Capital Regulations and the Management of Credit Commitments during Crisis Times

BY Paul Pelzl and Maria Teresa Valderrama

DISCUSSION PAPER

Institutt for foretaksøkonomi
Department of Business and Management Science

FOR 12/2020

ISSN: 1500-4066
October 2020

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

Paul Pelzl[a,b] and María Teresa Valderrama[c]

[a]Norwegian School of Economics (NHH)

[b]De Nederlandsche Bank (DNB)

[c]Oesterreichische Nationalbank (OeNB)

September 24, 2020

Abstract

Drawdowns on credit commitments by firms reduce a bank's capital buffer. Exploiting Austrian credit register data and the 2008-09 financial crisis as exogenous shock to bank health, we provide novel evidence that capital-constrained banks manage this concern by substantially cutting partly or fully unused credit commitments. Controlling for a bank's capital position, we further find that also larger liquidity problems induce banks to cut such commitments. These results show that banks manage both capital and liquidity risk posed by undrawn credit commitments in periods of financial distress, but thereby reduce liquidity insurance to firms exactly when they need it most.

JEL codes: E51, G01, G21, G28, G32
Keywords: Capital Regulations, Credit Commitments, Financial Crisis

*We thank members of the Economic Analysis and Research Department of the Oesterreichische Nationalbank (OeNB) and the Economic Policy and Research Division of De Nederlandsche Bank (DNB), Tim Eisert, Aysil Emirmahmutoglu, Jakob de Haan, Ralph de Haas, Sanja Jakovljević, Olivier de Jonghe, Steven Poelhekke, Doris Ritzberger-Grünwald, Glenn Schepens, Günseli Tümer-Alkan and seminar participants at the OeNB, DNB, Tinbergen Institute, Vrije Universiteit Amsterdam, University of Amsterdam, Norwegian School of Economics (NHH), WU Vienna, Carlos III Madrid and the European Bank for Reconstruction and Development (EBRD) as well as conference participants at the 3rd Annual Workshop of the ESCB Research Cluster 3 in Madrid, the EFA 2019 in Carcavelos, the CESifo Workshop on Banking and Institutions in Munich, the C.r.e.d.i.t. 2018 in Venice, the 6th WU-WAETRIX Workshop in Vienna, the 35th International Symposium of Money, Credit and Banking in Aix-en-Provence, the NOeG Annual Meeting 2018 in Vienna, the 5th Research Workshop of the MPC Task Force on Banking Analysis for Monetary Policy in Brussels, the 1st NOeG Winter Workshop in Vienna and the IFABS 2017 in Oxford for helpful comments and suggestions. The views expressed in this paper are those of the authors and do not necessarily reflect the views of the OeNB or DNB.

1 Introduction

A significant fraction of corporate bank lending is done via credit commitments that allow a firm to choose the credit usage level. The classic credit commitment is a revolving credit line, but also delayed-draw term loans or certain bank guarantees enable flexible usage. A credit commitment that is not fully used provides liquidity insurance, sends a positive signal on the quality of the firm (Fama, 1985) and is often required to back up commercial paper. From the bank's perspective, commitment fees charged on the unused credit portion make up an important source of revenue (Sufi, 2009; Berg et al., 2016). These earnings come at low cost as long as the commitment remains unused, since undrawn credit is largely off-balance sheet and must therefore be backed by only little capital in the Basel framework. The flip side is that drawdowns raise the size of the bank's balance sheet which lowers the bank's capital ratio and thereby the buffer towards its minimum capital requirement, limiting the bank's potential to absorb future losses. Exposure to unused credit commitments therefore puts a bank's capital buffer at risk. Acharya and Steffen (2020) recognise this issue and its consequences in a policy note focused on the U.S. economy: "drawdowns require additional bank capital as they manifest as loans on bank balance sheets, constraining the ability to provide further, new loans to the economy, and in some cases, potentially also bringing banks closer to insolvency." However, a shortage of granular and comprehensive data that distinguishes used from granted credit has prevented the literature from studying this problem. We overcome this challenge with Austrian credit register data that contains both the volume of committed and used credit at the bank-firm level, allowing us to measure the risk of additional drawdowns for individual banks and credit relationships. As in many other economies, credit commitments are highly relevant for Austrian banks. Covering 90% of the Austrian bank credit market, the register reveals that if the usage of all observed credit commitments at the onset of the 2008-09 financial crisis increased to match their committed volume, the average bank would have faced a capital buffer reduction of up to 20%.

This paper is the first to study if and how banks manage capital concerns that come with exposure to undrawn credit commitments in periods of financial distress, and what consequences this has on lending to the corporate sector. We study the 2008-09 financial crisis as a prime example of times in which the described risk of capital buffer reductions is particularly relevant. During financial turmoil bank capital positions are typically weakened, raising capital is more expensive and drawdowns on credit commitments are more likely. The latter is illustrated by a sharp increase in aggregate credit usage during 2008-09 in the Austrian register data. Banks can possibly adjust their credit commitment portfolio in three different ways: upon covenant violations by firms, as the maturities of commitments expire, or – in the case of unconditionally cancellable credit commitments – by using the right to cut or abandon the commitment unilaterally. We find that during the 2008-09 crisis, banks whose capital position was hit relatively hard and whose initial capital buffer was comparatively small made use of these options. They lowered the risk of capital buffer reductions by substantially reducing the granted credit volume to firms that did not fully use their commitment, and the larger the unused volume, the more so. Capital-constrained banks thus either cut existing commitments or refrained from supplying new commitments to existing clients during the crisis, or both. While we know that bank capital generally matters for credit supply, our results shed light on a novel and important link between capital regulations and bank lending to the real economy.

As a second contribution we show that controlling for a bank's capital position, relatively large exposure to a general liquidity dry-up affects a bank's supply of credit commitment volumes as well. In particular, such exposure also induced banks to cut partly or fully unused commitments at the peak of the 2008-09 crisis, thereby limiting the scope of additional credit drawdowns and the resulting liquidity costs. Our results are conditional on changes in firm-specific credit demand and creditworthiness as well as changes in bank-specific unobservables during the crisis. Furthermore, we show that the credit commitment supply of "treated" and "untreated" banks followed a common trend before the crisis. We therefore provide plausibly

causal evidence that banks actively manage both capital and liquidity risk posed 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 insurance to firms exactly when they need it most and when alternatives to bank financing tend to be scarce. Making things worse, a reduced bank credit commitment might also have negative effects on access to non-bank funding, either via sending a negative signal on the firm or by making the firm unable to back up commercial paper (via an undrawn "backup line of credit"). Our evidence thus indicates a transfer of liquidity risk from banks to firms, a phenomenon that has received little attention so far. On the positive side, we find that in Austria firms were largely able to substitute credit reductions during the 2008-09 crisis via other banks and did not suffer real effects. However, this may be different in other countries or times in which a given financial crisis has a bigger impact.

Our identification strategy is to exploit the 2008-09 financial crisis as a shock of varying degree to the capital and liquidity positions of banks. 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 unforeseen to the Austrian banking sector. We expect that the more a bank's capital position is hit by the crisis and the smaller the bank's initial capital buffer, the more vulnerable the bank is to a capital ratio reduction and therefore to additional credit drawdowns during the crisis. As an exogenous proxy for the crisis effect on bank capital, we use a bank's pre-crisis exposure to US asset markets. Using confidential bank-level data, we show that banks with larger US asset holdings 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 affect a bank's capital buffer. Besides capital concerns, we also expect that the more a bank's cost of liquidity increases due to the crisis, the more sensitive it is to additional credit drawdowns over 2008-09. 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.

We find that a one standard deviation increase in US asset exposure induces a bank with a relatively small capital buffer to reduce the granted credit volume of the average commitment that is not fully used by around 11% between January 2008 and December 2009. At the same time, larger US asset exposure does not affect the credit commitment supply of banks with a large capital buffer, and having a small capital buffer has no impact on the credit supply of banks with no US asset exposure. Our interpretation of these results is that capital-constrained banks, i.e. those with relatively large US asset exposure and a small capital buffer, cut commitments with a positive undrawn volume mostly as a precautionary move to limit further capital problems. This conclusion is supported by two additional findings: (i) the larger the bank-firm-specific unused credit volume, the larger the percentage reduction in the granted credit amount by capital-constrained banks; and (ii) the more unused credit a bank faces in the aggregate, the more it cuts individual commitments that are not fully used. Further results suggest that our main findings are largely driven by a supply reduction of the volume of partly or fully unused *revolving credit lines*. For this credit type we also observe a particularly large increase in credit usage during the crisis. We also present evidence suggesting that covenant violations were common in Austria over 2008-09 and observe that 50% of the average Austrian firm's bank debt had a maturity of less than a year at end-2007. This further illustrates that banks did have opportunities to cut commitment volumes during the crisis. Finally, we also find that capital- or liquidity-constrained banks do not cut credit commitments that are *fully* used at the onset of the crisis, which they could do for example by not renewing such commitments at maturity over 2008-09. We conclude that this is because fully-used commitments pose no risk of a capital buffer reduction or additional liquidity needs, but perhaps also because cutting such commitments is on average less feasible and more harmful for the firm and thus potentially also for the bank.

Our main results provide an additional rationale for the policymaker's quest to strengthen bank capital buffers. What's more, our findings arguably reflect that the regulatory framework prior to the 2008-09 crisis induced banks to excessively grant credit commitment vol-

umes that cannot be sustained in crisis times, when both the risk and the consequences of additional credit 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 has arguably been a first step towards smoother credit commitment supply over the business cyle and greater financial stability. 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 lower the liquidity risk posed by undrawn credit commitments and therefore limit reductions in granted credit volumes during crisis times.

1.1 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. 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 and Schnabl (2010) and Acharya et al. (2013) describe the motivation and risks behind ABCP conduits, while Covitz et al. (2013) document a run on ABCP programs at the onset of the 2008-09 crisis. Our paper also builds on Chodorow-Reich and Falato (2017), who show that banks in worse health during the 2008-09 crisis are more likely to force a credit commitment reduction in response to a covenant violation of a borrower, but do not touch upon the channel we introduce. More generally, our findings confirm that bank capital is an important determinant of bank lending behaviour (e.g. Gambacorta and Mistrulli, 2004; Berrospide and Edge, 2010; Gambacorta and Shin, 2018). We also corroborate the finding that banks adjust their credit supply as a reaction 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; Ongena et al., 2018; Acharya et al., 2018; De Marco, 2019). Regarding capital regulations, we relate to Gropp et al. (2018) and De Jonghe et al. (2020) who find that banks respond to an increase in their minimum capital requirement by reducing credit supply to firms.[1] Our results further confirm the results of the literature on macro-financial feedback loops, which suggest that well-capitalised banks cut back assets and loans less than poorly-capitalised banks as a response to adverse capital shocks (Brunnermeier and Sannikov, 2014; Brunnermeier et al., 2016; Farhi and Tirole, 2017).

Our paper also contributes to a growing literature that deals with liquidity (as opposed to capital) risk posed by unused credit commitments. Deposit funding can help to mitigate this risk (Kashyap et al., 2002), especially during periods of tight liquidity (Gatev et al., 2009). Acharya and Mora (2015) highlight that in the US, banks were only able to honour credit line drawdowns during 2007-2009 because of explicit and large support from the government and government-sponsored agencies. 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. Ippolito et al. (2020) find that banks facing higher liquidity risk due to the collapse of the ABCP market in 2007-08 increased interest rates and commitment fees on previously committed corporate credit lines upon a covenant violation by the borrower. Ippolito et al. (2016) show that banks with larger wholesale funding dry-ups in the summer of 2007 actively managed liquidity risk *ex ante* by granting fewer credit lines to firms that were expected to draw down unused lines more extensively in times of financial distress. We contribute to this literature by showing that banks also limit liquidity risk by reducing the granted credit volume of partly or fully unused credit commitments during crisis times. Furthermore, we

[1] A general overview of empirical research on the design and impact of regulation in the banking sector is provided by Jakovljević et al. (2015).

are able to measure exposure to unused credit at the bank-firm-level rather than only at the bank level. This improves identification as it allows us to set up an empirical specification that controls for firm- and bank-specific unobservables of time-invariant or time-varying nature.

In a broader sense, our paper also relates to the literature studying the effect of liquidity shocks on credit supply without focusing on unused credit (Khwaja and Mian, 2008; Schnabl, 2012; Iyer et al., 2014; Cingano et al., 2016). Last, but not least, our paper builds on the theoretical (Boot et al., 1987; Martin and Santomero, 1997; Holmström and Tirole, 1998; Acharya et al., 2014) and empirical (Berger and Udell, 1995; Shockley and Thakor, 1997; Agarwal et al., 2006; Sufi, 2009; Jiménez et al., 2009; Demiroglu and James, 2011; Acharya et al., 2013) literature that analyses the nature, motivation and use of credit commitment – and in particular revolving credit line – contracts.

2 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 a bank to hold capital (Tier 1 + Tier 2) worth at least 8% of its risk-weighted assets. Independently of the borrower-specific risk (weight) a bank faces when granting a credit commitment, the used portion and the unused portion of the commitment do not equally enter risk-weighted assets in the Basel II framework. The used credit portion obtains a 'credit conversion factor' (CCF) of 100%, which implies that it fully enters risk-weighted assets. The unused credit portion only obtains a CCF of at most 50%, where the specific CCF depends on the type and original maturity of the credit commitment. The unused portion of an *irrevocable* credit commitment – which cannot be amended or cancelled without the borrower's consent before it matures – has a CCF of 20% if the original maturity is below one year and a CCF of 50% otherwise. *Revocable* commitments in turn face no

capital charge (CCF=0%) in Basel II. These are "unconditionally cancellable at any time by the bank without prior notice, or (...) effectively provide for automatic cancellation due to deterioration in a borrower's creditworthiness", thus due to a covenant violation (Basel Committee on Banking Supervision, 2006, p.26). However, this cancellation right only holds before a firm actually draws down credit.[2] In terms of empirical relevance, data from annual reports of Austrian banks suggest that revocable credit commitments made up a fair share of total commitment volumes at the beginning of the crisis in Austria.[3] 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. In Basel III irrevocable commitments have a CCF of 40% irrespective of their maturity and revocable commitments have a CCF of 10%.[4]

Bank capital and the crisis in Austria

Austrian banks suffered a deterioration of capital buffers due to losses during the crisis (Schürz et al., 2009). These losses were quite substantial: over the 24 months of 2008-09, the banks in our sample on average incurred a total loss worth 42% of their capital buffer as of

[2] This distinguishes a revocable credit commitment from an *uncommitted credit facility*, in which the bank can decide not to lend after a firm's borrowing request. Since the bank has this option, the unused portion of an uncommitted credit facility does not even qualify as off-balance sheet item (thus no CCF applies), such that the bank does not have to hold capital against it.

[3] For example, for Austria's third-largest bank as of 2007, the share of revocable to total credit commitment volume equalled 38% in end-2007, and rose to 53% by end-2008.

[4] In January 2007, the standardised 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 standardised 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 ("usage ratios"). The general implication of this is that also in the A-IRB approach the unused portion of the commitment must be backed with less capital than the used portion. Only some of the very largest banks operating in Austria have adopted the A-IRB approach. Those banks face a trade-off. While cutting a credit commitment that is not fully used reduces the risk of a sizeable drawdown, it also raises the usage ratio, which leads to a higher future CCF. Banks that apply the A-IRB approach thus might have a smaller incentive to cut credit commitments than banks applying the standardised 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 threat to identification.

2008:Q1, and the median loss was 18.6% (see Table 1 for these and other descriptive statistics, and Online Appendix Figure 1 for the distribution of bank losses over time).[5,6] Losses were especially problematic since for Austrian banks raising additional capital has been difficult. Specifically, Austria's Financial Market Stability Board has argued that "central risks for the Austrian banking system emanate (...) from banks' specific ownership structures, which would not fully ensure the adequate recapitalisation of banks in the event of a crisis" (FMSG, 2017). The background is that same as in Germany 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 Online Appendix Figure 2).[7,8] 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

[5] The loss statistics are based on confidential monthly data on write-offs on loans and net value gains on security holdings and equity shares at the bank level. By definition, net gains on security holdings and equity shares are not affected by transactions or exchange rate changes, but instead solely reflect changes in the market value of the underlying assets. A bank's capital buffer is computed as Tier 1 + Tier 2 capital holdings minus the bank's minimum capital requirement.

[6] Bank-level descriptive statistics indicated in the text and displayed in Table 1 are weighted based on the frequency of the bank as lender in our main sample of bank-firm relationships.

[7] Demirgüç-Kunt et al. (2013) study a multi-country panel of banks and find that a stronger capital position is associated with better stock market performance during the crisis.

[8] Another reason for the weak stock market performance of Austrian banks was their exposure to central, eastern and southeastern Europe (CESEE), whose financial and economic performance was regarded as uncertain by financial markets at the time. The average Austrian bank's exposure to CESEE assets clearly exceeded its US asset 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 Austrian banks were purely a result of the global financial crisis and in this sense exogenous to the Austrian banking sector. Second, we find that pre-crisis CESEE asset holdings do not significantly correlate with total net asset value gains at the bank level over 2008-09, which 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. We do however feature CESEE exposure as a control variable in selected specifications of our empirical analysis.

the institutional problems caused by the banking group structures. These considerations increase the capital risk that Austrian banks face from unused credit, though the channel we introduce is clearly relevant in other countries as well. To some extent the situation in Austria was improved by the government's banking package, which started in November 2008 and "helped prevent a liquidity squeeze and expand banks' capital buffers" (Schürz et al., 2009, p.56). For example, the package included a €15 billion capital injection program into financial institutions.

Measuring a bank's US asset exposure and capital buffer

We use a bank's US asset holdings divided by its corresponding volume of total assets in December 2006 as a proxy for how the bank's capital position is affected by the crisis. This is arguably the "cleanest", i.e. most exogenous proxy because the origins of the crisis lie in the United States and are not related to the Austrian banking sector. Our exposure variable is thereby 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. Our approach also follows the literature that uses ex-ante asset holdings to capture ex-post losses during crisis times (see e.g. Popov and Van Horen, 2015; Ongena et al., 2018; De Marco, 2019). We define US assets as the sum of securities and equity shares acquired from US counterparties and loans to US counterparties.[9] Data is provided by the Austrian Central Bank (OeNB), same as all other bank-level as well as firm- and bank-firm-level data used in our analysis. US assets may be denominated in any currency, but only assets for which the direct counterparty is located in the United States are included.[10] The measure of total assets in the denominator

[9] In the average bank in our sample, 50% of US assets are securities, 49% are loans and 1% are equity shares.

