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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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Capital Regulations and the Management of Credit Commitments during Crisis Times*

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Abstract

Drawdowns on credit commitments by firms reduce a bank's regulatory capital ratio. Using the Austrian Credit Register, we provide novel evidence that during the 2008-09 financial crisis, capital-constrained banks managed this concern by substantially cutting partly or fully unused credit commitments. Controlling for a bank's capital position, we also find that greater liquidity problems induced banks to considerably cut such credit commitments during the crisis. These results suggest that banks actively manage both capital and liquidity risk caused by undrawn credit commitments in periods of financial distress, but thereby reduce liquidity provision to firms exactly when they need it most.

JEL codes: E51, G01, G21, G28, G32

Keywords: Capital Regulations, Credit Commitments, Financial Crisis

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1 Introduction

A significant fraction of corporate bank lending is done via credit commitments that allow a firm to choose the actual credit usage level. Specifically, such facilities commit a bank to lend to a firm up to an agreed amount for an agreed period of time unless the firm violates a covenant, which makes them a particularly flexible source of debt financing. The classic credit commitment is a revolving credit line, which allows the firm to repeatedly withdraw and repay funds subject to the contracted terms and conditions. However, also a term loan that can be obtained within a certain period (and perhaps be split in several parts) or a bank guarantee on a loan are credit commitments. A commitment that is not fully used provides liquidity insurance and, in the case of credit lines, also sends a positive signal on the quality of the firm to other financial market participants (Mosebach, 1999). From the bank's perspective, commitment fees charged on the unused portion make up an important source of revenue (Sufi, 2009; Loukoianova et al., 2006). These earnings come at relatively low cost for the bank as long as the commitment remains unused. The reason is that from a regulatory perspective, the undrawn portion of a credit commitment is largely off-balance sheet and must therefore be backed by only little capital in the Basel framework. The flip-side is that additional drawdowns result in a direct and possibly unexpected increase in the size of the bank's balance sheet and thus decrease in its regulatory capital ratio. This reduces a bank's buffer towards its minimum capital requirement, which limits the bank's potential to absorb future losses and also harms its stock market performance (Demirgüç-Kunt et al., 2013). Exposure to unused credit commitments may therefore put a bank's capital buffer at risk. This source of risk has received virtually no attention in the academic literature. At the same time, it is far from negligible: if the usage

of all credit commitments that we observe increased to match their committed volume in early 2008, the average bank in our sample would have had to increase its capital stock by up to eight percent to keep its capital ratio and thus capital buffer constant. Without raising extra capital, the bank would have suffered a decrease in its capital buffer by up to 20 percent. Since we do not observe relatively small credit commitments, the total impact is still somewhat higher.

The described risk of capital buffer reductions is particularly relevant in periods of financial distress. The reason is that the capital position of banks is then typically weakened, raising capital is more expensive and drawdowns on credit commitments are more likely. This raises the question of whether and to what extent banks actively manage capital concerns that come with exposure to undrawn credit commitments in crisis times, and what consequences this has on lending to the corporate sector. To the best of our knowledge, we are the first to study this question. Banks can adjust their credit commitment portfolio after covenant violations by firms, after expiring maturities or, for "revocable" credit commitments, by using the right to cut or abandon the commitment unilaterally. We find that during the 2008-09 financial crisis, banks whose capital position was hit relatively hard and whose initial capital buffer was comparatively small made use of these options. In particular, they reduced the risk of capital buffer reductions by substantially cutting the volume of partly or fully unused credit commitments over 2008-09, and the larger the unused volume, the more so. This result sheds light on a novel yet important link between capital regulations and bank lending to the real economy.

As a second contribution, we show that conditional on a bank's capital position, relatively large exposure to the liquidity dry-up during the crisis affected a bank's supply of credit commitments as well. In particular, such liquidity problems also induced banks to cut partly or fully unused commitments at the peak of the crisis, thereby limiting the scope of additional credit draw-

downs and the resulting costs. Our findings are conditional on changes in firm-specific credit demand and creditworthiness as well as bank-specific unobservables during the crisis. We therefore provide causal evidence that banks actively manage both capital and liquidity risk caused by exposure to undrawn credit commitments in periods of financial distress. From the perspective of banking system stability, this is good news. However, the implication is that banks reduce liquidity provision to firms exactly at a time in which they need it most and when alternatives to bank financing tend to be scarce, especially in bank-dependent financial systems. Our evidence thereby indicates a transfer of liquidity risk from banks to firms. This phenomenon has received little attention so far, partly because limited data availability has often prevented a comprehensive analysis of credit commitment volumes as opposed to actual levels of credit usage. On the positive side, we find that in Austria which is the focus of our study, firms were largely able to substitute lost credit via other banks and did not suffer real effects. However, this may have been different in other countries with different institutional features or where the impact of the crisis was more severe.

Our primary data source is the Austrian credit register, which is ideally suited to pursue our research goals. The register provides information on credit commitments over time at the bank-firm level and thus allows us to convincingly account for selection effects and to control for bank unobservables. What's more, the register also provides information on how much a firm makes use of a credit commitment in a given month, which allows to measure the risk of additional drawdowns for each individual credit relationship we observe. Data are available for the universe of banks and firms operating in Austria, as long as the bank-firm-specific credit commitment or usage exceeds €350,000. This results in a coverage of around 90 percent of total

credit commitment volume in Austria.

Not only due to the quality of data, but also from a conceptual perspective Austria is an ideal setting to study our research questions. This is in part because Austrian banks have traditionally had relatively small capital buffers compared to banks in other countries (Fonseca and González, 2010). Furthermore, for many Austrian banks it has been particularly difficult to raise external capital due to their ownership structure, as we explain in Section 3. Austrian banks have therefore been exceptionally sensitive to capital buffer reductions and thus additional credit commitment drawdowns.

Our identification strategy is to exploit the 2008-09 financial crisis as a shock of varying degree to the capital and liquidity position of banks operating in Austria. The Austrian economy is relatively small and did not experience a domestic housing market bubble burst before or during 2008-09. Therefore, the outbreak of the crisis was clearly exogenous and unexpected to the Austrian banking sector. We expect that the more a bank's capital position was hit by the crisis and the smaller the bank's initial capital buffer, the more vulnerable the bank was to a capital ratio reduction and therefore additional drawdowns on credit commitments during the crisis. As an exogenous proxy for the effect of the crisis on a bank's capital position, we use the bank's pre-crisis exposure to US asset markets. Using confidential data at the individual bank level, we show that banks with higher US asset exposure at the onset of the crisis experienced larger total asset value losses in 2008-09. Since such losses have to be marked to market, they directly affected a bank's capital buffer. Our proxy is in the tradition of the literature to use ex-ante asset holdings to capture ex-post losses during crisis times (see e.g. Popov and Van Horen, 2015; De Marco, 2019; Ongena et al., 2018). Furthermore, the proxy is in the spirit of Peek and

Rosengren (1997), Puri et al. (2011) and Ongena et al. (2018) since it exploits an exogenous shock occurring in a distant country. Besides capital concerns, we also expect that the more a bank depended on wholesale funding before the crisis, the more sensitive it was to additional credit commitment drawdowns in 2008-09. This is because it faced a larger shock to its cost of liquidity and thus the cost of meeting additional credit demand from its firms. To proxy for this type of crisis exposure, we follow Ongena et al. (2015) and use a bank's pre-crisis dependence on international interbank funding.

Controlling for firm-specific changes in credit demand and creditworthiness (Khwaja and Mian, 2008), we find that a one standard deviation increase in US asset exposure for a bank with a relatively small initial capital buffer lead to a significant reduction of partly or fully unused credit commitments by around 11 percent between January 2008 and December 2009. In turn, US-exposed banks with a large capital buffer or banks with a small buffer but no US exposure did not cut such commitments more than other banks. Our interpretation of these results is that capital-constrained banks cut commitments with a positive undrawn volume mostly as a precautionary move to limit further capital problems. This conclusion is supported by our findings that the larger the unused commitment volume the larger the supply cut by constrained banks, and the result that firms whose loans carry a larger risk weight faced larger credit reductions. Further regression and graphical evidence studying the timing of events suggests that credit commitment supply cuts were at least partly a reaction to actual increases in credit usage levels by firms. Our results also indicate that capital-constrained banks did not cut fully used credit commitments. We conclude that this is because such commitments pose no risk of a capital buffer reduction, but perhaps also because cutting such commitments was potentially less feasible and more harmful

for the firm and thus potentially also the bank.

Our main set of results provides an additional rationale for the policymaker's quest to strengthen bank capital buffers. What's more, our findings may reflect that the regulatory framework prior to the crisis induced banks to excessively grant credit commitment volumes that could not be sustained in crisis times, when both the risk and the consequences of additional drawdowns are larger. In this light, the measure of Basel III to increase the capital charge on the unused portion of most credit commitments compared to Basel II may smoothen credit the supply of credit commitments over the business cycle in the future. This would limit the impact of runs on undrawn credit commitments on banks and may also benefit firms. Similarly, the introduction of the Liquidity Coverage Ratio (LCR) in Basel III, which requires banks to hold an adequate stock of unencumbered high-quality liquid assets, may better prepare banks for liquidity problems and a rise in credit commitment drawdowns at a particular moment.

2 Contribution to the literature

We empirically establish a link between bank capital requirements and credit supply in light of the regulatory treatment of unused credit commitments. Conceptually, this contribution relates to a small literature on asset-backed commercial paper (ABCP) conduits (often called "shadow banks"). Assets held by ABCP conduits are similar to undrawn credit commitments in the sense that they fully come on the balance sheet of the bank that set up the conduit only if liquidity guarantees on these assets are used, which then decreases the bank's capital ratio. Acharya et al. (2013) and Acharya and Schnabl (2010) describe the motivation and risks behind ABCP

conduits, while Covitz et al. (2013) document a run on ABCP programs at the onset of the Great Recession. More generally, our results confirm that bank capital is an important determinant of bank lending behavior (Gambacorta and Mistrulli, 2004; Berrospide and Edge, 2010; Gambacorta and Shin, 2018). We also corroborate the finding that banks actively adjust their credit supply as a response to changes in net worth due to exposure to certain assets and asset markets (Santos, 2010; De Haas and Van Horen, 2012; Popov and Van Horen, 2015; De Marco, 2019; Ongena et al., 2018; Acharya et al., 2018). Regarding capital regulations, we relate to Gropp et al. (2018) who find that banks respond to an increase in their minimum capital requirement by reducing their risk-weighted assets – including lending to the real sector – rather than raising their levels of capital. Our results further confirm the results of the literature on macro-financial feedback loops, which suggest that well-capitalized banks cut back assets and loans less than poorly-capitalized banks as a response to adverse capital shocks (Brunnermeier and Sannikov, 2014; Brunnermeier et al., 2016; Farhi and Tirole, 2017). Our study also builds on Chodorow-Reich and Falato (2017), who show that banks in worse health during the 2008-09 crisis were more likely to force a loan commitment reduction in response to a covenant violation of a non-financial firm. This result and the fact that more than one-third of loans in the US data of Chodorow-Reich and Falato breach a covenant over 2008-09 may suggest that besides expiring maturities and the right to cut revocable commitments, covenant violations provided a noteworthy opportunity for capital- or liquidity-constrained banks to cut little-used credit commitments in Austria during the crisis.

The results of our study also contribute to a growing literature that deals with liquidity risk caused by unused credit commitments. Several studies have shown that deposit funding can help

to mitigate this risk (Kashyap et al., 2002), especially during periods of tight liquidity (Gatev et al., 2009; Gatev and Strahan, 2006). Acharya and Mora (2015) highlight that in the US, banks were only able to honor credit line drawdowns during 2007-2009 because of explicit and large support from the government and government-sponsored agencies. Ippolito et al. (2016) find that the likelihood of Italian firms to draw down previously unused credit lines during the interbank market freeze in the summer of 2007 increased with the dependence on interbank funding of their banks. Exposed banks did not significantly reduce credit line volumes though, despite higher funding costs. This may be because most credit lines could not be adjusted downwards over a period of only two months even if the bank had wanted to; however, in our study we do find significant credit commitment cuts over the two-month period from August to October 2008 and thus at the peak of the crisis, which might reflect a larger presence of *revocable* credit commitments in Austria. Ivashina and Scharfstein (2010) document a run on credit lines in the US after the Lehman default and find that banks responded to this drain on liquidity and higher funding costs by reducing new lending. Cornett et al. (2011) find that banks with higher levels of unused credit commitments managed the resulting liquidity risk by increasing their liquid asset holdings and by reducing new credit origination during 2007-2009. We mainly contribute to this liquidity-oriented literature by showing that banks not only take action outside of their credit commitment portfolio conditional on liquidity risk due to unused commitments, but also actively limit this risk itself by reducing their exposure to undrawn credit commitments.

In a broader sense, our study relates to the literature that studies the effect of liquidity shocks on credit supply to firms without explicitly focusing on heterogeneity in credit usage levels and the resulting risks from little-used credit commitments (Khwaja and Mian, 2008; Schnabl, 2012; Iyer et al., 2014; Allen et al., 2014; Cingano et al., 2016). We contribute to this body of work

by showing that while financial distress does not necessarily imply a reduction in actual loan volumes, it can reduce the amount of credit firms can at most obtain from banks. Last, but not least, our paper adds to the theoretical (Boot et al., 1987; Martin and Santomero, 1997; Holmström and Tirole, 1998; Acharya et al., 2014) and empirical (Sufi, 2009; Acharya et al., 2013; Jiménez et al., 2009; Berger and Udell, 1995; Shockley and Thakor, 1997; Agarwal et al., 2006; Demiroglu and James, 2011) literature that analyses the nature, motivation and use of credit commitment – and in particular revolving credit line – contracts.

3 Background and Data

Credit commitments and Basel capital regulations

Basel II, which was fully implemented in Europe in January 2008 and was practised until 2013, requests banks to hold capital worth at least eight percent of their risk-weighted assets.[1] Independently of the risk associated with an individual credit commitment, the used portion and the unused portion of the commitment do not equally enter risk-weighted assets in this framework. The used portion obtains a 'credit conversion factor' (CCF) of 100%, which implies that it fully

[1] In January 2007, the standardized approach and the foundation internal rating-based approach (F-IRB) of Basel II became applicable, while the advanced internal rating-based approach (A-IRB) could be applied from January 2008 onwards (Musch et al., 2008; Deutsche Bundesbank, 2009). The CCFs indicated in the main text apply only to the standardized and F-IRB approach. In the A-IRB approach, banks estimate CCFs themselves, at the individual credit commitment level. Among other factors, this is done based on past usage-to-granted volume ratios. This implies that on average, also in the A-IRB approach unused commitments must be backed with less capital than used commitments, which is what ultimately motivates our research question around the "capital effect". Only some of the very largest banks operating in Austria have adopted the A-IRB approach. Those banks face a trade-off. While cutting little-used credit commitments reduces the risk of sizable drawdowns, it also raises the usage-to-granted volume ratio of the commitment, which leads to an increase in the commitment-specific future CCF. Banks that apply the A-IRB approach thus might have a larger incentive not to cut credit commitments than banks applying the standardized or F-IRB approach, conditional on a given current CCF. This "works against us" in finding a negative effect of capital concerns on credit commitment supply and is therefore not a major concern in terms of identification.

enters risk-weighted assets. The unused portion in turn only obtains a CCF of at most 50%. This implies that a rise in the usage of the credit commitment triggers an increase in risk-weighted assets for the granting bank and thus a reduction in its capital ratio, unless the bank raises additional capital.

The specific CCF of the unused portion of a credit commitment in the Basel II framework depends on the type and maturity of the credit commitment. The unused portion of an *irrevocable* credit commitment has a CCF of 20% if the original maturity is below one year and a CCF of 50% otherwise. A credit commitment is irrevocable if its volume cannot be reduced before the commitment matures unless the firm violates a covenant. *Revocable* commitments, which are unconditionally cancellable by the bank at any time but only before a firm actually draws down credit, face no capital charge in Basel II.[2] While Basel II already brought the unused portion of credit commitments more on the balance sheet of banks compared to Basel I, Basel III continued this process for most types of commitments. Specifically, in Basel III irrevocable commitments have a CCF of 40% irrespective of their maturity and revocable commitments have a CCF of 10%.

Bank capital and the crisis in Austria

Austrian banks suffered a deterioration of bank capital ratios due to losses during the crisis (Schürz et al., 2009). This was especially problematic since for Austrian banks raising additional capital has been difficult. Specifically, Austria's Financial Market Stability Board (FMSB) has argued that "central risks for the Austrian banking system emanate (...) from banks' specific

[2] The fact that the bank is obliged to honor a revocable credit commitment once the firm decides to draw down credit from the facility distinguishes revocable commitments from an *uncommitted credit facility*, in which the bank can decide not to lend after a firm's borrowing request. The unused portion of an uncommitted credit facility does not qualify as off-balance sheet item in the first place, such that naturally the bank does not have to hold capital against them.

ownership structures, which would not fully ensure the adequate recapitalization of banks in the event of a crisis" (FMSG, 2017). The background is that many Austrian banks are part of a banking group, which makes it difficult for a specific group member to raise capital from financial markets without diluting the equity share of other members. Making things worse, Austrian banks already had relatively small capital buffers as they entered the crisis (Fonseca and González, 2010). These factors possibly contributed to the weak stock market performance and large CDS spreads of Austrian banks in 2008-09 (see Figure 2).[3,4] This development occurred despite the Austrian banking package which "helped prevent a liquidity squeeze and expand banks' capital buffers" (Schürz et al., 2009, p.56), for example via a €15 billion capital injection program into financial institutions. The weak stock market performance in turn reduced the amount of capital that could be raised at the expense of a given loss of (perhaps voting) equity and thus aggravated the institutional problems caused by the banking group structures. These considerations imply that Austrian banks were particularly sensitive to a reduction in their capital ratio and thus additional credit drawdowns during the 2008-09 financial crisis.

[3] Supporting evidence for this claim is provided by Demirgüç-Kunt et al. (2013), who study a multi-country panel of banks and find that a stronger capital position was associated with better stock market performance during the crisis.

