8%, the standard deviation 2.26 , the minimum value 8%, and the maximum value 23%. As Figure 2 shows, changes in capital ratio requirements varied significantly over the business cycle, too. More

[9] The data used in this study exclude outliers based on the following criteria: (1) trivially small banks (with total loans less than £3,000,000 on average), or (2) observations for which the absolute value of the log difference of lending in one quarter exceeded 1.

detailed information about the distribution of changes in capital requirements, divided according to the size and frequency of the changes in bank minimum capital requirements, as well as additional information regarding the cyclical pattern of capital requirement changes and their cross-section correlates, can be found in Aiyar, Calomiris, and Wieladek (2014a).

Average non-weighted capital requirement ratios ranged from a minimum of 10.2% in 2007 to a maximum of 11.2% in 2003. This is a striking amount of counter-cyclical variation given that the sample period was one of varying positive growth, but no actual recessions (by way of comparison, the Basel III countercyclical buffer is to vary between 0 and 2.5% over the entire business cycle inclusive of recessions).[10] Thus, although the FSA lacked any explicit macroprudential mandate over the period, the outcome of its decisions made on a bank-by-bank basis was in fact macroprudential in nature.

Aiyar, Calomiris and Wieladek (2014a) consider the extent to which capital requirements were binding on bank behaviour, based on the co-movements between weighted capital ratios and weighted capital ratio requirements over time, with banks sorted into quartiles according to the buffer over minimum capital requirements that they maintain. For all four groups of banks, the variation in minimum capital requirements was associated with substantial co-movement in actual capital ratios, confirming the conclusions of Alfon et al (2005), Francis and Osborne (2009), and Bridges et al. (2012) that capital ratio requirements were binding on banks' choices of capital ratios for UK banks during this sample period.

[10] Within this framework, national authorities can choose to raise the counter-cyclical capital buffer above 2.5%, but international reciprocity is voluntary beyond that point.

IV. The Effects of Capital Requirement and Monetary Policy Changes on Bank Lending

In this Section, we estimate the effects of changes in monetary policy and capital requirements on bank lending. Our measure of bank lending is loans to the domestic non-financial sector and is constructed from the Bank of England's AL form.[11]

The change in the stance of monetary policy is measured as the change in the key instrument of monetary policy, Bank Rate. Figure 3 shows the variation in Bank Rate over our sample period. Of course, Bank Rate is endogenous with respect to other macroeconomic variables. For example, if central banks follow some form of Taylor Rule, they adjust their policy rate in reaction to levels of inflation (relative to its long-term target) and output growth. Thus, in regressions that seek to identify the effects of monetary policy on bank lending (e.g., Kashyap and Stein 1995, 2000; Ehrmann, Gambacorta, Martinez-Pages, Sevestre and Worms 2003, Gambacorta and Mistrulli 2004) researchers control for the effects of other variables, such as GDP growth and inflation, which may be correlated with monetary policy.

Changes in capital requirements should affect lending by a regulated bank only when bank equity is relatively expensive to raise, and when regulatory requirements are binding constraints (see Aiyar, Calomiris and Wieladek 2014a).[12] We confine our sample to UK-regulated banks and measure their lending responses to both economy-wide monetary policy and bank-specific capital requirements.[13] Following the logic of Kashyap and Stein (1995, 2000), Ehrmann, Gambacorta, Martinez-Pages, Sevestre and Worms (2003) and Gambacorta and Mistrulli (2004) we include bank characteristics as interaction effects in our regression analysis. In so doing, we allow the effects of monetary policy and changes in capital ratio requirements to affect bank lending differentially depending on bank characteristics.

[11] http://www.bankofengland.co.UK/statistics/Pages/reporters/defs/default.aspx.
[12] As we noted before, a binding minimum capital requirement is not synonymous with banks having zero buffers. Banks will generally target a positive buffer above the regulatory minimum.
[13] As discussed in Aiyar, Calomiris, and Wieladek (2014a), branches of foreign banks operated in the UK, but were not subject to UK capital requirements. Thus, our sample includes only UK-based banks and subsidiaries of foreign-based banks operating in the UK, which were subject to UK capital requirements.

Bank lending may also vary due to changes in loan demand. To identify loan-supply responses to capital requirement changes, we also control for loan-demand changes. Following Aiyar (2011), and Aiyar, Calomiris and Wieladek (2014a), the basic strategy is to exploit sector level lending by bank *i* to 14 different sectors in conjunction with employment growth for each of these sectors at time *t*. Our bank-specific measure of demand is therefore $z_{it} = \sum_q s_{iqt} \Delta z_{qt}$, where s_{iqt} denotes the share of sector *q* in bank *i*'s lending portfolio in period *t*. Δz_{qt} is the growth rate of real activity in sector *q*, which we define as the quarter *t* on *t*-6 quarter employment growth rate, expressed at quarterly frequency.[14]

Our empirical model follows previous work that tries to assess the effects of monetary policy on bank lending growth with individual bank balance sheet data. In this approach, lending growth is typically regressed on changes in monetary policy and several macroeconomic control variables. This body of work has also found that certain bank characteristics affect the transmission of monetary policy to bank lending. In particular, Kashyap and Stein (1995) find that, as a result of informational asymmetries, smaller banks find it more difficult to raise non-depository debt in times of monetary tightening and their lending growth therefore responds to a greater degree. In follow-up work, Kashyap and Stein (2000) also find that banks with a greater stock of liquidity tend to react less to an equivalent change in monetary policy (see also Campello 2002, and the discussions in Peek and Rosengreen 1995a, 1995b, 1997, 2000 of differential adjustment of banks to shocks to capital).

Finally, in their study of the monetary policy transmission mechanism with bank level data across European countries, Ehrmann, Gambacorta, Martinez-Pages, Sevestre and Worms (2003) argue that capital and liquidity ratios, as well as the size of a bank, may enter interactively with monetary policy. Their simple theoretical model also suggests the inclusion of inflation and real GDP

[14] It is not only the level of growth in real activity, but also the persistence that matters, for banks to increase lending growth to a particular sector. Because employment growth is volatile, we therefore use the *t* on *t*-6 quarter employment growth rate as a proxy for the expansion in real activity in that sector. We note that all of our results are robust to expressing demand as either a year-on-year growth rate, or omitting measures of demand entirely. Note also that in this case, expressing the growth at quarterly frequency effectively means dividing the six-quarter growth rate by 6.

growth in the modelling of the loan-supply effects of monetary policy. Following their simplest baseline model (before considering bank-specific interaction effects), and adding changes in minimum capital requirements as well as our measure of loan demand, we arrive at the following baseline panel regression specification:

$$(1)\ \Delta \log(L_{i,t}) = \alpha_i + \sum_{j=0}^{L} a_j \Delta BBKR_{i,t-j} + \sum_{j=0}^{L} b_j \Delta r_{t-j} + \sum_{j=0}^{L} c_j \Delta \log(GDP)_{t-j} + \sum_{j=0}^{L} d_j \Delta \log(GDPDEF)_{t-j} + \sum_{j=0}^{L} e_j DEMAND_{i,t-j} + \varepsilon_{i,t}$$

Here α_i is a bank-specific fixed effect, r_t is the nominal bank rate, and $L_{i,t}$ is the stock of real lending to the real economy(deflated using the GDP deflator). $\Delta BBKR$ denotes the change in the banking book capital requirement ratio; $\Delta \log(GDP)_{t-j}$ the real GDP growth rate and $\Delta \log(GDPDEF)_{t-j}$ GDP deflator inflation.[15] $DEMAND_{i,t-j}$ is the previously defined measure of bank-specific changes in loan demand.

