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Bank Losses, Monetary Policy, and Financial Stability—Evidence on the Interplay from Panel Data

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Abstract

We assess the extent to which loan losses affect banks' provision of credit to companies and households and examine how feedback from losses to a reduction in credit is affected by the monetary policy stance. Using a unique cross-country dataset of more than 600 banks from 32 countries, we find that losses lead to a reduction in credit and that this effect is more pronounced when either initial bank capitalization is thin or when monetary policy is tight. Moreover, in the face of credit losses, ample capital is more important in cushioning the effect of loan losses when monetary policy is tight. In other words, capital buffers and accommodating monetary policy act as *substitutes* in offsetting the adverse effect of losses on loan growth. While most of these effects are stronger in crisis times, we find them to operate both in and outside full-blown banking crises. These findings have important implications for the interplay between financial stability and monetary policy, which this paper also draws out.

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I. INTRODUCTION

The 2007/08 crisis has highlighted how banking system losses can lead to tightening credit conditions for companies and households which in turn can impose costs on real activity. It has also shown that monetary policymakers are aware that they can use monetary policy to help offset the adverse effects of financial instability on real activity. According to the minutes of the September meeting of the Federal Open Market Committee (FOMC):

"…members judged that a lowering of the target rate was appropriate to help offset the effects of tighter credit conditions on the economic outlook. Without such policy action, members saw a risk that tightening credit conditions and an intensifying housing correction would lead to significant broader weakness in output and employment. In order to forestall some of the adverse effects on the economy that might otherwise arise all members agreed that a rate cut of 50 basis points was the most prudent course of action."

Indeed, in a number of such policy steps the Federal Reserve reduced the target federal funds rate by a total of 325 basis points until it came to rest at 2 percent, having been reduced by 25 basis points at the meeting in June 2008. But the recent crisis experience has also shown that a monetary policy response may come at a cost when it threatens to unhinge inflation expectations in an environment of concurrent shocks to the price of goods and services. The minutes of the June meeting illustrates this dilemma starkly,[2] by noting that:

"…many financial institutions continued to experience significant credit losses and balance sheet pressure and in these circumstances credit availability was likely to remain constrained for some time. At the same time, however, the near term outlook for inflation had deteriorated and risks that underlying inflation pressures could prove to be greater than anticipated had risen."

This puts a premium on empirical research on the following questions: First, how severe is the effect of financial sector losses on credit (and hence on output).[3] Second, how much loosening is required to counter the effect? Third, how does the answer to the first question depend on the initial capital

[2] The monetary authorities in the U.S., the U.K., and the Eurozone have responded in different ways to this dilemma, partly as a result of differences in the emphasis placed on price stability relative to other central bank objectives, but partly also as a result of uncertainty as to the monetary transmission mechanism under conditions of a severely impaired financial system.

[3] The extent to which a contraction in lending leads to a reduction in activity is an empirical question which is not analyzed in this paper, but is the subject of a sizable literature. This includes evidence derived from U.S. aggregate data, such as Lown and Morgan (2006) and Bayoumi and Melander (2008), cross-country evidence on the effect of banking crises in emerging markets, e.g., Dell'Ariccia, Detragiache and Rajan (2008), Kroszner, Laeven and Klingebiel (2007), as well as a number of recent event studies such as Peek and Rosengren (2000), Ashcraft (2005) and Chava and Purnanandam (2005). See the cited papers, as well as Gorton and Winton (2000) for a survey of the earlier literature on real effects of credit supply.

strength of the banking system and on financing conditions more broadly? And fourth, how do banks' capital strength and broader financial conditions modify the effectiveness of monetary policy and hence the slope of the trade-off faced by policymakers in the face of banking system losses?

Given their importance for central bank policy it is perhaps surprising that these questions have not yet been addressed fully in the literature. In an influential study, Peek and Rosengren (1995) examined the impact of losses on credit extension for New England banks during the early 1990s "credit crunch" and studied how the effect of losses on credit depended on banks' initial capital buffers. However, for lack of variation in monetary conditions over the sample period, this study was unable to explore in detail the effect of monetary policy on the severity of the credit crunch. In one of very few existing cross-country-studies, Cosimano, Chami and Barajas (2004) examined how banks' lending responded to losses. However, their study does not assess further the determinants of the strength of this feedback and does not examine either the effect of monetary policy or of financial conditions more generally.

A partial answer to the aforementioned questions can also be found in the growing literature on the "bank capital channel" of monetary policy and the literature on the broader "bank lending channel," e.g., Romer and Romer, (1990) and Kashyap and Stein (2000). This literature emphasizes how the effect of monetary policy works through banks' ability and willingness to lend. And a number of existing studies of the bank capital channel examine how bank capital influences banks' lending response to monetary policy shocks. Most of this literature investigates the experience in particular countries, e.g., Kishan and Opiela (2000) for the U.S. and Gambacorta and Mistrulli (2004) for Italy. Ehrmann et al (2001) present cross-country evidence on how the effect of monetary policy might be affected by bank capitalization.

Our approach differs from that typically adopted in the "bank capital channel" literature in that we consider losses, that is, *shocks* to bank capital as a key determinant of bank lending behavior, enabling us to study the interplay between shocks to capital and initial capital levels. As regards the extant empirical literature, our paper therefore closes the gap between the literature on credit crunches, e.g., Peek and Rosengren (1995) and Cosimano, Chami, and Barajas (2004), which examines the effect of shocks to capital on credit, but does not analyze monetary policy, and the literature on the bank capital channel, e.g., Kishan and Opiela (2000) and Ehrmann (2001), which analyses the interaction between monetary policy and the *level* of capital, but does not assess the importance of balance sheet shocks.

Using a unique sample of more than 600 listed banks from 32 different countries over the period 1992- 2000, we study the following four questions: (i) To what extent do banks that are weakened by loan losses reduce their loan growth? (ii) How is the strength of this effect affected by initial balance sheet strength? (iii) How does the strength of these effects depend on monetary policy? And how do losses, initial capital buffers and monetary policy interact to bring about changes in credit provision? (iv) Do losses lead to stronger reductions in credit when financing conditions are tight and banks might find access to new capital expensive?

Our main findings can be summarized as follows: First, controlling for general economic conditions, we find that when banks are weakened by loan losses, banks extend less credit. Second, and in line with Peek and Rosengren (1995), the size of the reduction depends on banks' initial balance sheet strength. The reduction in lending is weaker for banks with ample capital buffers and stronger for banks that start out with smaller capital buffers. Third, as regards the effect of monetary policy, we document that losses lead to a stronger reduction in credit when monetary policy is tight. Moreover, in the face of credit losses, tight monetary policy leads to further reductions in credit supply in particular when initial capital is thin. In other words, initial capital and loosening monetary policy are shown to act as substitutes in cushioning shocks to banks' balance sheets. Fourth, and finally, initial capital is more important in cushioning the effect of losses on loan growth during crisis times, when financing conditions more broadly are tight. Moreover, we find that the interaction between losses, initial capital and monetary policy develops greater force in crisis episodes. At the same time we find that the impact of losses on loan growth as well as its interplay with initial capital and monetary policy is present both for crisis countries and for those countries that did not experience a banking crisis in the period under study.

These findings are considerably richer than those that could be obtained by studying a particular country or crisis episode, such as the 2007/8 crisis that originated in the U.S. mortgage markets[4] or selected earlier cases of financial instability, such as the crises in emerging market countries in the late 1990s, or the early 1990's credit crunch in the U.S. This is because for a single country there is typically only one path for monetary policy and assessment of the effects of monetary policy will be complicated by the lack of a counterfactual. Our empirical design introduces such a counterfactual by comparing the effect of differences in the monetary stance across countries as well as differences in its evolution through time for a given amount of losses at individual banks. By seeking a counterfactual from cross-country information, we also alleviate concerns typically leveled at any empirical analysis of the monetary policy transmission about the potential endogeneity of the monetary policy path actually chosen when its effect is being measured. For example, we can analyze the effect of both tightening and loosening policy for a given amount of banking system losses, and capital.

[4] There is reason to think that the 2007/08 crisis episode was special as regards the interplay between monetary policy and loan losses. First, in the run-up to the crisis, many financial firms had reduced constraints on the financing of their lending through the so-called originate-and-distribute model of financing. There already is ample evidence that securitization has reduced the effect of monetary policy changes on credit conditions in the run-up to the crisis, see e.g., Estrella (2002), Altunbas, Gambacorta and Marqués (2007) and Loutskina and Strahan (2006). Second, as the crisis unfolded, a large share of the securitized loans were reintermediated, creating pressure on institutions' capital ratios as well as difficulties for institutions' funding. The empirical results presented here suggest that both of these effects should have increased the adverse effect of losses on the availability of credit. However, since we rely on balance sheet information and thus disregard off-balance sheet activity, the techniques employed in our analysis are not easily applied directly to data taken from the run-up to and the unfolding of the 2007/08 crisis.