[4] Another reason for the weak stock market performance of Austrian banks was their exposure to the CESEE region, whose performance was regarded as uncertain by financial markets at the time. The average Austrian bank's exposure to CESEE assets clearly exceeded its US assets exposure and triggered substantial news coverage during the crisis. Nonetheless, for three reasons we do not choose CESEE exposure to proxy for the effect of the crisis on a bank's capital position. First, it must be doubted that losses in the CESEE region that affected the capital position of banks operating in Austria were purely a result of the global financial crisis and in this sense exogenous to the Austrian banking sector. Second, while pre-crisis CESEE asset holdings are associated with larger CESEE-related losses during 2008-09, they do not significantly correlate with total net asset value gains over the same time period. This makes CESEE asset holdings a worse predictor of total losses than US asset holdings. Third, banks that were more exposed to CESEE markets exhibited different lending trends before the crisis than other banks. Nonetheless, we do feature CESEE exposure as a control variable in our empirical analysis.

Measuring US asset exposure

We use a bank's pre-crisis holdings of US assets divided by total assets as a proxy for how the capital position of a bank operating in Austria was affected by the crisis. The data comes from the Austrian Central Bank's database of individual bank balance sheets. Pre-crisis US asset holdings are arguably the "cleanest", i.e. most exogenous proxy for the change in the health of a bank's capital position during the crisis. This is because the origins of the crisis lied in the United States and were not related to the Austrian banking sector. We measure US assets over total assets as the sum of securities and equity shares acquired from US counterparties and loans to US counterparties divided by the sum of a bank's total loans, securities and equity shares, in December 2006.[5] In line with previous studies, this moment of time is chosen well ahead of the crisis.[6] Importantly, US assets as we measure them may be denominated in any currency, not only in US dollars. At the same time, assets for which the direct counterparty is not located in the United States are not included in our measure.[7] Although US assets only constituted one percent of (non-risk-weighted) total assets of the average bank in our sample (see Figure 6 for the distribution of this variable), they made up 15 percent of capital and more than half of a bank's capital buffer in December 2006 (see Table 1, panel II).[8] These statistics should be taken as a lower bound of the actual exposure to US asset markets, given that only direct counterparties are considered. Using confidential data at the bank level, we are able to track the distribution of

[5] On the average balance sheet of the banks in our sample (weighted based on the frequency of the bank in our sample), 50 percent of US assets were securities, 49 percent were loans and one percent were equity shares in December 2006.

[6] This avoids for example to classify a bank that sold off its US assets with losses as the crisis began to unravel in 2007 as not exposed to the crisis.

[7] This implies that if an Austrian bank buys a security that was issued in the United States from a German bank, then the security is classified as a German security, since the direct counterparty is German.

[8] We use weights to compute the descriptive statistics in panel II of Table 1. The weight of each bank equals its share in the number of bank-firm relationships in our sample. The results are similar when we use a bank's share in the total credit commitment volume in our sample as weight.

US asset-specific value gains and losses due to changes in market values over time (see Figure 3). In September 2008 alone, the month of the Lehman default, US asset write-downs on average wiped out around five percent of the average bank's capital buffer. Since these losses have to be marked to market, they imply a smaller buffer towards the bank's regulatory minimum capital requirement. We further show in Section A1 in the Appendix that larger pre-crisis US asset holdings were significantly associated with larger total losses at the bank level during 2008-09. These results suggest that pre-crisis US asset exposure is not only exogenous to the Austrian banking sector but also an economically relevant predictor of capital losses incurred by banks operating in Austria during the Great Recession. Figure 3 further shows that also the volatility of net US asset value gains was elevated from 2007-09, which suggests that banks also faced increased uncertainty about the value of their US asset holdings and thus their capital during the crisis.[9] Since such increased uncertainty may also affect a bank's credit commitment management, pre-crisis US asset holdings is arguably a better proxy for how a bank's capital position was affected by the crisis than the incurred losses throughout the crisis.

The extent to which a bank can absorb losses on its balance sheet and a resulting capital ratio reduction clearly depends on the bank's initial capital buffer. Therefore, we use confidential supervisory data to incorporate this variable into our analysis. We compute a bank's capital buffer as the ratio of its Tier 1 + Tier 2 capital holdings and the bank's corresponding minimum capital requirement. This variable is a more precise indicator of how well a bank can absorb capital losses than bank capital over total assets, which has been used by many studies but does not take the riskiness of a bank's asset portfolio into account. In terms of timing, we compute a

[9] The actual uncertainty was arguably still higher than Figure 3 suggests, since the valuation of assets whose market completely dried up was often done using bank-internal *models* (Ellul et al., 2014).

bank's capital buffer as of the end of the first quarter of 2008 in order to take into account the regulatory changes that came with the full implementation of Basel II in January 2008.[10] The average realization of our capital buffer measure in our sample equals 1.79 and the median 1.54; see Figure 8 for the variable's distribution.

Liquidity problems during the crisis in Austria and measurement

The 2008-09 financial crisis was also a crisis of liquidity. For example, the cost of unsecured interbank funding increased sharply with the Lehman default (see Figure 4). This was mainly driven by a sharp increase in perceived counterparty risk, and lead to a reduction in the volume of unsecured interbank deposits on a global scale. It was difficult for banks to fully substitute interbank funding with other sources of finance during the crisis. The cost of issuing bonds increased and the sudden nature of the crisis made it impossible to increase retail deposits quickly (Brunnermeier, 2009). Several studies have adopted pre-crisis dependence on interbank funding as a proxy for bank-specific exposure to wholesale funding and thus exposure to higher liquidity costs during the 2008-09 crisis (Iyer et al., 2014; Ongena et al., 2015; Cingano et al., 2016). We follow this literature and in particular Ongena et al. (2015) by using *international* interbank borrowing divided by total assets on the bank's balance sheet in December 2006 as our proxy. We do so since Austria is a relatively small economy and *domestic* pre-crisis interbank borrowing within, but also outside of the banking group is arguably a poor proxy for exposure to increased liquidity cost in the aftermath of the Lehman default. As Table 1, panel II shows, the (weighted) average of international interbank borrowing over total assets in this month across the banks in

[10] Our results are robust to choosing the last quarter of 2006, which parallels the timing of our other bank-specific explanatory variables; see section A1 in the Appendix.

our sample was 10.3 percent; see Figure 7 for the distribution of the variable. Figure 5 reveals that banks operating in Austria continuously reduced both international interbank lending and borrowing after a peak in late 2008, which shows that they were feeling the repercussions of the higher interbank funding rates. However, liquidity problems may have been more short-lived and less severe in Austria than in other countries since the government introduced a €75 billion package to support the interbank market via a clearing bank that started operating in November 2008.

The Austrian Credit Register as primary data source

Our source of credit data is the Austrian credit register. The register documents all bank-firm-specific credit relationships as of the end of a given month as long as the offered credit volume or usage exceeds €350,000.[11] This threshold implies that we study credit supply to medium-sized and large firms.[12] Our sample includes foreign banks but does not contain firms outside of Austria.[13] While Austrian banks are often organized in groups, credit decisions are typically made at the individual bank level, which is why our unit of observation is a bank-firm relationship. However, to rule out the possibility that the smallest banks of a group are not independent and to focus on the most relevant banks, we drop bank-firm pairs where the lending bank had less than 20 client firms in the register at the beginning of our sample period.[14] For a given lending relationship we observe the sum of all irrevocable and revocable credit commitments the bank grants to the firm in a given month. This sum can include up to six different credit types: revolv-

[11] Credit usage may exceed the commitment volume since overdrawing may be possible.

[12] Table 1, panel III contains summary statistics on firms included in our sample, as of 2007. We only have firm-specific data for 76 percent of firms that appear in the sample of credit commitments (i.e. bank-firm relationships) of our main specification for the year 2007. This is because not all firms are required to send their balance sheet to the Austrian Central Bank, and not all remaining firms follow the invitation to send it voluntarily.

[13] We track bank mergers, split-ups, and bank identifier changes for other reasons over time in our analysis; see Section A6 in the Appendix for details.

[14] Our results are robust to including all banks; see Section A1 in the Appendix.

ing credit lines, term loans, guarantees, leasing loans, special purpose loans and trust loans. We further observe total credit usage and usage by credit type, but not the granted amount by credit type except for guarantees. For all individual credit types the granted amount may exceed the firm's actual usage and this also occurs in practice, as post-2012 data which reports the granted commitment by type reveals (see Appendix-Table A5 for details). Importantly, an increase in credit usage translates into a higher capital requirement for the lending bank no matter which credit type is additionally drawn down, with the only exception of trust loans. Such facilities are however negligible in terms of volume and we deal with this special case in our empirical analysis.[15] Our main dependent variable is the change in the total credit commitment at the bank-firm level between January 2008 and December 2009. On the right-hand side, we control for the bank-firm-specific usage ratios of the distinct credit types. On average, credit commitments were reduced by 4.7 percent over our sample period (see Table 1, panel I). The choice of January 2008 as beginning of our sample period comes at the cost of disregarding potential credit commitment reductions based on early crisis warning signs in 2007. More importantly, however, by choosing January 2008 as starting date we avoid to pick up the effect of regulatory changes across Basel I and Basel II in our estimations. December 2009 is chosen as the end of our sample period since lending standards and credit volumes continuously tightened from the borrower's perspective until the end of 2009 (see Figure 1) and due to a change in reporting requirements with January 2010 that affected the credit register variables.

[15] Trust loans are used in almost 10% of bank-firm pairs in our sample but account for only 2.5 percent of total used credit on average, as Table 1 reveals. We account for this special case by controlling for the share of trust loan usage in total credit usage at the bank-firm level in our analysis and by dropping bank-firm pairs in which *Trust Loan Usage = Total Credit Usage = Total Commitment* at the beginning of our sample period, as this implies that no other credit type had been granted. Furthermore, we show in Section A1 in the Appendix that our results are robust to excluding bank-firm pairs in which the usage of trust loans is positive. The reason why higher trust loan usage by a firm does not imply a larger capital requirement for a bank despite being typically on-balance-sheet is that here the bank only acts as an intermediary of a loan from a third-party entity to the firm and bears no risk, such that trust loans have a zero risk weight.

For each bank-firm-pair, we determine whether the total credit commitment was fully used or not in January 2008, and further the volume of unused credit. We do so since unused credit commitments posed a larger threat to the capital and liquidity position of banks during the crisis, and the larger the unused volume, the more so. 58 percent of commitments were partly or fully unused, the average unused volume across all commitments equaled roughly 2 million Euros and the median stood at roughly 100,000 Euros. See Figure 9 for the distribution of the variable. The average drawn-to-granted ratio stood at 82.2 percent. Appendix-Table A4 further shows that the volume of unused credit increases with a firm's profitability, sales/assets ratio and relationship duration with the bank, and decreases with the firm's cash holdings, leverage, liquid asset holdings and its average probability to default on a loan. The credit register data from 2013 onwards suggests that unused revolving credit lines typically make up most of the total unused credit commitment volume (see Appendix-Table A5). From the banks' perspective, the total unused volume of granted credit commitments made up 4.4 percent of assets of the average bank in our sample in January 2008. We also incorporate this variable into our empirical analysis in complementary regressions. The average commitment that was not fully used in January 2008 was cut by 9.4 percent between January 2008 and December 2009, while the average fully-used commitment was increased by 1.9 percent in volume.

4 Empirical Strategy

Our empirical specification shall capture potential changes in credit *supply* during the crisis and possible heterogeneity across banks with different exposure to liquidity or capital problems and across commitments with different usage levels. Therefore, we set up the following specifi-

cation:

$$\Delta ln(CredComm_{ij}) = \beta_1[US\ Exposure_j \times Unused\ Volume_{ij}]$$
$$+\beta_2[USExposure_j \times Small\ Capital\ Buffer_j \times Unused\ Volume_{ij}]$$
$$+\beta_3[Small\ Capital\ Buffer_j \times Unused\ Volume_{ij}]$$
$$+\beta_4[Interbank_j \times Unused\ Volume_{ij}]$$
$$+\beta_5 Unused\ Volume_{ij} + \beta_6 C_{ij} + \eta_i + \delta_j + \epsilon_{ij} \quad (1)$$

$\Delta ln(CredComm_{ij})$ approximates the percentage change in the credit commitment volume offered by bank j to firm i between January 2008 and December 2009. *US Exposure*$_j$ is the bank-specific ratio of US assets to total assets and *Interbank*$_j$ the bank-specific ratio of international interbank borrowing to total assets in December 2006. *Small Buffer* equals one if the bank's capital buffer is smaller than the median.[16] All bank-specific variables are scaled by their standard deviation.[17] For simplicity, $Unused\ Volume_{ij}$ is in most regressions a bank-firm dummy variable that equals one if the commitment was not fully used in January 2008. Otherwise we also use a variable that equals the log of a firm's total unused volume if the latter is positive and zero otherwise. The vector C_{ij} is also measured in January 2008 and includes the share of bank j in total credit usage of firm i, the duration of the credit relationship and credit type-specific variables that indicate the ratio of their usage to total credit usage.[18] η_i are firm fixed effects

[16] We build this median in such a way that it is not the median across banks, but across observations of the sample of our main specification, such that the number of credit commitments associated with *Small capital buffer* = 1 is equal to the number of credit commitments associated with *Small capital buffer* = 0. Since banks that have a relatively small capital buffer grant more credit commitments in our sample, the subsample for which *Small capital buffer* = 1 includes 38 banks, while the subsample for which *Small capital buffer* = 0 includes 71 banks.

[17] This standard deviation is measured based on our baseline sample of 7,262 credit commitments, thus banks that granted more credit commitments over our sample period obtain a larger weight in the computation.

[18] Relationship duration is censored at 97 months since credit register data are only available to us from January 2000 onwards.

(Khwaja and Mian, 2008) that absorb all firm-specific factors that lead to a *change* in the granted credit commitment volume between January 2008 and December 2009, such as credit demand or creditworthiness. The implication of their inclusion is that we restrict our sample to firms that borrowed from multiple banks in both January 2008 and December 2009. While this results in dropping around 50% of firms from our sample, credit commitments to these single-bank firms only made up 17 percent of the total commitment volume in January 2008. This is partly because single-bank firms are smaller and are granted credit commitments that are smaller in volume. The omission of these firms is therefore not a big issue since large commitments on average have a greater potential to cause a non-negligible capital ratio reduction and also imply larger liquidity risk. δ_j are bank fixed effects that allow to control for all confounding factors that affected a specific bank's *change* in credit supply between January 2008 and December 2009. Intuitively, adding bank fixed effects implies that we analyse how different types of credit commitments are treated *within* a certain bank. For example, β_2 indicates the impact of a rise in US exposure by one standard deviation for a bank with a small capital buffer on the supply of credit commitments that were not fully used at the onset of the crisis, *relative* to an initially fully-used commitment in the same bank. β_1 indicates conceptually the same but for banks with a large capital buffer. The cost of including bank fixed effects is that we cannot include our key variables separately into the specification and only estimate the mentioned relative effect, and relatedly, do not estimate the direct impact on the supply of initially fully-used commitments. To make both possible, in selected regressions we replace the bank fixed effects with a vector of bank-level controls and also include our exposure variables separately. The mentioned vector of bank controls includes a bank's log total assets, liquid assets over total assets, the capital to asset ratio, return on assets, loan write-offs over total assets and CESEE assets over total assets, and are measured at

the latest possible time in 2006.[19] We cluster standard errors at the firm and bank level in all bank-firm-level regressions to account for possible serial correlation of errors within these groups.

Conditional on the inclusion of firm fixed effects, there is one remaining identification assumption that must hold for our coefficients to purely reflect supply effects. Specifically, it must be that a firm does not disproportionally ask for a reduction in the credit commitment volume during the crisis to those of its banks that are then particularly strongly or weakly exposed to capital and/or liquidity problems. For several reasons, this appears unlikely. First of all, a change in credit demand in a firm arguably leads first and foremost to a change in credit *usage*, rather than a request to reduce the committed amount. This order is likely to hold especially in a crisis, since committed yet unused credit provides insurance for unexpected liquidity needs which occur more frequently in crisis periods. If anything, a firm may ask for a reduction in the committed volume to save commitment fees, and then perhaps do so in the bank that charges the largest fee. Since the fee was agreed upon at the beginning of the crisis, there is no clear rationale that banks that were more troubled during the crisis charged higher fees; and if such banks were able to raise commitment fees during the crisis, then this would again be a supply rather than demand effect. Nonetheless, we address the concern of bank-firm-specific credit demand in several robustness

[19] CESEE assets over total assets is an important control due to the exposure of some Austrian banks to the region, and the prior variables are standard in the literature. The liquidity ratio is measured in December 2006 and computed as the ratio of cash and balance with central banks plus loans and advances to governments and credit institutions divided by total assets, following Jiménez et al. (2012). As Iyer et al. (2014) point out, a high liquidity ratio helps to absorb subsequent liquidity shocks. Return on assets (ROA) are measured as net income over average total assets in 2006, and also captures the ability of banks to take risk and absorb losses during a crisis besides the bank's capital buffer (Cingano et al., 2016). Loan write-offs are the total as of 2006 and capture whether banks were making losses at the onset of the crisis and thus may have been particularly sensitive to shocks during the crisis (Santos, 2010). Total assets are measured in December 2006. The same holds for CESEE assets, which are defined analogously to US Assets but focus on 22 countries in central, eastern and southeastern Europe. See Section A5 in the Appendix for a complete list of included countries.

checks.

5 Results

5.1 Baseline Results

Table 2 presents the results of estimating equation (1) (see columns 4-5) and adapted versions of the specification (see columns 1-3). In column 1, we start with a simple version without interaction terms and include separate bank-level variables instead of bank fixed effects. The results show that neither US exposure, the size of a bank's capital buffer nor dependence on interbank funding has a significant impact on credit commitment supply for the *average* bank-firm relationship in our sample. Column 2 however shows that a rise in US asset exposure has a significantly more negative effect on credit supply for banks with a small capital buffer compared to banks with a large buffer. While this is a first indication of the importance of these variables for credit supply, we need to account for the bank-firm-specific unused credit volume to test our hypotheses. In column 3, we thus include all interactions of equation (1), while keeping the bank variables as separate regressors as well. The results clearly show that the negative impact found in column 2 is driven by credit commitments that were partly or fully unused at the onset of the crisis. Specifically, the triple interaction *US Exposure* $\times$ *Small Capital Buffer* $\times$ *Unused Volume* is negative and highly significant, and the marginal effect displayed at the bottom of the column indicates that a one standard deviation increase in US asset exposure leads to a 11.4 percent reduction in the supply of partly or fully unused commitments if the bank had a small capital buffer. This effect is absent for US-exposed banks with a large capital buffer and banks with a small capital buffer but no US exposure. This is entirely consistent with our hypothesis,

since banks that suffer losses during the crisis *and* have a small cushion to absorb these losses are most affected by additional credit commitment drawdowns. In column 4 we replace the bank variables with bank fixed effects, which leaves the coefficients roughly similar. Note that the marginal effects at the bottom of the table are now relative to fully-used commitments. However, since we see from the top three coefficients of column 3 that fully-used commitments were not cut by any type of US-exposed banks or by banks with a small capital buffer, it is not surprising that the marginal effects regarding capital-constrained banks are similar across columns 2 and 3. The results of column 5 show that the larger the unused volume, the more credit commitments are cut by capital-constrained banks, which is another piece of evidence in favor of our hypothesis.[20] In terms of implications for firms, we note that the magnitude of credit commitment cuts did not imply acute credit constraints on the *average* holder of a partly or fully unused credit commitment borrowing from a capital-constrained bank even if the firm was fully using all its other credit commitments. This is because the average ratio of usage to granted volume of credit commitments with a positive unused volume equaled around 60 percent in January 2008. That said, capital-constrained banks did reduce liquidity insurance to their firms quite substantially.

