FOUR ESSAYS ON BANKS, FIRMS AND REAL EFFECTS OF BANK LENDING

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ABSTRACT

This dissertation collects four essays on banks, firms and real effects of bank lending. Owing to the appliance of different econometric methods on several datasets, insights in the behavior of and the impacts from financial markets and market participants are generated.

In the first chapter, our results uncover a so far undocumented ability of the interbank market to distinguish between banks of different quality in times of aggregate distress. We show empirical evidence that during the 2007 financial crisis the inability of some banks to roll over their interbank debt was not due to a failure of the interbank market per se but rather to bank-specific shocks affecting banks' capital, liquidity and credit quality as well as revised bank-level risk perceptions. Relationship banking is not capable of containing these frictions, as hard information seems to dominate soft information. In detail, we explore determinants of the formation and resilience of interbank lending relationships by analyzing an extensive dataset comprising over 1.9 million interbank relationships of more than 3,500 German banks between 2000 and 2012.

The second chapter examines the relationship between central bank funding and credit risk-taking. Employing bank-firm-level data from the German credit registry during 2009:Q1-2014:Q4, we find that banks borrowing from the central bank rebalance their portfolios towards ex-ante riskier firms. We further establish that this effect is driven by the ECB's maturity extensions and that the risk-taking sensitivity of banks borrowing from the ECB is independent of

idiosyncratic bank characteristics. Finally, we show that these shifts in bank lending are associated with an increase in firm-level investment and employment, but also with a deterioration of bank balance sheet quality in the following year.

Once we analyze the relationship of banks as lenders vis-à-vis banks as borrowers and banks as lenders vis-à-vis non-financial companies as borrowers, we enlarge the understanding of non-financial companies not only in terms of being simply borrowers, respectively subjects exhibiting of credit risks. Instead, we try to understand the inner working of those companies more generally and analyze their quality not only in terms of a bank's risk assessment but also in terms of the overall market assessment. However, this in turn can generate information useable to assess the quality of a bank's credit portfolio in dimensions that so far are not taken into account by the current regulatory framework. Moreover, a better understanding of banks and non-banks beyond the standard lens of the banking and corporate finance literature might promote new scopes for future research connecting those discrete subjects. In this regard, the third chapter analyzes the dependence of price reactions to corporate insider trading on several measures of corporate governance quality. Our results strongly support the view that first, higher corporate governance levels seem to prevent or discourage insiders from engaging in insider trading as means of opportunistic rent extraction. Second, results confirm the notion of buy and sell trades not being just two sides of the same coin. That is, a higher level of corporate governance leads to a better pre-event information environment which results in less positive abnormal returns after insider buy trades as the incremental positive information revealed by the trade is smaller. In contrast, sell trades in firms with better corporate governance are perceived to convey more valuable and most importantly negative information to the capital market so that prices adjust more for companies with better governance schemes. Third, we show that institutional ownership even on an aggregate level is a sufficient measure to proxy a company's corporate governance level. Hence, as information on companies' bylaws and on investors' investment dedication and type for example are scarce, respectively associated with higher costs because one has to gather that information one can refrain from that and instead proxy the governance level with the aggregate measure of institutional ownership. The latter result is important for carrying out future analyses merging and extending the findings of the first two chapters.

Last, the fourth chapter abstracts from borrowers as subjects of credit risk, as well, and most importantly extends the analysis of banks, firms and their interactions effecting each other by a macroeconomic perspective of the real effects of bank lending. That is, as capital flows and real estate are pro-cyclical, and real estate has a substantial weight in economies' income and wealth Chapter 4 studies the role of real estate markets in the transmission of bank flow shocks to output growth across German cities. In this regard, real sector firms play a central role in the transmission mechanism we uncover. More specifically, the empirical analysis relies on a new and unique matched data set at the city level and the bank-firm level. To measure bank flow shocks, we show that changes in sovereign spreads of Southern European countries (the so-called PIGS spread) can predict German cross-border bank flows. To achieve identification by geographic variation, in addition to a traditional supply-side variable, we use a novel instrument that exploits a policy assigning refugee immigrants to municipalities on an exogenous basis. We find that output growth responds more to bank flow shocks in cities that are more exposed to tightness in local real estate markets. We estimate that, during the 2009-2014 period, for every 100-basis point increase in the PIGS spread, the most exposed cities grow 15-2 basis points more than the least exposed ones. Moreover, the differential response of commercial property prices can explain most of this growth differential. When we unpack the transmission mechanism by using matched bank-firm-level data on credit, employment, capital expenditure and TFP, we find that firm real estate collateral as measured by tangible fixed assets plays a critical role. In particular, bank flow shocks increase the credit supply to firms and sectors with more real estate collateral. Higher credit supply then leads firms to hire and invest more, without evidence of capital misallocation.

Keywords: Financial Stability, Interbank Market, Aggregate and Idiosyncratic shocks, Relationship Banking, Risk Perception, Market Discipline, Monetary Policy, LTRO, Bank Lending, Credit Risk-taking, Real Effects, TFP Growth, Institutional ownership, Corporate Governance, Insider Trading, Price Reaction, Corporate Bylaws, Insider Compensation, BIS Cross-border flows, Capital Flows, Collateral, City Business Cycles, Credit, Germany, Misallocation, PIGS Spread, Real Estate, Tangible Assets

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

List of Abbreviations

AME	Average marginal effects
AP	Abnormal profits
AR	Abnormal return
BaFin	German Federal Financial Supervisory Authority
BAKIS	Deutsche Bundesbank’s Prudential Database
BAMF	Federal office for immigration and refugees
Bista	Deutsche Bundesbank’s Monthly balance sheet statistics
BHC	Bank holding company
BNK	Bank trust
BPI	Borrower preference index
CAPR	Regulatory capital to risk-weighted assets ratio
CBF	Central bank funding
CBOE	Chicago board options exchange
CPS	Corporate (private) pension fund
CCyB	Countercyclical capital buffer
DED	Dedicated investor
Delt	Option's sensitivity to a change in the price of the underlying
ECB	European Central Bank
E-Index	Entrenchment index

FSB	Financial Stability Board
GFC	Global or great financial crisis
GIIPS	Greece, Italy, Ireland, Portugal and Spain
H	Hypothesis
IIA	Independent investment advisor
INS	Insurance company
INV	Investment company
IRRC	Investor responsibility research center
IV	Instrument variable
LAR	Loans to assets ratio
LDV	Lagged dependent variable
LHS	Left-hand side
LIQR	Liquid assets to total assets ratio
Log	Natural logarithm
LPI	Lender preference index
LTRO	Long-term refinancing operation
MRO	Main refinancing operations
MEM	Marginal effects at means
MiMik	Deutsche Bundesbank‘s Credit Register Database
MSC	Miscellaneous of institutional investor
NPLR	Non-performing loans to total loans ratio
OLS	Ordinary least squares
PD	Probability of default
PPS	Public pension fund
Prob	Probability
Q	Quarter
QIX	Quasi-indexer
RHS	Right-hand side