Moreover, our approach allows us to compare the strength of the effects for crisis periods and for periods of relative calm. Indeed, overall, our evidence suggests that feedback effects from losses to credit conditions are pervasive and that monetary policy affects this feedback both in crisis times and outside of crises. Others have argued that bank loan supply may have effects on macroeconomic performance in crisis times and that these effects might be more pronounced for households and firms that might depend on continued bank financing, e.g., Dell'Ariccia, Detragiache and Rajan (2008). If that is the case, then the evidence presented here suggests that credit supply effects might play an important role in amplifying macroeconomic fluctuations more broadly, i.e., even outside of full-blown banking crises.

The remainder of the paper is organized as follows. Section II draws on the existing theoretical literature to develop our main hypotheses. The empirical method and data are described in section III. Sections IV-VI present our empirical results in a number of steps. In section IV we establish benchmark results on the effect of losses on loan growth. In section V we proceed by analyzing the interaction between balance sheet stress and monetary policy. Section VI develops this analysis further by investigating differences between crisis and noncrisis episodes as regards the effects of losses, capital and monetary policy. Section VII presents robustness checks. Section VIII concludes by summarizing the main findings and drawing out their implications for policy.

II. THEORY AND HYPOTHESIS DEVELOPMENT

A number of recent theoretical studies consider bank balance sheet constraints and their effect on bank credit provision, e.g., Chiesa (2001), Diamond and Rajan (2006), Brunnermeier and Pedersen (2007), van den Heuvel (2001). At the heart of these models is the observation that the Modigliani-Miller theorem breaks down for banks.[5] In other words, bank capital structure matters for bank investments (loan supply).

The first main prediction of these models is that losses lead to balance sheet stress which can lead to a reduction in the provision of credit. Diamond and Rajan (2006) explain how borrower defaults lead banks to refrain from rolling over credit to stricken borrowers and lead them instead to restructure these projects, when banks are faced with the threat of a depositor run. In other words, they show how bank losses tighten banks' balance sheets and lead to a reduction of credit supply. In a similar vein, Brunnermeier and Pedersen (2007) show how (investment) banks may not provide a sufficient amount of liquidity to the market when they are subject to a funding constraint. Rationing of liquidity is exacerbated when banks sustain losses that further tighten banks' balance sheet constraints.

[5] Gambacorta and Mistrulli (2004) provide a survey of the earlier theoretical literature.

A second important implication of the Chiesa (2001) and Brunnermeier and Pedersen (2007) models is that the effect of loan losses on credit provision depends on the initial capital position of the bank. For example, in Brunnermeier and Pedersen (2007), liquidity is rationed only if initial capital is sufficiently low; and only in this case is the supply of liquidity sensitive to losses. On the other hand, when initial capital is ample, losses do not affect banks' lending. Hence these models suggest that the marginal effect of losses on credit provision is stronger when initial capital is thin.

Third, a number of studies argue that tight monetary policy leads to tighter financing conditions at banking firms, which in turn might amplify credit crunch effects, e.g., Stein (1998), Chiesa (2001), van den Heuvel (2001), Diamond and Rajan (2006). Specifically, the Diamond and Rajan (2006) model shows how temporary monetary tightening may increase the threat of a run on nominal deposits and can thus exacerbate banks' balance sheet constraints. This in turn leads banks to further reduce their liquidity provision to borrowers. A key ingredient of the model presented by van den Heuvel (2001) is that banks are exposed to interest rate risk due to their being engaged in maturity transformation (of short term liabilities into long term assets). This means that when monetary policy tightens, financing becomes more expensive and this leads to a cut-back in lending. Finally, the paper by Chiesa (2001) contains tight predictions for the interaction between bank capital and monetary policy. In this model, banks need to monitor borrowers, but monitoring is subject to moral hazard incentives. An increase in capital relaxes the bank's incentive compatibility constraint and reduces the incentive to shirk. This implies that banks can expand their balance sheet. Likewise, loosening monetary policy relaxes the incentive compatibility constraint and enables banks to expand their balance sheets. The reason is that under imperfect competition, loosening monetary policy increases a bank's interest margin, so that more of the benefit of monitoring accrues to the bank. Chiesa's model therefore suggests that high levels of capital and loose monetary policy may be substitutes in effecting an increase in bank lending.

Fourth, theory suggests that the strength of credit crunch effects should depend on financing conditions at banking firms more generally, e.g., Stein (1998). Eisfeldt (2004) argues that financing conditions tighten when asymmetric information problems between banks and their (capital) investors' become more pronounced. The model also implies that this is more likely to be the case when aggregate economic conditions are bad.[6] More specifically, theory predicts that banks are more likely to see depositors run if the aggregate state of the economy is bad, since this increases the scope for informational contagion, Chen (1999). Financial conditions faced by banks are therefore likely to be tighter if overall economic conditions are unfavorable and they should be particularly tight when a country undergoes a banking crisis.

[6] This is in line with prior evidence that the stock price response to new financing is more adverse when overall economic conditions are unfavorable, Pilotte (1992).

In sum, theory implies the following four hypotheses:

(H1) Provision of credit by banks that are weakened by losses is lower than that of stronger banks.

(H2) The effect of loan losses on banks' provision of credit is amplified for banks with little initial capital.

(H3) In the face of losses, the effect of initial capital on lending is more pronounced if monetary conditions are tight. High initial capital and loose monetary policy are substitutes in their effect on bank lending.

(H4) In the face of loan losses, the effect of initial capital and monetary policy should be more pronounced if financing conditions more generally are tight and banks do not have easy access to additional funds, such as during crises.

III. Empirical Method and Data

Our empirical approach builds on the seminal studies by Bernanke and Lown (1991) and Peek and Rosengren (1995). It is also related to a large literature on the bank lending channel that attempts to identify changes in bank loan supply by use of bank-level characteristics that can be argued to affect loan supply, but not loan demand, e.g., Kashyap and Stein (2000). One strategy that has proved particularly successful in this literature is to examine cross partial effects. For example, Kashyap and Stein (2000) show that smaller banks—that arguably find access to uninsured funding more difficult—react more strongly to a tightening monetary policy and that this effect is stronger for those banks with smaller cushions of liquid assets. Similarly, Peek and Rosengren (1995) show that losses lead to reductions in credit growth and that this effect is stronger if initial capital is thin[7].

We follow this basic strategy. In our benchmark specification, a bank's loan growth is regressed on its loan loss provision ratio (Provisions), the nominal GDP growth of the country in which the bank is located, as well as a number of further controls. In addition, the loan loss provisions ratio is interacted with the initial capital buffer of the bank. Our basic specification can be represented as follows:

$$\Delta \log(Loans)_{it} = \alpha Z_{it} + \beta GDPG_{jt} + \gamma Loss_{it} + \delta Loss_{it} * CAP_{it-1} \qquad (1)$$

[7] More precisely, this study examined the impact of losses on the growth of (deposit) liabilities, rather than assets.

where *Loss* is measured by loan loss provisions,[8] *GDPG* is the growth of nominal GDP,[9] and *Z* represents a vector of control variables. *Z* includes further bank-specific characteristics, such as a measure of bank profitability—the return on equity—as well as the level of capital. In addition we control for differences across countries and through time that may affect a bank's loan growth, by use of a full set of country dummy variables and time-fixed effects. Regressions were performed using a feasible generalized least squares (FGLS) estimator that allows for first-order autocorrelation within units, as well as correlation and heteroskedasticity across units (banks).[10]

If losses are associated with a reduction of loan growth this is consistent with hypothesis (H1)—losses reduce provision of credit. However, losses experienced at banks might conceivably also be correlated with loan demand. In principle, this correlation could be positive or negative. For instance, bank losses might indicate that potential new borrowers might face poor economic prospects and might therefore be less likely to demand a loan. On the other hand, bank losses might be associated with an increase in the demand for loans as existing borrowers attempt to bridge cash flow problems that are associated with poor economic conditions, e.g., as in Diamond and Rajan (2006). Our specification therefore attempts to control for aggregate loan demand by including the growth rate of GDP in the country of origin of the bank as a proxy.[11]

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[8]We use the flow of new provisions for loan losses, as recorded in a bank's income statement. This is not the only possible, but arguably the best available measure of the amount of losses that are sustained and (through the income statement) affect bank capital. One alternative is (the change in) the ratio of nonperforming loans. However, as a measure of the incidence of default, the ratio of nonperforming loans takes no account of the bank's assessment of the likely loss (as opposed to amounts that can be recovered) given default. Moreover, as a memo item in the annual accounts this ratio is available only for a relatively small fraction of banks in our sample. There also are differences as regards the definition of a nonperforming loan across those countries where the ratio is available (with a loan being past due 90 days only one of several definitions applied). A second alternative is the ratio of write-offs to total loans. The drawback here is that while provisions and write-offs are highly correlated in the long run, write-offs are recorded with a considerable lag. For example, in a study of U.K. banks' provisioning behavior Pain (2003) finds that around 80 percent of provisions are reflected in write-offs after around 3–4 years with a mean lag of around 1.5 years.