The mentioned result that fully-used commitments were not cut by exposed banks is in line with our hypothesis since these commitments do not pose the risk of additional drawdowns. Other factors may also contribute to this result, however. For example, fully-used commitments i) on

[20] Note that this result also implicitly provides a robustness check regarding confounding bank-firm-specific credit commitment demand. Specifically, in columns 3 and 4 it would pose an identification problem if the unused credit volume were typically larger in bank-firm pairs in which the bank is more constrained during the crisis *and* firms would choose to reduce credit commitments that have a larger unused volume as opposed to others during the crisis due to lower demand. However, this potential critique is not applicable in column 5 because here the specific volume of unused credit does enter the equation. In this sense, the results of column 5 provide evidence against the just described effects.

average contain more term loans which typically have a longer maturity and are thus harder to cut, and ii) while directly freeing capital, not rolling over fully-used commitments imposes larger financial constraints on the average firm which may backfire onto the bank both via affecting the health of the firm and/or inducing the firm to switch lender in the short, medium or long term. However, none of these alternative channels speak against our hypotheses, as they do not directly imply that banks should instead cut partly or fully unused commitments.

The results in Table 2 also indicate that liquidity problems negatively affected the growth rate of partly or fully unused commitments during the crisis. However, the coefficient on *Int'l Interbank Borrowing* $\times$ *Unused Volume* and the marginal effect at the bottom of column 3 suggest that this occurred only relative to fully-used commitments within liquidity-constrained banks rather than also compared to banks with smaller liquidity problems. Specifically, liquidity-constrained banks seemed to *increase* the supply of fully-used commitments but not the supply of partly or fully unused ones. This might reflect that receiving support from the Austrian government's interbank support package was conditional on increasing credit supply and participating banks chose to rather roll over term loans (which are mostly fully-used) than commitments that would be used less, to have more control over their liquidity position. As we will discuss further below, Table 4 further shows that during the peak of the interbank market freeze, liquidity-constrained banks did actually *cut* commitments with a *large* unused volume. Taken together, these results do provide evidence that also liquidity-constrained banks actively managed the risk of additional credit drawdowns. Finally, we observe that the coefficient on *Unused Volume* is negative and significant across all columns of Table 2. Since in all tables we subtract the specific sample- (thus column-) specific mean from all bank variables before performing the regressions, this coefficient

indicates the effect for the average bank in terms of our included bank variables.[21] The negative coefficients suggest that not only banks with a larger crisis exposure, but also the average bank cut the volume of commitments that were not fully used. While this may also reflect a crisis effect, the coefficient on *Unused Volume* is also negative and significant in pre-crisis placebo regressions (contrary to the interactions; see Appendix-Table A1 and Section A1), thus we cannot be sure about this.

5.2 Additional Evidence

In Table 3 we present the results on additional specifications that provide further tests on our hypotheses. While column 1 repeats the results presented in column 4 of Table 2, column 2 reveals that the capital buffer does not matter for liquidity-constrained banks in terms of credit commitment supply. This speaks against the possibility that weakly-capitalized banks faced even larger liquidity constraints, and further strengthens the interpretation that US asset exposure matters because it implied capital losses. In column 3 we show that banks that faced a larger aggregate volume of unused credit cut individual commitments with a positive unused volume by significantly more as well, irrespective of the bank's crisis exposure. The results of column 4 show that this effect is stronger the larger the firm's unused credit volume. Furthermore, column 4 provides weak evidence that aggregate bank-level exposure to unused credit matters more for capital-constrained banks in terms of credit supply, since a corresponding four-tuple interaction term that we add is negative, though marginally insignificant.[22] All results are intuitive and strengthen our claim that banks do active risk management in terms of their capital

[21] Demeaning is useful as it allows us to always compare the coefficient on *Unused Volume* across all columns, and since it makes the computation of marginal effects more simple and transparent.

[22] We also add all other resulting relevant interactions but do not report their coefficients to save space.

position. In column 5 we drop the additional interactions of columns 2-4 but restrict the sample to commitments with a positive initial unused credit volume in order to have a more homogeneous sample, and define *Unused Volume* as a continuous variable in logs. The coefficients on capital-constrained banks remain negative and significant which is reassuring, while the coefficient on liquidity-constrained banks turns insignificant, which is consistent with the discussed results of column 3 of Table 2.

5.3 Credit commitment supply around the Lehman default

For several reasons it is useful to narrow down the period of analysis to the two months around Lehman default, which we do in Table 4. First of all, no other unrelated event of similar relevance occurred between August and October 2008. Our baseline sample period was instead characterised by different negative shocks and public responses at the European and Austrian level, such as the Austrian banking package that started in November 2008 and included capital injections into banks and measures to support interbank lending. Second, for the short period around the Lehman default it is even more unlikely than in our baseline period that bank-firm-specific demand effects regarding the commitment volume confound our effects, because the crisis had not yet fully reached Austria's real economy. Third, the short-term analysis may help us understand which types of credit were cut throughout the crisis and for which reason. In columns 1, 2 and 3 of Table 4, we repeat the analysis of columns 3, 4 and 5 of Table 2, respectively, but narrow down the dependent variable to August-October 2008. Here we observe no effects on credit commitment supply. In columns 4-6, we test the hypothesis that at this first stage of the crisis, constrained banks only cut credit commitments that had a relatively *large* unused credit volume. Specifically, we define *Unused Volume* to equal one if the unused volume exceeded the

variable's 25th percentile based on positive realisations in our baseline sample – which equaled around €241,000 – and zero otherwise.[23] The results confirm the mentioned hypothesis. In only two months, US-exposed banks with a small capital buffer significantly reduced the growth rate of credit commitments with a large unused volume as of August 2008, compared to US-exposed banks with a large capital buffer. To further rule out confounding demand effects that are very unlikely in the first place, in column 5 we drop firms in traded sectors as they were the first to feel the real repercussions of the crisis in the fall of 2008 (OeNB, 2009).[24] The findings for the resulting sample of non-traded firms are however even more pronounced, indicating a significant 7.6 percent cut of credit commitments with a large unused volume by capital-constrained banks relative to less constrained banks. Column 4 further shows that also liquidity-constrained banks cut such commitments by 3.3 percent compared to less constrained banks, which likely reflects the impact of the spike in interbank funding rates after the Lehman default (see Figure 4). Graphical evidence further suggests that at least in part, credit commitment cuts were a response to actual credit drawdowns. Specifically, Figure 11 shows that the usage of guarantees increased sharply between the end of August and the end of September 2008, while Figure 10 shows that commitment volumes hardly moved in this month but only decreased thereafter, and mostly so for more constrained banks.[25] Furthermore, between end-September and end-October the usage of revolving credit lines rose by around seven percent but then did not increase further,

[23] In column 8 of Appendix-Table A2, we use this definition of *Unused Volume* also for our baseline sample period, and find that the results are robust to this modification.

[24] The excluded traded sectors are: agriculture; mining; manufacturing; car trade and repair; information and communication; financial services; other economic services. The remaining non-traded sectors are: energy supply; water supply and waste management; construction; traffic and storage; hotels and restaurants; other services; education; health and social services; arts, entertainment and leisure; professional, scientific and technical activities; public administration; private households.

[25] Note that increased usage of guarantees does not reflect that the bank actually steps in and repays a debt of the firm to another party. Rather, it reflects that the firm makes us of the option to have the bank do so in case this is needed. Used guarantees in this exact sense (thus the bank has not yet stepped in to repay the debt) are fully on the bank's balance sheet, same as for example the used portion of a revolving credit line.

while capital-constrained banks then cut commitment volumes all the way until November. In sum, based on this admittedly non-parametric and merely suggestive evidence, we may conclude that banks took precautionary action to protect their capital ratio and liquidity position after initial alarming increases in credit usage from their client firms' side.

The results of Table 4 and Figures 10 and 11 also suggest that banks did not cut commitments purely by deciding to not roll over maturing commitments, since it appears unlikely that sufficiently many commitments expired over August-October 2008. Furthermore, it appears unlikely that many firms violated covenants for the first time between August and October 2008 and banks therefore cut credit commitments, given that the real economy was only starting to cool down. However, based on the results of Chodorow-Reich and Falato (2017) one may speculate that constrained banks forced a commitment reduction based on firm-specific covenant violations that had previously been tolerated. Given the short horizon of our analysis in Table 4, the most likely scenario is that constrained banks cut (especially) *revocable* credit commitments. This is because these can be cut at any time (before the firm decides to draws down) and by regulation an increase in usage had larger consequences on the bank's capital requirement than for irrevocable commitments, conditional on the firm's riskiness.

5.4 Which credit types were cut?

In this subsection, we try to better understand which specific credit commitment type(s) were cut by capital- or liquidity-constrained banks. Columns 2-4 of Table 5 present the results, while column 1 repeats our baseline findings from column 4 of Table 2. In column 2 we make use of the fact that we observe the supply of credit guarantees and study the change in this variable between February 2008 (the month when data became available) and December 2009. The coefficients

are insignificant and close to zero. In column 3, we change the dependent variable to the change in term loan *usage* over 2008:01 - 2009:12. This provides some information on term loan supply since for term loans usage and supply are very similar for the average firm, as we infer from the post-2012 data when commitment supply by type becomes available.[26] Again, the coefficients are relatively close to zero and insignificant. Finally, in column 4 we restrict the sample to bank-firm relationships in which term loan usage was equal to zero in January 2008 while revolving credit line usage was positive. Furthermore, we use the continuous version of *Unused Volume*, since the great majority of the resulting commitments were not fully used. Even though there are only around 200 degrees of freedom in this regression, the coefficient on our triple interaction term is statistically significant at the 10% level, and more than three times larger than the corresponding coefficient in Table 2 (see column 5). In sum, the results of Table 5 therefore clearly suggest that constrained banks mostly or exclusively cut revolving credit lines.

5.5 Heterogeneity across Firms

In Table 6 we study whether constrained banks treated distinct firm types differently in terms of credit supply, as found for example by De Jonghe et al. (2019). To do so, we use firm balance sheet and income statement data from the year 2007, which is available for 76% of firms in our baseline sample. Columns 4 and 5 of Appendix-Table A4 show that financially more sound firms appear more regularly in the data, thus the sample is not random. We also use information on the firm's average probability to default on its loans, as evaluated by the firm's banks and recorded in the credit register. This variable is only available for around 60% of firms in our baseline sample,

[26] Specifically, over 2013-2014, 82% of term loans were fully used, and the average usage-to-granted ratio was equal to 96% (see Table A5 for the latter and additional summary statistics).

since only banks that use the F-IRB or A-IRB approach in terms of complying with the Basel II framework (compare Section 3) are required to report their evaluation. We depart from equation (1) and interact every variable with different firm variables, which are scaled by their standard deviation (compare Table 1, Panel III). We also include all other possible interactions, but only report the most important ones. To account for the result that the volume of unused credit at the bank-firm level depends on firm characteristics (see columns 1-3 of Appendix-Table A4), we use the continuous version of *Unused Volume* (log if positive and zero otherwise). The results of Table 6 indicate that firms with a larger probability to default on their loans receive larger commitment cuts by capital-constrained banks, conditional on the unused credit volume. This is intuitive and supporting our hypothesis, since such firms have a larger risk weight such that the bank's capital ratio would fall more if the firm drew down additional credit. Furthermore, more profitable and larger firms also receive larger cuts by capital-constrained banks. This might suggest that banks cut credit to those firms that are thereby hurt less, but the fact that we do not observe the same pattern for liquidity-constrained banks speaks against this hypothesis. These results are thus more likely to reflect anecdotal evidence that larger and "better" firms prefer revocable as opposed to irrevocable credit commitments, as the commitment fees are lower and these firms do not need very strong liquidity insurance. Finally, relationship duration is negatively associated with credit commitment supply. Since a bank's importance for the firm in terms of bank-specific credit usage to total usage has no effect, it is however unlikely that this reflects a (counter-intuitive) relationship lending effect.

5.6 Credit Substitution and Real Effects

In this section, we study whether firms can substitute "lost" credit via other banks and potential effects on firm investment and employment. To do so, we follow the approach of the previous literature, including for example Cingano et al. (2016). As dependent variable we use the change in the *total* credit commitment volume at the firm level granted by all of its banks across January 2008 and December 2009. On the right-hand side, we compute weighted averages of our bank variables that we include in column 3 of Table 2 across all of the firm's banks (thus not only those in our baseline sample), using the share of usage in total credit usage of each bank as weight. To control for changes in firm-specific credit demand over the crisis, we include the *estimate* of the firm's fixed effect (i.e. firm dummy) from our baseline specification. Furthermore, we include our credit type controls at the firm level. The results are presented in column 1 of Table 7, and indicate that firms with more US-exposed banks that have a lower initial capital buffer face a lower credit growth than firms with US-exposed banks with a large capital buffer. In that sense, firms are not entirely unaffected by having more capital-constrained banks, but the results merely indicate that credit growth is zero for such firms, rather than in fact positive. In column 2 and 3 we distinguish firms for which all credit commitments as of January 2008 had a positive unused volume and those for which this was not the case, respectively. The results indicate that the findings of column 1 are clearly driven by the prior type of firms, which is in line with our bank-firm-level evidence. Column 4 however shows that the results are not robust to the inclusion of 'main bank fixed effects', which we determine based on a bank's credit share in total credit usage of the firm. In line, columns 5-8 indicate no effects on firm investment and employment, based on our not entirely representative sample of firms (see columns 4-5 of

Appendix-Table A4). Employment is measured as the log change in employment between 2007 and 2009; investment is measured as the difference in the sum of investment in fixed assets over 2008 and 2009 divided by total assets in 2007 and the sum of fixed asset investment in 2005 and 2006 divided by total assets in 2004. On the right-hand side we include the firm's average probability to default on its loans, several firm controls as well as province, sector and legal form fixed effects.

5.7 Robustness Checks

In Section A1 in the Appendix, we discuss a wide range of robustness checks. Specifically, we show that (i) before the crisis, capital- and liquidity-constrained banks did not exhibit different trends in terms of credit supply than banks that were less exposed to the crisis; (ii) our results are robust to a range of checks that further address the potential concern of confounding bank-firm-specific credit commitment demand; (iii) including all banks into our sample and measuring the capital buffer in the end of 2006 same as our other bank variables does not change our results; (iv) our results are robust to dropping credit commitments that include the slightly special case of trust loans; and (v) we show that pre-crisis US asset exposure significantly predicted the bank-specific amount of losses during the crisis.

6 Conclusion

In this paper, we shed light on a novel channel through which bank capital regulations affect lending to the real economy in crisis times. We departed by highlighting that exposure to undrawn credit commitments may put a bank's regulatory capital buffer at risk, since additional

credit drawdowns increase the size of the bank's balance sheet. This is particularly problematic during periods of financial distress, since the capital position of banks is then typically weakened, raising capital is more costly and drawdowns on credit commitments are more likely. We then showed that banks whose capital position was hit relatively hard during the 2008-09 financial crisis and whose initial capital buffer was low reduced the risk of additional drawdowns by substantially cutting the volume of partly or fully unused corporate credit commitments over 2008-09. While this is good news from the perspective of banking system stability, it implies a reduction of liquidity provision and insurance to firms exactly at a time in which they need it most. On the positive side, we find no clear evidence that firms were not able to substitute the loss in credit and we also do not find negative real effects. However, this result may not hold in other countries with different institutional features or where the crisis had a more severe impact. Generally speaking, our results therefore do provide an additional rationale for the regulator's quest to strengthen bank capital buffers. What's more, at least from the viewpoint of financial stability our findings justify the higher capital charge on the unused portion of most credit commitment types in Basel III, and may call for a further increase. This is because a higher capital charge makes banks more reluctant ex ante to grant excessively high credit commitment volumes that cannot be sustained during crisis times. This limits liquidity risk transfers from banks to firms and reduces the potential impact of runs on unused credit commitments on banks in periods of financial distress.

As a second contribution, we showed that also larger liquidity problems induced banks to substantially cut partly or fully unused credit commitments at the peak of the crisis, controlling for a bank's capital position. The introduction of the Liquidity Coverage Ratio (LCR) in Basel III may weaken such effects in periods of financial distress and thereby also increase future financial

stability.