[10] For example, if a bank buys a security that was issued in the United States but the seller is Deutsche Bank in Frankfurt, then the security is classified as German in the data.

is the sum of total loans, securities and equity shares.[11] Although US assets only constitute 1% of total assets in the average bank in our sample in December 2006 (see Online Appendix Figure 3 for the distribution of the ratio), they make up 15% of capital and more than half of the average bank's capital buffer. What's more, these statistics should be taken as a lower bound of the actual exposure to US asset markets given that only direct counterparties are considered. We show that larger US asset holdings in December 2006 are significantly associated with larger total asset value losses at the bank level during 2008-09 (see Online Appendix Table OA4).

The extent to which a bank can absorb losses and additional credit drawdowns clearly depends on its initial capital buffer. Therefore, we use confidential supervisory data to distinguish banks with a relatively small versus large buffer at the onset of the crisis. We do so by computing the ratio of a bank's Tier 1 + Tier 2 capital holdings to its individual minimum capital requirement.[12] This variable is easy to interpret and a more precise indicator of how well a bank can absorb 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 consideration. We measure capital divided by the minimum requirement as of (the end of) 2008:Q1 rather than 2006:Q4 in order to take into account the regulatory changes that came with the full implementation of Basel II in January 2008.[13] The average realisation in our sample equals 1.79 (which corresponds to a Tier 1 + Tier 2 capital ratio of 14.3%), while the median equals 1.54 (12.3%); see Online Appendix Figure 4 for details.

[11] The difference between this sum and a bank's actual total assets (which we otherwise use in our analysis, see below) consists of cash holdings, net asset value gains compared to the previous month, and "other assets". For simplicity, we refer to the described sum as "total assets" as well in the following. Neither US assets nor total assets are risk-weighted in our measure.

[12] The two variables are reported separately in the data. We verify that the the minimum capital requirement is equivalent to 8% of the bank's total risk-weighted assets, in line with Basel II regulations.

[13] Our results are robust to measuring the ratio as of 2006:Q4, which parallels the timing of our other bank-specific explanatory variables; see Online Appendix Table OA2.

Liquidity problems during the crisis: measurement and Austrian background

The 2008-09 crisis was also a crisis of liquidity. For example, the cost of unsecured interbank funding increased sharply after the Lehman default in September 2008 (see Online Appendix Figure 5), which was mainly driven by a rise in perceived counterparty risk. It was difficult for banks to fully substitute interbank funding with other sources of finance: 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 therefore adopted pre-crisis dependence on interbank funding as a proxy for bank-specific exposure to higher liquidity costs during the 2008-09 crisis (see e.g. 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 a bank's *international* interbank borrowing divided by total assets – measured in December 2006 – as our proxy. We do so because *domestic* pre-crisis interbank borrowing is arguably a poor proxy for exposure to increased liquidity cost during the crisis, due to the prevalence of banking groups in Austria. The average ratio of international interbank borrowing to total assets in our sample equals 10.3%; see Online Appendix Figure 6 for details. Online Appendix Figure 7 reveals that banks operating in Austria continuously reduced both international interbank lending and borrowing after the Lehman default, which shows that they were feeling the repercussions of the higher interbank funding rates. Certain relief was brought by a €75 billion interbank market support program, which was part of the government's banking package and was administered via a clearing bank that started operating in November 2008.

Credit register data

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 for the universe of Austrian banks, as long as the granted credit volume or the credit usage exceeds €350,000.[14] Our

[14] Credit usage may exceed the commitment volume since overdrawing may be possible, depending on the bank-firm-specific contract.

sample includes foreign banks but not firms outside of Austria. For a given bank-firm pair we observe the total credit volume across all credit commitments the bank grants to the firm in a given month.[15] This sum can include up to six different credit types: revolving credit lines, term loans, guarantees, leasing loans, special purpose loans and trust loans. Over our sample period the register does not document commitment volumes by credit type except for guarantees, but we do observe total credit usage as well as usage by credit type. While the total commitment volume may include credit that cannot be used flexibly or in parts (such as "classic" term loans), for all credit types the granted amount may exceed the firm's actual usage and this also occurs in practice. This is illustrated by post-2012 data which documents the commitment volume by credit type; see Online Appendix Table OA6 for details. Given the Basel framework, 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 quantitatively negligible and we deal with this special case in our empirical analysis.[16]

The main dependent variable in our empirical analysis is the bank-firm-specific change in the total credit commitment volume between January 2008 and December 2009. While the choice of January 2008 as starting point comes at the cost of disregarding potential credit cuts based on crisis warning signs in 2007, it prevents us from picking up the effect of regulatory changes across Basel I and Basel II. December 2009 is chosen as end point because lending standards and credit volumes continuously tightened from the borrower's perspective until

[15] This includes both revocable and irrevocable commitments, but we do not observe whether or which fraction of a commitment is revocable versus irrevocable. Furthermore, initial or remaining maturities as well as covenants or covenant violations are not documented.

[16] Trust loans are used in almost 10% of bank-firm pairs in our sample but only account for 2.5% of total used credit on average. We take care of this special credit type by controlling for the share of trust loan usage in total credit usage at the bank-firm level in our empirical 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 has been granted. Furthermore, in Online Appendix Table OA2 we show that our results are robust to excluding bank-firm pairs in which trust loan usage is positive. The reason why higher trust loan usage does not imply a higher capital requirement for a bank is that here the bank only acts as intermediary of a loan from a third-party entity and bears no risk.

the end of 2009 in Austria (see Online Appendix Figure 8) and due to a change in reporting requirements as of January 2010 that affects relevant credit register variables. In terms of sampling, we drop bank-firm pairs in which the bank has less than 20 client firms at the beginning of January 2008. The motivation is to rule out the possibility that small banks belonging to a banking group are not entirely independent in their credit decisions, and to focus on the most relevant banks. As we explain in Section 3, our identification strategy also implies the omission of firms borrowing from only one bank. The resulting baseline sample consists of 7,262 credit commitments (bank-firm pairs). This sample contains mostly firms operating in non-financial sectors, but also non-bank financial sector firms such as insurance companies.[17] Our results are robust to restricting the sample to non-financial borrowers (see Online Appendix Table OA2). Online Appendix Figure 9 plots the development of aggregate credit commitment volumes for different types of banks and credit commitments over 2008-09 on the basis of our sample. Online Appendix Figure 10 depicts aggregate credit usage and usage by credit type over our sample period.

We measure the bank-firm-specific degree of credit usage in January 2008 in our empirical analysis. 58% of commitments in our sample are not fully used in this month. The average difference between granted and used credit equals roughly €2 million across all commitments, and the median stands at roughly €100,000; see Online Appendix Figure 11 for details. Across commitments that are not fully used, the average unused credit volume equals around €4.7 million and the median €1 million. The mean usage ratio equals 82% across all commitments and 60% across those that are not fully used. Online Appendix Table OA5 shows that the volume of unused credit increases with a firm's profitability, sales/assets and relationship duration with the bank, and decreases with the firm's cash holdings and leverage. The mentioned post-2012 data suggests that unused *revolving credit lines* typically make up most of the total unused credit commitment volume. For the average bank in our

[17] See the Online Data Appendix for a list of all sectors represented in our sample and their respective share in terms of bank-firm pairs.

sample, the aggregate unused credit volume across all granted commitments we observe in the credit register makes up 4.4% of total assets in January 2008.

Firm balance sheet data

To study potential effects on corporate investment or employment, we use firm balance sheet and income statement data. Such data is not available for all firms in our sample, since not all of them are required to send data to the OeNB and not all remaining firms follow the invitation to send data voluntarily. The result is an incomplete and unbalanced panel; in the year 2007 for example, we have data for 76% of firms in our sample (see Table 1 for descriptive statistics). In the subsample of firms for which we can compare real outcomes before and during the crisis, larger and financially more sound firms are over-represented (see Online Appendix Table OA5).

3 Empirical Strategy

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

$$\begin{aligned}\Delta ln(Credit\ Commitment_{ij}) = \beta_1[US\ Exposure_j \times Unused\ Volume_{ij}] \\ +\beta_2[US\ Exposure_j \times Small\ Capital\ Buffer_j \times Unused\ Volume_{ij}] \\ +\beta_3[Small\ Capital\ Buffer_j \times Unused\ Volume_{ij}] \\ +\beta_4[Interbank_j \times Unused\ Volume_{ij}] \\ +\beta_5 Unused\ Volume_{ij} + \beta_6 C_{ij} + f_i + b_j + \epsilon_{ij} \qquad (1)\end{aligned}$$

$\Delta ln(Credit\ Commitment_{ij})$ approximates the percentage change in the credit commitment volume granted 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 ratio of international interbank borrowing to total assets in December 2006. *Small Capital Buffer*$_j$ equals one if the bank's capital buffer is smaller than the median buffer.[18] For ease of interpretation of our coefficient estimates, $Unused\ Volume_{ij}$ is in most regressions a dummy variable that equals one if the bank-firm-specific commitment is not fully used in January 2008. In selected specifications we instead define $Unused\ Volume_{ij}$ to equal the log of the unused credit volume if this volume is positive, and zero otherwise. C_{ij} is a vector of bank-firm-level controls measured in January 2008 that includes the share of bank j in total credit usage of firm i, the duration of their credit relationship in months, and a set of variables that each indicate the ratio of the usage of a particular credit type to total credit usage.[19] f_i are firm fixed effects in the spirit of Khwaja and Mian (2008). These 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 borrow from multiple banks in both January 2008 and December 2009. While this results in disregarding around 50% of firms, commitments to these "single-bank firms" only make up 17% of the total credit commitment volume recorded in the credit register in January 2008. This is because these firms are on average smaller and are being granted credit commitments that are smaller in volume. Their omission is therefore not a major concern in the context of our study because on average, larger commitments have a greater potential to trigger a quantitatively relevant capital buffer reduction and also imply larger liquidity risk. b_j are bank fixed effects that

[18] We compute this median not across banks but across the 7,262 bank-firm pairs in our main sample. Thereby, the number of bank-firm pairs associated with *Small Capital Buffer* = 1 is equal to the number of pairs associated with *Small Capital Buffer* = 0. The subsample for which *Small Capital Buffer* = 1 includes 38 banks, while the subsample for which *Small Capital Buffer* = 0 includes 71 banks.

[19] See Section 2 and Table 1 for the different credit types. Relationship duration is censored at 97 months since credit register data is only available to us from January 2000 onwards.

control for potential confounding factors at the bank level that affect a bank's *change* in credit supply between January 2008 and December 2009. Intuitively, the inclusion of bank fixed effects implies that we analyse how credit commitments with distinct usage levels are differently treated within a certain bank. For example, $\beta_1 + \beta_2$ 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 are not fully used in January 2008, *relative* to the supply of fully-used commitments in the same bank.[20] If this marginal effect is negative and statistically significant, then this is an indication that banks actively manage the risk of capital buffer reductions posed by undrawn credit commitments. In Section 4 we discuss and perform additional specifications which aim at verifying the validity of this interpretation. While including bank fixed effects improves identification, it implies that we cannot include the bank-level variables of equation (1) separately (i.e. non-interacted) into the specification and only estimate the described *relative* effect. Relatedly, we are unable to estimate the direct impact of capital and liquidity problems on the supply of initially fully-used commitments. To address these shortcomings, in selected regressions we replace the bank fixed effects with a vector of bank-level controls and also include the bank-level variables of equation (1) separately, at the expense of potentially not being able to control for all bank-level

[20] β_1 indicates conceptually the same but for banks with a large capital buffer. These interpretations hold when using our baseline definition of *Unused Volume*$_{ij}$. The use of our alternative definition (log of unused volume if positive and zero otherwise) implies that the estimated effects are relative to commitments with a smaller unused volume in the same bank.

confounding factors.[21] We cluster standard errors at both the firm and the bank level 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 such that our coefficients purely reflect supply rather than (also) demand effects. In particular, it must be that a firm does not disproportionally ask for a reduction (or increase) in the credit commitment volume during the crisis to those of its banks that have particularly large or small 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 change 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 times. If anything, a firm may ask for a reduction in the granted volume to save commitment fees, and then perhaps do so with the bank that charges the highest fee. However, there is no clear rationale that banks with larger capital or liquidity problems during the crisis charge higher commitment fees in January 2008; and if such banks raise commitment fees over our sample period, then this would be a supply rather than demand effect. Nonetheless, we address the concern of confounding bank-firm-specific credit demand in several robustness checks (see Online Appendix Table OA2). Finally, note that the empirical strategy to test

[21] The vector of bank controls includes a bank's log total assets, liquid assets over total assets, return on assets, loan write-offs over total assets and CESEE assets over total assets. The latter is an important control due to the exposure of some Austrian banks to the region, while the remaining variables are standard in the literature. CESEE assets are defined analogously to US Assets and are also measured in December 2006 but focus on 22 countries in central, eastern and southeastern Europe; see the Online Data Appendix for a complete list. The liquidity ratio is measured in December 2006 and is computed as 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 a bank 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 in 2006 and provide an indication of whether the bank is making losses at the onset of the crisis and thus may be particularly sensitive to shocks during the crisis (Santos, 2010). Total assets are measured in December 2006.

for credit substitution across banks and real effects at the firm level are described in Section 4.5.

4 Results

4.1 Baseline results

Table 2 presents the results of estimating equation (1) (see columns 4-5) and adapted versions (see columns 1-3). In column 1 we start with a simple specification without interaction terms and with bank-level variables instead of bank fixed effects.[22] The results show that by itself, neither US Exposure, the size of a bank's capital buffer nor dependence on interbank funding has a statistically significant impact on credit commitment supply over 2008-09 for the *average* bank-firm relationship (in terms of credit usage) in our sample. However, column 2 shows that a one standard deviation increase in US Exposure has a significantly more negative effect on credit commitment supply in banks with a small capital buffer than in banks with a large capital buffer. While this is a first indication of the importance of these variables, 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) but still keep the bank variables as separate regressors rather than include bank fixed effects. The results show that the negative impact found in column 2 is driven by credit commitments that are partly or fully unused at the onset of the crisis. Specifically, the coefficient on the triple interaction *US Exposure* $\times$ *Small Capital Buffer* $\times$ *Unused Volume* is negative and highly significant, and the marginal effect at the bottom indicates that a one standard deviation increase in US Exposure leads to a 11.4% supply reduction in the volume of partly or fully unused commitments if the bank has a small capital buffer. Meanwhile, larger US Exposure does not affect the supply of partly or fully unused credit commitments in banks with a large

[22] Furthermore, we add the bank-firm-specific credit usage ratio as additional control to the vector C_{ij} (but do not interact the ratio with any variable). The same we also do in column 2.

capital buffer, and having a small capital buffer has no impact on the credit supply of banks with no US Exposure. These findings are entirely consistent with our hypothesis that banks actively manage capital risk posed by undrawn credit commitments, since banks that suffer losses during the crisis *and* have a small cushion to absorb these losses are most affected by additional credit drawdowns. In column 4 we replace the non-interacted bank variables with bank fixed effects, which leads to equation (1) and thus our preferred specification for identification reasons. The coefficient on *US Exposure* × *Small Capital Buffer* × *Unused Volume* (which has the same interpretation across columns 3 and 4, contrary to the marginal effects at the bottom) remains roughly similar, which implies that the bank controls in columns 1-3 actually do a decent job in controlling for potential confounding factors at the bank level.[23] The results in column 5 show that the larger the actual volume of unused credit, the more the credit commitment is cut by a capital-constrained bank, i.e. a bank with larger US Exposure and a small capital buffer. In particular, a bank with US Exposure equal to one standard deviation and a small capital buffer cuts a partly or fully unused credit commitment by 1.6 percentage points more as the unused credit volume in the commitment doubles. As we show in Table 3, this negative effect continues to hold if we restrict the sample to commitments that are not fully used. The key take-away, which is consistent with banks worrying more about sizeable drawdowns, is that a larger unused volume does not only imply a larger credit cut in absolute (Euro) terms, but also in *percentage* terms. This

[23] The marginal effects in column 4 indicate effects that are relative to the supply of fully-used commitments, while the marginal effects in column 3 do not have this relative interpretation. Nonetheless, the actual estimates of the marginal effects on banks with larger US Exposure and a small capital buffer are similar across columns 3 and 4. This is not surprising since the supply change in the granted volume of fully-used commitments (more on these further below) by such banks is small (and as we verify, statistically insignificant), as we can infer from the sum of the coefficients on *US Exposure* and *US Exposure* × *Small Capital Buffer* in column 3.

result is another piece of evidence in favour of our hypothesis.[24]

In terms of implications for firms, the magnitude of credit commitment cuts does not imply acute credit constraints on the *average* holder of a partly or fully unused credit commitment who borrows from a capital-constrained bank – even if the firm is fully using all its other credit commitments. This is because the average ratio of credit usage to the granted volume across credit commitments that are not fully used equals around 60% in January 2008. However, capital-constrained banks reduce liquidity insurance to their borrowing firms by reducing credit commitment supply, and the magnitude is clearly not negligible.

The results in column 3 of Table 2 also show that commitments that are fully used in January 2008 are not cut by capital-constrained banks over 2008-09. This is in line with our hypothesis since these commitments do not pose the risk of additional drawdowns. However, also other factors may contribute to this result. For example, our data reveals that fully-used commitments on average contain a comparatively large volume of term loans, which typically have a longer maturity and are thus harder to cut within a given period than for instance revolving credit lines. Furthermore, while directly freeing capital, not rolling over fully-used commitments imposes larger financial constraints on the average firm. This may harm the bank via affecting the firm's health or inducing it to switch lender. However, none of these alternative explanations speak against our hypothesis, as they do not directly imply that banks should instead cut commitments that are *not* fully used.