[9]Since our dependent variable—loan growth—is nominal, it is natural to include the nominal, rather than the real growth in GDP on the right hand side. Some of the extant literature explaining loan growth (e.g., Ehrmann et al 2001) goes further and separates nominal GDP growth out into real GDP growth and inflation. However, since these studies find similar coefficients for the two constituent variables we prefer the more parsimonious specification set out above.

[10] Some of the existing literature instead estimates a dynamic equation, including lags of the dependent variable. Typically the samples used relate to specific countries and provide quarterly observations on the variables of interest. For the present sample that comprises annual observations with T<=7 a dynamic specification would have been difficult to estimate. However, in any case, first-order autocorrelation in the residuals was found to be small (it is equal to 0.07 for the specification in column 1 in Table 1), suggesting that a static specification can be justified.

[11] Note that in our cross-country context this variable will vary across countries as well as time. This increases its ability to account for differences across countries in the time profile of loan demand and thus aids identification of bank loan supply.

More importantly, as set out above, we follow Peek and Rosengren (1995) and interact loan losses with the lagged value of the bank's level of capital. While the lagged level of capital might conceivably again be correlated with loan demand, e.g., Bernanke and Lown (1991), we argue that loan demand should not be correlated with the *interaction* between losses and initial levels of capital. On the other hand, theory predicts that loan *supply* should depend on the interaction between losses and initial capital, as set out as hypothesis (H2) above. In particular, the models by Chiesa (2001) and Brunnermeier and Pedersen (2007) imply that the marginal impact of losses on loan supply should be stronger if initial capital is thin and weaker if initial capital is ample.

Finally, in a number of exercises that are related to our hypotheses H3 (the effect of monetary policy) and H4 (the effect of financial conditions more broadly), we further examine how the strength of the interaction (between losses and capital) might in turn depend on monetary and financial conditions banks face, by introducing further interaction terms into the basic specification (1).

The sample used in the empirical analysis contains data on more than 600 listed banks from 32 countries[12] from 1993 to 2000.[13] In principle, a cross-country sample of banks is open to the criticism that banking systems in different countries may be different in terms of institutional characteristics. For example, German "savings banks" and Italian "cooperatives" may be very different from large U.S. commercial banks. To minimize such differences across banks from different countries that may be hard to control for we restricted attention to listed banks. The downside of this approach is that, as a result, access to capital markets is likely to be similar across the banks in our sample and therefore cannot be used as an additional test.[14] On the other hand, our sampling technique ensures a reasonable degree of homogeneity across banks[15] and allows for a cleaner comparison of banks across both countries and time. Table 1 below shows summary statistics of the variables in our basic model specification for the banks in our sample.

[12] The countries in the data set are Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, Finland, France, Germany, Greece, Hong Kong, Indonesia, Ireland, Israel, Italy, Japan, Korea Republic, Malaysia, the Netherlands, Norway, Poland, Portugal, Singapore, Spain, Sweden, Switzerland, Thailand, Turkey, the United Kingdom, and the United States.

[13] Because loan growth is the dependent variable, only seven years (between 1994 and 2000) are used in the regressions.

[14] For example, we found that, as the banks in our sample are typically large, listed entities, the banks' response to loan losses was unaffected by the bank's size.

[15] It also means that our results are valid for the universe of large listed banks and should not be read to generalize to smaller banks and savings institutions. In fact, however, if anything we would expect our results to be even stronger for those banks that have less easy access to capital markets.

Table 1. Summary Statistics

	Mean	Std. Dev.	Min	Max	Obs.	No. of banks
Loan growth	0.095	0.189	-0.583	0.962	4213	735
RoE	0.108	0.116	-0.798	0.554	4811	736
Provisions	0.009	0.014	-0.004	0.132	4444	676
Capital	0.098	0.131	0.013	1.929	4913	718
GDP growth	0.031	0.023	-0.069	0.095	4913	718

Source: Authors' calculations; see Table 12 for definition of variables and data sources.

All variable definition and data-sources are provided in Table 12 (in the appendix). It is worth pointing out here that capital is defined as the ratio of total equity capital to noncapital liabilities. We think of this as measuring the buffer of capital available to absorb losses.[16]

Our sample comprises a number of banking crises over the sample period. It is therefore possible to distinguish between the effects of bank losses on credit provision for crises countries and for noncrisis countries. In particular, according to Caprio and Klingebiel (2003) crises countries are Argentina (1995), Brazil (1994-1999), Indonesia (1994 and 1997-), Japan (1991-), Korea (1997-), Malaysia (1997-), Thailand (1997), Poland (1990s) and Turkey (1994). Table 2 shows the average provisions by country and by year. While for the whole sample the provisions ratio is just under 1 per cent, Table 2 documents that there are a number of episodes where average provisions rise substantially above that number (as high as 8.5 per cent in Thailand in 1999). Moreover, note that most of the country-years with average provisions above the 75th percentile are associated with banking crises, according to the account of Caprio and Klingebiel (2003). This can be taken to validate the underlying assumption that provisions are correlated positively with actual losses sustained by banks.[17]

[16] Since all banks in the sample are subject to Basel 1 capital requirements the capital ratio may also proxy for the buffer of capital banks have over and above the Basel 1 requirement. But this is approximate for two reasons. First, requirements under Basel 1 are defined in terms of risk-weighted assets, rather than noncapital liabilities. Second, some countries in our sample require larger ratios than the 8 percent that is mandated under Basel 1. Since data on these aspects are not publicly available we are unable to investigate this issue further.

[17] For our purposes this correlation need not be perfect. One reason why it might not be is that banks may not always have an incentive to recognize losses in their accounts. On the other hand, if losses are not recognized, such losses are less likely to affect banks' behavior, see e.g., Giannetti (2007). A case in point is Japan, where through the 1990s banks may not have fully accounted for losses made. At the same time, it has been shown that during this period Japanese banks were engaged in a process of 'evergreening' of loans, Peek and Rosengren (2005). Thus, if banks do not recognize their losses, loan growth may not be reduced.

Table 2. Average of Provision Ratio

Year	Argentina	Australia	Austria	Bel gium	Brazil	Canada	Chile	Finland	France	Germany	Greece	Hong Kong	Indonesia	Ireland	Israel	Italy
1993	0.018	0.007	.	.	0.008	0.005	0.001	0.021	0.014	.	0.011	0.003	0.009	0.008	0.006	0.018
1994	0.0194	0.0036	.	.	0.0195	0.0069	0.0049	0.0175	0.0141	0.0067	0.0123	0.0050	0.0110	0.0034	0.0035	0.0128
1995	0.0313	0.0022	.	.	0.0654	0.0048	0.0028	0.0150	0.0123	0.0051	0.0078	0.0053	0.0078	0.0027	0.0052	0.0127
1996	0.0315	0.0015	0.0080	.	0.0612	0.0038	0.0053	0.0058	0.0103	0.0047	0.0100	0.0049	0.0071	0.0023	0.0047	0.0117
1997	0.0210	0.0017	0.0107	0.0024	0.0449	0.0036	0.0072	0.0016	0.0154	0.0057	0.0113	0.0082	0.0251	0.0016	0.0050	0.0092
1998	0.0241	0.0034	0.0059	0.0001	0.0463	0.0035	0.0146	-0.0004	0.0076	0.0048	0.0131	0.0244	0.0500	0.0018	0.0051	0.0082
1999	0.0293	0.0031	0.0074	0.0036	0.0437	0.0039	0.0188	0.0003	0.0098	0.0051	0.0120	0.0267	0.0520	0.0013	0.0036	0.0070
2000	0.0268	0.0017	.	0.0024	0.0365	0.0044	0.0110	0.0003	0.0068	0.0041	0.0095	0.0144	0.0127	0.0028	0.0040	0.0064
Total	0.0261	0.0029	0.0080	0.0021	0.0431	0.0044	0.0100	0.0065	0.0114	0.0050	0.0111	0.0115	0.0177	0.0027	0.0046	0.0103
Obs	40	85	4	12	94	58	54	19	147	35	42	92	82	31	87	276
No of banks	7	11	1	3	20	8	9	3	22	9	9	12	14	5	12	42