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Tables

Table 1: Descriptive Statistics

	Mean	Median	Min	Max	sd	N
I: Bank-Firm Variables						
Δ ln(Credit Commitment) 2008:01 - 2009:12	-0.047	-0.051	-8.569	7.110	0.753	7,262
...if Firm has Unused Credit Volume	-0.094	-0.050	-8.569	7.110	0.720	4,229
...if Firm has no Unused Credit Volume	0.019	-0.053	-7.357	6.725	0.792	3,033
Unused Credit Volume (in '000 Euros)	2,051	96.5	-428,113	529,643	15,112	7,262
Unused Credit Volume (Dummy)	0.582	1	0	1	0.493	7,262
Credit Used / Credit Granted	0.822	0.962	0	1.815	0.404	7,262
Share of Bank in Total Credit Usage	0.289	0.209	0	1	0.270	7,262
Relationship Duration in Months	65.228	75	1	97	33.627	7,262
% of Revolving Credit Line in Total Credit Usage	0.186	0	0	1	0.330	7,262
% of Term Loans	0.578	0.796	0	1	0.442	7,262
% of Guarantees	0.184	0	0	1	0.341	7,262
% of Trust Loans	0.025	0	0	1	0.127	7,262
% of Leasing Loans	0.011	0	0	1	0.105	7,262
% of Special Purpose Loan	0.016	0	0	1	0.122	7,262
II: Bank Variables (weighted using bank frequency in sample)						
US Assets / Total Assets 2006:12	0.011	0.009	0	0.051	0.010	109
Int'l Interbank Borrowing / Total Assets 2006:12	0.103	0.076	0	0.262	0.091	109
Tier 1&2 Capital / Capital Requirement 2008:Q1	1.787	1.537	1.099	3.039	0.548	109
Liquid Assets / Total Assets 2006:12	0.220	0.206	0.018	0.646	0.122	109
Total Assets 2006:12 (bn. Euros)	36.001	11.325	0.155	129.920	46.395	109
Return on Assets 2006	0.005	0.004	-0.006	0.014	0.002	109
Loan Charge-offs / Total Assets 2006	0.000	0.000	0	0.004	0.000	109
CESEE Assets / Total Assets 2006:12	0.082	0.047	0	0.807	0.109	109
Total Unused Credit Volume / Total Assets 2008:01	0.044	0.036	-0.009	0.211	0.038	109
US Assets / Tier 1&2 Capital 2006:Q4	0.155	0.102	0	1.412	0.176	109
US Assets / Tier 1&2 Capital Buffer 2006:Q4	0.515	0.300	0	5.754	0.668	109
Required Capital rise if full drawdowns 2008:01	0.080	0.060	-0.014	1.086	0.112	109
Net US Value Gains 2008-09 / T1&2 Cap-Buff 08:Q1	-0.022	0.000	-0.413	0.149	0.082	109
Net US Value Gains 2008:09 / T1&2 Cap-Buff 08:Q1	-0.045	-0.004	-0.470	0.000	0.088	109
% Fall in Cap. Buffer if full drawdowns 2008:Q1	-0.199	-0.107	-1.409	0.029	0.277	109
III: Firm Variables (weighted using firm frequency in sample)						
Number of Banks	6.806	4	2	60	7.936	1,719
Total Assets 2007 (mn. Euros)	248.519	48.314	1.954	4,108	628.106	1,719
Employment	396.867	91.000	1.000	23,045	1,440	1,719
Return on Assets	0.089	0.046	-0.128	0.407	0.125	1,719
Sales / Assets	0.994	0.723	0.000	3.353	0.976	1,719
Cash holdings / Assets	0.039	0.015	0.000	0.228	0.057	1,719
Assets / Capital (Leverage)	4.778	3.428	-0.539	16.505	4.020	1,718
Probability of Default	4.075	0.887	0.018	77.474	8.993	1,367
Δ Investment/Assets 05-06 vs 08-09	-0.013	-0.002	-1.727	1.301	0.219	636
Δ ln(Employment) 07-09	0.018	0.011	-7.199	3.549	0.466	1,084

This table provides descriptive statistics on the bank-firm and bank variables used in our specifications, as well as firm-level statistics. *Unused Credit Volume* and all variables below in Panel I are measured in January 2008. *Relationship Duration in months* is censored at 97 months since we only have data from January 2000 onwards. The usage shares of the different credit commitment types is computed based on the 6,838 commitments for which total usage is larger zero. Liquid Assets are those with a maturity of less than one year. *Net US Value Gains 2008-09* equals the sum of monthly net US asset value gains caused by changes in market values and loan write-offs in the 24 months of 2008 and 2009. *Required capital rise if full drawdowns 2008:01* and *% Fall in capital buffer if full drawdowns 2008:01* are based on our incomplete coverage of credit commitments and, within our sample, an upper bound as it assumes that all observed credit commitments are revocable. The corresponding lower bound is half of the indicated values, and holds under the assumption that all credit commitments are irrevocable and have an original maturity of more than one year. Firm-specific variables are measured as of 2007, apart from *Number of Banks* (2008:01) and *Probability of Default* (earliest available moment in 2008) as assessed by the firm's banks. Numbers are rounded to the nearest integer if they are larger than 1,000.

Table 2: Supply of Credit Commitments during the 2008-09 Financial Crisis

Dependent variable →	$\Delta ln(Credit\ Commitment_{ij})$ 2008:01 - 2009:12				
Definition of Bank-Firm-Level Variable *Unused Volume* →	Dummy = 1 if positive				ln(U.V.) or =0
	(1)	(2)	(3)	(4)	(5)
US Exposure	0.004	0.045*	0.026		
	(0.012)	(0.023)	(0.024)		
Small Capital Buffer	-0.033	0.034	-0.012		
	(0.024)	(0.037)	(0.049)		
US Exp × Small Capital Buffer		-0.060**	-0.009		
		(0.025)	(0.030)		
US Exp. × Small Cap-Buffer × Unused Volume			-0.129***	-0.106**	-0.017***
			(0.040)	(0.046)	(0.006)
US Exp. × Unused Volume			-0.003	-0.017	0.001
			(0.024)	(0.024)	(0.003)
Small Capital Buffer × Unused Volume			-0.030	-0.019	-0.003
			(0.041)	(0.044)	(0.007)
Int'l Interbank Borrowing	0.008	0.005	0.067**		
	(0.026)	(0.025)	(0.027)		
Int'l Interbank Borrowing × Unused Volume			-0.108***	-0.098***	-0.011***
			(0.023)	(0.023)	(0.003)
Unused Volume			-0.159***	-0.153***	-0.032***
			(0.022)	(0.023)	(0.004)
Bank Controls	Yes	Yes	Yes	No	No
Bank-Firm Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	Yes	Yes
Observations	7,262	7,262	7,262	7,262	7,262
# Banks	109	109	109	109	109
# Firms	2,266	2,266	2,266	2,266	2,266
Marginal Effects on credit commitment supply (relative to: col.2&3: non- or less exposed banks; col.4: *Unused Volume=0*; col.5: smaller unused volume)					
1sd Rise in US Exposure if large capital buffer		0.045*			
1sd Rise in US Exposure if small capital buffer		-0.016			
1sd Rise in US-Exp if large cap-buffer & unused credit volume			0.023	-0.017	0.001
1sd Rise in US-Exp if small cap-buffer & unused credit volume			-0.114***	-0.123**	-0.016***
1sd Rise in Int'l Interbank Borr. if unused credit volume			-0.040	-0.098***	-0.011***

This table shows the results of estimating equation (1). The dependent variable is the change in the maximum amount of credit firm i can obtain from bank j, between January 2008 and December 2009. The sample consists of credit commitments (bank-firm pairs) by banks with at least 20 client firms in 2008:01 to firms that borrowed from at least two banks in 2008:01 and 2009:12. Bank-specific variables are measured at the latest possible time in 2006, except the capital buffer, which is measured in 2008:Q1. *Small Capital Buffer* equals one if the buffer is smaller than the median, based on our baseline sample of 7,262 bank-firm pairs; it is thus a weighted median across the banks in our sample. *US Exposure* is defined as the sum of securities and shares acquired from counterparties located in the United States and loans to US customers – in whichever currency – divided by the bank's total amount of securities, shares and loans. *Int'l Interbank Borrowing* is scaled by total assets. All bank variables are first scaled by their standard deviation in our sample, and then demeaned using the column-specific sample. *Unused Volume* and *Bank-Firm Controls* are measured in January 2008. Standard errors are clustered at the bank and firm level and reported in parentheses. *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

Table 3: Additional Evidence

Dependent variable →	Δ $ln(Credit\ Commitment_{ij})$ 2008:01 - 2009:12				
Definition of Bank-Firm-Level Variable *Unused Volume* →	Dummy = 1 if positive			ln(U.V.) or =0	
Sample →	All Bank-Firm Relationships				R'ships where U.V.>0
	(1)	(2)	(3)	(4)	(5)
US Exposure × Unused Volume	-0.017	-0.013	-0.030	0.000	0.017
	(0.024)	(0.023)	(0.023)	(0.004)	(0.013)
US Exp. × Small Capital Buffer × Unused Volume	-0.106**	-0.130**	-0.093**	-0.019***	-0.043**
	(0.046)	(0.051)	(0.046)	(0.006)	(0.017)
Small Capital Buffer × Unused Volume	-0.019	-0.020	-0.017	-0.001	-0.001
	(0.044)	(0.043)	(0.042)	(0.005)	(0.015)
Int'l Interbank Borrowing × Unused Volume	-0.098***	-0.098***	-0.064**	-0.007*	-0.013
	(0.023)	(0.022)	(0.031)	(0.004)	(0.011)
Int'l Interbank Borr. × Small Cap-Buffer × Unused Vol.		0.034			
		(0.042)			
Total Unused Volume at Bank Level × Unused Volume			-0.044*	-0.007***	
			(0.025)	(0.003)	
US Exp. × Small C-B × Unused Vol. × Bank Unused Vol.				-0.015	
				(0.010)	
Unused Volume	-0.153***	-0.150***	-0.152***	-0.032***	-0.064***
	(0.023)	(0.024)	(0.033)	(0.003)	(0.008)
Additional Relevant Interactions	NA	NA	NA	Yes	NA
Bank-Firm Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
Observations	7,262	7,262	7,262	7,262	3,514
# Banks	109	109	109	109	105
# Firms	2,266	2,266	2,266	2,266	1,262
Marginal Effects on credit commitment supply (relative to *Unused Vol.*=0 (col.1-3) or smaller U.V. (col.4&5))					
1sd Rise in US-Exp if large cap-buffer & unused c-vol.	-0.017	-0.013	-0.030	0.000	0.017
1sd Rise in US-Exp if small cap-buffer & unused c-vol.	-0.123**	-0.143**	-0.123**	NA	-0.027*
1sd Rise in Int'l Interbank Borr. if unused credit vol.	-0.098***	-0.098***	-0.064**	-0.007*	-0.013

In this table, we present the results on additional specifications to further test our hypotheses. The dependent variable is the change in the maximum amount of credit firm i can obtain from bank j, between January 2008 and December 2009. The sample consists of credit commitments (bank-firm pairs) by banks with at least 20 client firms in January 2008 to firms that borrowed from at least two banks in 2008:01 and 2009:12. Bank-specific variables are measured at the latest possible time in 2006, except the capital buffer, which is measured in 2008:Q1. *Small Capital Buffer* equals one if the buffer is smaller than the median, based on our baseline sample (see Table 2). See Table 2 for a description of the other explanatory variables. All bank-specific variables are scaled by their standard deviation based on our baseline sample (see Table 2), and then demeaned using the column-specific sample. *Unused Volume* and *Bank-Firm Controls* are measured in January 2008. Standard errors are clustered at the bank and firm level and reported in parentheses. *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

Table 4: Zooming in: Supply of credit commitments around the Lehman default

Dependent variable →	$\Delta ln(Credit\ Commitment_{ij})$ 2008:08 - 2008:10					
Def. of Bank-Firm-Level Var. *Unused Volume* →	= 1 if positive		ln(U.V.) or =0	= 1 if > 25th percentile		
Sample →	All Firms					Non-Traded
	(1)	(2)	(3)	(4)	(5)	(6)
US Exposure	-0.001			-0.014		
	(0.008)			(0.012)		
Int'l Interbank Borrowing	-0.000			0.003		
	(0.012)			(0.010)		
US Exp. × Small Capital Buffer	0.005			0.012		
	(0.010)			(0.010)		
US Exp. × Small Cap-Buffer × Unused Volume	-0.007	-0.002	-0.002	-0.038**	-0.041**	-0.111***
	(0.020)	(0.024)	(0.003)	(0.017)	(0.018)	(0.027)
US Exp. × Unused Volume	-0.007	-0.016	0.000	0.024**	0.019**	0.035**
	(0.011)	(0.013)	(0.002)	(0.009)	(0.008)	(0.016)
Small Capital Buffer × Unused Volume	0.005	0.025	0.002	-0.005	0.010	0.007
	(0.013)	(0.015)	(0.002)	(0.014)	(0.013)	(0.026)
Int'l Interbank Borrowing × Unused Volume	-0.014	-0.008	-0.002	-0.036***	-0.031***	-0.062***
	(0.013)	(0.013)	(0.002)	(0.011)	(0.010)	(0.016)
Unused Volume	-0.056***	-0.061***	-0.011***	-0.061***	-0.064***	-0.079***
	(0.009)	(0.009)	(0.001)	(0.008)	(0.008)	(0.015)
Bank Controls	Yes	No	No	Yes	No	No
Bank-Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	Yes	Yes	No	Yes	Yes
Observations	9,249	9,249	9,249	9,249	9,249	2,718
# Banks	110	110	110	110	110	102
# Firms	2,811	2,811	2,811	2,811	2,811	837
Marginal Effects on credit commitment supply (relative to: col.1&4: non-/less exposed banks; col.2&3: *Unused Volume=0*; col.5&6: *U.V.<25th pctl*)						
1sd Rise in US-Exp if large cap-b. & unused c-vol.	-0.008	-0.016	0.000	0.011**	0.019**	0.035**
1sd Rise in US-Exp if small cap-b. & unused c-vol.	-0.010	-0.019	-0.002	-0.017	-0.022	-0.076***
1sd Rise in Int'l Interb. Borr. if unused credit vol.	-0.014	-0.008	-0.002	-0.033***	-0.031***	-0.062***

In this table, we narrow down the period of analysis to the two months around the default of Lehman Brothers on September 15, 2008. The dependent variable is the change in the maximum amount of credit firm i can obtain from bank j, between August 2008 and October 2008. *Non-Traded* represents the sample of firms that operate in a non-traded sector; see Section 5 for details. The sample consists of credit commitments (bank-firm pairs) by banks with at least 20 client firms in January 2008 to firms that borrowed from at least two banks in August 2008 and October 2008. Bank-specific variables are measured at the latest possible time in 2006, except the capital buffer, which is measured in 2008:Q1. *Small Capital Buffer* equals one if the buffer is smaller than the median, based on our baseline sample (see Table 2). All bank variables are first scaled by their individual standard deviation based on our baseline sample (see Table 2), and then demeaned using the column-specific sample. *Unused Volume* and *Bank-Firm Controls* are measured in August 2008. Standard errors are clustered at the bank and firm level and reported in parentheses. *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

Table 5: Different observed Credit Types during the 2008-09 Financial Crisis

Dependent variable →	Δln *Total Credit Commitm.*$_{ij}$ 08:01-09:12	Δln *Granted Guarantees*$_{ij}$ 08:02-09:12	Δln *Term Loan Usage*$_{ij}$ 08:01-09:12	Δln *Total Credit Commitm.*$_{ij}$ 08:01-09:12
Def. of Bank-Firm-Level Variable *Unused Volume* →	Dummy = 1 if positive			ln(U.V.) or =0
Sample →	All Bank-Firm Relationships			Credit Line but no Term Loan Usage
	(1)	(2)	(3)	(4)
US Exposure × Unused Volume	-0.017	-0.021	-0.011	0.026
	(0.024)	(0.195)	(0.030)	(0.019)
US Exposure × Small Capital Buffer × Unused Vol.	-0.106**	0.001	-0.048	-0.060*
	(0.046)	(0.158)	(0.060)	(0.034)
Small Capital Buffer × Unused Volume	-0.019	-0.150	-0.051	-0.005
	(0.044)	(0.202)	(0.066)	(0.024)
Int'l Interbank Borrowing × Unused Volume	-0.098***	0.095	-0.047	-0.013
	(0.023)	(0.211)	(0.035)	(0.018)
Unused Volume	-0.153***	0.333***	0.140***	-0.023*
	(0.023)	(0.115)	(0.033)	(0.012)
Bank-Firm Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Observations	7,262	984	4,008	465
# Banks	109	51	107	46
# Firms	2,266	400	1,244	202
Marginal Effects on credit commitment supply (relative to: col.1-3: *U.V.=0*; col.4: smaller *U.V.*)				
1sd Rise in US-Exp if large cap-buff. & unused c-vol.	-0.017	-0.021	-0.011	0.026
1sd Rise in US-Exp if small cap-buff. & unused c-vol.	-0.124**	-0.020	-0.059	-0.034
1sd Rise in Int'l Interbank Borr. if unused credit vol.	-0.098***	0.095	-0.047	-0.013

In this table, we investigate credit type-specific developments during the crisis, to the extent that our data permits this. For convenience, in column 1 we repeat the baseline results of column 4 of Table 2. The dependent variable in column 2 is the change in the maximum amount of guarantees firm i can obtain from bank j, between February 2008 (data for January is not available) and December 2009. The dependent variable in column 3 is the change in bank-firm-specific term loan usage between January 2008 and December 2009. In column 4, we restrict the sample to those bank-firm relationships in which the firm's term loan usage equals zero and the revolving credit line usage is larger zero. The sample selection of banks as well as the measurement timing and scaling of bank-level variables are equivalent to our main specification (see Table 2) in all columns. See Table 2 for a description of the explanatory variables. *Unused Volume* and *Bank-Firm Controls* are measured in January 2008 in columns 1, 3 and 4 and in February 2008 in column 2. Standard errors are clustered at the bank and firm level and reported in parentheses. *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

Table 6: Heterogeneity across different types of firms and lending relationships

Dependent variable →	Δ *ln Total Credit Commitment*$_{ij}$ *08:01 - 09:12*
Definition of Bank-Firm-Level Variable *Unused Volume* →	ln(U.V.) or =0
	(1)
US Exp. × Small Cap-Buffer × Unused Volume × Prob. of Default	-0.013**
	(0.006)
US Exp. × Small Cap-Buffer × Unused Volume × Return on Assets	-0.022**
	(0.010)
US Exp. × Small Cap-Buffer × Unused Volume × Size (Total Assets)	-0.015*
	(0.009)
US Exp. × Small Cap-Buffer × Unused Volume × Leverage	-0.003
	(0.007)
US Exp. × Small Cap-Buffer × Unused Volume × R'ship Duration	-0.018**
	(0.007)
US Exp. × Small C-B × Unused Volume × Share of Bank in Total Credit Usage	-0.005
	(0.009)
Int'l Interbank Borrowing × Unused Volume × Probability of Default	0.002
	(0.007)
Int'l Interbank Borrowing × Unused Volume × Return on Assets	-0.006
	(0.006)
Int'l Interbank Borrowing × Unused Volume × Size (Total Assets)	0.001
	(0.011)
Int'l Interbank Borrowing × Unused Volume × Leverage	-0.000
	(0.005)
Int'l Interbank Borrowing × Unused Volume × R'ship Duration	-0.003
	(0.007)
Int'l Interbank Borr. × Unused Volume × Share of Bank in Total Credit Usage	-0.003
	(0.007)
Additional Interactions	Yes
Bank-Firm Controls	Yes
Firm FE	Yes
Bank FE	Yes
Observations	3,731
# Banks	96
# Firms	1,204