The results in Table 2 also show that liquidity problems negatively affect the growth rate of

[24] This result also provides an implicit robustness check regarding confounding bank-firm-specific credit demand. In columns 3 and 4 it would pose an identification problem if (i) the unused credit volume were typically larger in bank-firm pairs in which the bank is more capital- or liquidity-constrained *and* (ii) lower credit demand induced firms to effectuate a reduction in the granted credit amount more often in those banks in which it has a larger unused credit volume. However, this potential critique is not applicable in column 5 because here the specific volume of unused credit enters the equation and is therefore controlled for. To understand the degree of robustness, we can compare the magnitude of the coefficient estimate on *US Exposure* × *Small Capital Buffer* × *Unused Volume* in column 5 to the one in column 4 by multiplying the estimate of column 5 by the average of *ln(Unused Volume)* across commitments with a positive unused volume, which equals 6.73. The computation yields -0.017 × 6.73 = -0.114, which is very similar to the estimate of -0.106 in column 4. Therefore, the results in column 5 provide strong evidence against the described potential identification concern.

the volume of partly or fully unused commitments during the crisis. However, the coefficient on *Int'l Interbank Borrowing* × *Unused Volume* and the marginal effect at the bottom of column 3 suggest that this only occurs relative to the supply of fully-used commitments. We find that banks that depend more on interbank funding significantly *increase* the supplied credit volume in initially *fully*-used commitments over 2008-09 relative to other banks, but do not do the same in commitments that are not fully used. This might reflect that receiving support from the government's interbank support package was conditional on increasing credit supply, and in order to have more control over their liquidity position, participating banks chose to rather increase the supply of term loans (which are usually fully-used, see Online Appendix Table OA6) than of commitments that would be used less. To investigate this point further (and for other reasons), in Section 4.3 we analyse credit supply around the peak of the interbank market freeze, which occurred shortly after the Lehman default but before the start of the interbank support package. Over this shorter time horizon of only two months, liquidity-constrained banks do actually *cut* credit commitments with a *large* unused credit volume, relative to other banks. At the same time, they do not cut or raise the granted volume of commitments that are fully-used or have a small unused volume. Taken together, these findings and the results of Table 2 provide evidence that also liquidity-constrained banks actively manage the risk of additional credit drawdowns during crisis times.

Finally, we observe that the coefficient on *Unused Volume* is always negative and statistically significant in Table 2. Since in all tables we subtract the 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.[25] The negative coefficients therefore suggest that not only credit commitment volumes offered by more capital- or liquidity-constrained banks, but also credit volumes granted by the average bank fall between

[25] Demeaning is useful because it allows us to always compare the coefficient on *Unused Volume* across all columns and because it makes the computation of marginal effects more simple and transparent in the presence of multiple interaction terms. Demeaning has no impact on the estimation and interpretation of the coefficients on the interaction terms and bank-specific variables.

January 2008 and December 2009. It is not impossible that this at least partially reflects demand effects, i.e. that some firms ask their banks for a smaller commitment volume to save fees on unused credit during the crisis. However, this per se is not a threat to identification: only if firms do so more often with more capital- or liquidity-constrained banks then the estimates on our key interaction terms in equation (1) are contaminated by demand effects, and as we discuss in Section 3, there is no particular reason to believe so.

4.2 Additional evidence

In Table 3 we present the results on additional specifications that provide further tests on our hypotheses. Column 1 reveals that the capital buffer does not matter for liquidity-constrained banks in terms of credit commitment supply. This speaks against the possibility that conditional on a given dependence on interbank funding, weakly-capitalised banks face (considerably) larger liquidity constraints than other banks. More importantly, the finding further strengthens the interpretation that US Exposure matters because it proxies for losses during the crisis, as we also verify more directly in Online Appendix Table OA4. In columns 2-4 we incorporate a bank's *aggregate* volume of unused credit across all of its client firms in January 2008 into the analysis. The results show that as this volume increases by one standard deviation, a bank cuts an individual commitment with a given unused credit volume (we use our continuous version of $Unused\ Volume_{ij}$) by up to one percentage point more, irrespective of the bank's crisis exposure.[26] Column 3 further provides weak evidence that more unused credit at the bank level leads to larger credit supply cuts in capital-constrained banks: a corresponding four-tuple interaction term that we add is negative though marginally insignificant.[27] All of these additional findings are intuitive and corroborate the hypothesis that banks actively manage their capital position in view of exposure to unused credit. The

[26] In Online Appendix Table OA3 we show that this effect is clearly not driven by bank size.

[27] We also add all other resulting relevant interactions but do not report their coefficients in column 3 to save space.

results on an additional interaction term we include in column 4 speak against the hypothesis that liquidity-constrained banks reduce credit commitment supply by more if they face more aggregate unused credit. However, the corresponding test may not have enough statistical power due to a high correlation between aggregate unused credit and interbank funding dependence. In column 5 we return to estimating equation (1) but restrict the sample to commitments that are not fully used to have a more homogeneous sample, and again use the continuous version of *Unused Volume*$_{ij}$. The estimates on capital-constrained banks remain negative and statistically significant. Finally, we note that the coefficient on *Int'l Interbank Borrowing* $\times$ *Unused Volume* turns insignificant in column 5. This is consistent with the earlier result that over 2008-09 the supply reduction of partly or fully unused commitments by more liquidity-constrained banks only holds relative to the supply of fully-used commitments (see column 3 of Table 2).

4.3 Credit commitment supply around the Lehman default

In Table 4 we narrow the period of analysis down to August - October 2008, the two months around the Lehman default. This is useful for two reasons. First, the Lehman default triggered substantial bank losses (see Online Appendix Figure 1) and a sharp rise in interbank funding rates (see Online Appendix Figure 5). Meanwhile, no other unrelated event of similar relevance occurred between August and October 2008, and public policies responding to the Lehman default were not yet implemented by the end of October. Second, for the short period around the Lehman default it is even more unlikely than in our baseline period that bank-firm-specific demand confounds our results, because the crisis had not yet fully reached Austria's real economy. In columns 1, 2 and 3 of Table 4 we repeat the analysis of columns 3, 4 and 5 of Table 2, respectively, but reduce the study period to August-October 2008 (as always, assessed at end-month) and measure bank-firm-level variables in August 2008. Based on these regressions we observe no effects on credit commitment supply. In columns

4-6 we test the hypothesis that at this stage of the crisis, "as a first step" constrained banks only target credit commitments with a relatively *large* unused credit volume, as they pose larger capital and liquidity risk. Specifically, we define $Unused\ Volume_{ij}$ to equal one if the unused credit volume exceeds the variable's 25th percentile based on positive unused volume realisations in our baseline sample (which equals around €240,000), and zero otherwise.[28] The results largely confirm the hypothesis. Over the two-month period, banks with a one standard deviation larger US Exposure and a small capital buffer reduce the granted credit amount of commitments with a large unused credit volume by 2.1%, relative to otherwise similar banks that also have a small capital buffer. Furthermore, a one standard deviation increase in interbank funding dependence induces banks to cut commitments with a large unused volume by 3.3 percent between August and October 2008 (see the marginal effects in column 4 for both results). Again, the coefficients are roughly similar in our preferred specification with bank fixed effects (see column 5). In column 6 we drop firms in traded sectors, which are the first to feel the real repercussions of the crisis in the fall of 2008 (OeNB, 2009).[29] Thereby we create a sample in which, over the short time horizon we study in Table 4, confounding changes in the demand for granted credit volumes are even more unlikely than in the sample of all firms. The results are even more pronounced than those on all firms in column 5, which further dispels potential doubts about the presence of supply effects. Based on the sample of non-traded sector firms, we find for example that a one standard deviation rise in US Exposure induces banks with a small capital buffer to cut credit commitments with a large unused volume by 7.6%, relative to commitments that are

[28] In column 8 of Online Appendix Table OA2 we use this definition also for our baseline sample period and find that the results are robust to this modification.

[29] The excluded traded sectors are (see ÖNACE 2008 sector classification): agriculture; mining; manufacturing; wholesale & retail trade; information & communication; financial & insurance services (we exclude banks and other credit institutions); other economic services. The remaining non-traded sectors are: energy supply; water supply; construction; transportation & storage; accommodation & food services; other economic services; education; health; arts, entertainment & recreation; professional, scientific & technical activities; public administration. Note that we use short sector names here; see the Online Data Appendix for the full names.

fully-used or have a small unused credit volume.

Finally, Online Appendix Figures 9 and 10 reveal that August - October 2008 is not only the period in which credit commitment volumes granted by constrained banks fall the most over 2008-09, but also a period in which credit usage increases particularly strongly. Notably, revolving credit line drawdowns rise by around 7% only between September and October 2008, an increase that does not fall short of the rise in the US over this period (see Ivashina and Scharfstein, 2010). This combined evidence may suggest that at least at the peak of the crisis, credit commitment cuts are to some degree a response to actual credit drawdowns, but we cannot be sure about this.

4.4 Which credit types are cut?

In the first part of this subsection we exploit the available credit register data to gain an impression on which credit commitment types (such as revolving credit lines versus term loans) are cut by capital- or liquidity-constrained banks. The results are presented in Table 5. Column 1 repeats our baseline findings from column 4 of Table 2 for comparison. In column 2 we make use of the fact that we observe the granted volume of credit *guarantees* and estimate equation (1) with the change in the log of this variable between February 2008 (the month when data becomes available) and December 2009 as dependent variable.[30] The coefficients are close to zero and not statistically significant. In column 3 the dependent variable is the change in log term loan *usage* over 2008:01 - 2009:12.[31] Term loan usage provides an indication of the granted term loan amount since these two variables are typically

[30] We measure *Unused Volume*$_{ij}$ as of February 2008 in this specification. The dummy equals one if the firm has unused volume of any credit type with the bank, as in our baseline specification. We only feature relationship duration and the bank's share in total credit usage of the firm (both as of 2008:02) in the vector C_{ij}.

[31] The corresponding specification is equation (1). Again, *Unused Volume*$_{ij}$ is defined as in our baseline specification and C_{ij} only contains relationship duration and the bank's share in total credit usage of the firm (as of 2008:01).

equivalent or very similar.[32] Again, the coefficients are relatively close to zero and statistically insignificant. Finally, in column 4 we use our standard dependent variable but restrict the sample to bank-firm relationships in which term loan usage equals zero while revolving credit line usage is positive (in January 2008). In this specification we use the continuous version of *Unused Volume*$_{ij}$ (log if positive and zero otherwise), since the great majority of commitments in the resulting sample are not fully used. Even though there are only around 200 degrees of freedom in this regression, the coefficient on the triple interaction term *US Exposure* $\times$ *Small Capital Buffer* $\times$ *Unused Volume* is statistically significant at the 10% level, and more than three times larger than the corresponding coefficient based on our full sample (see column 5 of Table 2).[33] Considering that trust loans, leasing loans and special purpose loans are quantitatively unimportant (see Table 1 and Online Appendix Table OA6), the overall results of Table 5 therefore clearly suggest that constrained banks mostly or exclusively cut revolving credit lines.

While we do not have granular data on covenants and covenant violations, remaining maturities or on whether a commitment is unconditionally cancellable (revocable), another question that does arise is how banks in Austria "manage" to reduce credit commitment supply over 2008-09. In this regard Online Appendix Figure 12 plots the development of two common covenants over time for Austrian firms in a European comparison, using the BACH (Bank for the Accounts of Companies Harmonized) database. These covenants are a firm's interest coverage ratio (ebitda/interest on financial debt) and a leverage ratio com-

[32] We infer this from the post-2012 credit register data in which the granted volume by credit type is documented. Over 2013-2014, 82% of term loans are fully used, and the average ratio of term loan usage to the granted term loan amount is equal to 96% (see Online Appendix Table OA6).

[33] Note further that the estimated magnitude of the coefficient is arguably a lower bound of the true effect. This is because revolving credit lines that are not used at all are not represented in the sample but on average pose larger capital and liquidity risk. Over the 24 months of 2013-2014, an average of 14% of revolving credit lines are completely unused.

puted as net debt/ebitda (see also Chodorow-Reich and Falato, 2017).[34] While the leverage ratio increases only slightly during the crisis, the interest coverage ratio is markedly lower in 2008-09 compared to previous (and later) years. Therefore, covenant violations by Austrian firms during the crisis may have provided a non-negligible "opportunity" for their banks to reduce the volume of (conditionally revocable) credit commitments. Based on the results of Chodorow-Reich and Falato (2017) it also appears possible that constrained banks in our sample forced a commitment reduction based on covenant violations that were tolerated before the crisis. Our results may also be partly driven by banks cutting *un*conditionally revocable commitments, given the overall empirical relevance of revocable credit commitments in Austria at the onset of the crisis as discussed in Section 2. Expiring maturities are another potential candidate for explaining the commitment volume cuts we find – in this case banks simply roll over the commitment with a smaller granted credit volume. The reason is that 50% of the average Austrian firm's bank debt was due to be settled within 12 months as of end-2007. While this share is comparable to a European average (46%), it is much higher than for example in France (27%) or the United States, where only 10% of bank loans had a remaining maturity of less than a year at the start of the crisis (Chodorow-Reich and Falato, 2017).[35]

[34] ebitda stands for earnings before interest, tax, depreciation and amortisation. Net debt equals debt minus cash and cash equivalents. The two ratios are the principal covenants studied by Chodorow-Reich and Falato (2017). Due to data availability, our leverage ratio differs slightly from the one in their paper. The interest coverage ratio must not fall below a certain value, while the leverage ratio must not exceed a certain value.

[35] We use the BACH database to compute the indicated statistics on Austria and other European countries. The results on Austria are very similar when using the matched balance sheet data we have for a subset of firms in our baseline sample: as of end-2007, we then obtain short-term bank debt ratios of 51% (simple average across firms) and 49% (weighted average, using the firm's relative frequency in our bank-firm sample as weight). Based on the sample in which revolving credit lines play a larger role (see column 4 of Table 5), the average ratio is even higher at 68% (69%). The reported ratios that are computed using BACH data are a weighted average across all sectors in BACH, using the sector's relative frequency in our baseline sample of bank-firm pairs as weight. Besides Austria, BACH contains data on Belgium, Czech Republic, Denmark, Germany, France, Italy, Poland, Portugal, Slovakia and Spain.

4.5 Credit substitution and real effects

In this section we study whether firms can substitute "lost" credit commitment volume in a troubled bank with additional credit from a more healthy bank (either an existing or new lender), and analyse potential effects on firm investment and employment. To do so, we follow the approach of previous literature, for example Cingano et al. (2016). As dependent variable we use the change in the *total* credit commitment volume of a firm across *all* of its banks (thus not only those in our baseline sample) between January 2008 and December 2009. On the right-hand side, we compute weighted averages of the bank variables that we include in column 3 of Table 2 across all of the firm's banks, using the share of bank-specific credit usage in total credit usage as a bank's weight. To control for changes in firm-specific credit demand or creditworthiness over our sample period, we include the *estimate* of the firm's fixed effect (i.e. of the firm dummy) from our baseline specification (see Table 2, column 4). Furthermore, we include a vector of firm-level controls which parallels the vector C_{ij} in our bank-firm-level specifications.[36] The results are presented in column 1 of Table 6. They indicate that firms with banks that have on average larger US Exposure and a smaller capital buffer face a lower growth in their total credit commitment volume 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 (not significantly different from) zero for such firms, rather than in fact positive. In column 2 we restrict the sample to firms that (in January 2008) have unused credit volume in all of their commitments that feature in our baseline bank-firm-level regression; in column 3 we only include the remaining firms, which fully use at least one of those commitments. The results show that the findings in column 1 are entirely driven by the prior type of firms, which is in line with our bank-firm-level evidence. However, column 4 shows that the results are not robust to the inclusion of 'main bank fixed effects', which control for potential unobserved

[36] This vector includes total credit usage divided by total granted credit across all banks of the firm in January 2008, as well as firm-level ratios of usage to granted credit for the different credit types.

bank characteristics.[37] Furthermore, columns 1-4 show no effect of reduced firm-level credit availability for firms whose banks are on average more liquidity-constrained. Overall, the hypothesis that firms are able to substitute away credit reductions can thus not be rejected. In line, columns 5-8 indicate no effects on firm investment and employment, based on our unrepresentative sample of firms with information on these variables for the relevant years.[38]

4.6 Robustness Checks

In the Online Appendix we perform and discuss a wide range of robustness checks. Most importantly, we show that (i) banks that are more capital- or liquidity-constrained during the crisis do not exhibit different trends in credit commitment supply than other banks before the crisis; and (ii) our results are robust to alternative specifications that further address the potential concern of confounding bank-firm-specific credit demand.

5 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 capital buffer at risk, since additional credit

[37] The 'main bank' of a firm is defined as the bank with the largest share in total credit usage of the firm. Including main bank fixed effects implies that identification stems from differences in US Exposure, the size of the capital buffer and interbank funding dependence across the remaining banks, which makes the specification rather demanding on the data (see also Cingano et al., 2016).

[38] To measure effects on employment we compute the log change in the number of employees between 2007 and 2009. A drawback of this measure is that it does not capture potential reductions in working hours, which is the main margin of employment adjustment in Austria during the 2008-09 crisis (Stiglbauer, 2010). For investment we compute the difference in total investment in fixed assets over 2008-09 divided by total assets in 2007 and total fixed asset investment in 2005-06 divided by total assets in 2004. On the right-hand side we include several firm controls as well as province fixed effects (Austria is divided into nine provinces) and sector and legal form fixed effects. Firm controls include log assets, return on assets, sales/assets, cash holdings/assets, leverage (assets/capital), and current assets/assets. Sector fixed effects distinguish 18 principal sectors of the Austrian industry classification ÖNACE 2008 (see the Online Data Appendix for details). Legal form fixed effects distinguish 12 different legal forms, of which "limited liability company", "public corporation" and "limited partnership" are the most common.

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 is hit relatively hard during the 2008-09 financial crisis and whose initial capital buffer is low reduce the risk of capital buffer reductions 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 insurance to firms exactly at a time in which they need it most. On the positive side, our evidence suggests that firms are able to substitute the loss in credit via other banks and we do not find negative real effects at the firm level. However, this result may not hold in other countries or times in which a given financial crisis has a bigger impact. Generally speaking, our results therefore provide an additional rationale for the regulator's quest to strengthen bank capital buffers, as has been done to some extent since the 2008-09 crisis. 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 in turn limits liquidity risk transfers from banks to firms and reduces the impact of potential runs on unused credit commitments on banks in periods of financial distress. Last, but not least, our results highlight an additional benefit of countercyclical capital buffers, since lower minimum capital requirements during crisis times (relative to normal times) may limit credit commitment cuts that aim at preventing capital buffer reductions. As a second contribution, we showed that controlling for a bank's capital position, larger liquidity problems during crisis times induce banks to reduce the supply of partly or fully unused credit commitments to decrease liquidity risk. The introduction of the Liquidity Coverage Ratio (LCR) in Basel III may weaken such effects and thereby also increase financial stability.

References

Acharya, V., H. Almeida, F. Ippolito, and A. Perez (2014). Credit lines as monitored liquidity insurance: theory and evidence. *Journal of Financial Economics 112*(3), 287–319.

Acharya, V. and S. Steffen (2020). 'Stress tests' for banks as liquidity insurers in a time of COVID. *VoxEU, 22 March 2020*.