PIGS	Portugal, Italy, Greece and Spain
Profitability	Pre-tax operating income to equity ratio
SD	Standard deviation
TRA	Transient investor
Trans. Vol.	Transaction volume
TS	Tangible assets
UFE	University and foundation endowment
US	United States
USD	United States dollars
Vega	Option's sensitivity of a change in volatility
WPS	Wealth-performance sensitivity

SUMMARY

The four chapters presented in this dissertation discuss specific aspects of banks, firms and real effects of bank lending. Chapter 1 analyses the interbank market, that is, the interaction between banks as lenders and banks as borrowers, especially in periods of aggregate turmoil. Chapter 2 adds another sector into the discussion, namely the non-financial sector by analyzing the interaction between banks as lenders and non-financial (real sector) companies in their capacity as borrowers and the effects of those interactions on the banks as well as on real sector outcomes. The third chapter dives deeper into the non-financial sector and analyses how to proxy a company's level of corporate governance and how corporate governance affects a company's insider trading activity in conjecture with the subsequent market reaction. Last, the fourth chapter extends the role of real sector firms even further, as they play a central role in the transmission mechanism of bank flow shocks to output growth across German cities via bank lending.

To answer the raised research hypotheses, advanced time series econometrics are used. In addition to the main analyses and results of each chapter, extensive appendices with additional information and several robustness checks are provided. In the following, a more detailed summary of the four chapters is given.

Chapter 1 examines whether the inability of some banks to roll over their interbank position during the 2007 financial crisis was due to a failure of the interbank market in reallocating liquidity efficiently within the banking sector, i.e. a frozen interbank market. During the crisis banks were hit by global aggregate as well as idiosyncratic, i.e. bank-specific shocks. The crucial questions are how stable is interbank lending to shocks of a different kind and how periods of market turmoil affect the general functioning of market discipline.

A number of features clearly distinguish this chapter from the existing literature. First, we control not only for the volume but also for the persistence of interbank lending. This allows us to explore both intensive and extensive margins of interbank market dynamics. Second, we are the first that by disentangling the effects and the inherently differing information content of aggregate and idiosyncratic shocks, provide evidence of whether the inability of some banks to roll over their interbank positions was due to a failure of the interbank market, or rather to revised bank-level risk perceptions that lead to a stressed money market. Third, the length of our sample allows us to make comparisons between normal and crisis times. In detail, we analyze the most extensive dataset so far, comprising over 1.9 million interbank lending relationships of more than 3,500 German banks conducted between 2000 and 2012.

The inability of some banks to roll over their interbank position and the ensuing financial market turmoil was not due to a failure of the interbank market per se but rather to bank-specific shocks affecting the banks' capital, liquidity and credit quality and revised bank-level risk perceptions. Most importantly, our results uncover a so far undocumented ability on the part of the interbank market to distinguish between banks of different quality in times of aggregate distress. We show empirical evidence that questions the hypothesis of market discipline being undermined by a lower sensitivity to fundamentals in times of aggregate market turmoil. In fact, our results show that the negative effect of higher risk levels is even larger in the crisis period than in the non-crisis period. In this regard, relationship banking is not capable of containing these frictions, as hard information seems to dominate soft information.

Chapter 2 explores the broader liquidity support programs, which the European Central Bank (ECB) employed in order to counteract the consequences of the global financial crisis of 2007-2008 and the sovereign debt crisis of 2010-2012, as they went way beyond the operational scope of classical monetary policy in several directions. For example, the ECB extended the pool of eligible collateral and introduced a full allotment strategy. Most notably, in the framework of its long-term refinancing operations (LTROs), the ECB substantially increased the maturity spectrum of central bank refinancing, providing loans to banks in the euro area with a maturity of up to three years. In this chapter, we examine the following question: How did the extended liquidity provisions affect credit risk-taking? Specifically, how does central bank refinancing affect banks' loan supply to borrowers with different ex-ante risk levels? In this regard, we focus on the effect of the maturity extension and explicitly differentiate between short-term and long-term central bank funding (CBF).

The ECB's non-standard refinancing operations motivated recent research to revisit the issue of how monetary policy affects bank lending. This strand of the literature shows that the interventions have been successful in increasing bank lending volumes, thus counteracting contractions in aggregate credit and investment. We contribute to this literature by investigating the quality composition of banks' loan portfolios, allowing us to identify the side effects of lax monetary policy in terms of risk shifting. By explicitly differentiating between short-term and long-term central bank funding, our results also add to the literature on the implications of bank funding maturities for the risk-taking incentives of banks. Finally, we also contribute to the policy debate on adequacy of potential macroprudential instruments and the ex-post effects of the expansionary monetary policy.

The chapter provides four main findings. First, we document that higher central bank funding leads to both increased bank loan volumes and increased credit risks. Specifically, banks with larger volumes of CBF expand their lending to ex-ante riskier firms, where firm risk is measured by firms' interest coverage, leverage and size. Second, we show that this effect does not depend on idiosyncratic bank characteristics, such as size and capitalization. This finding is important from a policy perspective, since it suggests that the macroprudential surveillance of the banking sector and the choice of macroprudential instruments should not only place a special focus on specific bank types, but it should—instead—take the banking sector as a whole into account in order to minimize the risk-increasing implications of an expansionary monetary policy. Third, we document that especially long-term CBF is associated with an increase in banks' loan supply to riskier firms. Finally, we show that the documented shift in bank lending behavior leads to an deterioration of bank balance sheets (higher non-performing loans and lower capitalization), but also supports the real economy by raising firm-level investments and employment. In this sense, our results are indicative of the typical trade-off of lax monetary policy: the goal of achieving positive real economic outcomes commonly comes at the cost of potentially aggravated financial stability risk.

Moreover, by analyzing the most salient measures of corporate governance in Chapter 3, namely the level of institutional ownership, anti-takeover provisions and top executives characterization and compensation variables we are able to answer the following questions: What and how much information do corporate insiders convey to the capital market via their trades and how do market participants assess them? Furthermore, how does a company's corporate governance affect insiders and market participants and how does one measure the level of corporate governance in the first place?