Both the contemporaneous change in capital requirements and three quarterly lags are included in the equation. As noted by Francis and Osborne (2009), on the basis of regulatory data we only observe a change in the capital requirement when the trigger ratio in a particular report differs from the trigger ratio in the preceding report from three months earlier; we do not know when, within that three month period, the change in capital requirements was introduced. Moreover, it is possible that FSA regulators—who maintain an ongoing dialogue with the banks they supervise—might inform a bank in advance of a forthcoming change in the capital requirement ratio. Both these

[15] Some previous studies (e.g., Gambacorta and Mistrulli 2004) use CPI, rather than the GDP deflator, as their preferred measure of inflation. The Bank of England's inflation target was switched from RPIX to CPI in December 2003 making it difficult to use consumer price inflation indices to identify monetary policy in this equation. It is for this reason that we use the GDP deflator instead.

considerations indicate the necessity for a contemporaneous term of the dependant variable in addition to lags.

In addition to the above baseline specification, we also consider interaction effects. Banks respond to policy shocks differentially depending on their access to alternative sources of funding (high costs of alternative sources of finance should increase banks' responses to both monetary policy shocks and changes in minimum capital requirements). Previous research has also included banks' cash asset ratios and capital buffers (capital ratios in excess of capital ratio requirements) as measures of "financial slack" that could mitigate the effects of policy shocks on loan supply.

In our specifications, we allow for all of these possible influences except capital buffers. As shown in Francis and Osbourne (2009) and Aiyar, Calomiris and Wieladek (2014a), cross-sectional variation in capital buffers is not a measure of financial slack, but rather captures long-term cross-sectional differences in targeted buffers, which likely reflect different risk preferences and different costs of accessing finance. A similar argument can be made for liquid asset holdings (as noted in Kashyap and Stein 2000), and indeed, there is substantial evidence that firms with higher costs of finance endogenously target higher long-term liquidity (e.g., Calomiris, Himmelberg and Wachtel 1995, Almeida, Campello and Weisbach 2004). Nevertheless, Kashyap and Stein (2000) find in their sample of U.S. banks that liquid assets do seem to measure financial slack. Thus, in addition to bank size (which proxies for the cost of finance from non-depository sources) we include the liquid asset ratio as a bank characteristic in our model.

Finally, in order to investigate possible interactions between changes in monetary policy and minimum capital requirement ratios, we include an interaction term between the two policy instruments. This interaction term is also allowed to vary with bank-specific size and liquidity.

$$(2)\ \Delta \log(L_{i,t}) = \alpha_i + \sum_{j=0}^{L} a_j \Delta BBKR_{i,t-j} + \sum_{j=0}^{L} b_j \Delta r_{t-j} + \sum_{j=0}^{L} c_j \Delta \log(GDP)_{t-j} + \sum_{j=0}^{L} d_j \Delta \log(GDP\_Def)_{t-j} + \sum_{j=0}^{L} e_j DEMAND_{i,t-j} + \sum_{j=0}^{L} f_j \Delta r_{t-j} \Delta BBKR_{i,t-j} + \sum_{j=0}^{L} g_j x_{i,t-j} \Delta BBKR_{i,t-j} + \sum_{j=0}^{L} h_j x_{i,t-j} \Delta r_{t-j} + \sum_{j=0}^{L} m_j x_{i,t-j} \Delta \log(GDP)_{t-j} + \sum_{j=0}^{L} q_j x_{i,t-j} \Delta r_{t-j} \Delta BBKR_{i,t-j} + \varepsilon_{i,t}$$

In this specification, output growth, the change in Bank Rate, and the change in the capital requirement ratio, as well as the interaction between Bank Rate and the capital requirement ratio, are interacted with the vector $x_{i,t-j}$, which captures bank-specific attributes (balance sheet size and proportion of liquid assets). Inflation is not interacted with the other bank characteristics, a modelling choice that follows previous work by Kashyap and Stein (1995) and Gambacorta and Mistrulli (2004). We estimate various versions of this model. Some versions of the model employ a subset of the regressors presented in equation (2).

Specification (2) is well suited to test for interactions between changes in monetary policy and minimum capital requirements as predicted by the bank lending channel of monetary policy. But the theory developed in Thakor (1996) suggests that minimum capital requirements interact with changes in monetary policy through induced changes in the term premium. Equation (3) below seeks to test that proposition:

$$(3)\ \Delta \log(L_{i,t}) = \alpha_i + \sum_{j=0}^{L} a_j \Delta BBKR_{i,t-j} + \sum_{j=0}^{L} b_j \Delta r_{t-j} + \sum_{j=0}^{L} c_j \Delta \log(GDP)_{t-j} + \sum_{j=0}^{L} d_j \Delta \log(GDP\_Def)_{t-j} + \sum_{j=0}^{L} e_j DEMAND_{i,t-j} + \sum_{j=0}^{L} f_j \Delta r_{t-j} \Delta term_{t-j} \Delta BBKR_{i,t-j} + \sum_{j=0}^{L} g_j x_{i,t-j} \Delta BBKR_{i,t-j} + \sum_{j=0}^{L} h_j x_{i,t-j} \Delta r_{t-j}$$

$$+\sum_{j=0}^{L} m_j \, x_{i,t-j} \Delta \log(GDP)_{t-j} + \sum_{j=0}^{L} q_j \, x_{i,t-j} \Delta r_{t-j} \Delta term_{t-j} \Delta BBKR_{i,t-j} + \varepsilon_{i,t}$$

The difference between specifications (2) and (3) is that the "double" interaction terms between capital requirements and monetary policy have been replaced with "triple" interaction terms between capital requirements, monetary policy and the term premium. We define the term premium as the difference between the three-year yield[16] on UK gilts and Bank Rate.[17] This difference reflects the alternative predictions of the bank lending channel and Thakor's (1996) theory of monetary transmission.

V. Results

Table 3 reports various versions of the loan-supply regressions based on equations (1) and (2), both with and without some control variables and some bank-specific interactions. All specifications are estimated in a panel fixed-effects framework, where the bank-specific fixed effect should capture heterogeneity in lending growth arising from relatively long-run, time-invariant bank characteristics.[18] The first column of the table does not include any macroeconomic controls. The second column introduces both real GDP growth and GDP deflator inflation as controls. The third column additionally interacts monetary policy and capital requirement ratio changes with each other, while the fourth, fifth, and sixth columns add an increasing number of interaction terms

[16] The results are very similar if we use the 10-year yield instead.

[17] We tried several variants of this specification. First, we *added* the 'triple interaction' terms to specification (2), rather than replacing the double interaction terms. Second, we replaced the term spread with a dummy variable taking the value of one when the term spread is positive and 0 otherwise. Finally, we replaced the change in Bank Rate with the term spread that is predicted by a regression of Bank Rate on the term spread. All of these specifications yielded very similar results and are available upon request.

[18] A fixed effects specification is preferred to random effects because we have no strong prior that the bank-specific effect is not correlated with other explanatory variables—as required by random effects. Post-estimation Hausman tests reject the null of a random effects specification.

relating to bank characteristics. All the coefficients reported here are the sum of the contemporaneous impact and three lags, and we report in parentheses beneath each coefficient the F-statistics for the joint test that the sum of the contemporaneous and lagged effects of each variable are statistically significantly different from 0.

In Table 3, we find that lending growth responds negatively to increases in capital requirements, regardless of the chosen specification. The estimated effects are large; given that the mean capital requirement ratio in our sample is 10.8%, a coefficient of -0.05 implies an elasticity of supply with respect to capital requirement changes of roughly 0.55. Once we control for GDP deflator inflation and real GDP growth, the change in Bank Rate also has a statistically significant negative effect on lending growth, regardless of specification. Column (5) in Table 3 shows that bank size interactions are important. Both the change in Bank Rate and GDP growth interact with bank size. Bank size is measured here using an indicator variable that distinguishes the top 30% of the UK's largest banks from other banks (i.e., SIZE=1 if the bank is in the large size grouping). The coefficient on the interaction of size and the change in bank rate is statistically significant and positive, which indicates that large banks display less of a contraction in loan supply than smaller banks with respect to a tightening of monetary policy. This is consistent with the finding of Kashyap and Stein (1995) that large banks contract their lending to a lesser degree in response to a tightening of monetary policy. In our sample, large banks exhibit roughly zero loan-supply responsiveness to monetary policy (columns (5) and (6)), while the effect of bank minimum capital requirements does not differ to a statistically significant degree between large and small banks.[19] Our results regarding the interaction of GDP growth and bank size indicate that pro-cyclicality in loan supply is also an exclusively small-bank phenomenon. As in the case of our results regarding the different effect of monetary policy on the loan supply of large banks, it appears that large banks' superior access to

[19] Although the coefficients on the variable DBankrate and the interaction term DBankrate*SIZE are slightly different from each other in magnitude, their sum is not significantly different from zero. This is the case in Table 3 and all subsequent tables providing regression results.

non-depository debt markets enables them to insulate their cost of funding loans from a variety of domestic macroeconomic shocks.