Acharya, V. V., H. Almeida, and M. Campello (2013). Aggregate risk and the choice between cash and lines of credit. *The Journal of Finance 68*(5), 2059–2116.

Acharya, V. V., T. Eisert, C. Eufinger, and C. Hirsch (2018). Real effects of the sovereign debt crisis in Europe: evidence from syndicated loans. *The Review of Financial Studies 31*(8), 2855–2896.

Acharya, V. V. and N. Mora (2015). A crisis of banks as liquidity providers. *The Journal of Finance 70*(1), 1–43.

Acharya, V. V. and P. Schnabl (2010). Do global banks spread global imbalances? Asset-backed commercial paper during the financial crisis of 2007–09. *IMF Economic Review 58*(1), 37–73.

Acharya, V. V., P. Schnabl, and G. Suarez (2013). Securitization without risk transfer. *Journal of Financial Economics 107*(3), 515–536.

Agarwal, S., B. W. Ambrose, and C. Liu (2006). Credit lines and credit utilization. *Journal of Money, Credit and Banking 31*(1), 1–22.

Basel Committee on Banking Supervision (2006). International convergence of capital measurement and capital standards. *https://www.bis.org/publ/bcbs128.pdf*.

Berg, T., A. Saunders, and S. Steffen (2016). The total cost of corporate borrowing in the loan market: don't ignore the fees. *The Journal of Finance 71*(3), 1357–1392.

Berger, A. N. and G. F. Udell (1995). Relationship lending and lines of credit in small firm finance. *Journal of Business 68*(3), 351–381.

Berrospide, J. M. and R. M. Edge (2010). The effects of bank capital on lending: what do we know, and what does it mean? Federal Reserve Board Working Paper.

Boot, A., A. V. Thakor, and G. F. Udell (1987). Competition, risk neutrality and loan commitments. *Journal of Banking and Finance 11*(3), 449–471.

Brunnermeier, M. K. (2009). Deciphering the liquidity and credit crunch 2007–2008. *The Journal of Economic Perspectives 23*(1), 77–100.

Brunnermeier, M. K., L. Garicano, P. R. Lane, M. Pagano, R. Reis, T. Santos, D. Thesmar, S. Van Nieuwerburgh, and D. Vayanos (2016). The sovereign-bank diabolic loop and ESBies. *American Economic Review 106*(5), 508–512.

Brunnermeier, M. K. and Y. Sannikov (2014). A macroeconomic model with a financial sector. *American Economic Review 104*(2), 379–421.

Chodorow-Reich, G. and A. Falato (2017). The loan covenant channel: how bank health transmits to the real economy. NBER Working Paper No. 23879.

Cingano, F., F. Manaresi, and E. Sette (2016). Does credit crunch investment down? New evidence on the real effects of the bank-lending channel. *Review of Financial Studies 29*(10), 2737–2773.

Cornett, M. M., J. J. McNutt, P. E. Strahan, and H. Tehranian (2011). Liquidity risk management and credit supply in the financial crisis. *Journal of Financial Economics 101*(2), 297–312.

Covitz, D., N. Liang, and G. A. Suarez (2013). The evolution of a financial crisis: collapse of the asset-backed commercial paper market. *The Journal of Finance 68*(3), 815–848.

De Haas, R. and N. Van Horen (2012). International shock transmission after the Lehman Brothers collapse: evidence from syndicated lending. *American Economic Review 102*(3), 231–237.

De Jonghe, O., H. Dewachter, and S. Ongena (2020). Bank capital (requirements) and credit supply: evidence from Pillar 2 decisions. *Journal of Corporate Finance 60*, 1–28.

De Marco, F. (2019). Bank lending and the European sovereign debt crisis. *Journal of Financial and Quantitative Analysis 54*(1), 155–182.

Demirgüç-Kunt, A., E. Detragiache, and O. Merrouche (2013). Bank capital: lessons from the financial crisis. *Journal of Money, Credit and Banking 45*(6), 1147–1164.

Demiroglu, C. and C. James (2011). The use of bank lines of credit in corporate liquidity management: a review of empirical evidence. *Journal of Banking & Finance 35*(4), 775–782.

Deutsche Bundesbank (2009). The Basel framework in practice – implementing the Basel advanced approaches in Germany. *Monthly Report 61*(1), 55–73.

Fama, E. F. (1985). What's different about banks? *Journal of Monetary Economics 15*(1), 29–39.

Farhi, E. and J. Tirole (2017). Deadly embrace: sovereign and financial balance sheets doom loops. *The Review of Economic Studies 85*(3), 1781–1823.

FMSG (2017). Recommendation concerning the adjustment of the systemic risk buffer (FMSG/4/2017). *https://www.fmsg.at/en/publications/warnings-and-recommendations/2017/recommendation-fmsg-4-2017.html*.

Fonseca, A. R. and F. González (2010). How bank capital buffers vary across countries: the influence of cost of deposits, market power and bank regulation. *Journal of Banking & Finance 34*(4), 892–902.

Gambacorta, L. and P. E. Mistrulli (2004). Does bank capital affect lending behavior? *Journal of Financial Intermediation 13*(4), 436–457.

Gambacorta, L. and H. S. Shin (2018). Why bank capital matters for monetary policy. *Journal of Financial Intermediation 35*, 17–29.

Gatev, E., T. Schuermann, and P. E. Strahan (2009). Managing bank liquidity risk: how deposit-loan synergies vary with market conditions. *The Review of Financial Studies 22*(3), 995–1020.

Gropp, R., T. Mosk, S. Ongena, and C. Wix (2018). Banks response to higher capital requirements: evidence from a quasi-natural experiment. *The Review of Financial Studies 32*(1), 266–299.

Holmström, B. and J. Tirole (1998). Private and public supply of liquidity. *Journal of Political Economy 106*(1), 1–40.

Ippolito, F., H. Almeida, A. Perez-Orive, and V. Acharya (2020). Bank lines of credit as contingent liquidity: covenant violations and their implications. *Journal of Financial Intermediation, forthcoming*.

Ippolito, F., J.-L. Peydró, A. Polo, and E. Sette (2016). Double bank runs and liquidity risk management. *Journal of Financial Economics 122*(1), 135–154.

Ivashina, V. and D. Scharfstein (2010). Bank lending during the financial crisis of 2008. *Journal of Financial Economics 97*(3), 319–338.

Iyer, R., J.-L. Peydró, S. da Rocha-Lopes, and A. Schoar (2014). Interbank liquidity crunch and the firm credit crunch: evidence from the 2007–2009 crisis. *Review of Financial studies 27*(1), 347–372.

Jakovljević, S., H. Degryse, and S. Ongena (2015). A review of empirical research on the design and impact of regulation in the banking sector. *Annual Review of Financial Economics 7*, 423–443.

Jiménez, G., J. A. Lopez, and J. Saurina (2009). Empirical analysis of corporate credit lines. *The Review of Financial Studies 22*(12), 5069–5098.

Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina (2012). Credit supply and monetary policy: identifying the bank balance-sheet channel with loan applications. *The American Economic Review 102*(5), 2301–2326.

Kashyap, A. K., R. Rajan, and J. C. Stein (2002). Banks as liquidity providers: an explanation for the coexistence of lending and deposit-taking. *The Journal of Finance 57*(1), 33–73.

Khwaja, A. I. and A. Mian (2008). Tracing the impact of bank liquidity shocks: evidence from an emerging market. *The American Economic Review 98*(4), 1413–1442.

Martin, J. S. and A. M. Santomero (1997). Investment opportunities and corporate demand for lines of credit. *Journal of Banking & Finance 21*(10), 1331–1350.

Musch, F. C., R. Ayadi, and M. Nieto (2008). *Basel II implementation in the midst of turbulence*. Center for European Policy Studies Task Force Report 2008.

OeNB (2009). Financial crisis hits the real economy. *Financial Stability Report,* Oesterreichische Nationalbank (Austrian Central Bank), *17*, 24–32.

Ongena, S., J.-L. Peydro, and N. Van Horen (2015). Shocks abroad, pain at home? Bank-firm-level evidence on the international transmission of financial shocks. *IMF Economic Review 63*(4), 698–750.

Ongena, S., G. Tümer-Alkan, and N. von Westernhagen (2018). Do exposures to sagging real estate, subprime, or conduits abroad lead to contraction and flight to quality in bank lending at home? *Review of Finance 22*(4), 1335–1373.

Peek, J. and E. S. Rosengren (1997). The international transmission of financial shocks: the case of Japan. *The American Economic Review 87*(4), 495–505.

Popov, A. and N. Van Horen (2015). Exporting sovereign stress: evidence from syndicated bank lending during the euro area sovereign debt crisis. *Review of Finance 19*(5), 1825–1866.

Puri, M., J. Rocholl, and S. Steffen (2011). Global retail lending in the aftermath of the US financial crisis: distinguishing between supply and demand effects. *Journal of Financial Economics 100*(3), 556–578.

Santos, J. A. (2010). Bank corporate loan pricing following the subprime crisis. *The Review of Financial Studies 24*(6), 1916–1943.

Schnabl, P. (2012). The international transmission of bank liquidity shocks: evidence from an emerging market. *The Journal of Finance 67*(3), 897–932.

Schürz, M., M. Schwaiger, J. Übeleis, et al. (2009). A review of the impact of the crisis on Austria's financial sector. *Financial Stability Report,* Oesterreichische Nationalbank (Austrian Central Bank), *17*, 54–62.

Shockley, R. L. and A. V. Thakor (1997). Bank loan commitment contracts: data, theory, and tests. *Journal of Money, Credit, and Banking 29*(4), 517–534.

Stiglbauer, A. (2010). The Austrian labor market and the Great Recession: developments and measures taken. *Monetary Policy & the Economy,* Oesterreichische Nationalbank (Austrian Central Bank), *3*, 25–44.

Sufi, A. (2009). Bank lines of credit in corporate finance: an empirical analysis. *The Review of Financial Studies 22*(3), 1057–1088.

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
Granted credit – Used credit (in '000 €)	2,051	96.5	-428,113	529,643	15,112	7,262
...if granted credit > used credit	4,689	1,000	1	529,643	16,927	4,229
Unused Credit Volume (Dummy)	0.582	1	0	1	0.493	7,262
Unused Credit Volume (ln if positive and zero otherwise)	3.918	4.570	0	13.180	3.680	7,262
Used credit / Granted credit	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 usage 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 Loans	0.016	0	0	1	0.122	7,262
Δ ln(Credit Commitment) 2008:08 - 2008:10	-0.005	0	-5.789	3.336	0.302	9,249
Δ ln(Credit Guarantees) 2008:02 - 2009:12	-0.044	0	-6.532	6.878	1.038	984
Δ ln(Term Loan Usage) 2008:01 - 2009:12	-0.021	-0.071	-7.575	8.029	0.788	4,008
II: Bank Variables (stats weighted based on bank frequency in sample)						
Required capital rise if full drawdowns (s.t. granted=used credit) 08:01	0.080	0.060	-0.014	1.086	0.112	109
% Fall in capital buffer if full drawdowns 2008:01	-0.199	-0.107	-1.409	0.029	0.277	109
Net asset value gains 2008-09 / Capital Buffer 08:Q1	-0.419	-0.186	-12.29	0.680	1.226	108
US Assets / Total Assets 2006:12	0.011	0.009	0	0.051	0.010	109
US Assets / Tier 1+2 Capital 2006:Q4	0.155	0.102	0	1.412	0.176	109
US Assets / Capital Buffer 2006:Q4	0.515	0.300	0	5.754	0.668	109
International 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
Tier 1+2 Capital / Risk-weighted Assets 2008:Q1	0.143	0.123	0.088	0.243	0.044	109
Tier 1 Capital / Risk-weighted Assets 2008:Q1	0.100	0.078	0.044	0.218	0.045	109
Granted credit – Used Credit 2008:01 (in '000 €)	954,092	871,397	-83,597	3,178,949	978,004	109
(Granted credit – Used Credit) / Total Assets 2008:01	0.044	0.036	-0.009	0.211	0.038	109
Total Assets 2006:12 (in billion €)	36.001	11.325	0.155	129.920	46.395	109
Liquid Assets / Total Assets 2006:12	0.220	0.206	0.018	0.646	0.122	109
Return on Assets 2006	0.005	0.004	-0.006	0.014	0.002	109
Loan Write-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
III: Firm Variables						
Total Assets (in millon €)	134.436	27.091	1.954	4,108	416.214	1,718
Employment	279.576	82	1	23,045	964.228	1,718
Return on Assets	0.100	0.064	-0.128	0.407	0.134	1,718
Sales / Assets	1.148	1.012	0.000	3.353	0.997	1,718
Cash holdings / Assets	0.043	0.015	0.000	0.228	0.062	1,718
Assets / Capital (Leverage)	4.509	3.211	-0.539	16.505	3.960	1,718
Current Assets / Assets	0.468	0.475	0.036	0.949	0.303	1,718
Number of Banks 2008:01	4.183	3	2	60	4.481	2,266
Δ ln(Total Credit Commitment Volume) 2008:01 - 2009:12	-0.030	-0.021	-3.966	2.937	0.521	2,266
Investment 08+09/Assets 07 – Investment 05+06/Assets 04	-0.013	-0.002	-1.727	1.301	0.236	636
ln(Employment 2009) – ln(Employment 2007)	0.017	0.008	-7.199	3.549	0.473	1,084

Notes: This table provides descriptive statistics based on our sample. *Granted credit – Used credit* and all variables below in Panel I, except the last three, are measured in 2008:01. *Used credit / Granted credit* (which is not used in the analysis and only listed for illustration) is winsorised from above at the 5% level to reduce the impact of outliers. *Relationship duration in months* is censored at 97 months since we only have data from 2000:01 onwards. The usage shares of the different credit commitment types is computed based on the 6,838 commitments for which total credit usage is larger zero (in our regressions, we define the usage shares of the remaining 7,262–6,838=424 commitments to be zero to prevent dropping these observations). *Liquid Assets* are those with a maturity of less than one year. *Capital Buffer* refers to (Tier 1+2 Capital – Capital Requirement). *Required capital rise if full drawdowns* and *% Fall in capital buffer if full drawdowns* are based on all commitments of the included banks observed in the credit register. The numbers are an upper bound as the underlying assumption is that all observed credit commitments are revocable. The corresponding lower bound is half of the indicated values, and holds assuming that all credit commitments are irrevocable and have an original maturity of more than one year. Negative values indicate that (some of) the bank's client firms were overdrawing their commitments in 2008:01. Firm-specific variables, except the last four, are measured as of end-2007 and winsorised at the 5% level. Balance sheet data are not available for all firms. Numbers that are larger than 1,000 are rounded to the nearest integer to save space.

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 *Unused Volume*$_{ij}$ →	Dummy = 1 if positive				ln(UV) if UV>0 o/w=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 Exposure × Small Capital Buffer		-0.060**	-0.009		
		(0.025)	(0.030)		
US Exposure × Small Capital Buffer × Unused Volume			-0.129***	-0.106**	-0.017***
			(0.040)	(0.046)	(0.006)
US Exposure × 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-Firm Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	No	No
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 (col.4: relative to commitments with no unused credit volume; col.5: rel. to commitments with smaller unused credit 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 c-b & comm. not fully (col.5:less) used			0.023	-0.017	0.001
1sd Rise in US-Exp if small c-b & comm. not fully (col.5:less) used			-0.114***	-0.123**	-0.016***
1sd Rise in Int'l Interb. Borr. if comm. not fully (col.5:less) used			-0.040	-0.098***	-0.011***

Notes: This table shows the results of estimating equation (1) (see columns 4-5) and alternative specifications (see columns 1-3). The dependent variable is the change in the log of 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) granted by banks with at least 20 client firms in January 2008, to firms that borrow from at least two banks in January 2008 and December 2009. 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 equity 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 continuous bank variables are first scaled by their standard deviation in our sample of bank-firm pairs, and all bank variables are demeaned using the column-specific sample. *Unused Volume* and *Bank-Firm Controls* are measured in January 2008. In columns 1-2 *Bank-Firm-Controls* additionally includes the ratio of total credit usage to total granted credit. 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 *Unused Volume*$_{ij}$ →	Dummy=1 if positive	ln(Unused Vol.) if UV>0, otherwise =0			
Sample →	All Bank-Firm Relationships				R'ships where UV>0
	(1)	(2)	(3)	(4)	(5)
US Exposure × Unused Volume	-0.013		0.000	-0.000	0.017
	(0.023)		(0.004)	(0.006)	(0.013)
US Exp. × Small Capital Buffer × Unused Volume	-0.130**		-0.019***	-0.018***	-0.043**
	(0.051)		(0.006)	(0.007)	(0.017)
Small Capital Buffer × Unused Volume	-0.020		-0.001	-0.001	-0.001
	(0.043)		(0.005)	(0.006)	(0.015)
Int'l Interbank Borrowing × Unused Volume	-0.098***		-0.007*	-0.007	-0.013
	(0.022)		(0.004)	(0.005)	(0.011)
Int'l Interbank Borr. × Small Cap-Buffer × Unused Vol.	0.034				
	(0.042)				
Total Unused Volume at Bank Level × Unused Volume		-0.010***	-0.007***	-0.008**	
		(0.003)	(0.003)	(0.004)	
US Exp. × Small C-B × Unused Vol. × Total Bank-Level UV			-0.015	-0.014	
			(0.010)	(0.012)	
Int'l Interbank Borr. × Unused Vol. × Total Bank-Level UV				0.001	
				(0.006)	
Unused Volume	-0.150***	-0.032***	-0.032***	-0.032***	-0.064***
	(0.024)	(0.004)	(0.004)	(0.003)	(0.008)
Bank-Firm Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Bank Controls	No	No	No	No	No
Bank FE	Yes	Yes	Yes	Yes	Yes
Additional Relevant Interactions	NA	NA	Yes	Yes	NA
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 supply of partly or fully unused credit commitments (col.1: relative to commitments with no unused credit volume; col.3-5: rel. to commitments with smaller unused credit volume)					
1sd Rise in US Exposure if large capital buffer	-0.013	NA	0.000	-0.000	0.017
1sd Rise in US Exposure if small capital buffer	-0.143**	NA	-0.019***	-0.019***	-0.027*
1sd Rise in International Interbank Borrowing	-0.098***	NA	-0.007*	-0.007	-0.013