These questions have motivated a growing literature on the relationship between abnormal returns subsequent to insider trades and the company's level of corporate governance, which could affect the insider's trading credibility. In this regard, the identification and quantification of feasible variables to measure a company's corporate governance quality is a difficult task and resulted in a heterogeneous number of governance proxies. Some of those measures are easier to track than others, with institutional ownership being more largely available and feasible to utilize than for instance information on companies' charter or corporate bylaws, e.g. voting rights or management provisions, or even compensation schemes, which are available for a limited number of top managers, only. We contribute to this discussions by pointing out that aggregate institutional ownership is a sufficient measure to proxy a company's level of corporate governance. Regarding the market reaction to corporate insider trading, there are two dimensions of evaluating trades by corporate insiders. First, by looking at insider trading as a channel of rent extraction and second, by considering the information role of insider trades (Fidrmuc et al., 2013). Moreover, it is important to distinguish between buy and sell trades. While an insider purchase conveys positive information about a firm's prospects, because the signal is costly and therefore credible as the insider put her own wealth at stake, it is less clear what information an insider sale conveys. On the one hand, it may convey unfavorable information about the firm's prospects, but on the other hand, an insider sale may be less informative if it is made to meet liquidity or diversification needs, especially when managers receive large part of their compensation in equity. The latter effect may soften the negative news conveyed to the market. In a nutshell: 'Insiders have many reasons to sell shares but the main reason to buy shares is to make money' (Lakonishok et al., 2001). In this context, proper corporate governance can restrain selfish managerial decisions that are detrimental to the firm and an ample body of literature shows that firms benefit from good corporate governance in general. Strong corporate governance has been documented to impact positively on share prices in the long run (Gompers et al., 2003; and Cremers et al., 2005), to decrease agency costs (Shleifer et al., 1997) and to curtail opportunistic insider trading (Fidrmuc et al., 2006; Rozanov, 2008; Ravina et al., 2010). Hence, it is straightforward to conclude that corporate governance affects the information content of insider trades and their subsequent market reaction, as well. For instance, Fidrmuc et al. (2013) find as insider purchases convey more information to outside shareholders when shareholders are more protected against expropriation that market participants are willing to trade on more firm-specific information because they are protected from insider self-dealing. Chapter 3 contributes to the discussion how to assess insider trades more generally and how corporate governance affects insider trading activity specifically.

Overall, we are able to reveal three important insights. First, as there is still an on-going debate in the academic literature whether to treat insider trading as rent extraction by insiders or as signals for firm value changes, our results strongly confirm the latter notion. Second, we highlight the view that insider buy and sell trades are not two sides of the same coin. In cases of insider purchases, we see lower abnormal returns for companies with higher levels of corporate governance indicating that insiders do not convey new or credible favorable information to the capital market via their buy trades. It seems to be the case that all positive information is already incorporated into stock prices before the insider trade takes place. However, the opposite is true in the case of sell trades. Insiders of companies with higher levels of corporate governance convey credible bad signals to the capital market when they sell shares. Third, we show that institutional ownership even on an aggregate level is a sufficient measure to proxy a company's corporate governance level. Results for institutional investors that because of their investment dedication and type exhibit distinctively higher incentives to enforce proper corporate governance standards show similar outcomes as results for the aggregated level of institutional ownership. Moreover, information on corporate bylaws that make it difficult or expensive for outside investors to effect changes with regard to the top management and board of directors do not provide additional information. Hence, as information on companies' bylaws and on investors' investment dedication and type are scarce, respectively associated with higher costs because one has to gather that information it is possible to refrain from that and instead proxy the governance level with the aggregate measure of institutional ownership.

Last, as cross-border capital flows can affect the real economy through different channels, for instance by changing the prices of real estate, which has a large weight in economies' income and wealth, Chapter 4 answers the following questions: Which role do real estate markets play in the transmission of capital flow shocks to economic growth? What are the transmission mechanisms? Specifically, the Chapter addresses these questions by studying the impact of capital flow shocks on economic growth across German cities.

The chapter contributes to the literature in multiple ways. First, we provide a novel identification strategy, which captures the tightness of the real estate markets across German cities. Second, we construct a data set for commercial and residential real estate prices at the city level, matched with bank-firm level data from the German credit registry. This unique data set enables us to study the role of real estate markets in the transmission of capital flow shocks.

Our results show that capital flow shocks, as measured by the sovereign bond spread of Southern European countries over Germany, have a more significant impact on economic growth in cities that are more exposed to tightness in local real estate markets. We estimate that, during our sample period (2009-2014), for every 100-basis point increase in the interest rate spread, the most exposed German cities grow 15-25 basis points more than the least exposed ones. Moreover, the differential response of commercial property prices can explain most of this growth differential. When we identify the transmission mechanism, we find that firms with more real estate collateral received more credit as capital flew into Germany. These firms, as a consequence, invested and hired more, thereby contributing to higher output growth. As opposed to this, we find no evidence of capital misallocation in Germany, possibly because the German real estate boom took place without a credit boom during the sample period studied.

Chapter 1 is based on Bednarek et al. (2015), "Fundamentals Matter: Idiosyncratic Shocks and Interbank Relations", Discussion Paper 44/2015, Deutsche Bundesbank.

The second chapter is based on Bednarek et al. (2020), "Central Bank Funding and the Dynamics of Bank Lending after the Crisis", Discussion Paper 36/2020, Deutsche Bundesbank, as well as on Bednarek et al. (2021), "To whom do banks channel central bank funds?", Journal of Banking and Finance.

The third chapter is based on Bednarek (2011), "How Does Corporate Governance Affect the Informational Content of Insider-Trading Disclosures in the US?", as well as on Bednarek et al. (2018), "Institutional Ownership, Corporate Governance and Price Reactions to Corporate Insider Trading". In this regard, it is important to point out that the basic idea to analyze abnormal returns subsequent to insider trades in conjuncture with the company's level of corporate governance is based on the Diploma Thesis by Bednarek (2011). Chapter 3 differs, however, in several important ways from the Diploma Thesis. Starting with the hypotheses, the Diploma Thesis does not distinguishes between insider trades as signals for firm value changes on the one hand and rent extraction on the other hand. Consequently, as Chapter 3 is not ignoring the notion of insider trades as means of an alternative source of wealth extraction and its interaction with corporate governance it highlights the first mayor contribution laid out in this analysis—namely the clear result of insider trades not being signals of rent extraction by insiders, but as signals for firm value changes. Moreover, this result is strengthened by the fact that Chapter 3 analysis the insiders' trading volume, also, which the Diploma Thesis does not. Moreover, insiders are not analyzed regarding their distinct characteristics, i.e. in terms of their compensation schemes, gender, age, share ownership or non-firm wealth. Second, the sample analyzed in Chapter 3 is approximately three to five times larger, depending on buy or sell trades. Consequently, the second important results of Chapter 3—pointing out that buy and sell trade are not two side of the same coin—could not be confirmed unambiguously in the Diploma Thesis. Another reason for that might be the fact that the Diploma Thesis analysis short event windows of a couple of days up to one month, only, while Chapter 3 emphasis the importance of longer event periods. Third, Chapter 3 extends the measures of corporate governance by using the level of institutional ownership and differentiates between investment type and dedication while the Diploma Thesis analyses block holdings, only. Hence, Chapters 3 in contrast to the Diploma Thesis is able to reveal to some extent the most important result by pointing out that institutional ownership—even on an aggregate level—is a sufficient measure to proxy a company's corporate governance level. This in turn is also the reason why it is possible to analyze more data points in Chapter 3 compared to the Diploma Thesis and to highlight that once we control for institutional ownership other governance measures become less, respectively insignificant. Hence, Chapter 3 not merely updates and refines the Diploma Thesis but instead redefines the whole notion of corporate governance and insider trading.