Year	Japan	Korea	Malaysia	Netherlands	Norway	Poland	Portugal	Singapore	Spain	Sweden	Switzerland	Taiwan	Thai land	Turkey	United Kingdom	USA
1993	0.0031	0.0069	0.0091	0.0053	0.0104	0.0252	0.0183	0.0031	0.0237	0.0212	0.0044	0.0044	0.0049	0.0047	0.0127	0.0059
1994	0.0039	0.0102	0.0105	0.0057	0.0037	0.0389	0.0146	0.0035	0.0121	0.0122	0.0099	0.0046	0.0053	0.0269	0.0072	0.0034
1995	0.0097	0.0085	0.0068	0.0051	0.0020	0.0210	0.0130	0.0023	0.0100	0.0076	0.0035	0.0035	0.0040	0.0408	0.0052	0.0039
1996	0.0073	0.0061	0.0071	0.0044	0.0015	0.0176	0.0120	0.0036	0.0061	0.0033	0.0063	0.0045	0.0042	0.0119	0.0051	0.0041
1997	0.0123	0.0128	0.0160	0.0026	0.0014	0.0065	0.0220	0.0137	0.0036	0.0019	0.0052	0.0069	0.0308	0.0074	0.0054	0.0044
1998	0.0156	0.0467	0.0509	0.0034	0.0029	0.0151	0.0098	0.0241	0.0033	0.0019	0.0054	0.0124	0.0719	0.0176	0.0054	0.0051
1999	0.0091	0.0457	0.0204	0.0020	0.0029	0.0114	0.0116	0.0164	0.0031	-0.0001	0.0047	0.0117	0.0855	0.0226	0.0052	0.0049
2000	0.0092	0.0534	0.0135	0.0015	0.0029	0.0213	0.0101	0.0037	0.0053	0.0008	0.0054	0.0152	0.0262	0.0252	0.0043	0.0049
Total	0.0090	0.0307	0.0191	0.0036	0.0032	0.0183	0.0139	0.0112	0.0082	0.0059	0.0053	0.0084	0.0334	0.0193	0.0061	0.0046
Obs	690	61	47	32	98	70	51	30	146	38	63	189	57	61	181	1472
No of banks	100	13	8	5	14	13	7	6	19	6	14	28	13	13	26	204

less than median
between median and 75th percentile
greater than 75th percentile

IV. BENCHMARK RESULTS

This section presents the basic results on our first two hypotheses (H1 and H2). Table 3, (columns 1 and 2) contains the results on each.

Table 3. Benchmark Equation—Determinants of Loan Growth

Dependent variable: Loan growth	(1)	(2)
RoE	**0.25*** **	**0.23*** **
Capital	0.005	**-0.09** **
Provisions	**-1.84*** **	**-2.85*** **
GDP	**0.43*** **	**0.43*** **
Lagged Capital*Provisions		**6.23*** **
Year dummies	Yes	Yes
Country dummies	Yes	Yes
No. of obs.	3460	3453
Goodness of fit 1/	0.25	0.25

*** denotes statistical significance at the one percent level, ** at the five percent level and * at the ten percent level.

Source: Authors' calculations; see Table 12 for definition of variables and data sources.

1/The goodness of fit is calculated as the square of the correlation coefficient between the actual and the fitted value of the loan growth.

First, for any given level of economic growth, banks with higher loan loss provisions tend to extend less credit.[18] In economic terms, a 1 percentage point increase in a bank's loan loss provision ratio is found to reduce its loan growth by 1.84 percentage points. To put this in perspective, note that average loan growth is just under 10 per cent and that, as documented in Table 1, an increase in provisions of 1 percentage point is relatively common—amounting to less than one standard deviation. Overall, the evidence is consistent with hypothesis (H1): negative shocks to capital appear to be associated with a decrease in loan origination. Banks that are weakened by losses extend less credit than stronger ones.

To test hypothesis (H2), an interaction term between a bank's loan loss provision ratio and its lagged capital ratio is added to the specification in column (2). The positive coefficient

[18] This result is consistent with the results obtained by Peek and Rosengren (1995): the authors found a positive and significant impact of changes in capital (represented in our specification by banks' RoE and loan loss provisions) on bank liabilities.

implies that the impact of loan losses on loan growth is reduced for banks whose initial capital buffers are high and more pronounced for banks which are poorly capitalized. This evidence is consistent with hypothesis (H2) and in line with the main finding in Peek and Rosengren (1995). To assess the economic significance of this effect, note that the mean capital ratio is close to 10 per cent, while its standard deviation is 13 percent. Thus an increase of the capital ratio by one standard deviation about its mean reduces the negative effect of provisions on loan growth by 0.81 (=6.32*0.13) percentage points.

As regards the controls, we find that more profitable banks tend to extend more credit, while on balance, a bank's *level* of capital does not appear to exercise a strong influence on its loan growth.[19] Finally, note that Table 3 documents a positive and significant correlation between a bank's loan growth and the nominal GDP growth, which proxies for domestic demand effects. This effect is also economically relevant: in specification (1), a 1 percentage point decrease in GDP growth causes a fall in loan growth by around 0.43 percentage points.

In sum, we find evidence in favor of the two basic hypotheses. Controlling for general economic conditions, when banks are weakened by loan losses, banks extend less credit, in line with hypothesis H1. Moreover, the size of the reduction depends on banks' initial balance sheet strength. The reduction in lending is weaker for banks with ample capital buffers and stronger for banks that start out with smaller capital buffers, in line with hypothesis H2.

V. THE EFFECT OF MONETARY POLICY

How is banks' response to loan losses affected by monetary policy? We examine this issue by analyzing changes in the short term interest rate prevailing in the country of origin of a bank. Specifically we define monetary policy to be tightening if short term rates have gone up over the course of the year, loosening if interest rates have come down over the course of the year, and neutral if interest rates have not moved over the year. Accordingly, we define three dummy variables: Δr^+, Δr^- and Δr^0. Use of a set of dummy variables is motivated by a concern that in a cross-country context both levels and changes in interest rates could be quite diverse in magnitude. Moreover, note that we identify the effect of the monetary policy stance through changes in tightness, rather than through its level, akin to a fixed effects approach.

The analysis then proceeds in four steps. We first check whether the monetary policy indicators as defined here affect loan growth in plausible ways. We then examine whether they modify the effect of loan losses on loan growth. That is, we interact the monetary policy indicators with our loan loss variable. In the third step, we interact the monetary policy

[19] Again, this finding is consistent with Peek and Rosengren (1995), who found a positive but insignificant relationship between capital ratio and total liabilities.

indicators with the level of capital, to see whether it determines the effect of monetary policy on loan growth. In the fourth and final step we introduce a three-way interaction between the monetary policy indicator, loan losses and lagged capital.

Table 4. The Effect of Losses and Monetary Policy—Interactions

Dependent variable: Loan growth	(1)	(2)	(3)	(4)	(5)	(6)
RoE	**0.25*** **	**0.25*** **	**0.25*** **	**0.25*** **	**0.24*** **	**0.25*** **
Capital	0.006	0.006	0.005	0.006	0.009	0.004
Provisions	**-1.87*** **	**-1.89*** **	**-1.85*** **	**-1.36*** **	**-3.15*** **	**-1.91*** **
GDP	**0.45*** **	**0.45*** **	**0.45*** **	**0.42*** **	**0.43*** **	**0.46*** **
Δr^+	**-0.02*** **			-0.005		
Δr^-		**0.02*** **			0.01	
Δr^0			-0.03			**-0.04***
Provisions*Δr^+				**-2.32*** **		
Provisions*Δr^-					**1.74*** **	
Provisions*Δr^0						0.94
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	3436	3436	3436	3436	3436	3436
Goodness of fit	0.25	0.25	0.25	0.26	0.26	0.26

*** denotes statistical significance at the one percent level, ** at the five percent level and * at the ten percent level.
Source: Authors' calculations; see Table 12 for definition of variables and data sources.