The coefficient on the interaction of the change in Bank Rate and the change in the capital requirement is never statistically significantly different from 0. This suggests that, while both instruments have independent effects on lending, the effect of monetary policy is not amplified/dampened significantly by simultaneous changes in banking book capital requirements, as might be expected under the several different hypotheses described in Section II.

Under the Thakor (1996) model, the lack of a significant interaction term between monetary policy and minimum capital requirement changes may arise from a failure to control for changes in the term spread, which have been both positive and negative during the sample period (Figure 4). Table 4 reports estimates of equation (3). The results are very similar to those presented the previous table. Size matters for the effect of monetary policy, but not the effect of minimum capital requirements, on bank lending; and changes in minimum capital requirements and monetary policy have an independent effect on bank lending. But the interaction between the change in Bank Rate, the change in the term premium, and the change in capital requirements is never statistically significant. Allowing this "triple interaction" term to vary by bank characteristics makes no difference to the result.[20] In other words, we cannot confirm the theory of contingent interactions between monetary policy and capital requirements presented in Thakor (1996).

The fact that large banks do not react to changes in monetary policy has an important implication for an economy with a highly concentrated banking system like the UK. Based on our definition of size, large banks provide 94% of lending to the real economy in the UK, which implies that, unlike minimum capital requirements, monetary policy did not seem to be an effective tool for managing bank lending in the UK during this time period. Of course, monetary policy may still affect lending growth via loan demand or other more interest-sensitive sources of credit supply.

[20] As noted in Section IV, we also experimented with several different variants of the specifications presented here, but the basic results remain the same.

VI. Endogeneity

One of the main identification assumptions in models (1), (2) and (3) is that the change in minimum capital requirements is exogenous with respect to bank lending growth. It is unclear whether this assumption is justified. The estimates presented in Tables 3 and 4 could be subject to both reverse causality and omitted variable bias. In this section we present institutional and statistical evidence to demonstrate that these biases are likely to be small.

VI.i. Reverse Causality

Aiyar, Calomiris and Wieladek (2014a) describe the institutional rules governing FSA regulation during this time in detail, which we briefly summarise below. The FSA's approach to supervision was implemented via ARROW (Advanced Risk Responsive Operating frameWork). In his review of UK financial regulation following the global financial crisis, Lord Turner, Chairman of the FSA, noted that regulatory decisions focused more on organization structures, systems and reporting procedures, than on credit risk factors (Turner 2009). Similarly, the inquiry into the failure of the British bank Northern Rock revealed that ARROW did not require supervisors to engage in financial analysis, defined as information on the institution's asset growth relative to its peers, its profit growth, its cost to income ratio, its net interest margin, or its reliance on wholesale funding and securitisation (FSA 2008). This approach to bank regulation suggests that bank-specific lending growth or loan quality were not the main determinants of FSA regulatory decisions about capital requirements, an assertion that is further verified with a panel VAR analysis, discussed below.

We estimate a panel VAR consisting of lending growth and the change in capital requirements to assess whether reverse-causality is likely to be a serious problem. Consider the following panel VAR model:

$$Y_{i,t} = \sum_{j=1}^{3} B_j \, Y_{i,t-j} + e_{i,t} \qquad e_{i,t} \sim N(0, \Sigma)$$

Where $Y_{i,t}$ contains $\Delta \mathrm{BBKR}_{i,t}$ and $\Delta \log(\mathrm{L_{i,t}})$. Both variables are expressed in deviations from their unit-specific mean, which is equivalent to removing the bank specific fixed effect. $e_{i,t}$ is a vector of reduced-form error terms which are jointly normally distributed with a mean of zero and the variance-covariance matrix Σ. To understand the effect of a change in capital requirements, further assumptions need to be made. To identify a change in capital requirements shocks, we assume that the change in capital requirements reacts to real lending growth with a lag. This is a realistic assumption, as regulators typically only observe real lending growth with a lag. In addition, the procedures necessary to change an institution's capital requirement imply that regulators can only react with a delay, even if they are able to observe real lending growth contemporaneously.

In general impulse responses obtained from the VAR model and the sum of coefficients from model (1) will be different.[21] But the sum of the impulse responses will be identical to the sum of coefficients over the same horizon, if and only if the following four conditions are jointly satisfied: i) $\Delta \log(\mathrm{L_{i,t}})$ is not autoregressive ii) $\Delta \log(\mathrm{L_{i,t}})$ does not Granger cause $\Delta \mathrm{BBKR}_{i,t}$ iii) $\Delta \mathrm{BBKR}_{i,t}$ is not autoregressive and iv) the impact coefficient of the change in capital requirements on lending growth in model (1) is identical to the unbiased impact coefficient in the VAR.

The model is estimated using the Bayesian hierarchical approach proposed in Jarocinski (2010) to avoid dynamic heterogeneity bias. Figure 5 plots the impulse responses to a 100 basis points change in capital requirements shock and the associated 5th and 95thposterior coverage bands based on the 1,000 draws from the posterior. The growth rate in real lending to the economy falls by about 3.8% upon impact and declines back to zero fairly rapidly. This impact response is almost identical to the estimated impact response of -3.77 in the single equation specification closest to the panel VAR (column (1) of table 3). Cumulating the real lending growth impulse response up to 4

[21] See Bagliano and Favero (1998) for an elaboration of this point in the context of monetary policy.

quarters yields a median value of 4.64 - with a 5th and 95th percentile of -9.89 and -.0067, respectively. This is similar to, and not statistically significantly different from, the sum of coefficients of 7.8 in column (1) of table 3. The similarity of the coefficients allows us to conclude that the joint conditions (i) through (iv) above are satisfied, among them the condition ruling out reverse causality from bank lending growth to changes in minimum capital requirements. This can also be seen more directly from Figure 6, where we assess the impact of a shock to real lending growth on the change in the capital requirement. The effect of a 100 basis point increase in lending growth is not significantly different from 0. We can therefore reject the view that Granger-causality runs from real lending growth to the change in capital requirements, but not vice-versa.

To summarize, we estimate a structural VAR model that is less restrictive than model (1), both in the dynamics of the variables, as well as, *conditional* on the correct identification scheme, with respect to the exogeneity assumption regarding the changes in the capital requirements variable. The similarity of the estimates from this approach to the single-equation approach suggest that the restrictions necessary for model (1) to provide an unbiased estimate of the effect of the change in capital requirements on lending growth are not rejected by the data.

VI.ii. Omitted variable bias

Even absent reverse causality, underlying changes to the quality of the bank's loan portfolio could be driving both regulatory changes in minimum capital requirements and changes in credit supply, thereby generating a spurious correlation between the latter two variables. To address this potential problem we examined the contemporaneous correlation between a proxy for loan quality—write-offs—and minimum capital requirements, and found none. Furthermore, we re-estimated Tables 3 and 4, alternatively with either lags (Tables 5 and 7) or leads (Tables 6 and 8) of changes in the ratio of writeoffs to risk-weighted assets. While the lags of the changes in writeoffs are statistically significant, including those effects has no effect on our previous results regarding the

effects of capital requirements on loan supply (as would be expected if loan quality were driving both regulatory changes and loan growth). Leads of writeoffs do not have a statistically significant effect on lending growth.