Chapter 4 is based on Bednarek et al. (2019), "Capital flows, real estate, and local cycles: evidence from German cities, banks, and firms", Discussion Paper 45/2019, Deutsche Bundesbank, as well as on Bednarek et al. (2021), "Capital Flows, Real Estate, and Local Cycles: Evidence from German Cities, Banks, and Firms", The Review of Financial Studies.

1 Fundamentals Matter – Idiosyncratic Shocks and Interbank Relations[1]

1.1 Introduction

Observing the interbank market distress of 2007-2008, major central banks around the world tried to contain the macroeconomic consequences by means of broad interventions, including not only injecting additional liquidity into the banking sector but also an adjustment of monetary policy instruments (Gabrieli and Georg, 2014). The large scale of these policies over the past years has effectively made central banks the main money market intermediaries (Bräuning and Fecht, 2012). Such interventions have been successful in preventing liquidity crunches, but come at the cost of neglecting the market discipline mechanism inherent to the interbank market. The question of how reliable the functioning of market discipline is in times of aggregate distress is therefore crucial for an evaluation of the benefits and costs of interbank interventions. In this regard, empirical research has already documented the role played by the intensity of interbank relations for the availability and the conditions of interbank borrowing in times of crisis (Cocco et al., 2009, Affinito, 2012, Bräuning and Fecht, 2012). However, it is still an open question how interbank positions change in response to idiosyncratic shocks and whether this change is contingent on times of aggregate distress.

[1] This chapter is based on Bednarek et al. (2015), which has been awarded the FMA Best Paper Award 2018 (European Conference) in "Financial Institutions & Markets".

In this chapter, we close this gap and empirically examine the sensitivity of bilateral interbank positions to both aggregate and idiosyncratic shocks. We employ several definitions of idiosyncratic shocks which are based on measuring the relative deterioration of a bank's capital, liquidity and credit quality. We then study how idiosyncratic shocks which hit the borrowing or lending bank affect the intensity of interbank positions in normal times and times of aggregate distress. By disentangling the role of idiosyncratic and aggregate shocks, we aim to provide evidence of whether the turmoil in the interbank market was due to a general failure of the interbank market in reallocating liquidity efficiently within the banking sector itself, or rather to revised bank-level risk perceptions that lead to a stressed money market.

The study is based on data on bilateral exposures of German banks for the period 2000:Q1 to 2012:Q3. We employ a two-stage estimation model which first evaluates the probability of the existence of a bilateral interbank position and then estimates the determinants of the volume of this position.

Our results show that aggregate distress has a statistically significant negative effect on bilateral interbank exposures, although, in economic terms, idiosyncratic shocks are economically by far more important. In addition, we find that interbank positions react to idiosyncratic shocks even if the market as a whole is in distress. More specifically, we show that lending banks statistically and economically reduce their exposures to banks that have suffered idiosyncratic shocks. In terms of existing relationships, we find that these are not fully terminated following a shock but that their intensity is reduced. Interestingly, the intensity of bilateral exposures is driven not only by the shocks that hit the borrowing bank but also by those that hit the lending bank.[2] In the case of borrowing banks, we find that the intensity of the interbank relation is sensitive to shocks to capital, liquidity and to credit quality. This sensitivity is highest, however, for shocks to a borrower bank's liquidity position. In the case of lending banks, we find that shocks to their capitalization do not affect the intensity of interbank relations, but shocks to liquidity and, in particular, shocks to credit quality have a strong negative effect.

[2] This is contrary to Afonso et al. (2011) who find a relationship for the US interbank market between bank characteristics and the volume of the exposure only for the borrowing banks but not for the lending banks.

Further, the effects are nonlinear for both borrowing and lending banks. They are also contingent on the aggregate state of the financial system.

Moreover, we explore whether relationship banking can outweigh the negative effects induced by bank-specific shocks. Unlike results of earlier studies, which find that relationship banking helps to overcome financial instability, we show distinct evidence that hard information seems to dominate soft information, as neither longer nor more intense interbank relationships in the past contain the negative effects of either aggregate or idiosyncratic shocks regarding the banks' capital, credit quality or liquidity.

A number of features underline the novelty of this chapter relative to the existing literature. First, we control not only for the volume but also for the existence of lending. This allows us to explore both intensive and extensive margins of interbank market dynamics. In this regard, we are the first to utilize a Heckman Correction methodology to counter the empirical problem of sample selection arising from the fact that banks participating in a bilateral interbank relation may differ in important unmeasured ways from banks which do not participate. For example differing business models may foster interbank market participation or restrain banks from doing so. Hence, we provide insights into both the main drivers which increase or decrease the probability of forming bank-to-bank relationships, as well as their impact on interbank lending exposures. Second, the length of our sample allows us to make comparisons between normal and crisis times. In detail, we analyze the most extensive dataset so far comprising over 1.9 million interbank lending relationships of more than 3,500 German banks conducted between 2000:Q1 and 2012:Q3.

Our results contribute to several strands of the literature. To start with, by showing that interbank exposure, even in times of aggregate distress, is related to the conditions of the borrowing bank, we confirm an insight gained from various studies on market discipline in banking. Thus, Goodfriend and King (1988), Kaufman (1991), Berger (1991) and Schwartz (1992), for example, also find that banks are well-informed parties in judging the solvency of illiquid peer banks. This view has been debated by Goodfriend (2002) and Martin and McAndrews (2007), also. These papers claim that banks are not apt to monitor other banks, because the implicit guarantee supplied by central banks, which are expected to intervene in a case of crisis, undermine the banks' incentives to monitor their peers. More recent studies, like DeYoung et al. (1998), Peek et al. (1999), Berger et al. (2000), and Furfine (2002) reconcile the two sides of the debate by finding that banks possess knowledge regarding other banks' health, even while highlighting that this is only complementary to the knowledge of central banks. More specifically, Furfine (2001) documents that interbank interest rates in the US federal funds market reflect in part the credit risk of the borrowing banks. Similarly, King (2008) demonstrates that high-risk banks pay more than safe banks for interbank loans. Dinger and von Hagen (2009) show that in systems characterized by longer-term interbank exposures the monitoring role of lenders is more important, and Bräuning and Fecht (2012) find evidence for the existence of private information in the German interbank market, as relationship lenders were already charging higher interest rates to their borrowers in the run-up to the financial crisis of 2007-2008, whereas, during the crisis, borrowers paid lower rates on average to their relationship lenders than to spot lenders.

While, in the case of a well-functioning interbank market, the evidence on peer monitoring is mixed, for times of aggregate market turmoil most existing literature predicts that market discipline will be further undermined by a lower sensitivity to fundamentals (Hasan et al., 2013; Levy-Yeyati et al., 2004; Martinez-Peria and Schmukler, 2001; Flannery, 1996; Freixas and Jorge, 2008; and Heider et al., 2009). These models have in common that information asymmetry becomes worse during a crisis period when the percentage of risky banks goes up and investors are unable to differentiate among the credit risks of individual banks. As a result, lenders require a higher yield to participate in the market. In cases of particularly severe distress, adverse selection issues can generate a complete freeze of the interbank market. Following this argument, central banks should intervene as a lender of last resort in order to prevent liquidity distress of solvent banks. The results of our study contradict this view and uncover a so far undocumented ability on the part of the interbank market to distinguish between banks of different quality in times of aggregate distress.