Notes: In this table, we present the results on additional specifications to further test our hypotheses. The dependent variable is the change in the log of 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) granted by banks with at least 20 client firms in January 2008, to firms that borrow from at least two banks in January 2008 and December 2009. Bank-specific variables are measured at the latest possible time in 2006, except (i) the capital buffer, which is measured in 2008:Q1, and (ii) *Total Unused Volume at Bank Level*, which is measured in 2008:01 and equals the difference between total credit granted and total credit used across *all* client firms of the bank. *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 bank-level explanatory variables. All continuous bank variables are first scaled by their standard deviation based on our baseline sample (see Table 2), and all bank variables are demeaned using the column-specific sample. *Unused Volume* and *Bank-Firm Controls* are measured in January 2008. In columns 3 and 4 we include all other relevant interactions that result from the inclusion of the four-tuple interaction term, but do not report their coefficients. 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					
Definition of *Unused Volume*$_{ij}$ →	Dummy = 1 if positive		ln(UV) if UV>0 o/w=0	Dummy=1 if > 25th percentile across positive values		
Sample →			All Firms			Non-Traded
	(1)	(2)	(3)	(4)	(5)	(6)
US Exposure	-0.004			-0.020		
	(0.008)			(0.013)		
Small Capital Buffer	-0.012			-0.019		
	(0.013)			(0.014)		
US Exp. × Small Capital Buffer	0.011			0.020		
	(0.012)			(0.013)		
US Exp. × Small Cap-Buffer × Unused Volume	-0.012	-0.002	-0.002	-0.046**	-0.041**	-0.111***
	(0.021)	(0.024)	(0.003)	(0.018)	(0.018)	(0.027)
US Exp. × Unused Volume	-0.007	-0.016	0.000	0.025***	0.019**	0.035**
	(0.011)	(0.013)	(0.002)	(0.009)	(0.008)	(0.016)
Small Capital Buffer × Unused Volume	0.010	0.025	0.002	0.003	0.010	0.007
	(0.014)	(0.015)	(0.002)	(0.014)	(0.013)	(0.026)
Int'l Interbank Borrowing	-0.000			0.003		
	(0.012)			(0.010)		
Int'l Interbank Borrowing × Unused Volume	-0.014	-0.008	-0.002	-0.036***	-0.031***	-0.062***
	(0.014)	(0.013)	(0.002)	(0.011)	(0.010)	(0.016)
Unused Volume	-0.057***	-0.061***	-0.011***	-0.061***	-0.064***	-0.079***
	(0.009)	(0.009)	(0.001)	(0.008)	(0.008)	(0.015)
Bank-Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	No	No	Yes	No	No
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 supply of partly or fully unused credit commitments (col.2: rel. to commitm. with no unused volume; col.3: rel. to commitm. with smaller unused vol.; col.5-6: rel. to commitm. with u. vol. < 25th pctl)						
1sd Rise in US Exposure if large capital buffer	-0.011	-0.016	0.000	0.004	0.019**	0.035**
1sd Rise in US Exposure if small capital buffer	-0.013	-0.019	-0.002	-0.021*	-0.022	-0.076***
1sd Rise in International Interbank Borrowing	-0.015	-0.008	-0.002	-0.033***	-0.031***	-0.062***

Notes: In this table, we narrow down the period of analysis to the two months around the Lehman default. The dependent variable is the change in the log of 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 4 for details. The sample consists of credit commitments (bank-firm pairs) granted by banks with at least 20 client firms in August 2008, to firms that borrow 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). See Table 2 for a description of the other bank-level explanatory variables. All continuous bank variables are first scaled by their standard deviation based on our baseline sample (see Table 2), and all bank variables are 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: The development of different observed credit types during the 2008-09 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
Definition of *Unused Volume*$_{ij}$ →	Dummy = 1 if positive			ln(UV) if UV>0 o/w=0
Sample →	All Bank-Firm Relationships			Credit Line but no Term Loan Usage
	(1)	(2)	(3)	(4)
US Exposure × Unused Volume	-0.017	-0.026	0.001	0.026
	(0.024)	(0.193)	(0.030)	(0.019)
US Exposure × Small Capital Buffer × Unused Vol.	-0.106**	0.020	-0.061	-0.060*
	(0.046)	(0.160)	(0.058)	(0.034)
Small Capital Buffer × Unused Volume	-0.019	-0.152	-0.046	-0.005
	(0.044)	(0.198)	(0.065)	(0.024)
Int'l Interbank Borrowing × Unused Volume	-0.098***	0.100	-0.058	-0.013
	(0.023)	(0.210)	(0.036)	(0.018)
Unused Volume	-0.153***	0.335***	0.170***	-0.023*
	(0.023)	(0.113)	(0.033)	(0.012)
Bank-Firm Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Bank Controls	No	No	No	No
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 supply of partly or fully unused credit commitments (col.1-3: rel. to commitments with no unused volume; col.4: rel. to commitments with smaller unused volume)				
1sd Rise in US Exposure if large capital buffer	-0.017	-0.026	0.001	0.026
1sd Rise in US Exposure if small capital buffer	-0.124**	-0.006	-0.060	-0.034
1sd Rise in International Interbank Borrowing	-0.098***	0.100	-0.058	-0.013

Notes: In this table we investigate the development of different credit types, to the extent that our data permits this. For comparison, 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 log of the maximum volume of guarantees firm i can obtain from bank j, between February 2008 (data for January are not available) and December 2009. The dependent variable in column 3 is the change in the log of bank-firm-specific term loan usage between 2008:01 and 2009:12. In column 4 we estimate the specification of column 1 based on the sample of commitments in which term loan usage equals zero and revolving credit line usage is larger zero. In all columns, we only include banks with at least 20 client firms at the beginning of the column-specific sample period and firms that have at least two banks at the beginning and end of the column-specific sample period. *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 bank-level explanatory variables. All continuous bank variables are first scaled by their standard deviation based on our baseline sample (see Table 2), and all bank variables are demeaned using the column-specific sample. *Unused Volume* and *Bank-Firm Controls* are measured in January 2008 in columns 1, 3 and 4 and in February 2008 in column 2. In columns 2 and 3 *Bank-Firm Controls* only includes relationship duration and the bank's share in total credit usage of the firm. 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: Credit substitution and real effects

Dependent variable →	$\Delta ln\ Total\ Credit\ \ Commitment_i$ 2008:01 - 2009:12			$\Delta\ Inv./Assets_i$ 08-09 vs. 05-06			$\Delta ln\ Employment_i$ 2007-2009	
Sample →	All Firms	UV> 0 in all Commitm.	UV=0 in 1 or >1 Commitm.	All Firms	All Firms	UV> 0 in all Commitm.	All Firms	UV> 0 in all Commitm.
	(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 Credit 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
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								
1sd Rise in W(US-Exp) if all banks have large cap-b.	0.062***	0.124***	0.028	0.018	-0.008	-0.048	0.028	-0.036
1sd Rise in W(US-Exp) if all banks have small cap-b.	-0.003	-0.012	0.000	-0.021	0.006	-0.045	0.026	0.027
1sd Rise in W(Int'l Interbank Borrowing)	0.010	-0.001	0.027	0.038	-0.001	0.051	-0.013	-0.015

Notes: In this table, we analyse whether firms can substitute reductions in the granted credit commitment volume with other banks, and potential real effects. *W(B)* equals the weighted average of bank variable *B* across *all* banks lending to firm *i* in January 2008. A bank's weight equals its share in the firm's total credit usage in 2008:01. In columns 1, 4, 5 and 7 we include all firms that enter 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) that are included in our baseline sample. In column 3 we include all firms that fully use at least one of those commitments. The dependent variable in columns 5 and 6 equals the sum of investment in fixed assets over 2008-09 divided by total assets in 2007 minus the sum of fixed asset investment in 2005-06 divided by total assets in 2004. *Firm Controls from Credit Register* include the ratio of total credit usage to total credit granted, and, in columns 1-4, also the equivalent ratios by credit type. *Firm Balance Sheet Controls* include log assets, return on assets, sales/assets, cash holdings/assets, leverage (assets/capital), and current assets/assets. All of these are winsorised at the 5% level. *Province FE* distinguishes the nine provinces of Austria, *Legal Form FE* 12 different legal forms, and *Sector FE* 18 principal sectors of the Austrian industry classification ÖNACE 2008. Robust standard errors are reported in parentheses. *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

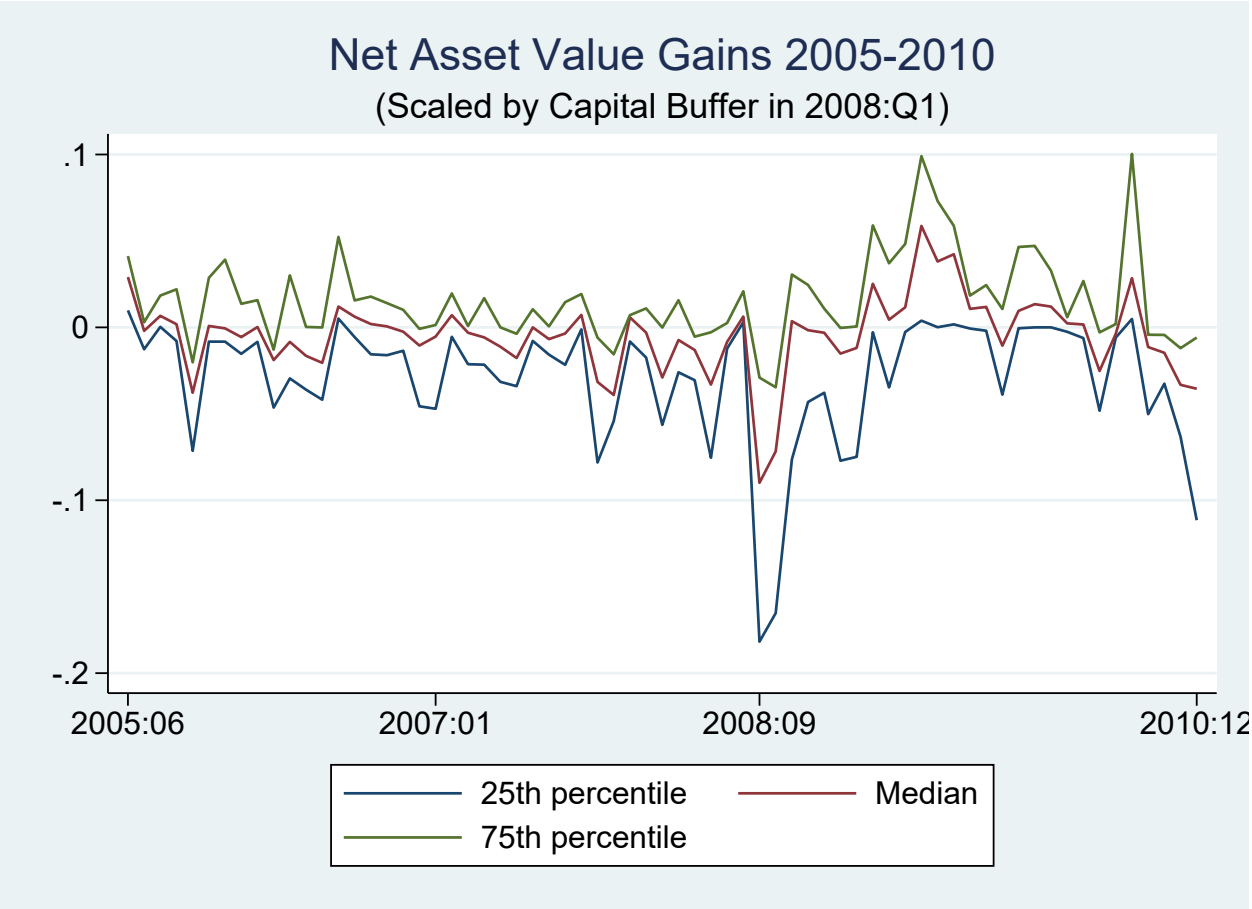
Online Appendix

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

Table of Contents

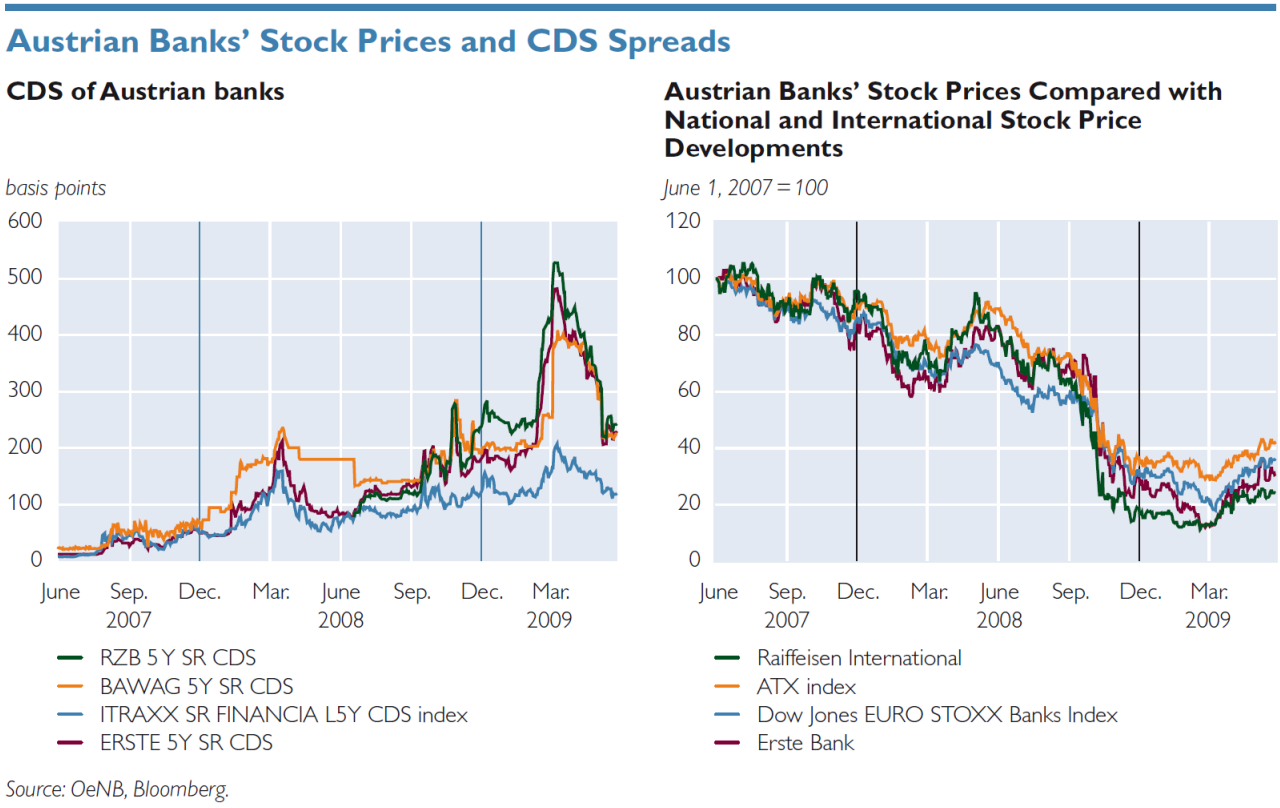
OA1 Figures

Figure 1: Bank-level net asset value gains, 2005-2010



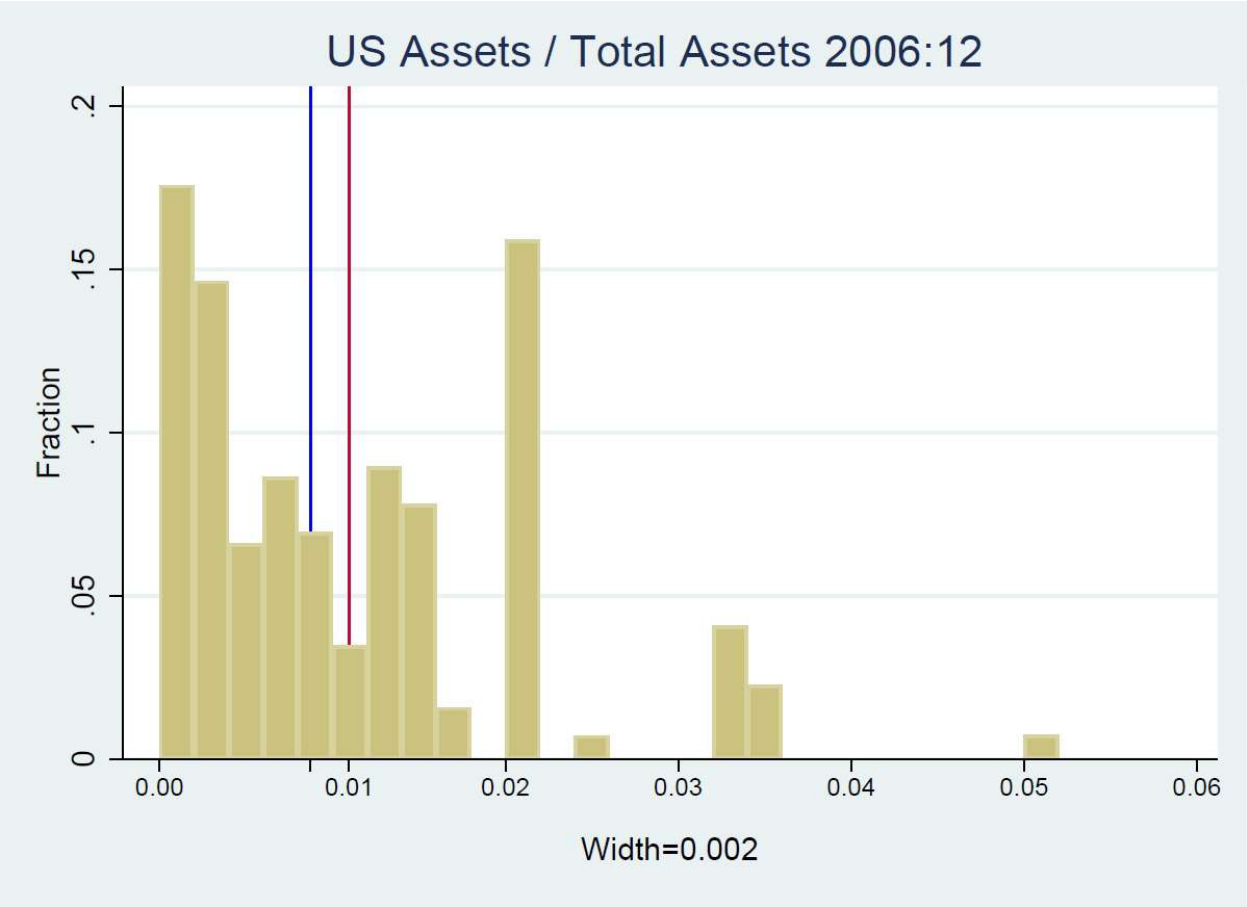
Notes: This figure shows the distribution of the sum of total loan write-offs and net gains on security and equity share holdings, scaled by the bank's capital buffer at the end of the first quarter of 2008, at the bank level across all banks in our baseline sample. The buffer is computed as the difference between the bank's Tier 1 + Tier 2 capital holdings and its minimum capital requirement. For each month over our time period, the graph shows the 25^{th} and 75^{th} percentile as well as the median. The underlying sample is the 7,262 credit commitments of our main sample, thus the realisation of a bank is weighted based on its number of client firms. Net gains on security holdings and equity shares are not affected by transactions or exchange rate changes but solely reflect changes in market values. June 2005 is chosen as starting point because data become available in this month. Source: OeNB.