In the absence of strong instrumental variables it is difficult to definitively rule out endogeneity bias. But in light of the institutional setup of the FSA, the striking similarity between the panel VAR and single equation estimates, and the robustness of our results to the inclusion of leads and lags of writeoffs, it seems unlikely that our estimates are contaminated by serious endogeneity bias.

VII. Conclusion

Following the global financial crisis, policy makers around the world are now discussing ways to strengthen capital requirements, and to use them not only as a microeconomic prudential tool, but also as a macroprudential tool to preserve the stability of the financial system through, *inter alia*, smoothing the credit cycle. With multiple policy instruments for leaning against the credit cycle, some of the fundamental questions that arise are: (1) what is the relative strength of each instrument; (2) how do they interact; and (3) what contingencies (cross-sectional differences or changes over time) affect the potency of each instrument? Theoretical contributions have argued that monetary policy will tend to be better able to achieve price stability objectives, and that capital requirement policy (and more generally, macroprudential policies), will tend to be better able to achieve financial stability objectives. Theoretical models also have stressed potentially important contingencies that may affect the potency of these tools (e.g., due to cross-time differences in the term premium, or cross-sectional differences in banks' costs of raising non-depository debt or outside equity) and have posited important interactions between monetary policy and capital requirement policy.

In this study, we address these three sets of questions by examining how monetary policy and changes in minimum capital ratio requirements affect bank loan supply. We exploit a unique UK data set on bank-specific, time-varying capital requirements together with bank lending data in what we believe to be the first microeconomic study of the joint operation of monetary policy and changes in capital requirements.

Consistent with previous work, we find that capital requirement policy is a more powerful tool for achieving financial stability objectives related to loan supply. Monetary policy has a powerful effect on the loan supply of small banks but not of large banks. In contrast, capital requirements affect the loan supply of both large and small banks. Unlike small banks, large banks appear to be able to access non-depository debt markets to insulate their loan supply from monetary policy shocks that raise the cost of funding loans with deposits. Large banks also seem to be able to insulate their funding costs from other cyclical shocks that affect the loan-supply of small banks. This difference in banks' ability to access debt markets has important implications for the relative potency and distributional consequences of the two primary policy instruments that can be used to control lending: monetary policy and minimum capital requirements.

The magnitude of the estimated effects of bank capital requirements are large in our sample. The elasticity of the response of loan supply to an increase in capital requirements is typically greater than one half. Given large banks' apparent ease in switching[22] between deposit and non-deposit sources of finance in response to monetary policy shocks, and given the concentration of the UK banking system, our results suggest that minimum capital requirement changes might offer a more potent tool for improving the resilience of the financial system, by moderating bank lending, over the cycle. But it is important to emphasize that these effects were based on observed sample averages during that period. In theory, higher capital requirements could increase lending at banks with very low or negative net worth; if capital ratio requirements help to prevent or overcome

[22] The ease with which Banks can switch between deposit and non-deposit sources of finance may change with the introduction of new liquidity regulations, such as the Net Stable Funding Ratio (NFSR).

a so-called “debt overhang” problem, which can occur at very low capital ratios, then in principle, higher capital could encourage lending. Similarly, there are numerous other channels through which monetary policy affects the real economy. Our study is confined to identifying only the effects of monetary policy on the bank lending channel.

Other theoretically posited implications are not confirmed in our analysis. We do not find evidence of important interaction effects between monetary policy and capital requirements policy, nor do we find that such an interaction effect varies with the term premium.

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Figure 1: Histogram of minimum capital requirement ratio

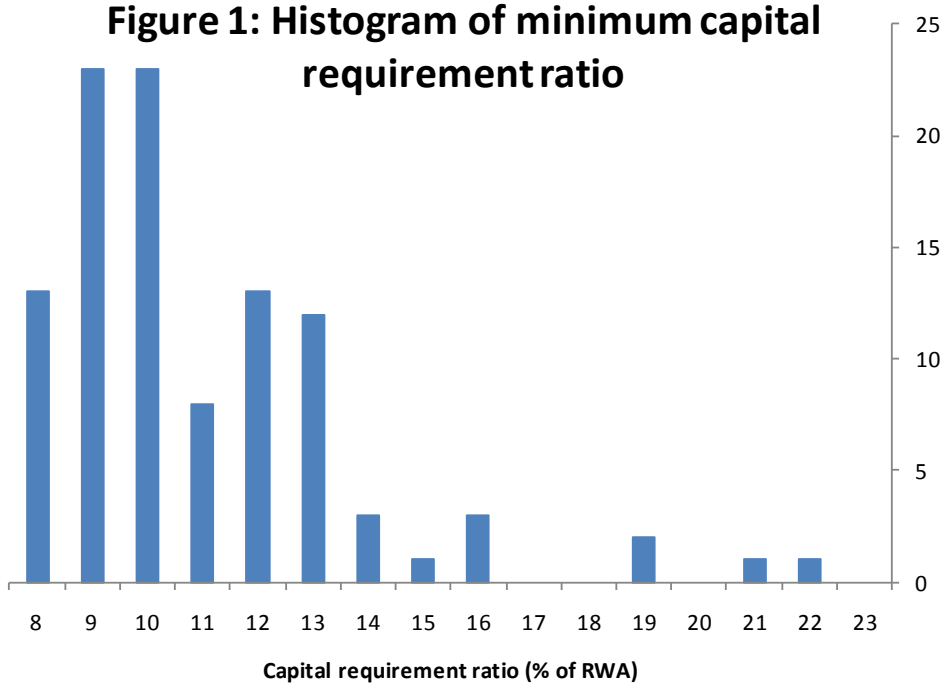
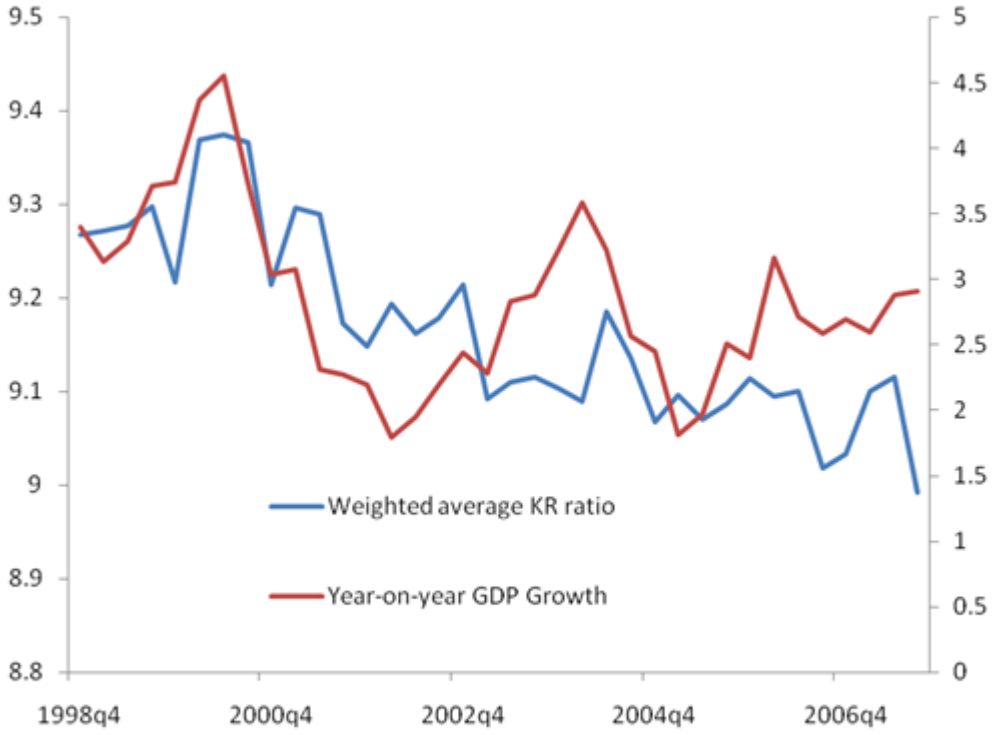