The remainder of this chapter is organized as follows. In subsection 1.2 we describe the data. Section 1.3 introduces the methodology. The main estimation results are presented in Section 1.4. Section 1.5 describes a battery of robustness tests. Section 1.6 concludes.

1.2 DATA AND SUMMARY STATISTICS

We construct a unique unbalanced panel bank-to-bank level dataset that contains information about the German interbank market from the first quarter of 2000 to the third quarter of 2012. The construction of the dataset makes use of several data sources. The central source is the Deutsche Bundesbank's credit register data (Mikrodatenbank Millionenkredite, MiMik) which contains information on all big individual exposures of German banks to firms (including other banks).[3] This source gives us information on whether a bank with a German charter has lent to any other banks and, if so, how much of the interbank lending is outstanding at the end of each quarter.[4] Next, we add information from the balance sheets of the lending and borrowing banks. This information stems from the monthly balance sheet statistics Bista and BAKIS.[5] Moreover, we utilize the banks' estimates of their counterparty's *probability of default (PD)* which has been part of the general MiMik dataset since 2008.[6]

1.2.1 DATA OVERVIEW

Panel A of Table 1.1 provides summary statistics on the number of banks, their distinct bank group and the number of bank-quarter observations on those entities as well as the overall number of observations. In total, our dataset covers an extensive amount of 4.6 million

[3] Details on the credit register can be found in Schmieder (2006), and in published work by Schertler et al. (2006), Hayden et al. (2007) and Ongena et al. (2012), for example. The Bundesbank also maintains a website with working papers based on its credit register.

[4] For a more detailed definition, see Section 14 of the Banking Act (*Deutsche Bundesbank*, 2001). If exposures existed during the reporting period but are partly or fully repaid, the remaining exposure is reported even if the amount is zero. Due data limitations, we take the actual amount of exposures into consideration that is the reported end-quarter amounts.

[5] We match the end of the quarter value of the Bista variables to the quarterly frequency of the interbank data. A few balance sheet items - such as non-performing loans - are not covered by Bista. We therefore uncover them from BAKIS, which is an information system that is shared between the Bundesbank and BaFin (the German Federal Banking Supervisory Office) and comes with annual frequency.

[6] Each counterparty is assessed by several different creditor banks; we take the median value of all estimated PDs.

bank-quarter observations on a total of 3,550 German banks. In around 40% of these bank-quarter observations we detect actual bank lending relationships between a creditor bank C and a borrower bank B. In the minority of the cases, lending is conducted between banks belonging to the same *bank holding company (BHC)*. Surprisingly, we detect a considerable amount of reciprocal lending relationships that is more than 820,000 bank-quarter observations show a pattern of a contemporaneous reverse lending from the initial borrowing bank B to creditor bank C.

Moreover, the German interbank market is not fragmented along the lines of the traditional three-pillar structure of the German banking system, in which private commercial banks form the first pillar, public banks, such as Landesbanken and saving banks, form the second pillar, and cooperative banks the third pillar. We detect a considerable interconnection between all market participants, where the large banks such as the big, i.e. major banks, regional banks and the Landesbanken emerge mostly as borrowers, and savings and cooperative banks emerge as lenders (see Craig et al., 2015). For instance, savings banks provide lending not only to Landesbanken but also to private mortgage banks and big banks.

TABLE 1.1 DESCRIPTIVE STATISTICS

PANEL A	NUMBER OF ENTITIES	NUMBER OF OBSERVATIONS		NUMBER OF ENTITIES	NUMBER OF OBSERVATIONS
Banks			Credit relationships		4,618,586
Creditor	3,550		True		1,923,521
Borrower	3,494		BHC		29,837
			Reciproc relationships		822,016
			BHC		47,201
Big bank			Cooperative bank		
Creditor	5	112,596	Creditor	1,964	1,719,816
Borrower	5	334,371	Borrower	1,589	360,599
Regional bank			Private mortgage bank		
Creditor	285	394,470	Creditor	30	151,338
Borrower	263	520,512	Borrower	27	1,070,486
Subsidiary of a foreign bank			Public real estate credit agency		
Creditor	120	63,292	Creditor	4	5,089
Borrower	1	20	Borrower	4	19,910
Landesbank			Bank with special functions		
Creditor	15	336,343	Creditor	23	152,438
Borrower	15	682,815	Borrower	25	198,418
Savings bank			Foreign subsidiary of a German bank		
Creditor	573	1,047,458	Creditor	34	79,349
Borrower	533	469,381	Borrower	31	98,457
Cooperative Central Bank			Others		
Creditor	4	110,015	Creditor	528	140,162
Borrower	2	128,902	Borrower	1,032	304,261

Panel A of this table shows summary statistics regarding the number of banks, their distinct bank group and the number of bank quarter observations regarding those entities as well as the overall number of observations. In this regard, BHC refers to bank holding company. Panel B provides summary statistics of (reciprocal) interbank exposures, concentration measures as well as summary statistics regarding the duration (break) of bank-to-bank relationships. Concentration measures are the lender preference index "LPI", which is the the amount lent by a creditor bank C to a borrower bank B relative to the overall amount lent by bank C in any distinct quarter, and the borrower preference index "BPI", which is calculated as the amount borrowed by bank B from bank C relative to the overall borrowing by bank B, respectively. "Credit relation span" adds up the bank quarters of a creditor bank C providing continuous lending to a specific borrower bank B, "Reciproc relation span" captures the continous reverse lending from bank B to bank C and "Total relation ship span" adds up the quarters both banks C and B are related to each other in either direction. Panel C provides descriptive statistics about the most important bank characteristics, whereas each bank’s Z-score is calculated as the sum of the return on risk-wighted assets and the capital asset ratio divided by the return on risk-weighted assets’ standard deviation.