Table 4 shows the result of the first two exercises. First we find that tightening monetary policy, as defined, is associated with a reduction in loan growth, Table 4, column 1, whereas loosening monetary policy is associated with an increase in loan growth, Table 4, column 2. Neutral monetary policy does not appear to have an effect on credit growth, Table 4, column 3. These findings are as one might expect. As regards the size of the effects[20] they are consistent with prior evidence, e.g., Kashyap and Stein (2000). Moreover, the effects of tightening and loosening policy are of similar magnitude. For the benchmark equation, shown in Table 4, as well as for the subsequent exercises, we checked whether the two effects were statistically different from each other in absolute terms, but did not find strong evidence for asymmetry in the effects, again in line with most of the previous literature. Note also that these results may relate equally to an effect of monetary policy on loan demand and to an effect on loan supply. To investigate the effect on loan supply we must examine

[20] The mean increase in rates, conditional on rates increasing is 0.67, i.e., 67 basis points over the year. The mean decrease in rates, conditional on rates decreasing, is of similar magnitude, at -.76, or -76 basis points over the year. This means that an increase in rates by 100 basis points over a year would reduce loan growth by close to 3 percentage points (0.02/0.67=.03), with the effect of monetary easing of similar magnitude.

interactions with bank-level characteristics, and be able to argue that either the bank-level characteristic in question, or the interaction of that variable with monetary policy is independent of loan demand.

We start by interacting the monetary policy stance with provisions, as our main bank-level measure of *changes* in balance sheet strength. The key finding is that weakening balance sheets lead to a stronger reduction in credit growth when monetary policy is tight than when it is loose. In particular, adding the coefficient on the dummy variable to the coefficient on provisions in specifications (4) and (5), respectively, we find that a 1 percentage point increase in provisions leads to a reduction in loan growth of 1.41 percentage points when monetary policy is loosening, but to a reduction of 3.68 percentage points when monetary policy is tightening. This suggests that tightening monetary policy exacerbates the effect of a weakening of bank balance sheets on bank loan supply, whereas easing monetary policy alleviates it.

Table 5. The Effect of Capital and Monetary Policy—Interactions

Dependent variable: Loan growth	(1)	(2)	(3)
RoE	**0.25*** **	**0.25*** **	**0.25*** **
Capital	-0.07	**0.11** **	0.001
Provisions	**-1.83*** **	**-1.86*** **	**-1.86*** **
GDP	**0.43*** **	**0.46*** **	**0.46*** **
Δr^+	**-0.04*** **		
Δr^-		**0.04*** **	
Δr^0			-0.04
Capital*Δr^+	**0.19*** **		
Capital*Δr^-		**-0.19*** **	
Capital*Δr^0			0.07
Year dummies	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes
No. of obs.	3436	3436	3436
Goodness of fit	0.25	0.26	0.25

*** denotes statistical significance at the 1 percent level; ** at the 5 percent level; and * at the 10 percent level.

Source: Authors' calculations; see Table 12 for definition of variables and data sources.

The analysis so far has shown how the effect of *shocks* to capital on loan growth may be affected by the monetary policy stance. We next investigate how in turn the effect of monetary policy changes on credit supply might be affected by the *level* of capital that banks hold. Table 5 shows the results. Specifications (1)-(3) document that bank capital cushions against the effect of both monetary tightening and monetary easing. Conversely, for banks that are more weakly capitalized monetary policy has a stronger effect on loan growth. In economic terms a one standard deviation (13 percent) increase in a bank's level of capital

roughly halves the effect of monetary policy on loan growth, either way (0.19*0.13=0.025). This result is plausible and in line with prior evidence in the literature on the so-called "bank capital channel" of monetary policy, see e.g., Gambacorta and Mistrulli (2004). It suggests that all else equal, monetary policy may be more powerful (either way) when the banking system is weak than when it is strong.

The final step in our analysis is to examine how the effect of shocks to capital on credit growth might depend both on the initial level of capital and the monetary policy stance. To investigate this, we include a three-way interaction term between initial capital, provisions and monetary policy. This is introduced in Table 6 in addition to the two-way interaction terms considered thus far and draws together the analysis in this section.

Table 6. The Effect of Losses, Capital, and Monetary Policy—Interactions

Dependent variable: Loan growth	(1)	(2)	(3)	(4)	(5)	(6)
RoE	**0.22*** **	**0.23*** **	**0.23*** **	**0.22*** **	**0.23*** **	**0.22*** **
Capital	**-0.09** **	**-0.09** **	**-0.08** **	**-0.08** **	**-0.15** **	-0.02
Provisions	**-2.85*** **	**-2.87*** **	**-2.30*** **	**-3.93*** **	**-2.00*** **	**-4.58*** **
GDP	**0.45*** **	**0.45*** **	**0.42*** **	**0.43*** **	**0.41*** **	**0.43*** **
Lagged Capital*Provisions	**5.99*** **	**6.03*** **	**5.57*** **	**5.61*** **	**4.08*** **	**10.49*** **
Δr^+	**-0.02*** **		-0.006		-0.014	
Δr^-		**0.02*** **		**0.014***		**0.02*** **
Provisions*Δr^+			**-2.15*** **		**-3.49*** **	
Provisions*Δr^-				**1.55*** **		**2.50*** **
Capital*Δr^+					0.12	
Capital*Δr^-						**-0.13***
Lagged Capital*Provisions*Δr^+					**9.47*** **	
Lagged Capital*Provisions*Δr^-						**-6.31*** **
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	3429	3429	3429	3429	3429	3429
Goodness of fit	0.26	0.26	0.26	0.26	0.27	0.26

*** denotes statistical significance at the 1 percent level; ** at the 5 percent level; and * at the 10 percent level.

Source: Authors' calculations; see Table 12 for definition of variables and data sources.

Table 6 illustrates four key findings: first, as before, the effect of provisions on credit growth is increased when monetary policy is tightening and attenuated when monetary policy is loosening. Second, as before, the effect of provisions on loan growth is reduced when the initial level of capital is high. Third, again as before, high capital cushions against the effect of both tightening and loosening monetary policy. Fourth, the initial level of capital is more

important for cushioning the effect of provisions on credit supply when monetary policy is tightening and less important when monetary policy is easing.

This fourth finding is new and in line with hypothesis (H3). It implies that loose monetary policy and high initial capital are substitutes in cushioning the effect of credit losses on loan supply. In other words, to offset the effect of a given capital shock on credit supply, monetary policy needs to be looser when the initial capital is thin, but can stay tighter when initial capital is high. This is plausible and consistent with recent theoretical models of bank balance sheet strength, monetary policy and their joint effects on bank liquidity provision, such as Chiesa (2001).

These findings lend empirical support to the view that monetary policy has an effect on bank balance sheet constraints that is distinct from the potential effect of monetary policy on the demand for investment, as has been argued by Kishan and Opiela (2000) and Diamond and Rajan (2006), among others. But importantly, our results imply that both the size of any capital shock and the level of initial capital are important for the strength of the effect of monetary policy on loan supply. In particular, we find that in the face of credit losses, tight monetary policy leads to further reductions in credit supply in particular when initial capital is thin. As regards the extant empirical literature, these findings therefore close the gap between the literature on credit crunches, e.g., Peek and Rosengren (1995) and Cosimano, Chami and Barajas (2004), which examines the effect of shocks to capital on credit supply, but does not analyze monetary policy, and the literature on the bank capital channel, e.g., Kishan and Opiela (2000) and Ehrmann (2001) which analyses the interaction between monetary policy and the *level* of capital, but does not assess the importance of balance sheet shocks.

VI. Financial Conditions: Crisis Versus Noncrisis Countries

During banking crises, banks' financing conditions will tend to be tight. Indeed, during crises banks may see depositors run on deposits, but more generally, during crises it will be difficult for banks to finance new lending by use of other funding sources, such as uninsured deposits or capital. In line with hypothesis (H4) we would therefore expect to see credit crunch effects to be more pronounced in crisis times. Moreover, when financing conditions are tight, such as during crises, one might expect monetary policy shocks to develop greater force in their interaction with balance sheet stresses experienced by banking firms. Finally, there may be a question as to whether or not the results discussed thus far may to some extent be driven by the inclusion of crisis episodes and it is important to ascertain whether they hold outside of crises (and therefore are pervasive).