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



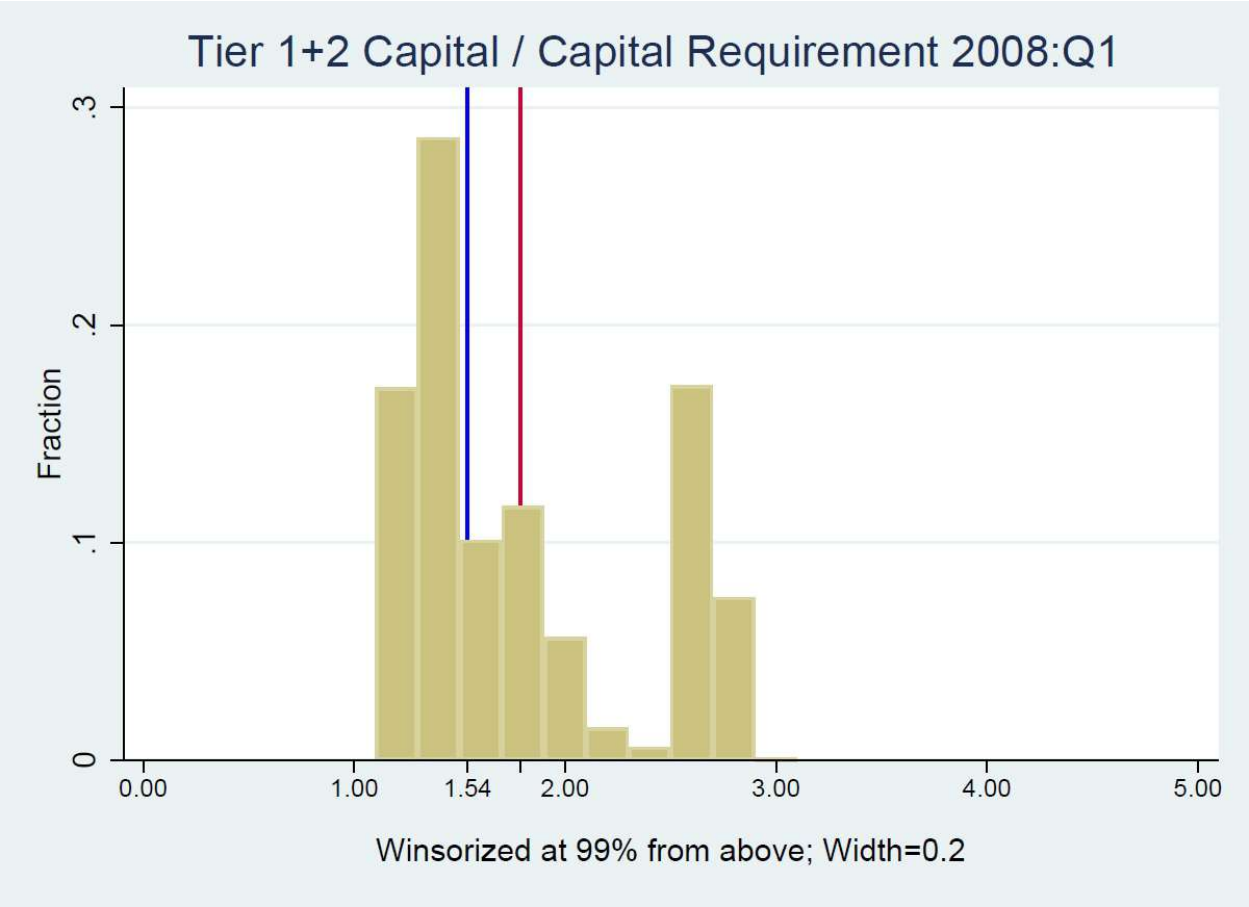
Notes: This graph is borrowed from OeNB (2009). The left panel shows the development of Credit Default Swaps (CDS) spreads of three major Austrian banks. The right panel displays the development of two Austrian banks' and the overall Austrian stock market performance, in an international comparison. ITRAXX SR FINANCIAL 5Y CDS index is the brand name for the family of credit default swap index products covering different regions – the present graph plots 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 capitalisation of the included banks. SR stands for senior debt.

Figure 3: Distribution of US Assets / Total Assets



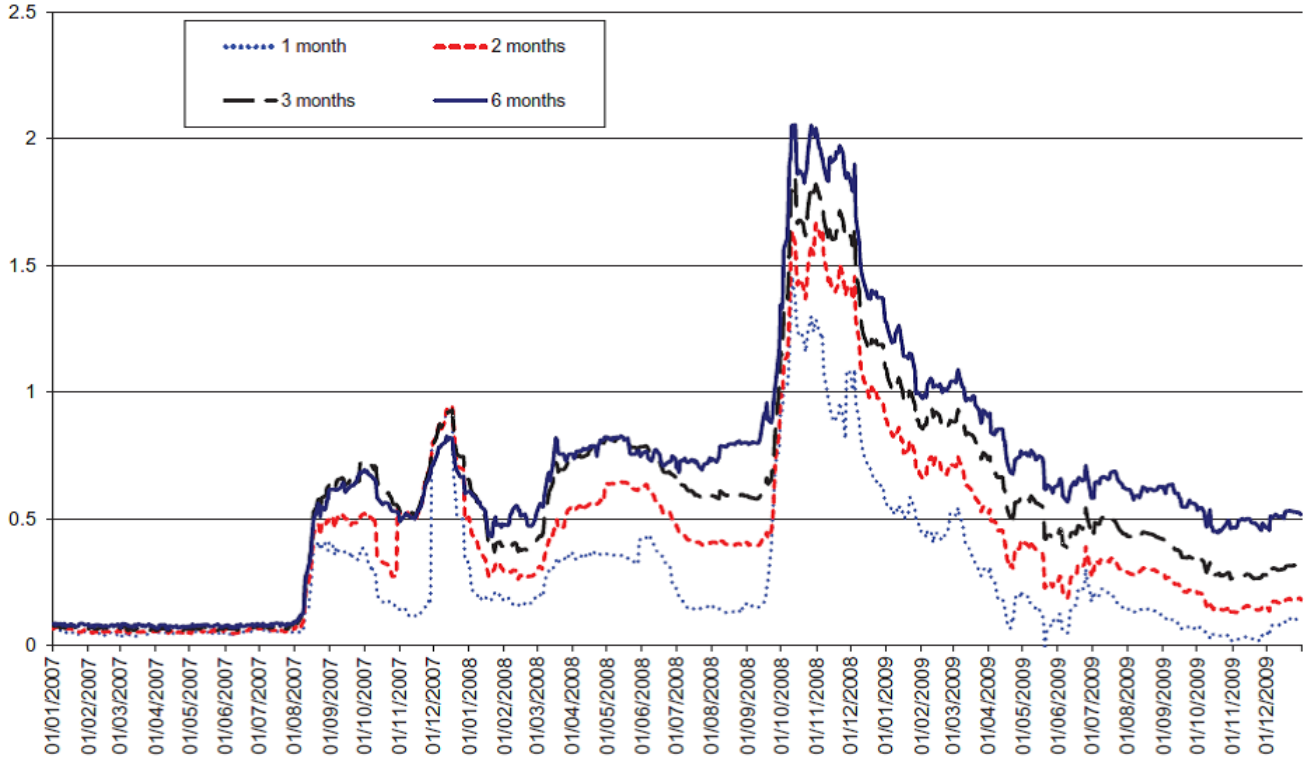
Notes: This figure displays the distribution of the bank-level variable US Assets / Total Assets in December 2006. The underlying sample is the 7,262 bank-firm pairs of our main sample, thus the realisation of a bank is weighted based on its number of client firms. The blue vertical line indicates the median across our sample, while the red vertical line displays the mean. The height of a given bar indicates the fraction of credit commitments granted by banks for which US Assets / Total Assets lies within the given interval of width 0.002. Source: OeNB.

Figure 4: Distribution of Tier 1+2 Capital / Capital Requirement



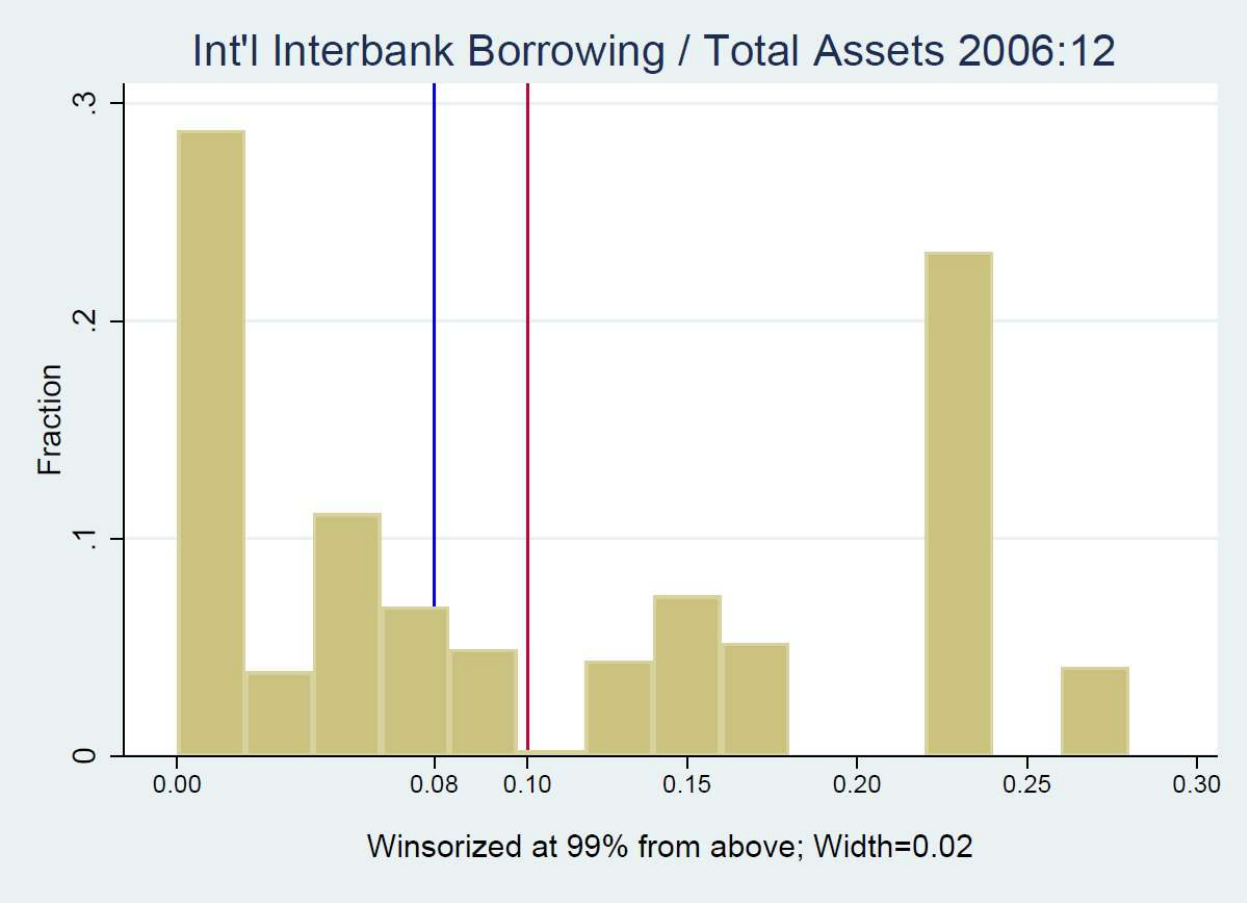
Notes: This figure displays the distribution of the ratio that provides the basis for computing our dummy variable *Small Capital Buffer*. The underlying sample is the 7,262 bank-firm pairs of our main sample, thus the realisation of a bank is weighted based on its number of client firms. The blue vertical line indicates the median (below which a bank has *Small Capital Buffer*=1), while the red vertical line displays the mean. The height of a given bar indicates the fraction of credit commitments granted by banks for which Tier 1 + 2 Capital / Capital Requirement lies within the given interval of width 0.2. For illustrative purposes, the data are winsorised from above at the 99% level, but the mean and median are computed based on the original data. Source: OeNB.

Figure 5: The cost of interbank funding 2007-2009



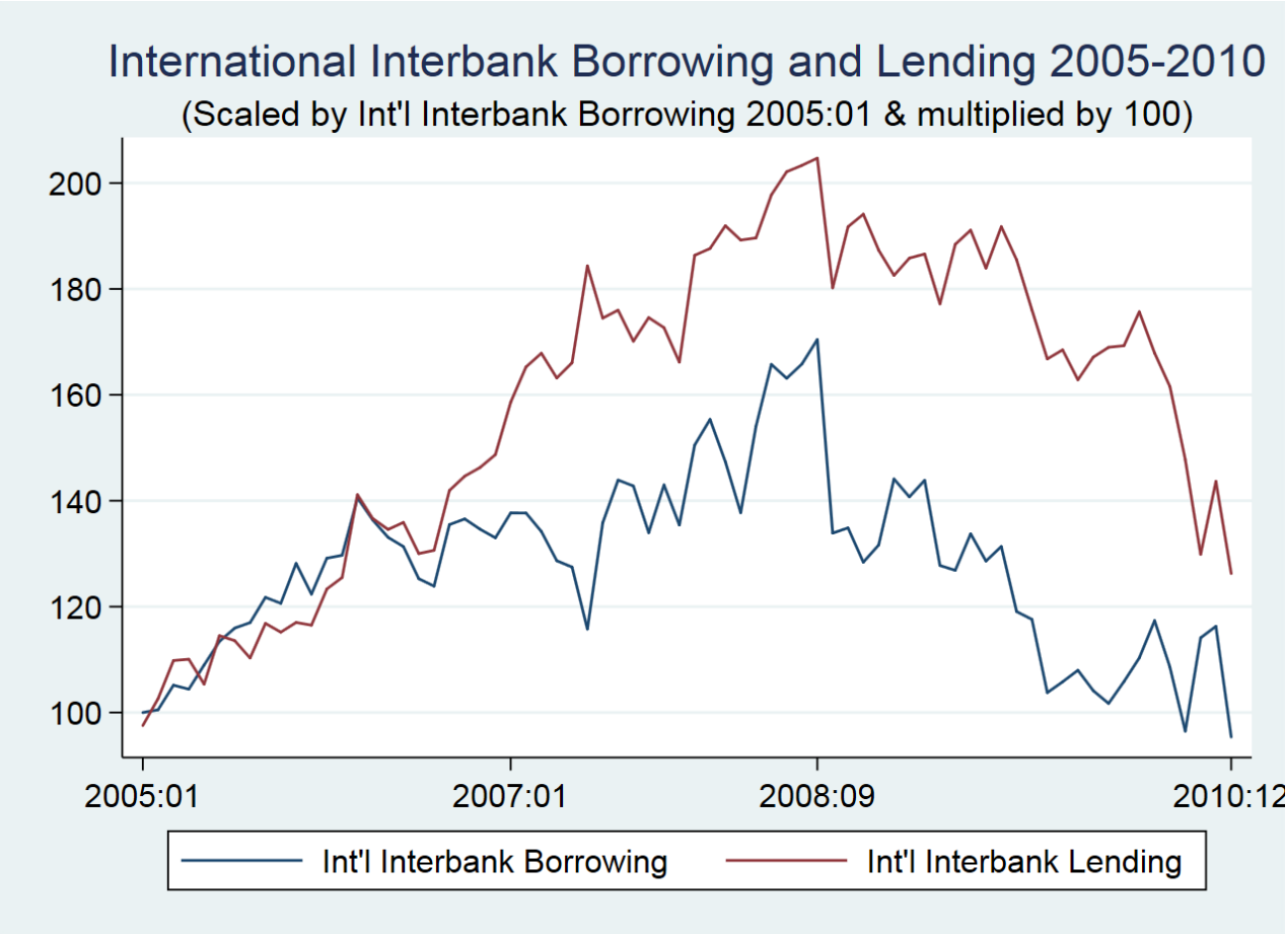
Notes: This figure is borrowed from Cingano et al. (2016) and depicts the spread between the unsecured ("Euribor") and secured ("Eurepo") interbank lending rates between 2007 and 2009 for different maturities. Original source: European Central Bank.