1.2.2 (INTER)BANK CHARACTERISTICS

Panel B of Table 1.1 provides descriptive statistics on these interbank exposures as well as some initial impressions of how German interbank relationships are structured. Interbank exposures and, especially, reciprocal exposures exhibit a strong variance with mean values of € 51 million and € 86 million and a standard deviation (SD) of around € 0.9 billion and € 1.4

billion, respectively. Following Furfine (1999), we measure the strength of an interbank relation first, by the duration of the bilateral exposure, and second, by the concentration of the banks' lending and/or borrowing activity. Regarding the relationship's duration, we calculate the variable *Credit relation span* by adding up the bank quarters of a creditor bank C providing continuous lending to a specific borrower bank B. As in the case of interbank lending, both borrower and creditor are financial institutions and can, for instance, cooperate by mutually providing liquidity to each other. We also consider the possible two-sided nature of interbank relationships by computing the variable *Reciproc relation span* by adding up the quarters the current borrower bank B is continuously lending to creditor bank C. Accordingly, the variable *Total relation span* adds up the number of quarters in which both banks C and B are related to each other in either direction. In line with Petersen and Rajan (1994) *Total relation span* is a proxy for private information mitigating problems of asymmetric information. Overall, interbank relationships between distinct bank pairs last on average for around three years. If a relationship breaks at some point, it takes approximately the same amount of time for a relation to be re-established. Regarding the concentration on one lender/borrower, we follow Cocco et al. (2009) and Bräuning and Fecht (2012) and compute the amount lent by a creditor bank C to a borrower bank B relative to the overall amount lent by bank C in any distinct quarter t. Formally, this *lender preference index (LPI)* is defined as

$$LPI_{CB_t} = \frac{Exposure_{CBt}}{\sum_B Exposure_{CBt}} * 100 \tag{1.1}$$

whereas we set the variable to zero if the denominator is zero, i.e. if the lender did not lend at all. Similarly, we compute the *borrower preference index (BPI)* as the amount borrowed by bank B from bank C relative to the overall borrowing by bank B in quarter t

$$BPI_{CB_t} = \frac{Exposure_{CBt}}{\sum_C Exposure_{CBt}} * 100. \tag{1.2}$$

Again we detect a considerable high variance with some banks lending to and borrowing from only a single counterparty, whereas the mean values of the indices are 6.1 and 6.3 percent, respectively.

Last, Panel C provides descriptive statistics on the most important bank characteristics.[7] Regarding *size*, most banks in our sample are rather small ones with total assets amounting to € 378 million, but with € 3.6 billion as a mean value. In general, *regulatory capital ratios (CAPR)* are quite high with a mean (median) value of 20.4% (13.8%). The importance of the traditional bank loan for financial intermediation in Germany is mirrored by the *loans to assets ratio (LAR)*, as loans to non-financials comprise around 60% of the banks' balance sheet. Around 4% of those loans are *non-performing (NPLR)*[8]. 20 percent of the banks' assets are *liquid (LIQR)* and the *return on risk-weighted assets (ROA(rw))* amounts in the mean (median) to 1.2% (1.7%). The mean (median) *Z-score* and *PD* values amount to 31.8 (29.5) and 0.85% (0.035%), respectively.

[7] To control for spurious outliers we delete all observations except *Size* at the 0.1% level. As robustness checks we rerun our specifications with varying measures or without any outlier correction measures. Results do not change qualitatively or quantitatively.

[8] Especially saving and cooperative banks exhibit high values of non-performing loans.

TABLE 1.1 CONTINUED

PANEL B	UNITS	NUMBER OF OBSERVATIONS	MEAN	STANDARD DEVIATION	5th PERCENTILE	MEDIAN	95th PERCENTILE
Exposure	m	1,923,521	51	938	0	5	143
Exposure change	%	1,820,018	0.2	4.8	-1.7	0	13.1
Reciproc exposure	m	822,016	86	1,390	0	6	281
LPI	%	1,923,521	6.1	15.4	0	1.5	30.9
BPI	%	1,923,521	6.3	19.9	0	0	55.6
Total relation span	levels	2,150,744	11.3	10.5	1	8	34
Credit relation span	levels	1,923,521	10.6	10	1	7	32
Reciproc relation span	levels	822,016	12.8	11.4	1	9	37
Total relation break	levels	2,467,842	11.7	10	1	9	33

PANEL C	UNITS	NUMBER OF OBSERVATIONS	MEAN	STANDARD DEVIATION	5th PERCENTILE	MEDIAN	95th PERCENTILE
Assets	m	109,140	3,610	29,800	39,3	378	6,530
Size	ln	109,140	19.9	1.6	17.5	19.8	22.6
CAPR	%	110,064	20.4	30.5	9.6	13.8	40.2
LAR	%	106,920	57.7	16.5	24.9	60.7	78.8
LIQR	%	101,818	21.5	11	9.7	19.3	40.4
ROA(rw)	%	107,632	1.2	6.5	-0.2	1.7	3.8
NPLR	%	109,669	4.1	3.4	0	3.6	10.1
Z-score	levels	102,057	31.8	20.5	5.1	29.5	68.3
PD	%	26,727	0.9	6.6	0.0	0.0	1.9

Panel A of this table shows summary statistics regarding the number of banks, their distinct bank group and the number of bank quarter observations regarding those entities as well as the overall number of observations. In this regard, BHC refers to bank holding company. Panel B provides summary statistics of (reciprocal) interbank exposures, concentration measures as well as summary statistics regarding the duration (break) of bank-to-bank relationships. Concentration measures are the lender preference index "LPI", which is the the amount lent by a creditor bank C to a borrower bank B relative to the overall amount lent by bank C in any distinct quarter, and the borrower preference index "BPI", which is calculated as the amount borrowed by bank B from bank C relative to the overall borrowing by bank B, respectively. "Credit relation span" adds up the bank quarters of a creditor bank C providing continuous lending to a specific borrower bank B, "Reciproc relation span" captures the continous reverse lending from bank B to bank C and "Total relation ship span" adds up the quarters both banks C and B are related to each other in either direction. Panel C provides descriptive statistics about the most important bank characteristics, whereas each bank's Z-score is calculated as the sum of the return on risk-wighted assets and the capital asset ratio divided by the return on risk-weighted assets' standard deviation.

1.3 METHODOLOGY

1.3.1 BASELINE SPECIFICATION

This rich data source makes it possible to observe the behavior of nearly the entire German interbank market and the use of the bank-specific balance sheet information enables us to analyze the most important determinants of interbank market (in)stability. However, before we can make meaningful causal inferences some methodological shortcomings have to be solved.

First, between the first quarter of 2000 to the third quarter of 2012 a number of bank mergers took place. We carry out a merger correction procedure by creating a new separate bank after the merger takes place.[9] The relationships' duration still amounts to nearly three years, which should be a sufficient amount of time to overcome asymmetric information due to relationship banking (Rochet & Tirole, 1996). Nevertheless, results are robust to alternative specifications.

Second, and most important, we have to account for the possibility of an endogenous sample selection, as around 60% of our bank quarters do not contain an interbank lending relationship, because either banks stopped participating in the interbank market in general or interrupted a specific interbank relationship. A sample selection bias may arise if the sample consists only of banks which choose to participate in the interbank market and these banks differ in important, unmeasured ways from banks which do not participate. We utilize the Heckman Correction methodology to overcome this issue. That is, we first estimate the probability of an interbank lending relationship taking place with a Probit (selection) equation by MLE

$$Prob(credit\ relation_{CB} = 1|X) = \Phi(X\gamma) \tag{1.3}$$

with X being a vector of explanatory variables, γ a vector of unknown parameters and Φ the cumulative distribution function of the standard normal distribution.[10] Afterwards, we compute the inverse Mills ratio

$$\hat{\lambda}(k) = \frac{\phi(k)}{\Phi(k)} \tag{1.4}$$

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[9] Our approach is based on separating the pre-merger banks from the merged bank. In the end, we have three banks, which are treated independently from each other. We repeat this procedure as often as a merger takes place. Each time a new merged bank receives a new identification number, we drop the target banks in that quarter.