Figure 2: Weighted time series average of KR



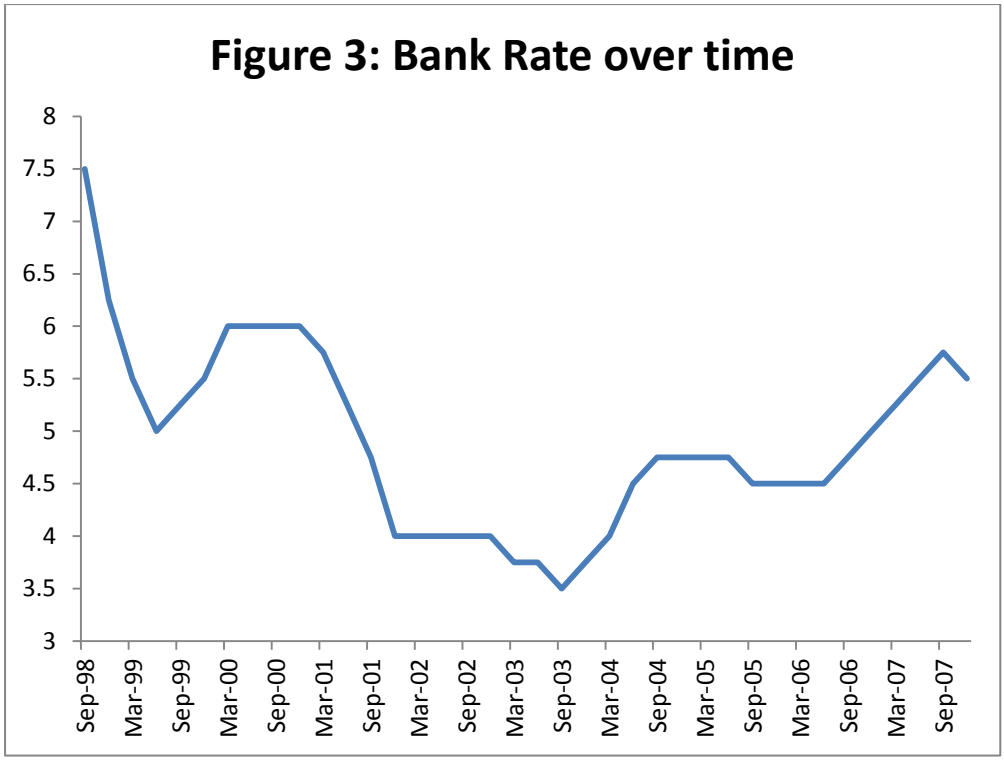


Figure 3: Bank Rate over time
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
Sep-98
Mar-99
Sep-99
Mar-00
Sep-00
Mar-01
Sep-01
Mar-02
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Mar-03
Sep-03
Mar-04
Sep-04
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Sep-06
Mar-07
Sep-07

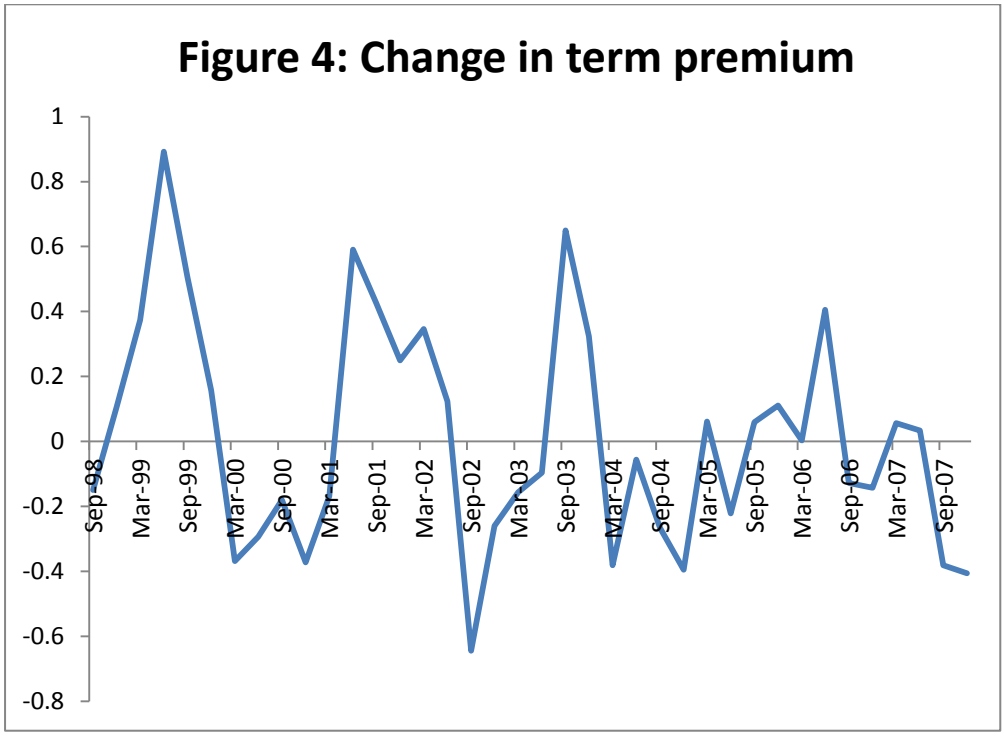
Figure 4: Change in term premium
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
Sep-98
Mar-99
Sep-99
Mar-00
Sep-00
Mar-01
Sep-01
Mar-02
Sep-02
Mar-03
Sep-03
Mar-04
Sep-04
Mar-05
Sep-05
Mar-06
Sep-06
Mar-07
Sep-07