In this table, we study whether the found effects differ across distinct types of firms and lending relationships. To this end, we interact firm level variables and bank-firm level variables (which we first scale by their standard deviation based on our baseline sample of Table 2) with all variables. We also form all other possible interactions and include them into the specification, but only report the key interaction terms for reasons of space. Otherwise, the dependent variable and scaling of variables are identical to our analysis in Table 2. See Table 2 for a description of the explanatory variables. Standard errors are clustered at the bank and firm level and reported in parentheses. *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

Table 7: Credit Substitution and Real Effects

Dependent variable →	Δln *Total Credit Commitment*$_i$ 2008:01 - 2009:12			Δ *Inv./Assets*$_i$ 08+09 vs. 05+06			Δln *Employment*$_i$ 07–09	
Sample →	All Firms	U.V.> 0 in all Commit.	U.V.=0 in some Commit.	All Firms	All Firms	U.V.> 0 in all Commit.	All Firms	U.V.> 0 in all Commit.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
W(US Exposure)	0.062***	0.124***	0.028	0.018	-0.008	-0.048	0.028	-0.036
	(0.017)	(0.027)	(0.021)	(0.039)	(0.043)	(0.057)	(0.033)	(0.044)
W(US Exposure × Small Capital Buffer)	-0.065***	-0.135***	-0.028	-0.039	0.014	0.003	-0.002	0.064
	(0.022)	(0.038)	(0.026)	(0.047)	(0.049)	(0.065)	(0.043)	(0.061)
W(Small Capital Buffer)	-0.007	0.019	-0.031	-0.007	-0.055	-0.134	0.040	-0.069
	(0.032)	(0.055)	(0.039)	(0.062)	(0.073)	(0.093)	(0.079)	(0.098)
W(Int'l Interbank Borrowing)	0.010	-0.001	0.027	0.038	-0.001	0.051	-0.013	-0.015
	(0.019)	(0.022)	(0.028)	(0.039)	(0.025)	(0.037)	(0.022)	(0.031)
Weighted Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Main Bank FE	No	No	No	Yes	No	No	No	No
Firm Controls from Credit Register	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated Firm Demand	Yes	Yes	Yes	Yes	No	No	No	No
Firm Balance Sheet Controls	No	No	No	No	Yes	Yes	Yes	Yes
Province FE	No	No	No	No	Yes	Yes	Yes	Yes
1-digit Sector FE	No	No	No	No	Yes	Yes	Yes	Yes
Legal Form FE	No	No	No	No	Yes	Yes	Yes	Yes
Observations (Firms)	2,265	687	1,578	2,196	606	184	1,028	346
Marginal Effects on total credit commitment supply (relative to firms with banks with no or smaller exposure)								
1sd Rise in US Exposure if large capital buffer	0.062***	0.124***	0.028	0.018	-0.008	-0.048	0.028	-0.036
1sd Rise in US Exposure if small capital buffer	-0.003	-0.012	0.000	-0.021	0.006	-0.045	0.026	0.027
1sd Rise in Int'l Interbank Borrowing	0.010	-0.001	0.027	0.038	-0.001	0.051	-0.013	-0.015

In this table, we analyse whether firms can substitute losses in the granted credit commitment volume with other banks, and potential real effects. *W(B)* equals a weighted average of bank variable B across *all* banks lending to firm i in January 2008, using the share of a bank in the firm's total credit usage in that month as weight. In columns 1, 4 and 7 we include all firms of our main specification; one firm is however dropped because of missing data for one of the firm's banks. In columns 2, 6 and 8 we restrict the sample to those firms that have unused credit volume in *all* of their credit commitments (bank relationships). In column 3, we include all firms that have no unused credit volume in one or more credit commitments. *Inv* in columns 5 and 6 stands for total investment in fixed assets. *Firm Controls from Credit Register* are total credit type usage ratios across all of the firm's banks. *Firm Balance Sheet Controls* include total assets, return on assets, sales/assets, cash holdings / assets, leverage (assets / capital), and current assets / assets. Robust standard errors are in parentheses. *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

Appendix

"Capital Regulations and the Management of Credit Commitments during Crisis Times"

Paul Pelzl and María Teresa Valderrama

December 13, 2019

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A1 Robustness Checks

Testing common trends before the crisis

We can only interpret our coefficients as reflecting active credit commitment management by banks in order to lower capital and liquidity risk during a financial crisis if our key explanatory variables do not affect lending in normal times. In other words, it is necessary that we observe a *common trend* in credit commitment volume before the crisis across banks whose capital and/or liquidity position was differently affected by the crisis. We test for this common trend by regressing the change in credit commitment volume granted by bank j to firm i between January 2005 and December 2006 on the right-hand side variables of equation (1). The motivation for choosing this early period and thus disregarding the year 2007 on the left-hand side is to avoid picking up the impact of regulatory changes caused by the (partial) implementation of Basel II in January 2007. The bank-specific regressors are measured at the same time as in our main specification to ensure that the "treatment" is equally defined. Bank-firm-specific variables are measured in January 2005. The results are reported in column 1 of Table A1. The hypothesis that the lending behavior of "treated" and "non-treated" banks followed the same trend before the crisis cannot be rejected; all coefficients and marginal effects are not significantly different from zero. In column 2, we additionally add a bank's aggregate volume of unused credit, and derive the same conclusions. Interestingly, the results of both columns however show that the average bank significantly cut partly or fully unused credit commitments over 2005-06, same as over 2008-09. In column 3, we analyse the period December 2004 - December 2006 to check whether this may be explained by seasonality, but the coefficient remains virtually identical. Therefore, the results might indicate an anticipation effect of the implementation of most of Basel II in January 2007,

which made unused credit more expensive for banks in terms of capital. In columns 4 and 5, we re-estimate the specifications underlying columns 5 and 6 of Table 4, respectively, for the period August - October 2006. Again, the coefficients and marginal effects are insignificant, providing further evidence of common pre-crisis credit supply trends across "treatment" and "control" banks.

Bank-firm-specific credit demand

The success of Khwaja and Mian (2008) fixed effects to control for firm-specific credit demand effects hinges on an assumption. Specifically, it is necessary that during the crisis a firm did not disproportionally ask those of its banks with particularly high or low capital or liquidity problems during the crisis for a modification of the granted credit commitment. As we discuss in Section 4, there is no particular reason to believe so, but nonetheless we estimate three robustness checks on the results of Table 2 to address such concerns. In our first check we compare credit supply in bank relationships that are relatively similar to each other in a given firm and thus might be characterized by more similar firm demand patterns during the crisis. This is done by adding interaction terms of the firm fixed effects and a dummy which takes the value one if a positive fraction of the credit commitment was used as a *revolving* credit line in January 2008. While the coefficient on our triple interaction term of interest turns marginally insignificant, this is mostly due to an increase in the standard error following a degrees of freedom reduction by around 25% rather than a reduction in the coefficient size. Therefore, it appears fair to conclude that our results pass this robustness check. In columns 2 and 3, we drop *Unused Volume* from the specification and instead estimate a conceptually similar specification only for credit commitments with a positive unused volume. The motivation behind this robustness check is that

overall bank-firm-specific credit demand becomes more homogeneous in this sample of partly or fully unused credit commitments; for example, the possibility that a firm first asks a bank whose commitment it does not fully use for a commitment volume reduction would not "bite" here. While this by itself would not be worrying, by restricting the sample to partly or fully unused commitments we however achieve that any potential correlation between such bank-firm-specific demand and our bank variables also becomes less of a concern. In column 3, we take this idea one step further, by only including commitments with an unused volume above one million Euros, which is the median across partly or fully unused commitments based on our baseline sample. In this sample, all commitments have a very large unused volume, so the dimension of bank-firm-specific unused credit volume appears even less relevant in driving bank-firm-specific demand. In both checks, the interaction term *US Exposure* × *Small Capital Buffer* is negative and highly significant, which provides further evidence for supply effects driving our main results.

Other

In column 5 of Table A2, we include all banks into the sample, thus also those with less than 20 client firms in January 2008. In column 6 we time the measurement of a bank's capital buffer at the end of the last quarter of 2006 in order to parallel the timing of our other bank-specific variables. In column 7 we drop commitments in which the usage of trust loans, for which it is not true that an increase in drawdowns leads to a capital ratio reduction, from our sample. In column 8 we re-define *Unused Volume* to equal one if it exceeds the continuous variable's 25^{th} percentile among positive realisations in our main sample – which equals €285,000 – and zero otherwise. The results are robust to all of these modifications.

US Asset holdings and gains and losses over time

While our empirical results suggest the contrary, one might be concerned that banks with larger US asset holdings did not actually suffer larger losses during the crisis. We contrast this concern by showing that higher US asset holdings at the onset of the crisis lead to significantly larger total losses during the crisis. This analysis is based on confidential monthly data on write-offs on loans and net value gains on security holdings and equity shares at the bank level. Importantly, by definition net gains of security holdings and equity shares are not affected by transactions but solely reflect changes in market value. The dependent variable in the regression framework underlying the mentioned results is the bank-specific sum of net value gains on security holdings and equity shares and write-offs on loans ("net gains" in the following) over the 24 months of 2008 and 2009. The main explanatory variable is the sum of US securities, equity shares and loans on the bank's balance sheet in December 2006. Variables are measured in Euros rather than in logs because the dependent variable takes both positive and negative values, and US asset exposure is not positive for all banks. The results are reported in Table A3. In column 1, we include all banks for which data exists, while in column 2 we restrict the sample to the 109 banks that are included as lenders in our baseline sample of 7,262 credit commitments. In column 3, we perform a weighted regression, which assigns a larger importance to those banks that occur more frequently in our baseline sample. The coefficient is negative and significant in all three columns, and mostly so in our preferred weighted regression. The coefficient in column 3 indicates that a one Euro increase in pre-crisis US asset holdings on average translates into a 2.1 Euro loss during the crisis.

Table A1: Robustness Check: Common Trends pre-Crisis?

Dependent variable →	Δln *Credit* $Commitment_{ij}$ 05:01 - 06:12	Δln *Credit* $Comm._{ij}$ 04:12 - 06:12	Δln *Credit* $Commitment_{ij}$ 06:08 - 06:10		
Def. of Bank-Firm-Level Var. *Unused Volume* →	= 1 if positive		= 1 if > 25$^{\text{th}}$ percentile		
Sample →	All Firms				Non-Traded
	(1)	(2)	(3)	(4)	(5)
US Exposure × Unused Volume	0.002	0.003	-0.007	0.002	-0.007
	(0.023)	(0.025)	(0.028)	(0.010)	(0.018)
US Exposure × Small Capital Buffer × Unused Vol.	0.003	0.003	0.045	0.012	0.020
	(0.045)	(0.045)	(0.055)	(0.018)	(0.031)
Small Capital Buffer × Unused Volume	-0.032	-0.032	-0.053	0.010	0.021
	(0.042)	(0.043)	(0.042)	(0.018)	(0.032)
Int'l Interbank Borr. × Unused Vol.	-0.032	-0.035	-0.017	-0.012	0.001
	(0.030)	(0.039)	(0.031)	(0.013)	(0.016)
Total Unused Volume at Bank Level × Unused Vol.		0.003			
		(0.021)			
Unused Volume	-0.096***	-0.096***	-0.096***	-0.043***	-0.067***
	(0.022)	(0.022)	(0.024)	(0.010)	(0.019)
Bank-Firm Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
Observations	6,811	6,811	6,689	9,061	2,869
# Banks	100	100	99	105	100
# Firms	2,100	2,100	2,062	2,676	781
Marginal Effects on credit commitment supply (relative to: col.1-3 *Unused Volume = 0*; col.4-5 *Unused Volume < 25th percentile*)					
1sd Rise in US-Exp if large cap-buffer & unused c-vol.	0.002	0.003	-0.007	0.002	-0.007
1sd Rise in US-Exp if small cap-buffer & unused c-vol.	0.005	0.005	0.034	0.013	0.013
1sd Rise in Int'l Interbank Borr. if unused c-vol.	-0.032	-0.035	-0.017	-0.012	0.001

In this table, we show the results of placebo tests on the results of column 4 of Table 2. In columns 1 and 2, the dependent variable is the change in the maximum amount of credit firm i can obtain from bank j, between January 2005 and December 2006. The sample consists of credit commitments by banks that were lending to at least 20 client firms in January 2008 to firms that borrowed from at least two banks in 2005:01 and 2006:12. In column 3 we compute the dependent variable over the horizon December 2004 to December 2006 and in columns 4-5 we focus on the change between August and October 2006. As in our main specification, in all columns bank-specific variables are measured at the latest possible time in 2006, apart from the bank's capital buffer (2008:Q1). *Unused Volume* and *Bank-Firm Controls* are measured in January 2005 (columns 1-2), December 2004 (column 3) or August 2006 (columns 4-5), respectively. See Table 2 for a description of the explanatory variables. Standard errors are clustered at the bank and firm level and reported in parentheses. *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

Table A2: Further Robustness Checks

Dependent variable →	$\Delta ln(Credit\ Commitment_{ij})$ 2008:01 - 2009:12							
Nature of Robustness Check →	Base-line	Firm × CL Type FE	Only U.V.> 0	Only U.V.> 1mn	All Banks	Cap.Buffer measured in 06Q4	No Trust Loan Usage	U.V. > 25th pctl.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
US Exposure × Unused Volume	-0.017	0.017			-0.004	0.037	0.001	0.000
	(0.024)	(0.030)			(0.022)	(0.035)	(0.025)	(0.022)
US Exposure × Small Capital Buffer × Unused Volume	-0.106**	-0.089			-0.104**	-0.104**	-0.094**	-0.116***
	(0.046)	(0.058)			(0.043)	(0.048)	(0.044)	(0.042)
Small Capital Buffer × Unused Volume	-0.019	-0.005			-0.016	-0.020	-0.033	-0.023
	(0.044)	(0.056)			(0.040)	(0.041)	(0.044)	(0.042)
Int'l Interbank Borrowing × Unused Volume	-0.098***	-0.101***			-0.103***	-0.094***	-0.112***	-0.082***
	(0.023)	(0.027)			(0.022)	(0.022)	(0.024)	(0.023)
Unused Volume	-0.153***	-0.159***			-0.136***	-0.148***	-0.168***	-0.207***
	(0.023)	(0.031)			(0.021)	(0.028)	(0.024)	(0.025)
US Exposure			0.094***	0.153**				
			(0.030)	(0.065)				
US Exposure × Small Capital Buffer			-0.134***	-0.194***				
			(0.037)	(0.063)				
Int'l Interbank Borrowing			-0.018	-0.034				
			(0.032)	(0.064)				
Bank Controls	No	No	Yes	Yes	No	No	No	No
Bank-Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Observations	7,262	6,104	3,520	1,349	8,336	7,262	6,643	7,262
# Banks	109	108	108	85	284	109	109	109
# Firms	2,266	1,829	1,265	488	2,535	2,266	2,064	2,266
Marginal Effects on credit commitment supply (relative to: col. 1,2,5,6,7: *Unused Vol.=0*; col.8: *U.V.<25th pctl.*; col.3 & 4: banks with no or less exposure)								
1sd Rise in US-Exp if large cap-buffer & unused c-vol.	-0.017	0.017	0.094***	0.153**	-0.004	0.037	0.001	0.000
1sd Rise in US-Exp if small cap-buffer & unused c-vol.	-0.123**	-0.072	-0.040*	-0.041	-0.108**	-0.067**	-0.093*	-0.116**
1sd Rise in Int'l Interbank Borr. if unused credit vol.	-0.098***	-0.101***	-0.018	-0.034	-0.103***	-0.094***	-0.112***	-0.082***

This table shows several robustness checks on the findings displayed in column 4 of Table 2. Column 1 repeats the baseline results reported in column 4 of Table 2. In column 2, we add interaction terms of the firm fixed effects and a dummy variable that equals one if the firm's usage of revolving credit lines in January 2008 is larger zero. In column 3 we restrict the sample to those commitments that are not fully used, and drop the interactions with *Unused Volume* and the bank fixed effects. In column 4 we do the same but restrict the sample to those commitments with an unused credit volume of more than one million Euros. This value is chosen since it is the median realisation of unused credit volume across the positive values of the variable in our baseline sample of 7,262 credit commitments. In column 5 we include all banks rather than only those that were lending to at least 20 firms in January 2008. In column 6 we use the capital buffer realisations in Q4:2006 to compute the variable *Small Capital Buffer*. In column 7 we exclude all bank-firm pairs in which trust loan usage in 2008:01 is positive. In column 8 we re-define *Unused Volume* to equal one if it exceeds the continuous variable's 25th percentile among positive realisations in our main sample – which equals €285,000 – and zero otherwise. Standard errors are clustered at the bank and firm level and reported in parentheses. *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

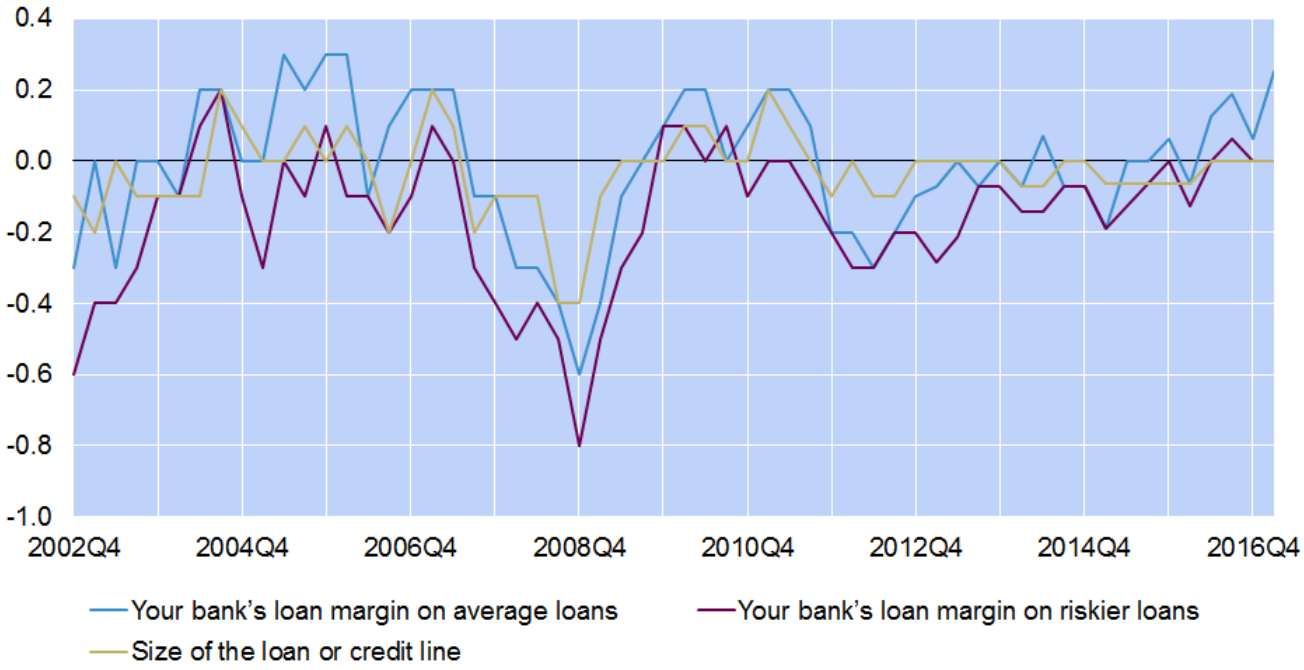
Table A3: Robustness Check: US assets and gains and losses around the crisis