As set out above, our sample comprises banks from a number of countries that experienced a banking crisis during the 1990s. We use information obtained from Caprio and Klingebiel (2003) on crisis episodes in two ways. First, we split the data set into two subgroups according to whether banks are located in a country that experienced a systemic banking

crisis over the period covered by our sample[21] and run separate regressions for these two groups (crisis versus noncrisis countries). Second, we construct a dummy variable that takes account of the timing of the crisis, where again the information is gleaned from Caprio and Klingebiel. The advantage of this variable is that—in contrast to the basic split into crisis and noncrisis countries—it varies both across countries and across time. It can therefore be used in regressions on the full sample in addition to a complete set of country dummy variables that control for any (additional) country-fixed effects. We use this variable (banking crisis time) in all exercises that aim to assess whether any of the effects are significantly different across crisis and noncrisis episodes.

We start by assessing whether the basic credit crunch effects shown in Table 3 are different across the two subsamples. Table 7, column (1) reports the results for the basic specification for the "banking crisis" sub-sample and column (2) for the "no banking crisis" sub-sample.

Table 7. Determinants of Loan Growth: Crisis Versus Noncrisis Countries

Dependent variable: Loan growth	(1) Banking Crisis	(2) No Banking Crisis	(3) Banking Crisis	(4) No Banking Crisis
RoE	**0.21*** **	**0.27*** **	**0.18*** **	**0.25*** **
Capital	-0.13	0.03	**-0.44*** **	-0.06
Provisions	**-1.69*** **	**-2.44*** **	**-3.33*** **	**-3.98*** **
GDP	**0.53*** **	**0.76*** **	**0.51*** **	**0.8*** **
Lagged Capital*Provisions			**13.33*** **	**6.86** **
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
No. of obs.	1040	2420	1036	2417
Goodness of fit	0.41	0.15	0.42	0.15

*** denotes statistical significance at the 1 percent level; ** at the 5 percent level; and * at the 10 percent level.

Source: Authors' calculations; see Table 12 for definition of variables and data sources.

The results shown in columns (1) and (2) confirm the evidence that a bank's loan growth depends positively on nominal GDP growth and profitability and that banks with higher loan loss provisions extend less credit. In particular, they document that loan losses are associated with a reduction in loan growth both in and outside crises. We checked whether coefficients on loan loss provisions were significantly different, by interacting all coefficients with

[21] According to Caprio and Klingebiel (2003) crises countries are Argentina (1995), Brazil (1994-1999), Indonesia (1994 and 1997-), Japan (1991-), Korea (1997-), Malaysia (1997-), Thailand (1997), Poland (1990s), Turkey (1994).

banking crisis time. It turns out that the sensitivity of loan growth to loan loss provisions does not vary significantly between crisis and noncrisis episodes. In other words, the effect of losses on loan growth is pervasive.[22]

In specifications (3) and (4), we include the interaction between a bank's loan loss provision ratio and its (lagged) capital ratio. The coefficient is significant in both subsamples, consistent with the results on the whole sample, but is found to be larger for crisis countries. For this sub-sample, an increase in capital of one standard deviation about its mean results in a reduction of the effect of losses on loan growth of 1.73 (=13.33*0.13) percentage points, roughly double the size of the effect for the noncrisis sample. When all variables are interacted with the crisis dummy we also find that this difference is statistically significant. This means that the impact of loan losses on loan growth is not only stronger for poorly capitalized banks, but more so during a banking crisis. This finding is consistent with the idea that it might be particularly costly for banks to issue new equity capital during such episodes.

The next step is to assess how the effectiveness of monetary policy and its interaction with credit crunch effects might be related to whether or not a country has undergone a banking crisis. We start by including the basic monetary policy indicators into the analysis and check whether or not their effect might be different across the two subsamples as well as when compared to the full sample. Table 8, columns (2) and (4) shows that the sign and size of the coefficients on the monetary policy indicators are the same, at (-0.02 and 0.02) when estimation is performed on a subsample excluding crisis countries as when the effect of monetary policy is estimated using the whole sample, see e.g., Table 6 above.

In Table 8, columns (1) and (3) also show that the effect of the monetary policy indicators is measured roughly twice as large (at -0.04 and 0.05) for the sample of crisis countries than it is for the noncrisis countries. However, it seemed plausible that the magnitude of changes in interest rates that are associated with the monetary policy indicator is different during crises times than during normal times. Investigating this, we found that the magnitude of changes in interest rates are about twice as large for crisis episodes than they are for noncrisis episodes and that this differential was present for both tightening and loosening episodes, see Tables 13 and 14 (in the appendix). This leads us to conclude that the benchmark effect of monetary policy on loan growth is similar for crisis and for noncrisis episodes.

[22] We also find that the impact of nominal GDP is significantly weaker for crisis episodes. This might suggest that during crises, loan demand (which we proxy with nominal GDP growth) is less important in determining bank loan growth than in normal times. This finding is plausible and consistent with the idea that bank supply effects may be stronger during crises.

Table 8. Monetary Policy and Banking Crises

Dependent variable: Loan growth	(1) Banking crisis	(2) No banking crisis	(3) Banking crisis	(4) No banking crisis
RoE	**0.18*** **	**0.25*** **	**0.18*** **	**0.25*** **
Capital	**-0.44*** **	-0.06	**-0.43*** **	-0.06
Provisions	**-3.27*** **	**-3.99*** **	**-3.32*** **	**-4.0*** **
GDP	**0.54*** **	**1.18** **	**0.54*** **	**1.19*** **
Lagged Capital*Provisions	**12.53*** **	**6.95*** **	**12.67*** **	**6.98*** **
Δr^+	**-0.04*** **	**-0.02** **		
Δr^-			**0.05*** **	**0.02*** **
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
No. of obs.	1036	2393	1036	2393
Goodness of fit	0.43	0.16	0.43	0.16

*** denotes statistical significance at the 1 percent level, ** at the 5 percent level and * at the 10 percent level.

Source: Authors' calculations; see Table 12 for definition of variables and data sources.

To investigate further whether and how monetary policy might be more or less potent during crisis times we finally re-introduce the three-way interaction term between monetary policy, provisions and capital and assess to what extent its measured effect might differ depending on whether or not the country undergoes a banking crisis.

Table 9 shows the results of a specification which includes a dummy variable indicating whether or not a country is in crisis in a particular year (bank crisis time) and where this variable is also interacted with the three-way interaction term introduced in the previous section (as well as with provisions, capital and monetary policy indicators, results for which are not shown).

The negative coefficient on the crisis indicator variable suggests that, as may be expected, loan growth is reduced during crisis times. Controlling for banking crisis episodes and a full set of country fixed effects, the coefficients on the three-way interaction term between provisions, capital and monetary policy indicator is, at -6.86 and 6.82, similar to the size of the coefficient as measured for the full sample, e.g., in Table 6. Most interestingly, the interaction between the three-way interaction term and the crisis indicator variable shows that during banking crises the effect of the three-way interaction term is considerably larger than it is in normal times. This is plausible: not only are initial capital and monetary policy substitutes in cushioning the effect of losses on loan growth, but this effect is stronger during crisis times. In other words, while capital is always useful for cushioning losses, it is more useful if monetary policy is tight and most useful when a country is in crisis.

Table 9. Monetary Policy and Banking Crises—Interactions 1/

Dependent variable: Loan growth	(1)	(2)
Lagged Capital*Provisions	**4.38****	**11.31*****
Bank crisis time	**-0.08*****	**-0.09*****
Δr^+	-0.01	
Δr^-		**0.02***
Lagged Capital * Provisions * Δr^+	**6.86***	
Lagged Capital * Provisions * Δr^-		**-6.82*****
Lagged Capital * Provisions * Δr^+ * Bank crisis time	**52.67*****	
Lagged Capital * Provisions * Δr^- * Bank crisis time		**-27.43*****
Year dummies	Yes	Yes
Country dummies	Yes	Yes
No. of obs.	3419	3419
Goodness of fit	0.29	0.29

*** denotes statistical significance at the 1 percent level, ** at the 5 percent level and * at the 10 percent level.

Source: Authors' calculations; see Table 12 for definition of variables and data sources.

1/ In the interest of saving space the table does not include estimates of the coefficients of all the variables included in the model. However, these are available from the authors on request.

In sum, bank loan supply effects are shown to operate both in and outside of banking crises. In particular we find evidence in favor of hypotheses (H1) and (H2) both for crisis countries and for noncrisis countries. This suggests that initial capital levels determine banks' response to losses both in and outside of crises. However, and consistent with our hypothesis (H4), the effect of initial capital is shown to be stronger during crises times than during normal times. Further, while monetary policy affects loan growth both in crisis countries and in noncrisis countries, the interaction of monetary policy with losses and initial capital develops greater force in crisis episodes, when financing conditions at banking firms are tight.