Figure 5

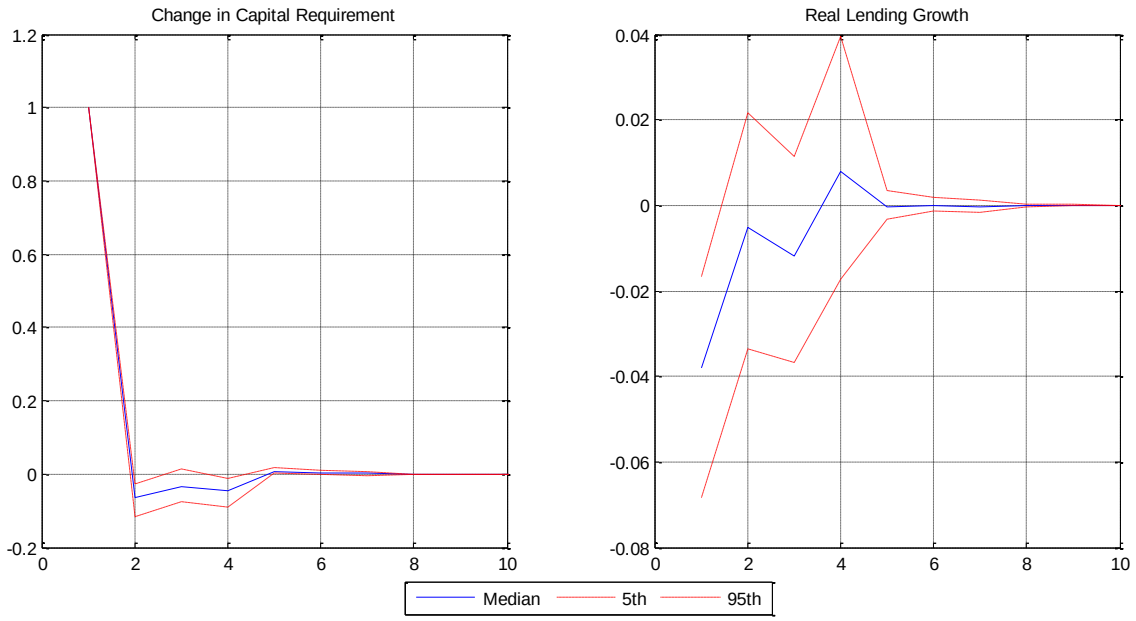

Figure 6

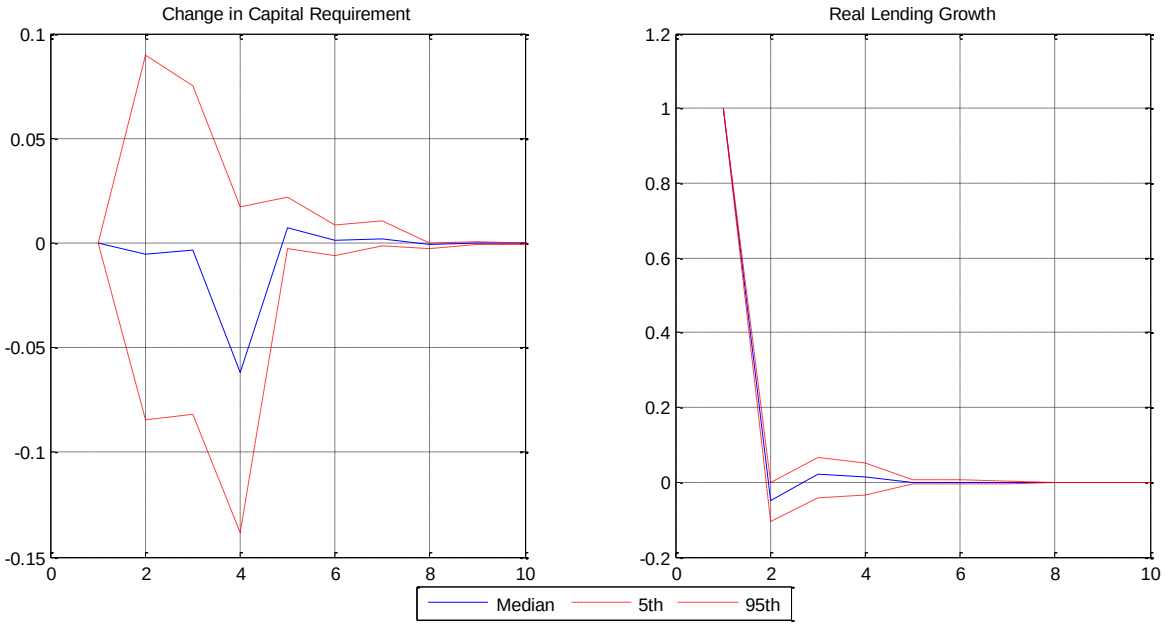

Table 1: Variables and data sources

Variable	Definition	Source (Bank of England Reporting Form)	Notes
DBBKR – change in banking book capital requirement ratio	FSA-set minimum ratio for capital-to-risk weighted assets (RWA) for the banking book. Also known as "Trigger ratio".	BSD3	
Lending	Bank lending to non-financial sectors of the economy	AL	
DBankrate	Change in the Bank of England main policy rate	Bank of England website	
Inflation	Log change in the GDP deflator	Office for National Statistics	
Real GDP Growth	Log change in real GDP	Office for National Statistics	
SIZE	Dummy variable =1 when the time average of relative size is in the top 30% of the distribution	BT	Relative size is defined as a banks total assets in terms of total banking system assets
LIQUIDITY	Dummy variable = 1 when the time average of the ratio of liquid to total assets is in the top 30 of the distribution	BT	Liquid assets are defined as the sum of BT21 (Cash), BT23 (Financial Market Loans) and BT32 (Investments)

For further information on the BT and AL form, please see:
http://www.bankofengland.co.UK/statistics/Pages/reporters/defs/default.aspx

Table 2: Summary Statistics

Variable	Units	Mean	SD	Min	Max	Obs
Capital requirement ratio	%	10.8	2.26	8	23	2,630
Change in capital requirement ratio	Basis points	-1.4	29.7	-500	500	2,524
Lending to real economy	£ 000s	9,483	28,510	0	274,140	2,630
Change in lending to real economy	%	0.8	16.5	-98.3	85.3	2,503

Table 3 – Estimates of Model (1) and (2) - Lending

	(1)	(2)	(3)	(4)	(5)	(6)
DBBKR	-0.078***	-0.073***	-0.057**	-0.048**	-0.067**	-0.056**
(Prob >F)	0.00169	0.0036	0.0165	0.0300	0.019	0.033
DBankrate	-0.0132	-0.05**	-0.048**	-0.054***	-0.06**	-0.071***
(Prob >F)	0.446	0.0159	0.0211	0.00951	0.0174	0.00548
Inflation		0.0199	0.0216	0.0203	0.0213	0.0199
		0.419	0.385	0.409	0.390	0.417
Real GDP growth		0.078*	0.078*	0.068*	0.098**	0.087*
		0.062	0.062	0.09	0.044	0.077
DEMAND	0.025**	0.029**	0.029**	0.028**	0.028**	0.027**
	0.0392	0.0190	0.02	0.023	0.018	0.019
DBBKR*DBankrate			0.115	0.0855	0.0959	0.0528
			0.170	0.375	0.349	0.687
DBankrate*Liq				0.0665		0.0839
				0.272		0.179
GDP growth*Liq				0.130		0.111
				0.343		0.427
DBBKR*Liq				-0.0861		-0.0770
				0.812		0.832
DBBKR*Bankrate*Liq				0.119		0.153
				0.791		0.738
DBBKR* SIZE					0.0545	0.0429
					0.227	0.329
DBankrate*SIZE					0.04*	0.05**
					0.0956	0.0319
GDP growth *SIZE					-0.07*	-0.06*
					0.053	0.094
DBBKR*DBankrate*SIZE					-0.0118	0.0311
					0.917	0.824
Constant	0.00134	-0.0681	-0.0682	-0.0709	-0.0682	-0.0704
	(0.00960)	(0.0478)	(0.0478)	(0.0474)	(0.0475)	(0.0472)
Observations	1,815	1,815	1,815	1,815	1,815	1,815
R-squared	0.024	0.031	0.036	0.045	0.039	0.048
Number of bank2	82	82	82	82	82	82

We report the sum of for contemporaneous and lagged coefficients of each variable, with the corresponding F-statistics provided in parentheses. DBBKR and DBankrate are the quarterly changes in the banking book capital requirement and Bank Rate, respectively. Inflation and real GDP growth are quarterly growth rates of the GDP deflator and real GDP. Demand is the residual demand definition described in the main text. Size is a dummy variable taking the value of 1, and 0 otherwise, if the time average of the banks size relative to the banking system is in the top 15% of the distribution. Similarly, Liq is a dummy variable taking the value of 1, and 0 otherwise, if a banks time average liquid to total asset ratio is in the top 15% of the distribution. *** p<0.01, ** p<0.05, * p<0.1. All regressions include bank fixed effects.