Dependent Variable →	Net Total Asset Value Gains 2008-09		
Sample →	All Banks	Banks in our Sample	
Weighting →	All banks have equal weight		Weighted using frequency in main sample
	(1)	(2)	(3)
US Assets 2006:12	-1.303*	-1.328*	-2.061***
	(0.665)	(0.678)	(0.434)
Observations (Banks)	347	108	108

In this table, we analyse the relationship between pre-crisis US asset holdings (explanatory variable) and total net asset value gains during the crisis (dependent variable) at the bank level. Specifically, the dependent variable is the net total asset value gains incurred by a bank due to changes in the market value of securities and equity share holdings and/or write-offs of loans. *US Assets* equals the sum of US securities, equity shares and loans on the bank's balance sheet, in whichever currency. Both the dependent and explanatory variables are measured in Euros. In column 1, we include all banks operating in Austria that are required to report the relevant data. In column 2, we restrict the sample to those banks that are in our sample (one bank is omitted due to lack of data for the dependent variable). In column 3, we weight every observation by the frequency (thus number of client firms) of the bank in our baseline sample of 7,262 credit commitments (see Table 2). Robust standard errors are in parentheses. *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

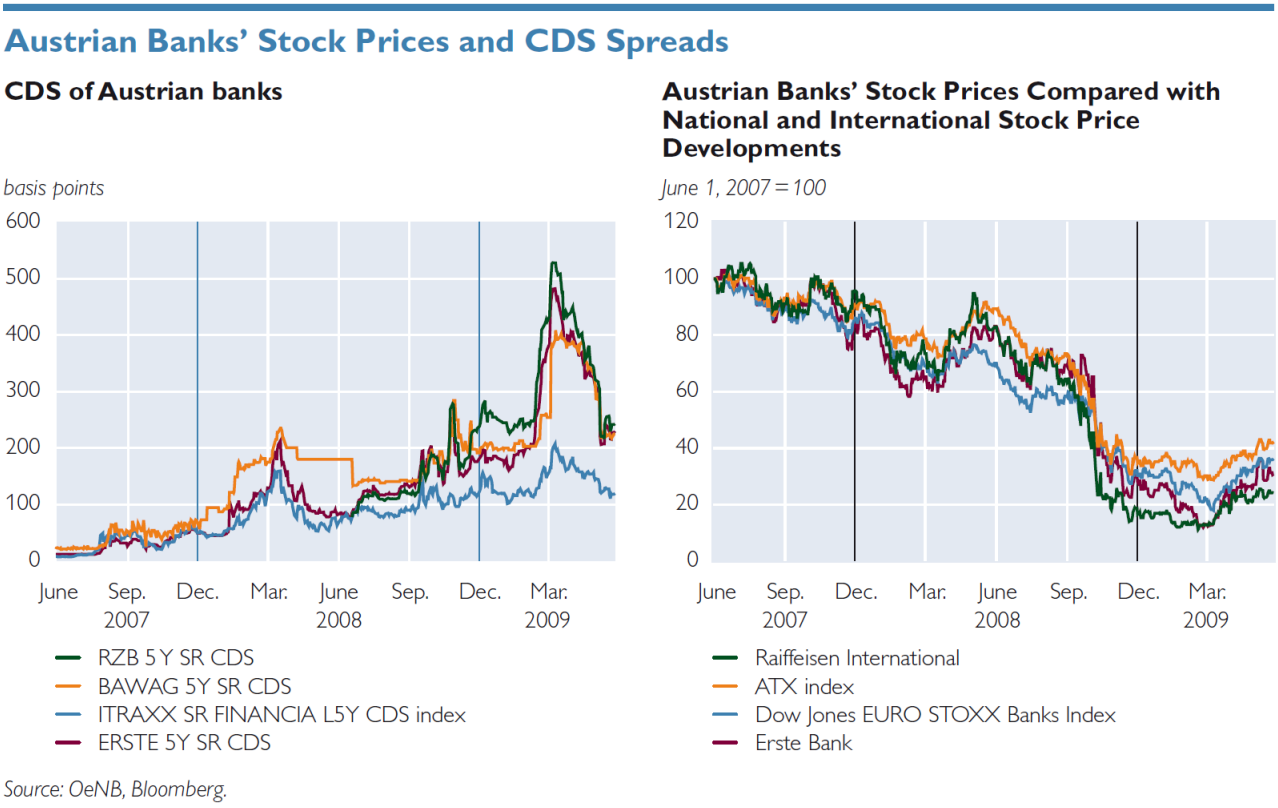
A2 Figures

Figure 1: Lending Standards and Volumes of Austrian Banks, Diffusion Index



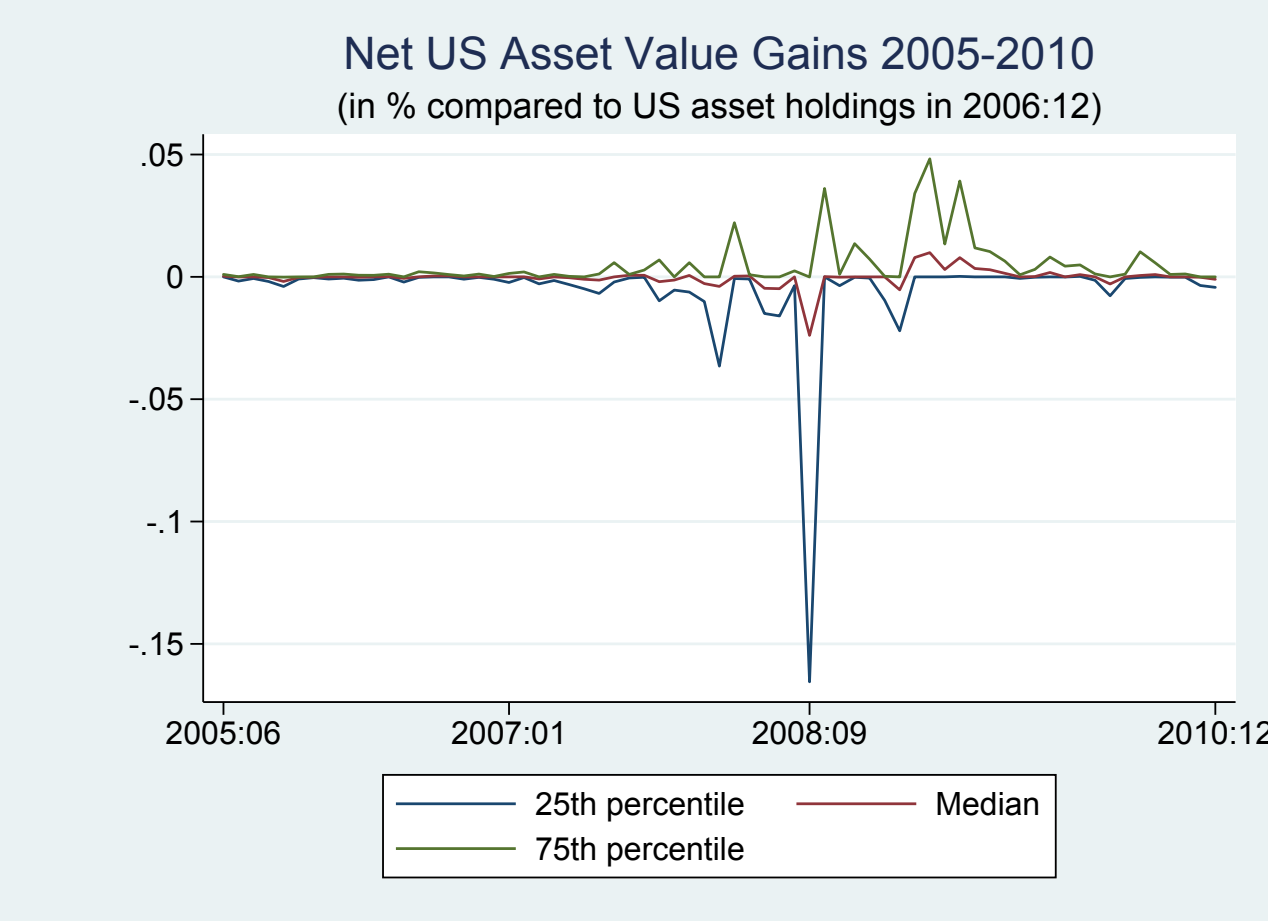
This figure depicts lending standards of the most important Austrian banks over time according to the Austrian version of the Euro area bank lending survey administered by the European Central Bank. A negative number indicates a deterioration/tightening of lending standards from the perspective of the borrower compared to the previous quarter. The graph also shows the development of credit volumes (as reported by the bank), in relative terms to the previous quarter. Source: OeNB.

Figure 2: CDS spreads and stock market performance of Austrian banks



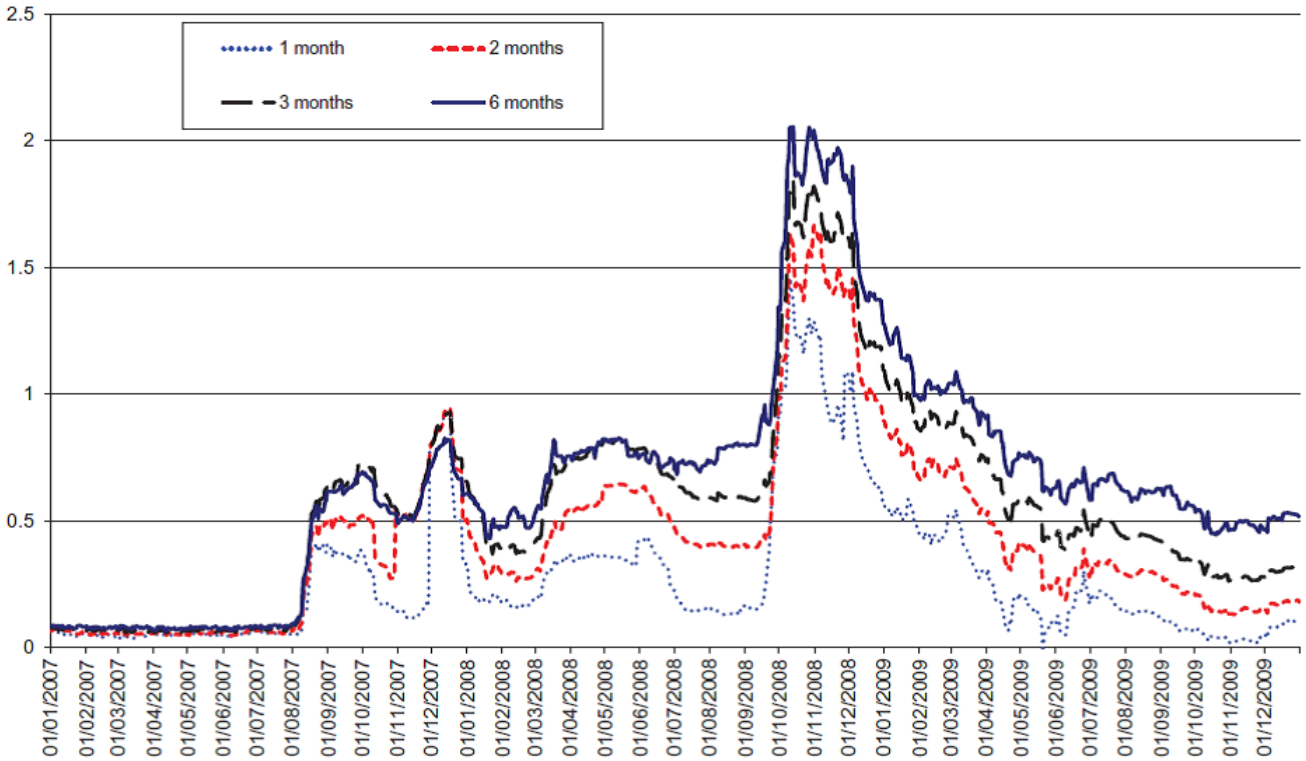
This graph shows the development of Credit Default Swaps (CDS) spreads of three Austrian major banks (left panel) and the development of two Austrian banks' and the overall Austrian stock market performance (right panel), in an international comparison. ITRAXX SR FINANCIAL 5Y CDS index is the brand name for the family of credit default swap index products covering different regions – in the present graph we plot the European index. The ATX index is the most important stock market index of the Vienna Stock Exchange. The Dow Jones EURO STOXX Banks Index is an index of stock market prices of the major banks within the European Union, and is weighted based on the market capitalization of the included banks. SR stands for senior debt.

Figure 3: Net US Asset Value Gains, 2005-2010



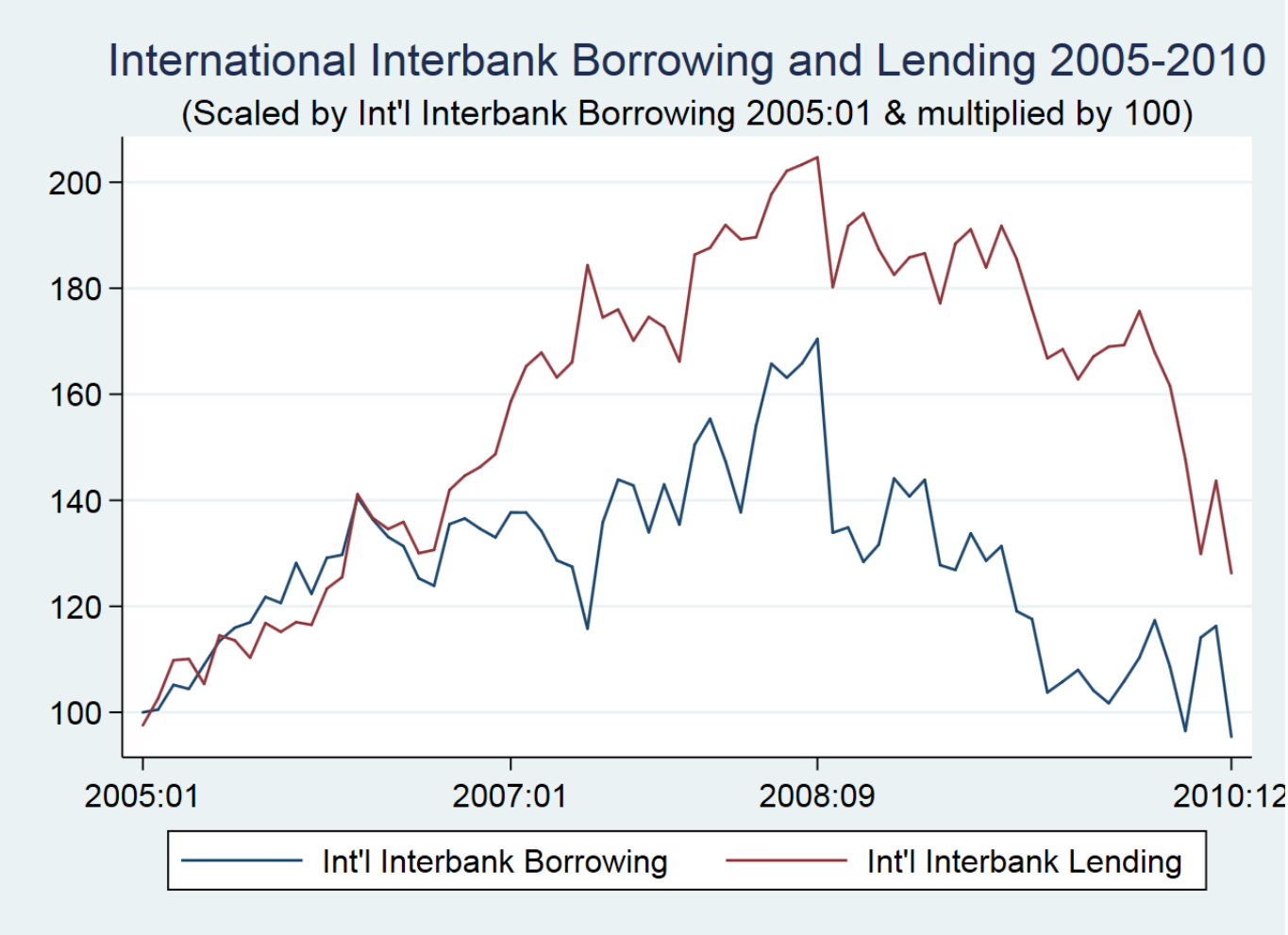
This graph shows the distribution of the sum of US-specific loan write-offs and net gains on security and equity share holdings at the bank level across all banks in our sample, over 2005-2010. The variable is scaled by the amount of a bank's US asset holdings in December 2006, the moment in time in which we measure US asset exposure in our empirical analysis. For each month over our time period, the graph shows the 25^{th} and 75^{th} percentile as well as the median, based on the individual bank-time observations. Net gains of security holdings and equity shares are not affected by transactions but solely reflect changes in market values. Source: OeNB.