VII. Robustness Checks

A. Bank-fixed Effects

We have undertaken a number of further robustness checks on our results. In particular, despite the fact that we routinely control for all differences across countries and across time, there might be a concern that other influences on a bank's loan growth might have been omitted from the equations and could be correlated with the included regressors, resulting in omitted variable biases. To check whether omission of other influences might have resulted in omitted variable bias, we replace country-fixed effects by bank-fixed effects that control

for all unobserved heterogeneity across banks, whether or not this relates to differences at the country level. Clearly, a fixed effects estimator also controls for all differences across banks with regard to bank balance sheet strength. The effect of the latter on bank loan supply is thus identified only by changes across time in bank health for each bank. Note that we continue to control for changes across time that might affect all banks at the same time, by keeping time fixed effects (year dummies). Table 10 presents the results.

It turns out that the result when bank fixed effects are included are qualitatively and quantitatively similar to the ones presented above, e.g., in Table 4. Indeed, the results were generally found not to be statistically different, when a Hausman test was performed. The test is based on the difference between the random effects and the fixed effects estimates and a statistically significant difference is interpreted as evidence against the random effect and in favor of the fixed effects specification. The chi-square statistic for model (2) is 9.74 (and the p-value is 0.55) and it is 13.52 for model (4) (with p-value equal to 0.26). This suggests that we cannot reject the hypothesis that the coefficients are the same. In other words, country- and time-fixed effects are generally sufficient to account for unobserved heterogeneity in our sample. Any remaining bank-specific heterogeneity does not appear to result in omitted variable bias, perhaps reflecting the fact that our sample of large listed banking institutions represents a relatively homogenous sample in this regard.

Table 10. The Effect of Losses and Monetary Policy—Fixed Effects

Dependent variable: Loan growth	(1)	(2)	(3)	(4)	(5)	(6)
RoE	**0.26*** **	**0.25*** **	**0.26*** **	**0.25*** **	**0.26*** **	**0.26*** **
Capital	0.08	0.09	0.08	0.09	0.08	0.05
Provisions	**-2.02*** **	**-1.70*** **	**-2.04*** **	**-3.35*** **	**-1.99*** **	**-2.10*** **
GDP	**0.36*** **	**0.34*** **	**0.36*** **	**0.34*** **	**0.36*** **	**0.37*** **
Δr^+	**-0.02** **	-0.002				
Provisions*Δr^+		**-2.25*** **				
Δr^-			**0.02*** **	0.008		
Provisions*Δr^-				**1.59*** **		
Δr^0					-0.014	-0.04
Provisions*Δr^0						**3.35** **
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	No	No	No	No	No	No
No. of obs.	3436	3436	3436	3436	3436	3436
Goodness of fit	0.17	0.17	0.17	0.17	0.17	0.17

*** denotes statistical significance at the one percent level, ** at the five percent level and * at the ten percent level.

Source: Authors' calculations; see Table 12 for definition of variables and data sources.

B. Endogeneity of Bank-specific Characteristics

We were further concerned that some of the bank-specific variables that are included in our specification might be endogenous. Specifically, we check whether we are able to afford to drop the return on equity (RoE) from the regressions. Table 11 shows that dropping RoE does not change the main conclusions. However, the coefficient on the provisions ratio appears slightly bigger (in absolute terms) and the coefficient on capital now turns significant, suggesting that dropping RoE results in an omitted variable bias. On balance we retain a preference for a specification that explicitly accounts for profitability.

Table 11. The Effect of Losses and Monetary Policy—Robustness to Endogeneity (Fixed-Effects Estimate)

Dependent variable: Loan growth	(1)	(2)	(3)	(4)	(5)	(6)
Capital	**0.19****	**0.19****	**0.19****	**0.21*****	**0.19****	**0.18****
Provisions	**-2.73*****	**-2.34*****	**-2.76*****	**-4.26*****	**-2.71*****	**-2.81*****
GDP	**0.74*****	**0.71*****	**0.76*****	**0.73*****	**0.74*****	**0.75*****
Δr^+	**-0.02****	-0.002				
Provisions*Δr^+		**-2.51*****				
Δr^-			**0.02*****	0.008		
Provisions*Δr^-				**1.88*****		
Δr^0					-0.016	-0.03
Provisions*Δr^0						1.88
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	No	No	No	No	No	No
No. of obs.	3473	3473	3473	3473	3473	3473
Goodness of fit	0.1	0.1	0.1	0.1	0.1	0.1

*** denotes statistical significance at the one percent level, ** at the five percent level and * at the ten percent level.

Source: Authors' calculations; see Table 12 for definition of variables and data sources.

VIII. CONCLUSIONS

Using a large cross-country sample of banks, we document the following main qualitative findings:

- Loan losses result in a reduction of banks' provision of credit and the reduction is larger for banks with smaller initial capital buffers, all else equal.

- Losses lead to a stronger reduction in the provision of credit when monetary policy is tightening than when it is loosening. Moreover, in the face of credit losses, tightening

monetary policy leads to further reductions in credit in particular when initial capital is thin. In other words, initial capital and loosening monetary policy are shown to act as substitutes in cushioning shocks to banks' balance sheets.

- Initial capital is more important in cushioning the effect of losses on loan growth during crisis times. Moreover, the interaction between losses, initial capital and monetary policy develops greater force in crisis episodes.

- At the same time we show that the impact of losses on loan growth as well as its interplay with initial capital and monetary policy is present both for crisis countries and for those countries that did not experience a banking crisis in the period under study.

These results have important implications for public policy. One key implication is that feedback effects from losses to the provision of credit are pervasive and not confined to the specific episodes considered in the literature thus far. Moreover, while this study does not provide evidence of the effect changes in credit conditions have on output[23], others have argued that bank loan supply may have effects on macroeconomic performance in crisis times and that these effects might be more pronounced for households and firms that might depend on continued bank financing, Dell'Ariccia, Detragiache and Rajan (2008). Taken together with these findings, the evidence presented here suggests that feedback between losses and credit provision effects might play an important role in amplifying macroeconomic fluctuations even outside of full-blown banking crises. This may need to be taken into account by central bank policymakers, whose policy frameworks afford little role to credit and whose workhorse forecasting tools—such as Dynamic New Keynesian Stochastic General Equilibrium models—do not currently contain a financial sector. [24]

Another implication arises from the potential costs of addressing financial instability by use of monetary policy. While again quantification of these costs is beyond the scope of this paper, it is clear that such costs arise through a number of channels. First, a monetary bail-out of the financial sector can affect expectations of future bail-outs, and by creating moral hazard sow the seeds of the next crisis. Second, as noted in the introduction to this paper, a monetary response may conflict with the central bank's objective to contain inflation. And it may conflict with other objectives the central bank may have. For example, a monetary response can lead to a depreciation of the currency, or even lead to forced abandonment of an exchange rate peg. In the face of these costs, it is important to appreciate what other action

[23] A number of papers that provide such evidence is listed in footnote 3, on page 4 of this paper.

[24] Peek, Rosengren and Tootell (2003) show that confidential supervisory information on bank health available to the Federal Reserve can improve on forecasts of both the inflation rate and unemployment. The study also suggests that this information is not actually exploited for monetary policy.

can shape the trade-off faced by the monetary policymaker. In this regard, a finding that high levels of capital and accommodative monetary policy are substitutes in relieving the impact of losses on credit conditions gains particular importance. It points to a moral hazard incentive on the part of banks, who might like to rely on ex post monetary support, rather than on holding costly capital buffers, all the more so if monetary policy relief is more forthcoming the less capital they hold. And it points to the need for prudential measures designed to increase capitalization in a countercyclical fashion in order to reduce the need for monetary policy to support the banking system ex post. When buffers are built up in good times and can be drawn upon in bad times, monetary policy will be less constrained by the need to bolster the financial sector, creating room for maneuver that can be used by the central bank to more vigorously pursue its other objectives.

Finally, our results support more generally the notion that financial stability and monetary policy are intimately related, as has been argued for a long time by the BIS, e.g., Borio and White (2003). This paper documents that there is a feedback effect from loan losses to credit provision and hence potentially to macroeconomic outcomes. And it shows how and to what extent this feedback interacts with the monetary policy stance. This evidence can be taken into account by central banks charged with overseeing both monetary and financial stability. Where responsibilities for financial stability and monetary policy reside in separate authorities, these findings also throw light on the extent to which supervisory authorities and central banks may need to coordinate their actions. They suggest that central banks have a stake in and may want to influence the design of capital requirements imposed on the banking system, as well as any actions taken ex post, should banks' capital become impaired.