Table 4 – Estimates of Model (3) – Lending

	(1)	(2)	(3)	(4)	(5)	(6)
DBBKR	-0.078***	-0.073***	-0.058*	-0.05*	-0.06*	-0.057*
	0.002	0.004	0.0604	0.0772	0.0628	0.0847
DBankrate	-0.013	-0.05**	-0.05**	-0.056***	-0.06**	-0.074***
	0.446	0.0159	0.0151	0.0073	0.013	0.005
Inflation		0.0199	0.0213	0.0206	0.0204	0.0196
		0.419	0.390	0.401	0.414	0.428
Real GDP growth		0.078*	0.078*	0.068*	0.097**	0.085*
		0.062	0.06	0.094	0.046	0.08
DEMAND	0.025**	0.029**	0.03**	0.028**	0.027**	0.027**
	0.0392	0.0190	0.021	0.022	0.018	0.02
DBBKR*DBankrate *DTerm			0.0862	-0.272	-0.321	-0.0318
			0.715	0.923	0.820	0.927
DBankrate*Liq				0.0645		0.0832
				0.304		0.198
GDP growth*Liq				0.127		0.109
				0.351		0.430
DBBKR*Liq				-0.124		-0.115
				0.702		0.723
DBBKR*DBankrate *DTerm*Liq				0.399		0.462
				0.737		0.702
DBBKR* SIZE					0.0461	0.0370
					0.410	0.509
DBankrate*SIZE					0.0425*	0.0525**
					0.0835	0.0348
GDP growth *SIZE					-0.0706	-0.0604
					0.0508	0.0962
DBBKR*DBankrate *DTerm *SIZE					0.370	-0.0264
					0.717	0.945
Constant	0.00134	-0.0681	-0.069	-0.0718	-0.0675	-0.0693
	(0.00960)	(0.0478)	(0.048)	(0.0470)	(0.0478)	(0.0471)
Observations	1,815	1,815	1,815	1,815	1,815	1,815
R-squared	0.024	0.031	0.036	0.046	0.039	0.049
Number of bank2	82	82	82	82	82	82

We report the sum of for contemporaneous and lagged coefficients of each variable, with the corresponding F-statistics provided in parentheses. DBBKR, DBankrate and DTerm are the quarterly changes in the banking book capital requirement, Bank Rate and the term premium, respectively. Inflation and real GDP growth are quarterly growth rates of the GDP deflator and real GDP. Demand is the residual demand definition described in the main text. Size is a dummy variable taking the value of 1, and 0 otherwise, if the time average of the banks size relative to the banking system is in the top 15% of the distribution. Similarly, Liq is a dummy variable taking the value of 1, and 0 otherwise, if a banks time average liquid to total asset ratio is in the top 15% of the distribution. *** p<0.01, ** p<0.05, * p<0.1. All regressions include bank fixed effects.

Table 5 – Estimates of Model (1) and (2) – Controlling for lags of writeoffs

	(1)	(2)	(3)	(4)	(5)	(6)
DBBKR	-0.076***	-0.071***	-0.056**	-0.047**	-0.066**	-0.055**
	0.002	0.004	0.018	0.034	0.021	0.037
DWriteoffs	0.00556	0.00617	0.00612	0.00581	0.00625	0.00594
	0.180	0.114	0.117	0.134	0.104	0.126
DBankRate	-0.0139	-0.05**	-0.049**	-0.055***	-0.062**	-0.072***
	0.420	0.0153	0.02	0.009	0.016	0.005
Inflation		0.0203	0.0219	0.0206	0.0217	0.0202
		0.414	0.382	0.403	0.387	0.412
Real GDP growth		0.078*	0.078*	0.07	0.097**	0.089
		0.061	0.061	0.092*	0.045	0.072*
DEMAND	0.026**	0.029**	0.029**	0.028**	0.028**	0.027**
	0.039	0.0194	0.0207	0.0226	0.0182	0.0197
DBBKR*DBankrate			0.112	0.0810	0.0917	0.0467
			0.182	0.404	0.370	0.723
DBankrate*Liq				0.0674		0.0851
				0.260		0.168
GDP growth*Liq				0.128		0.108
				0.386		0.470
DBBKR*Liq				-0.0992		-0.0904
				0.787		0.806
DBBKR*Bankrate*Liq				0.110		0.145
				0.811		0.755
DBBKR* SIZE					0.0530	0.0411
					0.242	0.353
DBankrate*SIZE					0.042*	0.053**
					0.08	0.028
GDP growth *SIZE					-0.068*	-0.062*
					0.0592	0.0945
DBBKR*DBankrate*SIZE					-0.00837	0.0359
					0.941	0.799
Constant	0.00182	-0.0690	-0.0690	-0.0718	-0.0690	-0.0712
	(0.00967)	(0.0482)	(0.0482)	(0.0477)	(0.0479)	(0.0476)
Observations	1,805	1,805	1,805	1,805	1,805	1,805
R-squared	0.026	0.033	0.038	0.048	0.042	0.051
Number of bank2	82	82	82	82	82	82

We report the sum of for contemporaneous and lagged coefficients of each variable, with the corresponding F-statistics provided in parentheses. DBBKR and DBankrate are the quarterly changes in the banking book capital requirement and Bank Rate, respectively. Inflation and real GDP growth are quarterly growth rates of the GDP deflator and real GDP. Demand is the residual demand definition described in the main text. DWriteoffs is the sum of the contemporaneous and three lags of the change in the writeoff to risk-weighted asset ratio. Size is a dummy variable taking the value of 1, and 0 otherwise, if the time average of the banks size relative to the banking system is in the top 15% of the distribution. Similarly, Liq is a dummy variable taking the value of 1, and 0 otherwise, if a banks time average liquid to total asset ratio is in the top 15% of the distribution. *** p<0.01, ** p<0.05, * p<0.1. All regressions include bank fixed effects.

Table 6 – Estimates of Model (1) and (2) – Controlling for leads of writeoffs

	(1)	(2)	(3)	(4)	(5)	(6)
DBBKR	-0.08***	-0.074***	-0.061**	-0.051**	-0.064**	-0.053*
	0.00130	0.0035	0.014	0.024	0.028	0.05
DWriteoffs	-0.000175	-0.000175	-0.000175	-0.000169	-0.000170	-0.000171
	0.251	0.246	0.248	0.285	0.255	0.277
DBankRate	-0.0133	-0.052**	-0.051**	-0.059***	-0.069**	-0.084***
	0.481	0.018	0.023	0.008	0.012	0.00252
Inflation		0.0144	0.0163	0.0155	0.0159	0.0147
		0.578	0.533	0.548	0.547	0.572
Real GDP growth		0.072*	0.073*	0.065	0.094*	0.087*
		0.0934	0.0940	0.128	0.0626	0.0898
DEMAND	0.025**	0.027**	0.027**	0.027**	0.026**	0.026**
	0.049	0.028	0.03	0.032	0.026	0.027
DBBKR*DBankrate			0.0980	0.0650	0.0906	0.0450
			0.252	0.518	0.378	0.731
DBankrate*Liq				0.0835		0.11*
				0.162		0.079
GDP growth*Liq				0.115		0.0922
				0.435		0.537
DBBKR*Liq				-0.113		-0.109
				0.755		0.766
DBBKR*Bankrate*Liq				0.104		0.127
				0.819		0.783
DBBKR* SIZE					0.0363	0.0246
					0.340	0.506
DBankrate*SIZE					0.059**	0.074***
					0.033	0.0086
GDP growth *SIZE					-0.078**	-0.073*
					0.0372	0.0580
DBBKR*DBankrate*SIZE					-0.00541	0.0400
					0.962	0.775
Constant	0.000321	-0.0635	-0.0637	-0.0672	-0.0633	-0.0658
	(0.00957)	(0.0497)	(0.0498)	(0.0494)	(0.0497)	(0.0494)
Observations	1,715	1,715	1,715	1,715	1,715	1,715
R-squared	0.027	0.034	0.039	0.048	0.042	0.052
Number of bank2	82	82	82	82	82	82

We report the sum of for contemporaneous and lagged coefficients of each variable, with the corresponding F-statistics provided in parentheses. DBBKR and DBankrate are the quarterly changes in the banking book capital requirement and Bank Rate, respectively. Inflation and real GDP growth are quarterly growth rates of the GDP deflator and real GDP. Demand is the residual demand definition described in the main text. DWriteoffs is the sum of the contemporaneous and three leads of the change in the writeoff to risk-weighted asset ratio. Size is a dummy variable taking the value of 1, and 0 otherwise, if the time average of the banks size relative to the banking system is in the top 15% of the distribution. Similarly, Liq is a dummy variable taking the value of 1, and 0 otherwise, if a banks time average liquid to total asset ratio is in the top 15% of the distribution. *** p<0.01, ** p<0.05, * p<0.1. All regressions include bank fixed effects.