Figure 4: The cost of Interbank funding



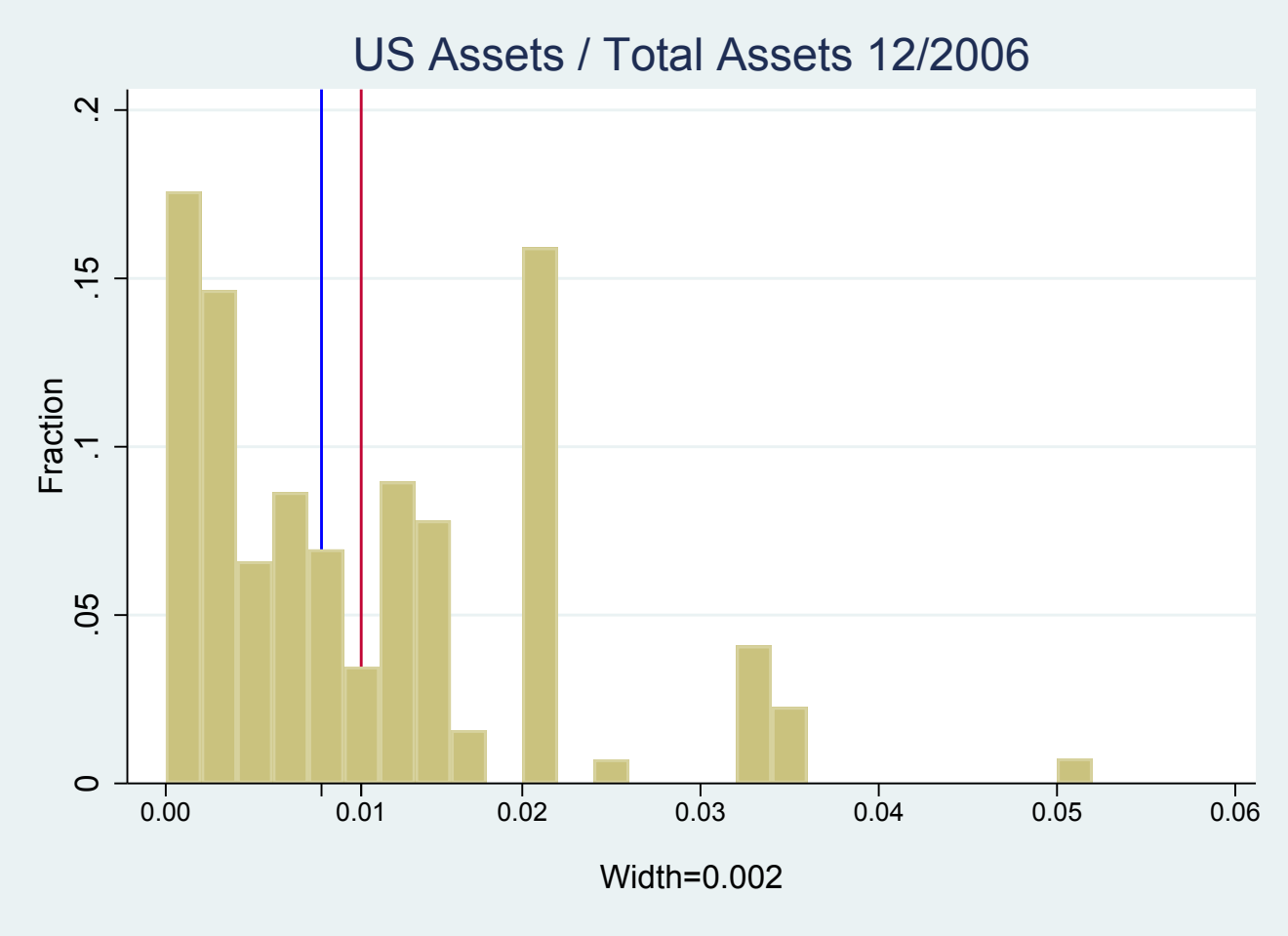
This figure depicts the spread between the unsecured ("Euribor") and secured ("Eurepo") interbank lending rates between 2007 and 2009 for different maturities. Source: European Central Bank, Cingano et al. (2016).

Figure 5: International Interbank Borrowing and Lending 2005-2010



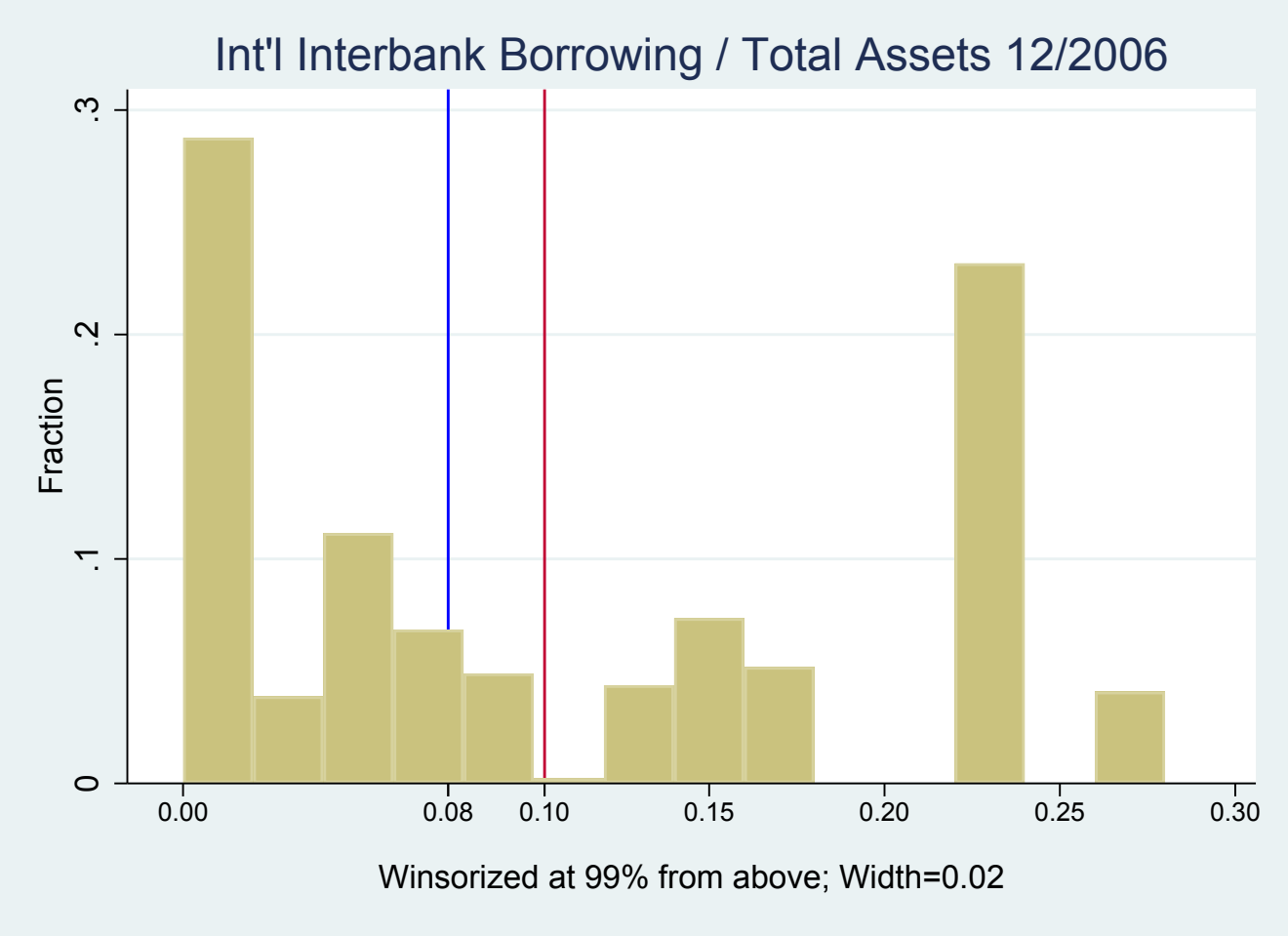
This figure depicts the sum of total international interbank borrowing and lending, respectively, of banks operating in Austria from 2005-2010. Both series are scaled by total international interbank borrowing in January 2005, and then multiplied by 100. Source: OeNB.

Figure 6: Distribution of US Assets / Total Assets



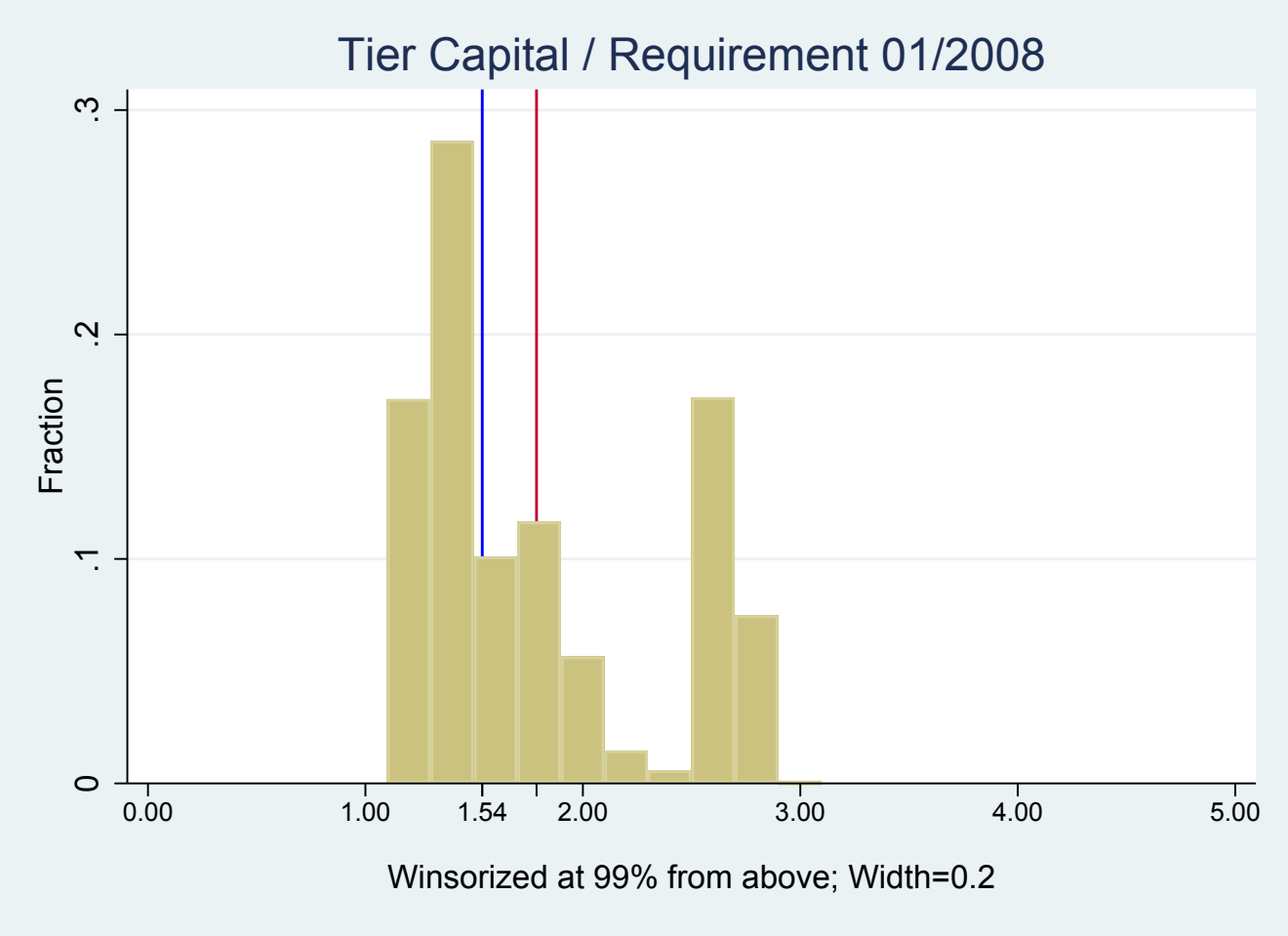
This figure displays the distribution of US Assets / Total Assets across our sample in December 2006. The underlying sample is not individual banks, but the US exposure of the banks associated to individual credit commitments. This ensures that the realizations of individual banks are properly weighted based on their importance in our sample of credit commitments. The blue vertical line indicates the median across our sample, while the red vertical line displays the mean. The individual bars indicate the fraction of credit commitments that are associated with a lender that has a realization of US Assets / Total Assets within the respective interval. Source: OeNB.

Figure 7: Distribution of International Interbank Borrowing / Total Assets



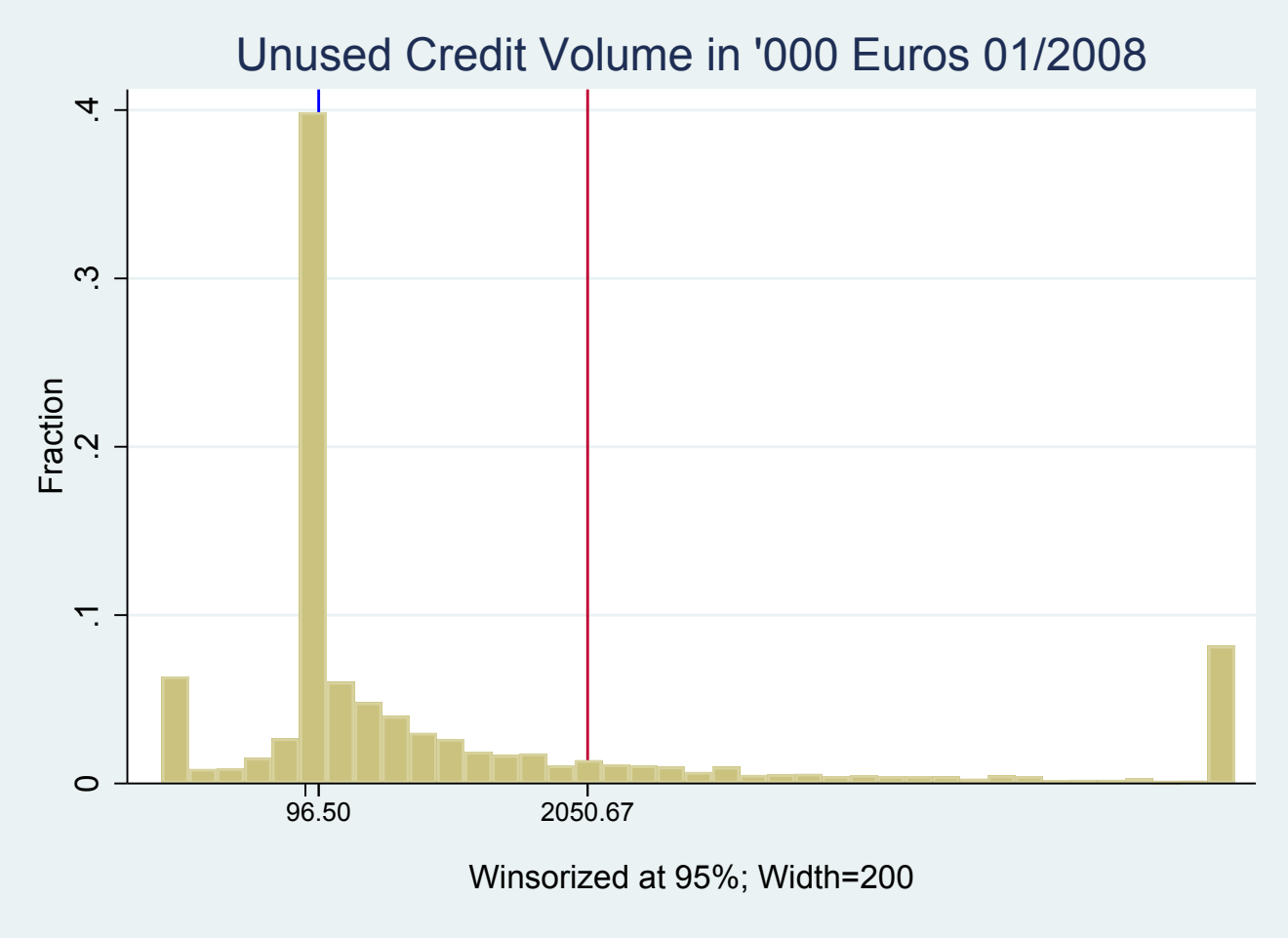
This figure displays the distribution of International Interbank Borrowing / Total Assets across our sample in December 2006. The underlying sample is not individual banks, but the interbank funding dependence of the banks associated to individual credit commitments. This ensures that the realizations of individual banks are properly weighted based on their importance in our sample of credit commitments. The blue vertical line indicates the median across our sample, while the red vertical line displays the mean. The individual bars indicate the fraction of credit commitments that are associated with a lender that has a realization of International Interbank Borrowing / Total Assets within the respective interval. For illustrative purposes, the data is winsorized from above at the 99% level, but the mean and median are computed based on the original data. Source: OeNB.