Appendix

Table 12. Description of Variables and Data Sources				
Data Source	**Date**	**Variable**	**Description**	**Details**
BankScope	2001	Loan growth	Growth rate of loans	
		Provisions	Ratio of loan loss provisions	Ratio of loan loss provisions to total loans
		Capital	Equity ratio	Ratio of equity capital to debt and deposits
		RoE	Return on equity	Net income divided by the book value of equity from the previous period
International Financial Statistics (IFS)	2005	Δr^+	Dummy for a positive change in the interest rate	Equal to 1 for a positive change in the nominal short-term interest rate, and to 0 otherwise
		Δr^-	Dummy for a negative change in the interest rate	Equal to 1 for a negative change in the nominal short-term interest rate, and to 0 otherwise
		Δr^0	Dummy for no change in the interest rate	Equal to 1 for no change in the short-term nominal interest rate, and to 0 otherwise
		GDP	Nominal GDP growth	Real GDP growth rate + inflation rate (based on CPI index)

Table 13. Summary Statistics: Monetary Policy and Banking Crisis Countries							
Given that the interest rate change is:		**Banking crisis countries**			**No banking crisis countries**		
		Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.
Change in the interest rate	Positive	2.71	6.24	556	1.08	0.74	1513
	Negative	-3.08	6.44	880	-0.92	0.92	1715

Source: Authors' calculations, see Table 12 for definition of variables and data sources.

Table 14. Summary Statistics: Monetary Policy and Banking Crisis Episodes							
Given that the interest rate change is:		**Banking crisis time**			**No banking crisis time**		
		Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.
Change in the interest rate	Positive	2.787	7.62	312	1.28	1.66	1757
	Negative	-3.02	7.14	684	-1.16	1.45	1911

Source: Authors' calculations; see Table 12 for definition of variables and data sources.

References

Altunbas, Yener, Leonardo Gambacorta, and David Marqués, 2007, "Securitization and the Bank Lending Channel," ECB Working Paper, No. 838, December (published also as Working Paper of the Bank of Italy, No. 653).

Bayoumi, Tamim, and Ola Melander, 2008, "Credit Matters: Empirical Evidence on U.S. Macro-Financial Linkages," IMF WP/08/169 (Washington: International Monetary Fund).

Bernanke, Ben S., and Cara S. Lown, 1991, "The Credit Crunch," *Brookings Papers on Economic Activity*, Vol. 2:1991, pp. 205-47.

Borio, Claudio, and William White, 2003, "Whither Monetary and Financial Stability? The Implications of Evolving Policy Regimes," *Monetary Policy and Uncertainty: Adopting to a Changing Economy*, Jackson Hole Symposium, Federal Reserve Bank of Kansas City, (August).

Brunnermeier, Markus K., and Lasse H. Pedersen, 2007, "Market Liquidity and Funding Liquidity," *Review of Financial Studies*, (forthcoming).

Chava, Sudheer, and Amiyatosh K., Purnanandan, 2005, "The Effect of Banking Crisis on Bank-dependent Borrowers," *mimeo*, Bauer School of Business, University of Houston and Ross School of Business, University of Michigan.

Caprio, Gerard, and Daniela Klingebiel, 2003, "Episodes of Systemic and Borderline Financial Crises," manuscript, *World Bank*.

Chen, Yehning, 1999, "Banking Panics: The Role of the First-come, First-served Rule and Information Externalities," *Journal of Political Economy*, Vol. 107 (5), pp. 946-968.

Chiesa, Gabriella, 2001, "Incentive-based Lending Capacity, Competition and Regulation in Banking," *Journal of Financial Intermediation*, Vol. 10 (1), pp. 28-53.

Cosimano, Thomas F., Ralph Chami, and Adolfo Barajas, 2004, "Did the Basel Accord Cause a Credit Slowdown in Latin America?" *ECONOMIA: The Journal of the Latin American and Caribbean Economic Association*.

Diamond, Douglas W., and Raghuram G. Rajan, 2006, "Money in a Theory of Banking," *American Economic Review*, Vol. 96 (1), pp. 30-53.

Dell'Ariccia, Giovanni, Enrica Detragiache, and Raghuram G. Rajan, 2008, "The Real Effect of Banking Crises," *Journal of Financial Intermediation*, Vol. 17 (1), pp. 89-112.

Ehrmann, Michael, Leonardo Gambacorta, Jorge Martinez-Pages, Patrick Sevestre, and Andreas Worms, 2001, "Financial Systems and the Role of Banks in the Monetary Policy Transmission in the Euro Area," ECB Working Paper No. 105.

Eisfeldt, Andrea L., 2004, "Endogenous Liquidity in Asset Markets," *Journal of Finance*, Vol. 59 (1), pp. 1-30.

Estrella, Arturo, 2002, "Securitization and the Efficacy of Monetary Policy," *FRBNY Economic Policy Review*, (May).

Gambacorta, Leonardo, and Paolo E. Mistrulli, 2004, "Does Bank Capital Affect Lending Behaviour," *Journal of Financial Intermediation*, Vol. 13 (4), pp. 436-57.

Giannetti, Mariassunta, 2007, "Financial Liberalization and Banking Crises: The Role of Capital Inflows and Lack of Transparency," *Journal of Financial Intermediation*, Vol. 16 (1), pp. 32-63

Gorton, Gary, and Andrew Winton, 2002, "Financial Intermediation," *NBER Working Paper 8928*. Available at: http://www.nber.org/papers/w8928.

Kashyap, Anil K., and Jeremy C. Stein, 2000, "What do a Million Observations of Banks Say About the Transmission of Monetary Policy?" *American Economic Review*, Vol. 90 (3), pp. 407-28.

Kishan, Ruby P., and Timothy P. Opiela, 2000, "Bank Size, Bank Capital and the Bank Lending Channel," *Journal of Money, Credit and Banking*, Vol. 32, pp. 121-41.

Kroszner, Randall S., Luc Laeven, and Daniela Klingebiel, 2007, "Banking Crises, Financial Dependence and Growth," *Journal of Financial Economics*, Vol. 84 (1), pp. 187-228

Loutskina, Elena, and Philip E. Strahan, 2006, "Securitization and the Declining Impact of Bank Finance on Loan Supply: Evidence from Mortgage Acceptance Rates," NBER Working Paper, No. 11983.

Lown, Cara S., and Donald Morgan, 2006, "The Credit Cycle and the Business Cycle: New Findings Using the Loan Officer Opinion Survey," *Journal of Money, Credit and Banking*, Vol. 38 (6), pp. 1575-97

Pain, Darren, 2003, "The Provisioning Experience of the Major UK Banks: A Small Panel Investigation," *Bank of England Working Paper* No. 177.

Peek, Joe, and Eric S. Rosengren, 1995, "The Capital Crunch: Neither a Borrower nor a Lender Be," *Journal of Money, Credit and Banking*, Vol. 27, No. 3, pp. 625-38.

____, 2000, "Collateral Damage: Effects of the Japanese Bank Crisis on Real Activity in the United States," *American Economic Review*, Vol. 90, pp. 30-45.

____, 2005, "Unnatural Selection: Perverse Incentives and the Misallocation of Capital in Japan," *American Economic Review*, Vol. 95, pp. 1144-1166.

Peek, Joe, Eric S. Rosengren, and Geoffrey M. B. Tootell, 2003, "Does the Federal Reserve Possess an Exploitable Informational Advantage? *Journal of Monetary Economics*, Vol. 50, pp. 817-839.

Pilotte, Eugene, 1992, "Growth Opportunities and the Stock Price Response to new Financing," *Journal of Business*, Vol. 65, pp. 371-394.

Romer, Christina D., and David H. Romer, 1990, "New Evidence on the Monetary Transmission Mechanism," *Brookings Papers on Economic Activity* 1990 No. 1, pp. 149-98.

Stein, Jeremy C., 1998, "An adverse Selection Model of Bank Asset and Liability Management with Implications for the Transmission of Monetary Policy," *RAND Journal of Economics*, Vol. 29, pp. 466-86.

Van den Heuvel, Skander J, 2001, "The Bank Capital Channel of Monetary Policy," University of Pennsylvania, *mimeo*.