Table 7 – Estimates of Model (3) – Controlling for lags of writeoffs

	(1)	(2)	(3)	(4)	(5)	(6)
DBBKR	-0.076***	-0.07***	-0.057*	-0.049*	-0.065*	-0.057*
	0.00188	0.004	0.0616	0.0791	0.0639	0.0864
DWriteoffs	0.00556	0.00617	0.00613	0.00588	0.00623	0.00599
	0.180	0.114	0.117	0.130	0.107	0.125
DBankrate	-0.0139	-0.05**	-0.052**	-0.056***	-0.066**	-0.075***
	0.420	0.0153	0.0145	0.0074	0.0114	0.00466
Inflation		0.0203	0.0217	0.0209	0.0208	0.0199
		0.414	0.385	0.395	0.408	0.421
Real GDP growth		0.078*	0.078*	0.069*	0.096**	0.086*
		0.0611	0.0590	0.0866	0.0466	0.0748
DEMAND	0.026**	0.029**	0.028**	0.028**	0.027**	0.027**
	0.0399	0.0194	0.0213	0.0233	0.0186	0.0202
DBBKR*DBankrate *DTerm			-0.267	0.0130	0.0480	-0.0496
			0.755	0.963	0.864	0.888
DBankrate*Liq				0.0652		0.0845
				0.294		0.187
GDP growth*Liq				0.124		0.106
				0.394		0.472
DBBKR*Liq				-0.135		-0.127
				0.677		0.697
DBBKR*DBankrate *DTerm*Liq				0.0992		0.133
				0.754		0.716
DBBKR* SIZE					0.0456	0.0363
					0.416	0.518
DBankrate*SIZE					0.044*	0.054**
					0.0689	0.0297
GDP growth *SIZE					-0.069*	-0.061*
					0.0564	0.0962
DBBKR*DBankrate *DTerm *SIZE					0.378	-0.0122
					0.746	0.975
Constant	0.00182	-0.0690	-0.0702	-0.0727	-0.0683	-0.0702
	(0.00967)	(0.0482)	(0.0482)	(0.0474)	(0.0481)	(0.0475)
Observations	1,805	1,805	1,805	1,805	1,805	1,805
R-squared	0.026	0.033	0.039	0.049	0.042	0.052
Number of bank2	82	82	82	82	82	82

We report the sum of for contemporaneous and lagged coefficients of each variable, with the corresponding F-statistics provided in parentheses. DBBKR, DBankrate and DTerm are the quarterly changes in the banking book capital requirement, Bank Rate and the term premium, respectively. Inflation and real GDP growth are quarterly growth rates of the GDP deflator and real GDP. Demand is the residual demand definition described in the main text. DWriteoffs is the sum of the contemporaneous and three lags of the change in the writeoff to risk-weighted asset ratio. Size is a dummy variable taking the value of 1, and 0 otherwise, if the time average of the banks size relative to the banking system is in the top 15% of the distribution. Similarly, Liq is a dummy variable taking the value of 1, and 0 otherwise, if a banks time average liquid to total asset ratio is in the top 15% of the distribution. *** p<0.01, ** p<0.05, * p<0.1. All regressions include bank fixed effects.

Table 8 – Estimates of Model (3) – Controlling for leads of writeoffs

	(1)	(2)	(3)	(4)	(5)	(6)
DBBKR	-0.078***	-0.07***	-0.057*	-0.048*	-0.062*	-0.053
	0.0016	0.004	0.067	0.097	0.083	0.127
DWriteoffs	-0.004	-0.003	-0.003	-0.003	-0.002	-0.003
	(0.07)	(0.03)	(0.04)	(0.05)	(0.03)	(0.04)
DBankrate	-0.0123	-0.052*	-0.054*	-0.061***	-0.072***	-0.086***
	0.515	0.0199	0.0181	0.007	0.009	0.002
Inflation		0.0153	0.0168	0.0174	0.0154	0.0156
		0.555	0.521	0.503	0.559	0.552
Real GDP growth		0.073*	0.074*	0.0662	0.094*	0.085*
		0.09	0.086	0.115	0.0632	0.0906
DEMAND	0.026**	0.028**	0.027**	0.027**	0.026**	0.026**
	0.0484	0.028	0.03	0.03	0.0252	0.0263
DBBKR*DBankrate *DTerm			-0.271	-0.000870	0.0374	-0.0652
			0.772	0.998	0.892	0.849
DBankrate*Liq				0.0947		0.120
				0.124		0.0601
GDP growth*Liq				0.122		0.101
				0.417		0.509
DBBKR*Liq				-0.150		-0.143
				0.645		0.661
DBBKR*DBankrate *DTerm*Liq				0.402		0.471
				0.741		0.703
DBBKR* SIZE					0.0162	0.00567
					0.738	0.908
DBankrate*SIZE					0.062**	0.076***
					0.027	0.0086
GDP growth *SIZE					-0.08**	-0.072*
					0.0339	0.0581
DBBKR*DBankrate *DTerm *SIZE					0.351	-0.0857
					0.568	0.823
Constant	0.000318	-0.0645	-0.0659	-0.0705	-0.0631	-0.0668
	(0.00960)	(0.0498)	(0.0497)	(0.0491)	(0.0499)	(0.0493)
Observations	1,715	1,715	1,715	1,715	1,715	1,715
R-squared	0.027	0.034	0.040	0.051	0.044	0.055
Number of bank2	82	82	82	82	82	82

We report the sum of for contemporaneous and lagged coefficients of each variable, with the corresponding F-statistics provided in parentheses. DBBKR, DBankrate and DTerm are the quarterly changes in the banking book capital requirement, Bank Rate and the term premium, respectively. Inflation and real GDP growth are quarterly growth rates of the GDP deflator and real GDP. Demand is the residual demand definition described in the main text. DWriteoffs is the sum of the contemporaneous and three leads of the change in the writeoff to risk-weighted asset ratio. Size is a dummy variable taking the value of 1, and 0 otherwise, if the time average of the banks size relative to the banking system is in the top 15% of the distribution. Similarly, Liq is a dummy variable taking the value of 1, and 0 otherwise, if a banks time average liquid to total asset ratio is in the top 15% of the distribution. *** p<0.01, ** p<0.05, * p<0.1. All regressions include bank fixed effects.

Table 9 – Comparing the Impact of Monetary and Capital Requirement Policy on Lending Growth

IMPACT OF MONETARY POLICY													
	Table - 3		**Table - 4**		**Table - 5**		**Table - 6**		**Table – 7**		**Table - 8**		**Mean**
Specification	5	6	5	6	5	6	5	6	5	6	5	6	
Large Bank	-2	-2.1	-1.75	-2.15	-2	-1.9	-.9	-1	-2.2	-2.1	-1	-1	**-1.7**
Small Bank	-6	-7.1	-6	-7.4	-6.2	-7.2	-6.8	-8.3	-6.6	-7.5	-7.2	-8.6	**-7.1**
Overall	-2.5	-2.7	-2.3	-2.8	-2.5	-2.6	-1.6	-1.9	-2.7	-2.8	-1.8	-1.9	**-2.35**

IMPACT OF CAPITAL REQUIREMENT POLICY													
	Table - 3		**Table - 4**		**Table - 5**		**Table - 6**		**Table – 7**		**Table - 8**		**Mean**
Specification	5	6	5	6	5	6	5	6	5	6	5	6	
Large Bank	-6.7	-5.6	-6	-5.7	-6.6	-5.5	-6.3	-5	-6.5	-5.7	-6.2	-5.3	**-5.9**
Small Bank	-6.7	-5.6	-6	-5.7	-6.6	-5.5	-6.3	-5	-6.5	-5.7	-6.2	-5.3	**-5.9**
Overall	-6.7	-5.6	-6	-5.7	-6.6	-5.5	-6.3	-5	-6.5	-5.7	-6.2	-5.3	**-5.9**

Note: In the UK small banks make up 12.5% of the total lending, while large banks make 87.5%. Correspondingly, these are the weight attached to small and large banks for monetary policy. For capital requirements policy there is no difference due to the absence of a statistically significant interaction term on bank size.