[10] We use clustered standard errors with the lending relationship between creditor bank C and borrower bank B as our cluster variable.

as the ratio between the standard normal probability density function ϕ and the standard normal cumulative distribution function Φ, each evaluated at observation k, and utilize $\hat{\lambda}$ finally in the second step as a further regressor in a standard OLS regression model.[11]

The dependent variable for the second step is the logarithmic change in the exposure of creditor bank C to borrower bank B and is defined as

$$Exposure\ change_{CB_t} = ln(Exposure_{CB})_t - ln(Exposure_{CB})_{t-1}. \tag{1.5}$$

Moreover, to compare our results with those of earlier studies we also employ LPI and BPI concentration measures as proxies for the change in the intensity of an interbank relation. Accordingly, we estimate the following baseline regression model with parameters estimated using OLS

$$\begin{bmatrix} Exposure\ change_{CB_t} \\ LPI_{CB_t} \\ BPI_{CB_t} \end{bmatrix} = \beta X + \beta_\lambda \hat{\lambda}(k) + v_{CB_t}$$
$$= \beta_0 + \beta_1 Crisis + \beta_2 Relation_{CB_t} + \beta_3 \sum_{i=C,B} Controls_{i_{t-1}} + \beta_\lambda \hat{\lambda}(k) + u_{CB_t} \tag{1.6}$$

where X is the vector of explanatory right-hand side (RHS) variables, β a vector of unknown parameters, β_λ the unknown parameter of the estimated inverse Mills ratio $\hat{\lambda}$ and u_{CB_t} is the composite error term including the time invariant unobserved effect. In detail, $Crisis$ is a varying time dummy variable capturing the effects of the 2007 financial crisis period and $Relation_{CB_t}$ is a vector of relationship variables defined as

[11] We use robust standard errors.

$$Relation_{CB_t} = [Total\,relation\,span_{CB_t} \;\; \ln(Exposure)_{CB_{t-1}} \\ ln(Reciproc\,exposure)_{BC_t} \;\; BHC\,dummy_{CB_t}] \tag{1.7}$$

which serves as a proxy for private information. As described in the previous section $Total\,relation\,span_{CB_t}$ captures the interbank history of a specific pair of banks C and B by adding up the quarters in which those two banks have either a lending or borrowing relationship in t. To proxy the bank's relationship intensity we use the logarithm of the lagged exposure from the creditor bank C to the borrower bank B, $\ln(Exposure)_{CB_{t-1}}$. Moreover, to analyze the effect of reciprocity we also utilize the reciprocal lending from the initial borrower bank B to the creditor bank C, $\ln\left(Reciproc\,exposure\right)_{BC_t}$. In the case of this variable, we take the contemporaneous values, since we are particularly interested in exploring whether truly reciprocal exposure increases the stability of the relation[12]. And finally, we account with a dummy variable for banks belonging to the same *bank holding company (BHC)* where the variable $BHC\,dummy_{CB_t}$ takes the value of one if both banks belong in quarter t to the same BHC and zero otherwise. Regarding the set of control variables, we use standard bank characteristics with a one-quarter lag and a set of dummy variables classifying each bank in any distinct quarter into a specific bank group listed in Panel A of Table 1.1. We utilize both types of controls for every bank i. More precisely, bank-specific characteristics are the bank's logarithm of total assets $(Size_{i_{t-1}})$, the loans to assets ratio $(LAR_{i_{t-1}})$, the liquidity to assets ratio $(LIQR_{i_{t-1}})$, the regulatory capital ratio $(CAPR_{i_{t-1}})$ and the return on risk-weighted assets ratio $(ROA(rw)_{i_{t-1}})$.[13]

Table 1.2 describes all variables employed in the estimations. In this regard, Panel A illustrates the left-hand side (LHS) variables, while Panel B focuses on the right-hand side (RHS) variables, including our fix set of control variables.

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[12] Results do not change qualitatively or quantitatively if we utilize reciprocal exposure with a lag of one quarter.

[13] As robustness checks we utilize varying sets of control variables and use varying lags for our main variables of interest. Furthermore, we rerun the models for private banks only, i.e. without Landesbanken, savings and cooperative and cooperative central banks. Results do not change qualitatively or quantitatively.

TABLE 1.2 DESCRIPTION OF VARIABLES

PANEL A	**Left-hand side (LHS)**	
Variable	*Description*	*Unit*
Credit relation	Dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise.	0|1
Exposure change	$Exposure\ change_{CB_t} = ln(Exposure_{CB})_t - ln(Exposure_{CB})_{t-1}$	%
Lender Preference Index	$LPI_{CB_t} = \frac{Exposure_{CBt}}{\sum_B Exposure_{CBt}} * 100$	%
Borrower Preference Index	$BPI_{CB_t} = \frac{Exposure_{CBt}}{\sum_C Exposure_{CBt}} * 100$	%

PANEL B	**Right-hand side (RHS)**	
Variable	*Description*	*Unit*
Crisis	Dummy variable that takes the value one from 2007Q3 onwards and zero otherwise.	0|1
Commercial Paper crisis	Dummy variable that takes the value one between 2007Q3 and 2008Q3 and zero otherwise.	0|1
Lehman crisis	Dummy variable that takes the value one between 2008Q4 and 2009Q4and zero otherwise.	0|1
Euro crisis	Dummy variable that takes the value one between 2010Q1 and 2012Q3 and zero otherwise.	0|1
Total relation span	Captures the interbank history of a specific pair of banks C and B by adding up the quarters these two banks have either a lending or borrowing relationship in quarter t.	levels
$Exposure_{t-1}$	Logarithm of the lagged exposure from the creditor bank C to the borrower bank B.	ln
Reciproc exposure	Reciprocal lending from the initial borrower bank B to the creditor bank C	ln
BHC dummy	Dummy variable for banks belonging to same bank holding company.	0|1
NPLR	Non-performing loans to total loans ratio	%
Z-score	$Z - score = \frac{ROA(rw) + CAPR}{SD(ROA(rw))}$	levels
PD	Median value of all creditor banks' C estimates on borrower bank's B probability of default.	%

PANEL B CONTINUED		
Shock `x'	The idiosyncratic shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavourable change in the distribution of the underlying shock variable x (= CAPR, NPLR, LIQR, ROA(rw), PD and Z-score) of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, i.e. we portioned the distribution into 10 equal percentiles.	0|1
Controls		
Size	Logarithm of total assets	ln
LAR	Loans to assets ratio (without interbank loans)	%
LIQR	Liquid assets to total assets ratio	%
CAPR	Regulatory capital ratio	%
ROA(rw)	Return on risk weighted assets	%
lambda	Heckman's lambda: Ratio between the standard normal probability density function ϕ and the standard normal cumulative distribution function Φ, each evaluated at observation k	
Bank group controls	Dummy variables classifying each bank in any distinct quarter into a specific bank group listed in Panel A of Table 1.1.	0|1

Panel A of this table presents our left-hand side (LHS) and Panel B a comprehensive list of varying right-hand side (RHS) variables.