Figure 6: Distribution of International Interbank Borrowing / Total Assets



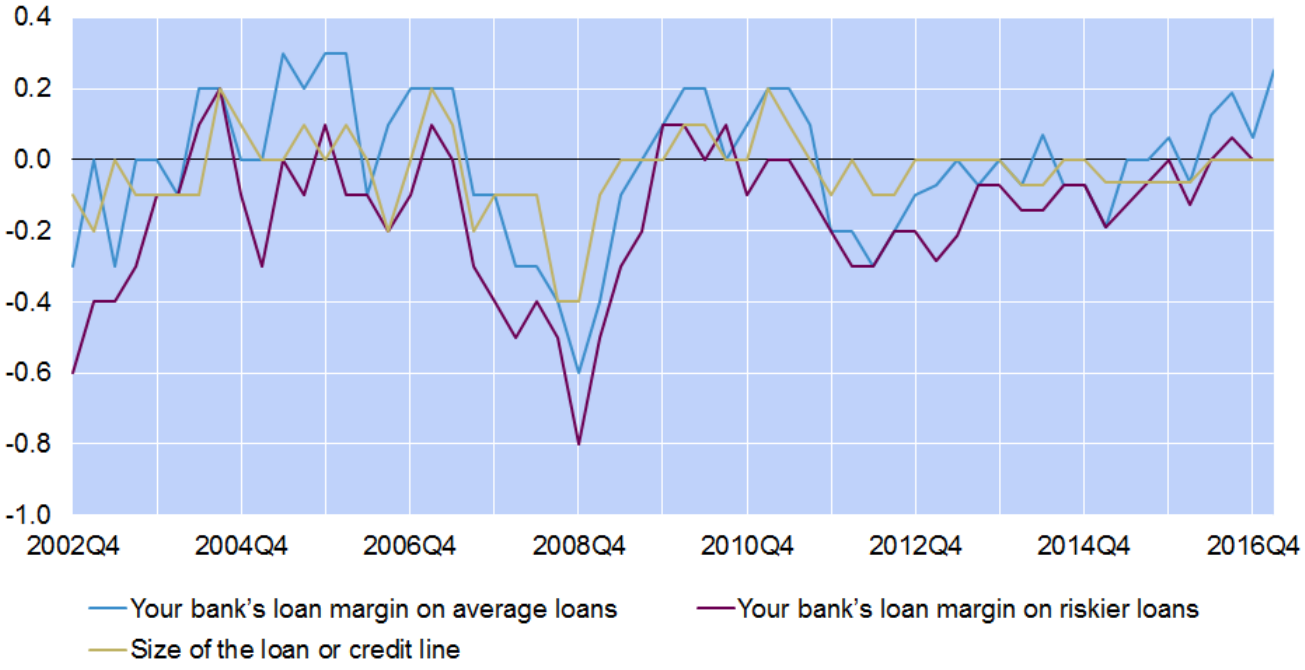
Notes: This figure displays the distribution of International Interbank Borrowing / Total Assets in December 2006. The underlying sample is the 7,262 bank-firm pairs of our main sample, thus the realisation of a bank is weighted based on its number of client firms. The blue vertical line indicates the median across our sample, while the red vertical line displays the mean. The height of a given bar indicates the fraction of credit commitments granted by banks for which International Interbank Borrowing / Total Assets lies within the given interval of width 0.02. For illustrative purposes, the data are winsorised from above at the 99% level, but the mean and median are computed based on the original data. Source: OeNB.

Figure 7: International interbank borrowing and lending 2005-2010



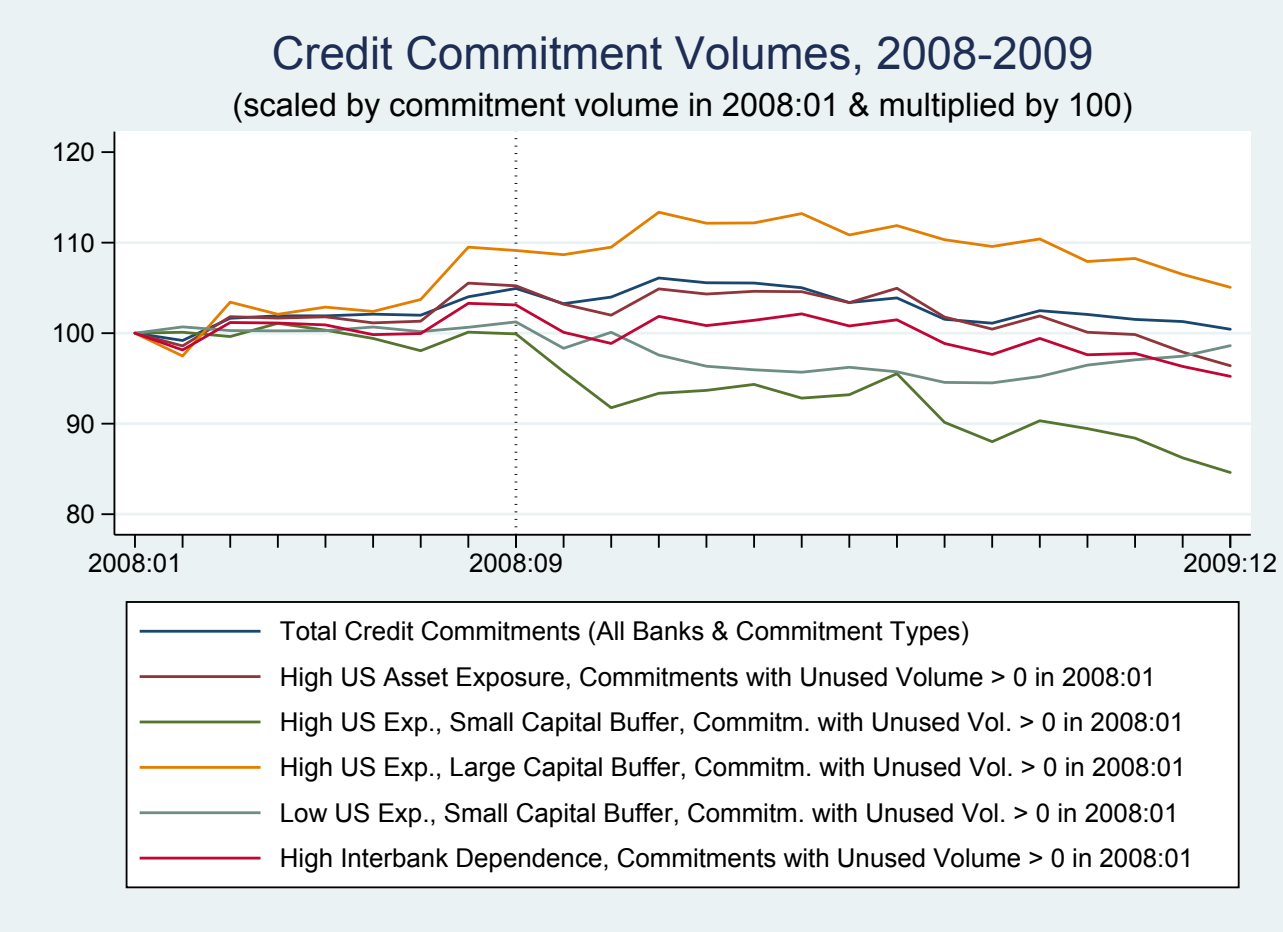
Notes: This figure depicts the development of total international interbank borrowing and lending, respectively, across all banks operating in Austria. Both series are scaled by total international interbank borrowing in January 2005, and then multiplied by 100. Source: OeNB.

Figure 8: Lending standards and volumes of Austrian banks



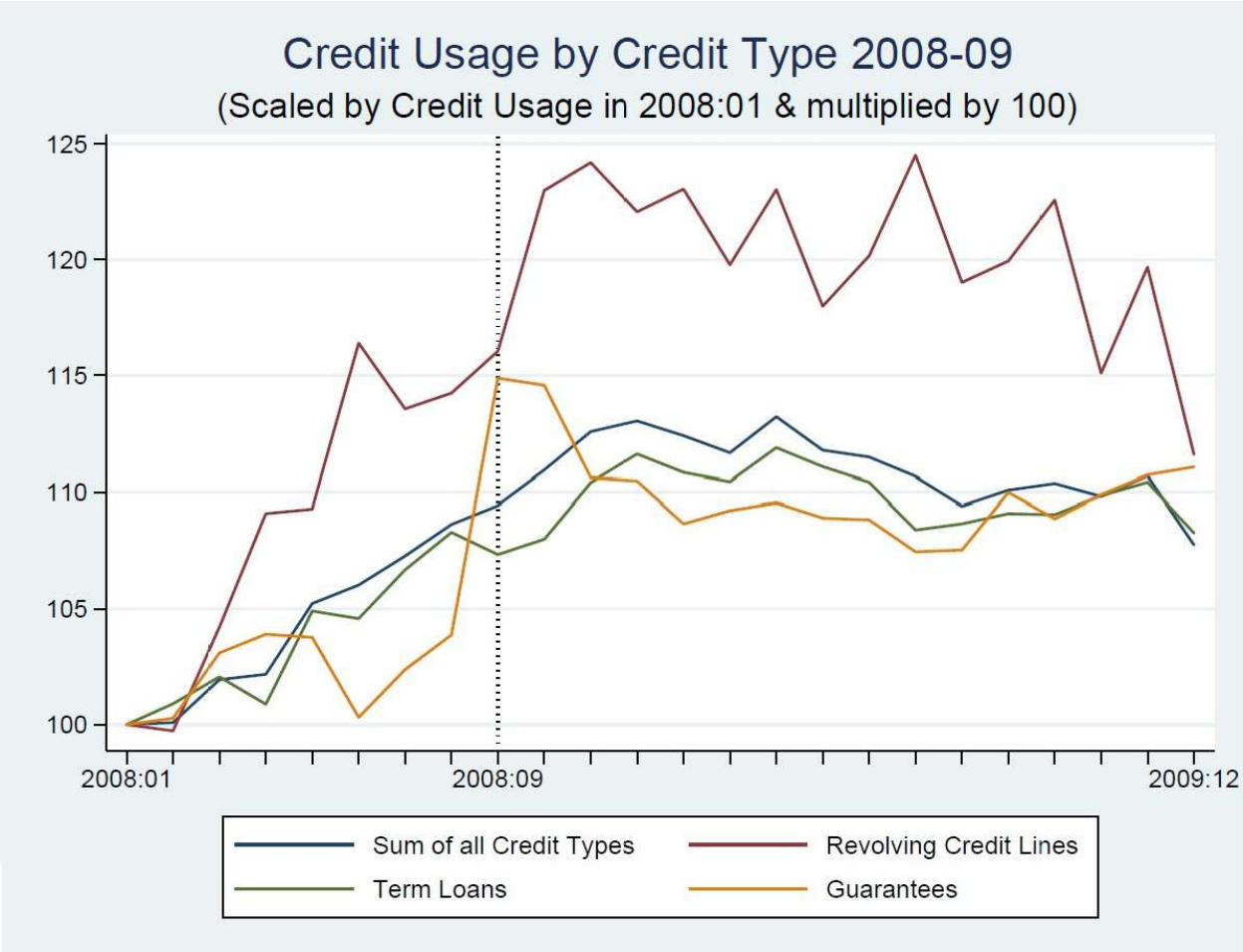
Notes: This figure depicts lending standards of Austrian banks over time based on data from the Austrian version of the Euro area bank lending survey, administered by the European Central Bank. Furthermore, the figure shows the development of credit volumes (as reported by the bank), in relative terms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

Figure 9: Credit commitment volumes 2008-2009



Notes: In this figure we plot the development of granted credit volumes between January 2008 and December 2009 for different types of banks and credit commitments. The basis for computing the respective sums is our baseline sample of 7,262 credit commitments (bank-firm pairs). The volumes are normalised by the granted volume in January 2008. *High* stands for above-median, based on the baseline sample of 7,262 commitments. *Low* and *Small* stand for below-median, based on the same sample. Source: OeNB.

Figure 10: Credit usage by type 2008-2009

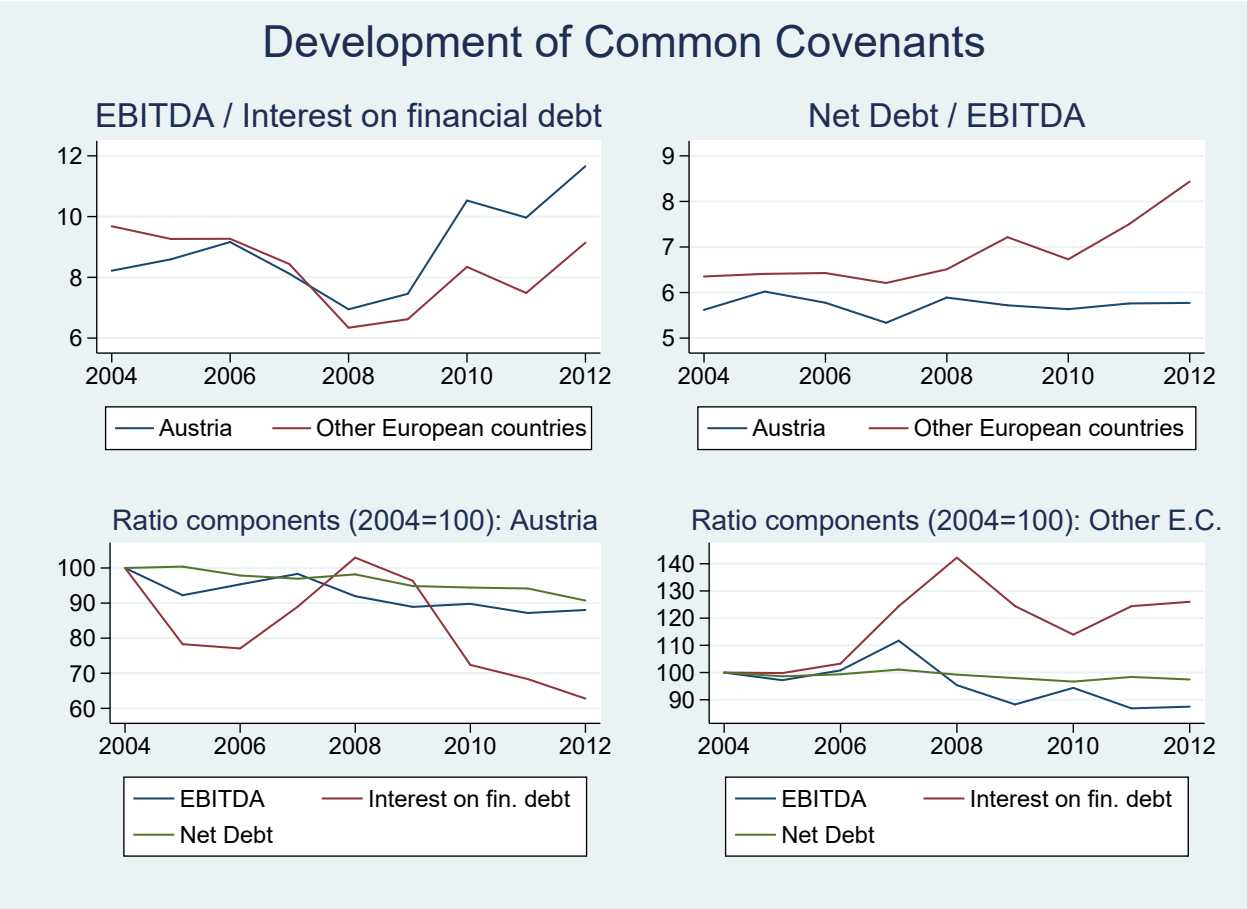


Notes: In this figure we plot the development of the usage of total credit and of the three most important credit types, which jointly make up about 95% of total credit usage (see Table 1), over 2008-2009. The basis for computing the respective sums is our baseline sample of 7,262 credit commitments (bank-firm pairs). The volumes are normalised by the respective usage volume in January 2008. Positive usage of credit guarantees in a given bank-firm relationship does not reflect that the bank actually steps in and repays debt of the firm to another party. Rather, it reflects that the firm makes use 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. Source: OeNB.

Figure 11: Distribution of (granted credit – used credit) at the bank-firm level

Notes: This figure shows the distribution of the difference between granted credit and used credit in thousand Euros across our main sample of 7,262 credit commitments (bank-firm pairs). The blue vertical line indicates the median, while the red vertical line displays the mean. The height of a given bar indicates the fraction of credit commitments that have a given unused credit volume within the given interval of €200,000. The x-axis tick to the left of the tick showing the median of 96.5 indicates zero. The mass of commitments in the negative range are being overdrawn by the respective firms. For illustrative purposes, the data are winsorised at the 95% level, but the mean and median are computed based on the original data. Source: OeNB.

Figure 12: Development of common covenants over time



Notes: The top two graphs show the development of common covenants over 2004-2012. The bottom two graphs reveal the driving forces of these covenant developments. Data is obtained from the BACH (Bank for the Accounts of Companies Harmonized) database, which contains aggregated and harmonized information on the annual accounts of the non-financial corporations of selected European countries. Besides the Austrian data, for comparison we also plot the simple average development across the five other countries for which data are available over 2004-2012: Belgium, Czech Republic, France, Portugal and Spain. EBITDA stands for earnings before interest, tax, depreciation and amortisation. Net debt equals debt minus cash and cash equivalents. A single country-year realisation is computed on the basis of sector-specific average values. In particular, we compute a weighted average across all sectors for a given country-year; the weight assigned to a specific sector equals its share across the credit commitments in our baseline sample that are granted to firms in non-financial sectors (which is true for around 75% of commitments). A given sector-year realisation represents firms of all sizes.

OA2 Robustness Checks (Tables OA1 - OA3)

Testing for common trends before the crisis

We can only interpret our coefficients as reflecting active credit commitment management by banks in order to lower capital or liquidity risk during a financial crisis if our key explanatory variables do not affect lending in normal times. In particular, it is necessary that we observe a *common trend* in the supply of partly or fully unused credit commitments before 2008-09 across banks with different capital and/or liquidity concerns during the crisis. We test whether this is the case by regressing the change in the 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 is to avoid picking up the impact of regulatory changes due to 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 OA1. The hypothesis that the lending behavior of "treated" and "non-treated" banks follow the same trend before the crisis cannot be rejected; all interaction terms and marginal effects are not significantly different from zero. In column 2 we only include the aggregate volume of unused credit at the bank level (same as in column 2 of Table 3) as of January 2005, and derive the same conclusions. Interestingly, the results in both column 1 and 2 of Table OA1 show that the volume of partly or fully unused credit commitments granted by the *average* bank (in terms of 2008-09 crisis exposure) significantly falls over 2005-06, similarly as over 2008-09 (see Table 2). In order to check whether this may be explained by seasonality, in column 3 we analyse the period December 2004 - December 2006, but the coefficient remains virtually identical. Therefore, the results might indicate a supply-driven anticipation effect of the implementation of (most of) Basel II in January 2007, which made unused credit more expensive for banks as it was required to be backed

by more 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 interaction terms and marginal effects are insignificant, providing further evidence of common credit supply trends before the crisis.[39]

Bank-firm-specific credit demand

The success of firm fixed effects in controlling for confounding firm-level credit demand hinges on an assumption: a firm does not disproportionally ask those of its banks with particularly large or small capital or liquidity problems during the crisis for a modification of the granted credit commitment volume over 2008-09. As we discuss in Section 3, there is no particular reason to believe so, but nonetheless we estimate three robustness checks on the results of Table 2 to further address such concerns. In our first check (see column 2 of Table OA2; column 1 reports the baseline results of column 4 of Table 2) we compare credit commitment supply in bank relationships that are relatively similar to each other in a given firm and thus might be characterised by more similar firm demand patterns during the crisis. This is achieved 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 is used as a revolving credit line in January 2008, which holds true for 39% of commitments. While the coefficient on the triple interaction term *US Exposure* $\times$ *Small Capital Buffer* $\times$ *Unused Volume* turns marginally insignificant, this is driven more by an increase in the standard error following a reduction in degrees of freedom by around 25% than by a reduction in the coefficient size. Therefore, it appears fair to conclude that our results pass this robustness check. Another way to address confounding demand effects is to study a more homogeneous sub-sample of credit commitments with regard to the unused credit volume. The underlying idea is that bank-firm demand is also more homogeneous in such a sample, and thus any potential correlation between bank-firm demand and the bank variables in equation (1) also becomes less

[39] Also in columns 4-5, the coefficient on *Unused Volume* is negative and statistically significant, which again might indicate an anticipation effect of the Basel II implementation.

of a concern. Our first specification in this spirit is in fact estimated in column 5 of Table 3, where we only include the sub-sample of commitments that are not fully used and use the continuous version of *Unused Volume*$_{ij}$ (log if positive and zero otherwise). Another, more simplistic approach is to exclude fully-used commitments and also entirely drop *Unused Volume*$_{ij}$ from equation (1), and instead estimate the specification underlying column 2 of Table 2. The results on this regression are presented in column 3 of Table OA2. In column 4 we estimate a similar specification which takes the idea of a homogeneous sample one step further by only including commitments with an unused volume above €1 million, which is the median across partly or fully unused commitments based on our baseline sample. In both columns the interaction term *US Exposure* × *Small Capital Buffer* is negative and highly significant, which provides further evidence that our baseline results reflect credit commitment supply cuts by capital-constrained banks. The coefficients on *Int'l Interbank Borrowing* are negative but not statistically significant, which parallels the results in column 5 of Table 3 and is consistent with the discussed results in column 3 of Table 2.