Figure 8: Distribution of Capital Buffers



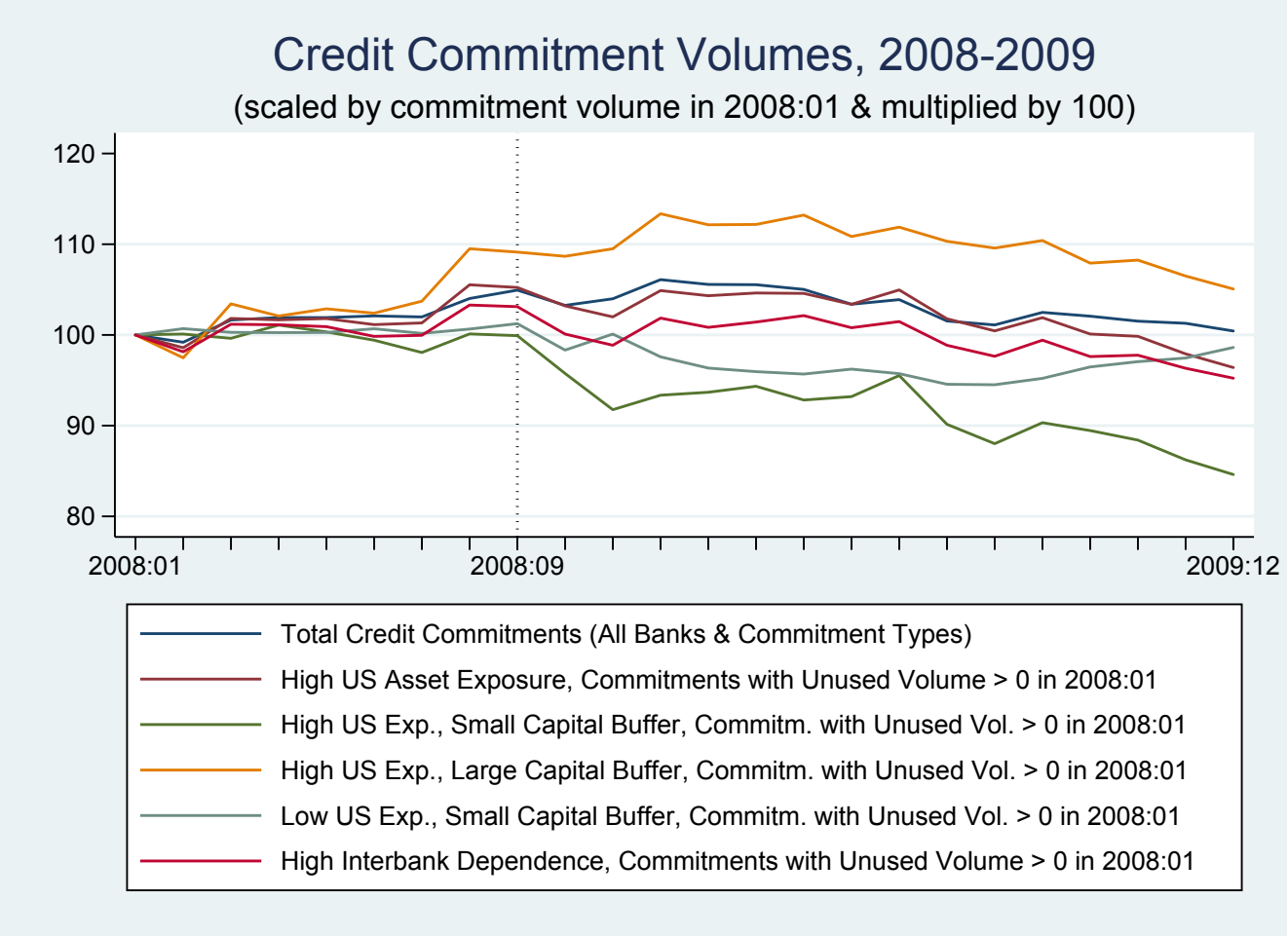
This figure displays the distribution of capital buffers across our sample in January 2008. The underlying sample is not individual banks, but the capital buffers of the banks associated to individual credit commitments. This ensures that the realizations of individual banks are properly weighted based on their importance in our sample of credit commitments. We measure a bank's capital buffer as the ratio of its Tier 1 + Tier 2 capital holdings divided by the individual bank's minimum capital requirement. The blue vertical line indicates the median, while the red vertical line displays the mean. The individual bars indicate the fraction of credit commitments that are associated with a lender that has a capital buffer realization within the respective interval. For illustrative purposes, the data is winsorized from above at the 99% level, but the mean and median are computed based on the original data. Source: OeNB.

Figure 9: Distribution of Unused Credit Volume



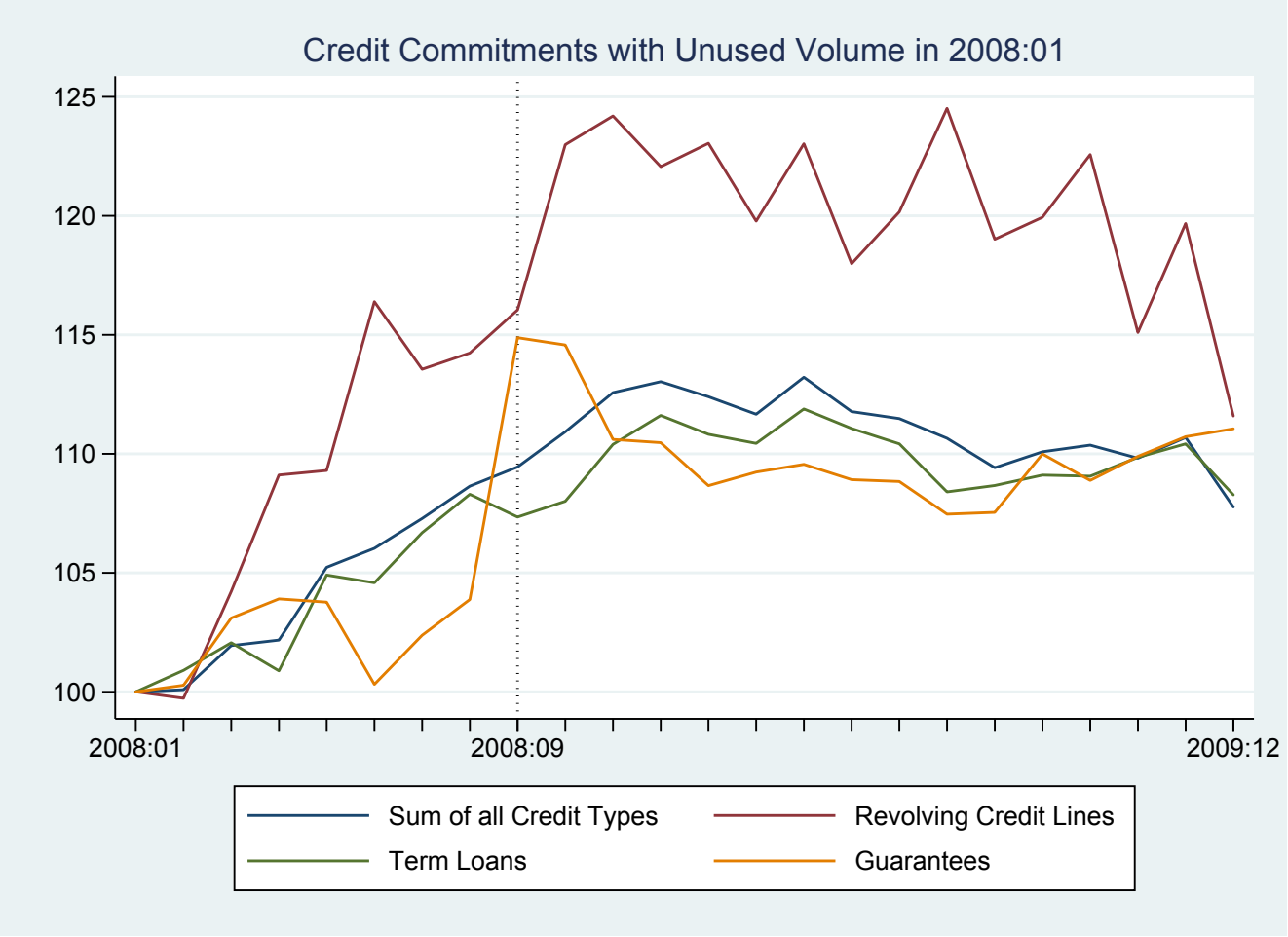
This figure shows the distribution of the bank-firm-specific unused credit volume in thousand Euros in January 2008 over our sample. The blue vertical line indicates the median, while the red vertical line displays the mean. The individual bars indicate the fraction of credit commitments that have a given unused credit volume within the respective interval. For illustrative purposes, the data is winsorized at the 95% level, but the mean and median are computed based on the original data. Source: OeNB.

Figure 10: Credit Commitment Volumes 2008-2009



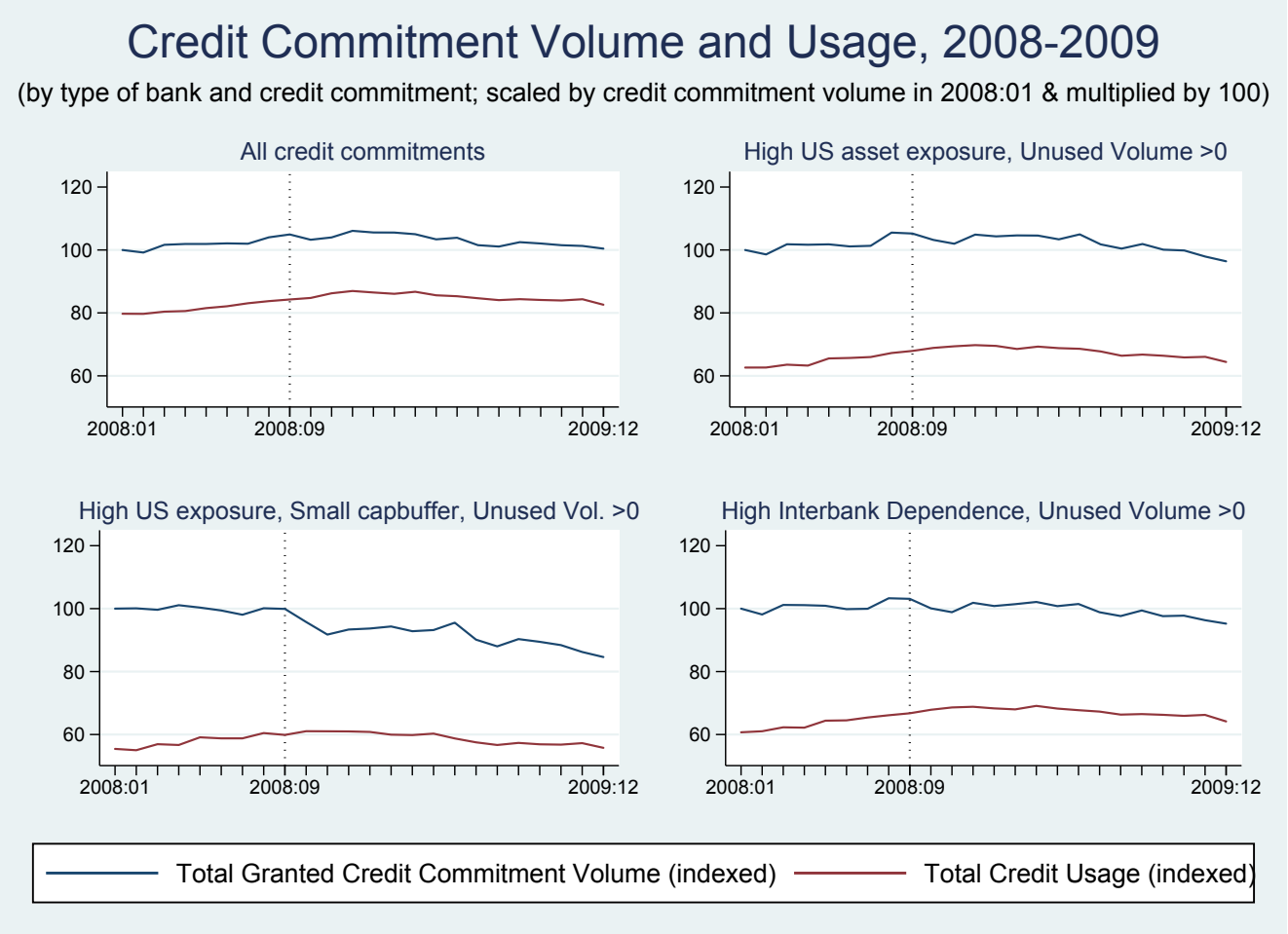
In this graphs we plot the development of granted credit volumes over 2008:01 - 2009:12 for different types of banks and credit commitments. The basis for computing the respective sums is our baseline sample of 7,262 bank-firm pairs. The volumes are normalized by the granted volume in January 2008. Source: OeNB.

Figure 11: Credit Usage by Type 2008-2009



In this graph we plot the development of the usage of total credit and of the three most important credit types, which jointly make up about 95% of total credit usage (see Table 1), over 2008-2009. The basis for computing the respective sums is our baseline sample of 7,262 bank-firm pairs. The volumes are normalized by the respective usage volume in January 2008. Source: OeNB.

Figure 12: Credit Commitment Volume and Usage 2008-2009



In these four graphs we plot the development of granted credit volumes and usage levels over 2008:01 - 2009:12 for different types of banks and credit commitments. The top-left graph shows the total granted credit volume as well as the total usage across all banks and firms in the sample based on which which we estimate our main specification. The volumes are normalized by the granted volume in January 2008, same as in the other graphs. In the top-right graph, we plot the total granted volume and usage of credit commitments that are not fully used and are granted by banks with above-median US asset exposure; in the bottom-left graph we further restrict banks to those with a below-median capital buffer. In the bottom-right graph we focus on credit commitments that are not fully used and are granted by banks with above-median dependence on international interbank funding. Source: OeNB.

A3 Unused Credit Volume Usage & Firm Characteristics and more

Table A4: Credit Commitm. Usage, Balance Sheet Data Avail. and Firm Characteristics

Dependent variable	ln(Unused Volume) or =0			Δ Inv. not miss.	Δ Empl. not miss.
	(1)	(2)	(3)	(4)	(5)
Return on Assets	0.220***	0.187**		0.009	0.015
	(0.069)	(0.075)		(0.015)	(0.011)
Assets	0.060	-0.085		0.028	0.049***
	(0.104)	(0.115)		(0.022)	(0.009)
Sales / Assets	0.403***	0.292***		-0.053***	0.030**
	(0.097)	(0.097)		(0.018)	(0.014)
Cash Holdings / Assets	-0.188***	-0.176**		-0.037***	-0.003
	(0.069)	(0.080)		(0.013)	(0.008)
Assets / Capital (Leverage)	-0.181***	-0.167*		-0.068***	-0.052***
	(0.065)	(0.090)		(0.016)	(0.015)
Current Assets / Assets	-0.091	-0.294***		0.075***	0.046***
	(0.096)	(0.096)		(0.020)	(0.015)
Relationship Duration	0.337***	0.391***			
	(0.071)	(0.081)			
Average Probability of Default		-0.122**	-0.203***	-0.036***	-0.030**
		(0.058)	(0.055)	(0.014)	(0.013)
Bank FE	Yes	Yes	Yes	No	No
Observations	5,650	3,733	4,202	1,206	1,206
# Firms	1,718	1,206	1,366	1,206	1,206
# Banks	109	96	99	NA	NA

This table analyses the correlation between several variables of interest and firm characteristics. Our analysis is based on the 7,262 bank-firm relationships that feature our main sample. *ln(Unused Credit Volume)* is measured in January 2008. Δ *Inv. not miss.* equals one if for the specific firm we are able to compute the dependent variable of columns 5-6 in Table 7, and zero otherwise. Δ *Empl. not miss.* equals one if we are able to compute the dependent variable of columns 7-8 in Table 7. Firm balance sheet variables are measured in 2007, while the average probability of default is measured in the earliest available moment in 2008, and is the average assessment across the firm's banks. The variable is measured in percent (e.g. if the probability of default equals one percent, then *Probability of Default* = 1). Standard errors are in parentheses and clustered at the bank and firm level in columns 1-3 and robust in columns 4-5. *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

A4 Granted Credit versus Used Credit by Credit Type, 2013-2014

Table A5: Descriptive Statistics

	Mean	Median	Min	Max	sd	N
I: Undrawn Credit Volume (UCV) in €						
Total	1,237	7	-199,923	999,371	8,291	540,570
Term Loans	227.519	0	-43,808	350,000	3,140	540,570
Revolving Credit Lines	715.870	0	-205,556	534,986	6,198	540,570
Guarantees	280.853	0	0	999,371	3,885	540,570
Special Purpose Loans	9.569	0	-10,597	69,856	461.279	540,570
Leasing Loans	-0.018	0	-6,578	2,199	11.458	540,570
Trust Loans	3.367	0	-8,318	14,000	121.490	540,570
II: Contribution to UCV in % by Credit Type						
Term Loans	0.149	0	0	1	0.340	275,382
Revolving Credit Lines	0.670	1	0	1	0.436	275,382
Guarantees	0.160	0	0	1	0.333	275,382
Special Purpose Loans	0.016	0	0	1	0.123	275,382
Leasing Loans	0.000	0	0	1	0.008	275,382
Trust Loans	0.006	0	0	1	0.069	275,382
III: Used / Granted Credit by Credit Type						
Total	0.808	0.976	0	1.001	0.296	482,109
Term Loans	0.958	1	0	1	0.158	330,123
Revolving Credit Lines	0.501	0.556	0	1	0.416	258,575
Guarantees	0.786	1	0	1	0.324	168,289
Special Purpose Loans	0.945	1	0	1.008	0.145	10,654
Leasing Loans	0.999	1	0	1	0.028	5,957
Trust Loans	0.882	1	0	1	0.267	7,724

From 2013 onwards, the Austrian Credit Register contains information on the granted credit amount by credit type, besides the information used in our analysis. This table provides summary statistics using these data, over the period 2013-2014. Numbers are rounded to the nearest integer if they are larger than 1,000. The statistics in Panel 2 are based on commitments with an unused volume larger zero.

A5 List of CESEE countries

We define a bank's CESEE assets as the sum of securities and shares acquired from counterparties in CESEE countries and loans to CESEE counterparties, divided by the sum of a bank's total loans, securities and shares. CESEE countries are: Albania, Azerbaijan, Bulgaria, Belarus, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia.

A6 Details on tracking bank mergers and changes in bank identifiers

We track bank mergers and split-ups and resulting changes in bank identifiers (which correspond to the bank's actual bank codes) as well as identifier changes that are not related to mergers or split-ups over 2004-2009. This is necessary because these changes are not taken into account in the raw credit register data. Data on bank mergers, splits and identifier changes is provided by the Austrian Central Bank. While especially mergers have been quite common over 2004-2009 (around 10 cases per year), mostly very small banks which hardly appeared in the credit register were taken over by other banks. For our main specification, we track changes between January 2008 and December 2009.

Considering mergers, three cases have to be distinguished. If bank j merges with bank k (such that only k remains thereafter) and firm i has a credit commitment with j but not with k in January 2008 and a credit commitment with k in December 2009, we treat j and k as one bank from the perspective of i (zero cases). If i has a credit commitment with k in both January 2008 and December 2009 and no commitment with j in January 2008, we ignore k's merger with j. If i has a credit commitment with both j and k in January 2008 and a commitment with k in

December 2009, we sum all credit commitment variables across j and k for January 2008 (zero cases). Bank-specific pre-crisis variables are chosen as those of j.

In case of bank splits, by which we mean bank j splitting from bank k such that both j and k remain thereafter, several cases must be distinguished. If firm i has a credit commitment with k in January 2008 and a commitment with only k in December 2009, we ignore the split. If firm i has a credit commitment with k in January 2008 and a credit commitment with only j in December 2009, we treat j and k as one bank, from the perspective of i (one case=split, which affects 47 credit commitments). If i has a credit commitment with k in January 2008 and credit commitments with both j and k in December 2009, we sum all commitment variables across j and k for December 2009 (one split, which affects 27 commitments).

Finally, we also keep track of banks changing identifier for other reasons (zero cases).

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