Other robustness checks

In column 5 of Table OA2 we include all banks into the sample, thus also those with less than 20 client firms in January 2008. In column 6 we measure the ratio underlying the computation of *Small Capital Buffer* as of (the end of) 2006:Q4, in order to parallel the timing of our other bank-specific variables. In column 7 we exclude credit commitments with a positive usage of trust loans, for which it is not true that an increase in drawdowns leads to a capital ratio reduction for the granting bank (see footnote 16 in the main text). In column 8 we re-define *Unused Volume*$_{ij}$ to equal one if the unused credit volume exceeds the variable's 25$^{\text{th}}$ percentile among positive realisations in our main sample – which equals €285,000 – and zero otherwise. In column 9 we restrict the sample to non-financial firms (borrowers). The results are robust to all of these modifications.

Robustness checks on results in Table 3: Bank-level unused credit volume and bank size

In columns 2-4 of Table 3, we include a bank's aggregate unused credit volume across all of its client firms into our specification. We do not scale this variable by bank size or another variable in order to parallel our unscaled continuous measurement of *Unused Volume*$_{ij}$ in columns 2-4 of Table 3. While this implies that our measure is positively correlated with bank size, here we show that bank size is clearly not driving the findings in Table 3. The results are presented in Table OA3. In column 1 we repeat the results of column 2 of Table 3 for comparison. In column 2 we regress the dependent variable of Table 3 on the interaction of *Unused Volume*$_{ij}$ and bank size (measured by total assets), as well as the vector C_{ij} and the fixed effects of equation (1). The results show that larger banks do not cut credit commitments with a given unused volume by more than others over 2008-09. In column 3 we additionally include *Total Unused Volume at Bank Level* $\times$ *Unused Volume*. The results show that a one standard deviation increase in aggregate unused credit at the bank level leads to a 0.9 percentage point larger cut in the volume of an individual credit commitment with a given unused credit volume. The magnitude and statistical significance of this effect are very similar to column 2 of Table 3. Furthermore, column 3 of Table OA3 again reveals no effect of bank size on credit commitment supply.

Table OA1: 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	
Definition of *Unused Volume*$_{ij}$ →	= 1 if positive	ln(UV) if UV>0 o/w=0	= 1 if positive	= 1 if > 25th percentile across positive values	
Sample →	All Firms				Non-Traded
	(1)	(2)	(3)	(4)	(5)
US Exposure × Unused Volume	0.002		-0.007	0.002	-0.007
	(0.023)		(0.028)	(0.010)	(0.018)
US Exposure × Small Capital Buffer × Unused Vol.	0.003		0.045	0.012	0.020
	(0.045)		(0.055)	(0.018)	(0.031)
Small Capital Buffer × Unused Volume	-0.032		-0.053	0.010	0.021
	(0.042)		(0.042)	(0.018)	(0.032)
Int'l Interbank Borrowing × Unused Vol.	-0.032		-0.017	-0.012	0.001
	(0.030)		(0.031)	(0.013)	(0.016)
Total Unused Volume at Bank Level × Unused Vol.		-0.001			
		(0.002)			
Unused Volume	-0.096***	-0.022***	-0.096***	-0.043***	-0.067***
	(0.022)	(0.004)	(0.024)	(0.010)	(0.019)
Bank-Firm Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Bank Controls	No	No	No	No	No
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 supply of partly or fully unused credit commitments (col.1&3: rel. to commitm. with no unused volume; col.4-5: rel. to commitm. with unused vol.<25th pctl)					
1sd Rise in US Exposure if large capital buffer	0.002	NA	-0.007	0.002	-0.007
1sd Rise in US Exposure if small capital buffer	0.005	NA	0.038	0.013	0.013
1sd Rise in Int'l Interbank Borrowing	-0.032	NA	-0.017	-0.012	0.001

Notes: In this table, we test for common trends in the supply of credit commitment volumes before the crisis across more versus less capital- or liquidity-constrained banks during the crisis. In columns 1 and 2, the dependent variable is the change in the log of the maximum amount of credit firm i can obtain from bank j, between 2005:01 and 2006:12. The sample consists of credit commitments granted by banks with at least 20 client firms in 2005:01, to firms that borrow from at least two banks in 2005:01 and 2006:12. In column 3 we compute the dependent variable over the horizon 2004:12 - 2006:12 and in columns 4-5 we do so for the period 2006:08 - 2006:10. 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) and *Total Unused Volume at Bank Level* (2008:01). *Small Capital Buffer* equals one if the buffer is smaller than the median, based on our baseline sample (see Table 2). See Tables 2 and 3 for a description of the other bank-level explanatory variables. All continuous bank variables are first scaled by their standard deviation based on our baseline sample, and all bank variables are demeaned using the column-specific sample. *Unused Volume* and *Bank-Firm Controls* are measured in 2005:01 (columns 1-2), 2004:12 (column 3) or 2006:08 (columns 4-5), respectively. 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 OA2: Further robustness checks

Dependent variable →	$\Delta ln(Credit\ Commitment_{ij})$ 2008:01 - 2009:12								
Nature of Robustness Check →	Base-line	Firm × Cr-Type FE	Only UV> 0	Only UV> €1mn	All Banks	Cap-Buffer measured in 06:Q4	No Trust Loan Usage	UV > 25th pctl.	Only nonfin. firms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
US Exposure × Unused Volume	-0.017	0.017			-0.004	0.037	0.001	0.000	-0.040
	(0.024)	(0.030)			(0.022)	(0.035)	(0.025)	(0.022)	(0.037)
US Exposure × Small Capital Buffer × Unused Volume	-0.106**	-0.089			-0.104**	-0.104**	-0.094**	-0.116***	-0.116*
	(0.046)	(0.058)			(0.043)	(0.048)	(0.044)	(0.042)	(0.068)
Small Capital Buffer × Unused Volume	-0.019	-0.005			-0.016	-0.020	-0.033	-0.023	0.024
	(0.044)	(0.056)			(0.040)	(0.041)	(0.044)	(0.042)	(0.054)
Int'l Interbank Borrowing × Unused Volume	-0.098***	-0.101***			-0.103***	-0.094***	-0.112***	-0.082***	-0.095***
	(0.023)	(0.027)			(0.022)	(0.022)	(0.024)	(0.023)	(0.034)
Unused Volume	-0.153***	-0.159***			-0.136***	-0.148***	-0.168***	-0.207***	-0.197***
	(0.023)	(0.031)			(0.021)	(0.028)	(0.024)	(0.025)	(0.031)
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-Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	No	No	Yes	Yes	No	No	No	No	No
Bank FE	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Observations	7,262	6,104	3,520	1,349	8,336	7,262	6,643	7,262	5,478
# Banks	109	108	108	85	284	109	109	109	108
# Firms	2,266	1,829	1,265	488	2,535	2,266	2,064	2,266	1,861
Marg. Effects on supply of partly or fully unused cred-comm. (columns 1,2,5,6,7,9: rel. to comm. with no unused volume; column 8: rel. to comm. with unused volume <25th pctl.)									
1sd Rise in US Exposure if large capital buffer	-0.017	0.017	0.094***	0.153**	-0.004	0.037	0.001	0.000	-0.040
1sd Rise in US Exposure if small capital buffer	-0.123**	-0.072	-0.040*	-0.041	-0.108**	-0.067**	-0.093*	-0.116**	-0.155**
1sd Rise in International Interbank Borrowing	-0.098***	-0.101***	-0.018	-0.034	-0.103***	-0.094***	-0.112***	-0.082***	-0.095***

Notes: This table shows several robustness checks on the findings displayed in column 4 of Table 2, which are repeated in column 1 for comparison. 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 in January 2008, and estimate the specification of column 2 of Table 2. In column 4 we do the same but restrict the sample to commitments with an unused credit volume of more than €1 million, which equals 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 with at least 20 client firms in January 2008. In column 6 we use the bank-level realisations of (Tier 1+2 Capital / Capital Requirement) in 2006:Q4 rather than 2008:Q1 to compute the variable *Small Capital Buffer*. In column 7 we exclude all bank-firm pairs in which trust loan usage in January 2008 is positive. In column 8 we re-define *Unused Volume* to equal one if the unused credit volume exceeds the variable's 25th percentile among positive realisations in our main sample – which equals €285,000 – and zero otherwise. In column 9 we restrict the sample to non-financial firms (borrowers). 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 OA3: Robustness check: Credit commitment supply, bank-level unused credit and bank size

Dependent variable →	$\Delta ln(Credit\ Commitm._{ij})$ 2008:01 - 2009:12		
Definition of *Unused Volume*$_{ij}$ →	ln(Unused Vol.) if UV>0, o/w =0		
	(1)	(2)	(3)
Total Unused Volume at Bank Level × Unused Volume	-0.010***		-0.009***
	(0.003)		(0.003)
Bank Assets × Unused Volume		-0.006	-0.004
		(0.004)	(0.004)
Unused Volume	-0.032***	-0.032***	-0.031***
	(0.004)	(0.004)	(0.004)
Bank-Firm Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Bank Controls	No	No	No
Bank FE	Yes	Yes	Yes
Observations	7,262	7,262	7,262
# Banks	109	109	109
# Firms	2,266	2,266	2,266

Notes: In this table, we perform two robustness checks on the results in column 2 of Table 3, which are repeated in column 1 of this table for comparison. *Total Unused Volume at Bank Level* equals the difference between total granted credit and total used credit across *all* client firms of the bank. All bank variables are first scaled by their standard deviation in our sample, and then demeaned using the column-specific sample. 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.

OA3 Additional Results and Descriptive Statistics (Tables OA4 - OA6)

US asset holdings and gains and losses over time

In this subsection we show that higher US asset holdings at the onset of the crisis are significantly associated with 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. By definition, net gains on security holdings and equity shares are not affected by transactions or exchange rate changes, but instead solely reflect changes in the market value of the underlying assets. We compute the bank-specific sum of net value gains on security holdings and equity shares minus write-offs on loans ("net gains" in the following) over the 24 months of 2008 and 2009. This is regressed on the sum of US securities, equity shares and loans on the bank's balance sheet in December 2006. Both variables are measured in Euros rather than in logs because net asset value gains may be positive or negative, and not all banks hold US assets. The results are reported in Table OA4. In column 1 we include all banks for which data exist, 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, in which a bank's weight equals its relative frequency as lender in our baseline sample. The coefficient is negative and statistically significant in all three columns. The coefficient in our preferred specification (see column 3) indicates that a €1 increase in pre-crisis US asset holdings is on average associated with a €2.1 loss during the crisis.

Table OA4: Bank-level US assets and gains and losses during the crisis

Dependent Variable →	*Net Total Asset Value Gains 2008-09$_j$*		
Sample →	All Banks	Banks in our sample	
Weighting →	All banks have equal weight		Weighted using frequency of bank 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

Notes: In this table, we analyse the correlation between pre-crisis US asset holdings and total net asset value gains during the crisis at the bank level. The latter variable equals the total net asset value gains incurred by a bank due to changes in the market value of securities and equity share holdings (but not due to exchange rate changes) and/or write-offs of loans over the 24 months of 2008-09. *US Assets* equals the sum of US securities, equity shares and loans on the bank's balance sheet, in whichever currency. Both 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 feature in our baseline sample of 7,262 credit commitments (see Table 2, and note that one of the 109 banks is omitted due to lack of data on net asset value gains and loan write-offs). In column 3 we weight every observation by the relative frequency (thus number of client firms) of the bank in that baseline sample. Robust standard errors are reported in parentheses. *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

Table OA5: Firm-level determinants of unused credit volume and repeated balance sheet data availab.

Dependent variable →	*ln(UV) if UV>0 o/w =0*	Δ *Inv. not miss.*	Δ *Empl. not miss.*
	(1)	(2)	(3)
Return on Assets	0.236***	0.032**	0.044***
	(0.074)	(0.013)	(0.013)
Assets	0.040	0.032**	0.048***
	(0.069)	(0.012)	(0.010)
Sales / Assets	0.412***	0.006	0.097***
	(0.099)	(0.016)	(0.015)
Cash Holdings / Assets	-0.206***	-0.032**	-0.004
	(0.076)	(0.012)	(0.011)
Assets / Capital (Leverage)	-0.178***	-0.055***	-0.059***
	(0.064)	(0.011)	(0.012)
Current Assets / Assets	-0.092	0.079***	0.066***
	(0.097)	(0.016)	(0.016)
Relationship Duration	0.337***		
	(0.071)		
Bank FE	Yes	No	No
Observations	5,650	1,718	1,718
# Firms	1,718	1,718	1,718
# Banks	109	NA	NA

Notes: This table analyses the respective correlation between three variables of interest and firm characteristics. Our analysis is based on the 7,262 bank-firm relationships that feature in our main sample, though not all of them enter the specification due to limited firm-level data availability. The dependent variable in column 1 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 of Table 6, and zero otherwise. Δ *Empl. not miss.* equals one if we are able to compute the dependent variable of columns 7-8 of Table 6. The sample in columns 2 and 3 consists of the 1,718 firms in our baseline sample for which balance sheet data are available for the year 2007. Firm balance sheet variables are measured at the end of 2007, winsorised at the 5% level and scaled by their standard deviation based on the sample of 1,718 firms. *Relationship Duration* is measured in January 2008, censored at 97 months (since credit register data is only available to us from January 2000 onwards) and scaled by its standard deviation based on our baseline sample of 7,262 credit commitments. See Table 1 for the standard deviation of the used variables. Standard errors are reported in parentheses and are cluster-robust at the bank and firm level in column 1 and robust in columns 2-3. *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

Table OA6: Additional descriptive statistics for the period 2013-2014

	Mean	Median	Min	Max	sd	N
I: Used / Granted Credit by Credit Type						
Total	0.808	0.976	0	1.001	0.296	482,109
Revolving Credit Lines	0.501	0.556	0	1	0.416	258,575
Term Loans	0.958	1	0	1	0.158	330,123
Guarantees	0.786	1	0	1	0.324	168,289
Trust Loans	0.882	1	0	1	0.267	7,724
Leasing Loans	0.999	1	0	1	0.028	5,957
Special Purpose Loans	0.945	1	0	1.008	0.145	10,654
II: Contribution to Unused Credit Volume in % by Credit Type						
Revolving Credit Lines	0.670	1	0	1	0.436	275,382
Term Loans	0.149	0	0	1	0.340	275,382
Guarantees	0.160	0	0	1	0.333	275,382
Trust Loans	0.006	0	0	1	0.069	275,382
Leasing Loans	0.000	0	0	1	0.008	275,382
Special Purpose Loans	0.016	0	0	1	0.123	275,382

Notes: From 2013 onwards, the Austrian credit register also contains information on the granted credit volume by credit type. We pool the monthly data over the 24 months January 2013 - December 2014 (the latter is the last month for which data is available to us) and compute descriptive statistics, which are presented in this table. *Used / Granted Credit* in Panel I is winsorised from above at the 5% level to reduce the impact of outliers on the statistics. The statistics in Panel II are based on commitments in which the total unused credit volume is larger zero.

OA4 Online Data Appendix

Sectors of the firms (borrowers) in our baseline sample

Firms in our baseline sample of bank-firm pairs operate in the following sectors (ÖNACE 2008 sector classification): manufacturing (26% of bank-firm pairs); financial and insurance services (we exclude banks and other credit institutions) (24%); wholesale and retail trade, repair of motor vehicles and motorcycles (16%); professional, scientific and technical activities (7%); construction (7%); transportation and storage (6%); accommodation and food services (3%); electricity, gas, steam and air-conditioning supply (2%); other economic services (2%); water supply, sewerage, waste management and remediation (2%); information and communication (1%); human health and social work activities (<1%); other services (<1%); mining and quarrying (<1%); arts, entertainment and recreation (<1%); agriculture, forestry and fishing (<1%); education (<1%); public administration and defence, compulsory social security (<1%).

List of CESEE countries

Albania, Azerbaijan, Bulgaria, Belarus, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia.

Tracking bank mergers and changes in bank identifiers

We track bank mergers and split-ups and resulting changes in bank identifiers over 2004-2009. For our main specification, we track changes between January 2008 and December 2009. Data on bank mergers, splits and identifier changes is provided by the OeNB. While especially mergers have been quite common over 2004-2009 (around 10 cases per year), the typical merger is a very small bank (which hardly appears in the credit register) being taken over by a larger bank. Therefore, it turns out that in practice there is no case of a merger that we have to consider in our analysis.

In the 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).

References

Cingano, F., F. Manaresi, and E. Sette (2016). Does credit crunch investment down? New evidence on the real effects of the bank-lending channel. *Review of Financial Studies 29*(10), 2737–2773.

OeNB (2009). The financial crisis takes its toll on the Austrian financial system. *Financial Stability Report,* Oesterreichische Nationalbank (Austrian Central Bank), *17*, 33–52.

NORGES HANDELSHØYSKOLE
Norwegian School of Economics

Helleveien 30
NO-5045 Bergen
Norway

T +47 55 95 90 00
E nhh.postmottak@nhh.no
W www.nhh.no