1.3.2 EXTENSIONS

To give an answer to the question of whether the German interbank market was frozen due to an aggregate shock disabling an efficient liquidity allocation or whether it was partially stressed due to bank-specific shocks and possibly revised risk perceptions, we expand this Heckit baseline model consisting of both model (3) and (6) stepwise. First, to analyze whether a longer or stronger interbank relationship in the past mitigates possible negative $Crisis$ effects, we expand the plain baseline models by interaction terms of the following form

$$Crisis * [Total\ relation\ span_{CB_t} \quad ln(Exposure)_{CB_{t-1}} \quad ln(Reciproc\ exposure)_{BC_t}]. \quad (1.8)$$

Second, we augment the baseline models by $Risk_{i_{t-1(4)}}$ which is a vector of different lagged risk measures for every bank i defined as

$$\sum_{i=C,B} Risk_{i_{t-1(4)}} = \begin{bmatrix} NPLR_{i_{t-4}} \\ Z-score_{i_{t-1}} \\ PD_{i_{t-1}} \end{bmatrix} \tag{1.9}$$

and to analyze whether risk perception changes to some extent during periods of aggregate distress, we estimate an interaction term model, also, with an interaction term of the following form

$$Crisis * \sum_{i=C,B} Risk_{i_{t-1(4)}}. \tag{1.10}$$

Third, and most important, we expand the baseline models (3) and (6) by an alternating set of idiosyncratic shock variables. In detail, we compute idiosyncratic shocks at the bases of the creditor, respectively the borrower bank's capitalization ($CAPR$), credit quality ($NPLR$), liquidity ($LIQR$) and profitability ($ROA(rw)$). Furthermore, we specify shocks regarding the bank's $Z-score$ and PD. Our framework distinctively expands those of existing studies. For instance, Afonso et al. (2011) concentrate on the banks' non-performing loans and profitability, whereas Cocco et al. (2009) and Bräuning and Fecht (2012) do not explicitly account for these and measure liquidity risks solely via reserve holdings and the banks' maturity mismatch. Moreover, to the best of our knowledge we are the first to account for a possible non-linear behavior of these determinants by employing the following method to determine bank-specific shocks.[14] First, we construct the yearly distribution of each of the above variables and divide this distribution into ten deciles. In a second step, we define an idiosyncratic shock as an alternating dummy variable that takes the value one if the value of the respective variable for the bank

[14] Results of unreported tests where we examine the effect of quadratic terms indicate a non-linear behavior of those underlying bank determinants.

has moved by 1 (2,..., 9) decile(s) in an unfavorable direction from one quarter to another and zero otherwise. Overall, the basic idea is to stress test somewhat not the bank's balance sheets to an unfavorable macroeconomic scenario, but rather the interbank relations to detect breaking points that, in turn, destabilize the interbank market itself. Hence, we expand both steps of the baseline Heckman Correction models by the following term

$$\sum_{i=C,B} \prod_{j=CAPR}^{PD} \prod_{x=1}^{9} Idiosyncratic\ shock_{ijx} \tag{1.11}$$

which determines creditor and borrower bank i specific shock variables for every underlying shock variable j of any strength x. It can be seen that we run a comprehensive set of regressions analyzes in which the idiosyncratic shock variable changes in two dimensions. First, with regard to the potential shock, we want to analyze shocks of the bank's capitalization, credit quality, liquidity, profitability and risk. Second, the idiosyncratic shock variable alters regarding the strength of the shock, i.e. whether it is a moderate or a more serious shock, such as a heavy slip from one quarter to another amounting to several deciles in the underlying variable's distribution.

Last, to analyze possible differences between crisis and non-crisis periods we estimate an interaction term model with an interaction term of the following form

$$Crisis * \sum_{i=C,B} \prod_{j=CAPR}^{PD} \prod_{x=1}^{9} Idiosyncratic\ shock_{ijx} \tag{1.12}$$

and to answer the question of whether relationship banking, i.e. a longer and more intense interbank relationship in the past, can help to overcome possible negative effects of idiosyncratic shocks, we expand the baseline models (3) and (6), finally, by

$$Relation_{CB_t} * \sum_{i=C,B} \prod_{j=CAPR}^{PD} \prod_{x=1}^{9} Idiosyncratic\ shock_{ijx}. \quad (1.13)$$

1.4 EMPIRICAL RESULTS

1.4.1 RELATIONSHIP BANKING AND THE 2007 FINANCIAL CRISIS

We start by presenting the results of the baseline regression model of the determinants of interbank lending and the effects of the 2007 financial crisis period in Table 1.3. To capture the effect of an aggregate shock we utilize a $Crisis$ variable which is a time dummy variable taking the value one from 2007:Q3 onwards (columns 1, 3, 5 and 7). In this quarter, several important events happened likely to disrupt market confidence, triggering general market turmoil, such as the announcement by the German bank *IKB* that it was in distress on July 30th and the close-down of two *BNP Paribas* funds on August 9th.[15] Additionally, we run robustness tests with altering crisis period definitions, for example also splitting the crisis period into different sub-crisis periods, such as the Commercial Paper crisis (2007:Q3-2008:Q3), the Lehman crisis (2008:Q4-2009:Q4) and the Euro crisis (2010:Q1-2012:Q3). Results of the latter, disaggregated $Crisis$ definition are presented in column (2), (4), (6) and (8). Nevertheless, as results applying these alternating definitions do not vary a lot either economically or statistically, we adhere to the aggregated $Crisis$ definition in subsequent analyses.

With regard to the parameter estimates, columns (1) and (2) depict the results of the first step of the Heckman Correction method where the dependent variable is *Credit relation*, which is a binary variable taking the value one if there is a specific lending relationship between a creditor bank C and a borrower bank B, and zero otherwise. The results of the second step of the Heckman correction method are presented in columns (3) to (8), where the dependent

[15] As BNP Paribas became the first major financial group to acknowledge the impact of the sub-prime crisis by closing those two funds exposed to it, this date is generally seen as the start of the global credit crisis.

variable in columns (3) and (4) is the *Exposure change* in log differences, the *lender preference index (LPI)* in columns (5) and (6), and the *borrower preference index (BPI)* in columns (7) and (8), respectively.

Not surprisingly, we detect a highly significant negative effect of $Crisis$ on the probability of establishing an interbank lending relationship, although the effect is most severe in the Commercial Paper and Euro crisis period. The negative coefficients can be interpreted to some extent as rising search costs due to the inability to assess institutions' risk during the crisis period. However, the actual economical effect is rather small. Unreported marginal effects show a decrease of between 1.5 and 9.6 percent in the probability.[16]

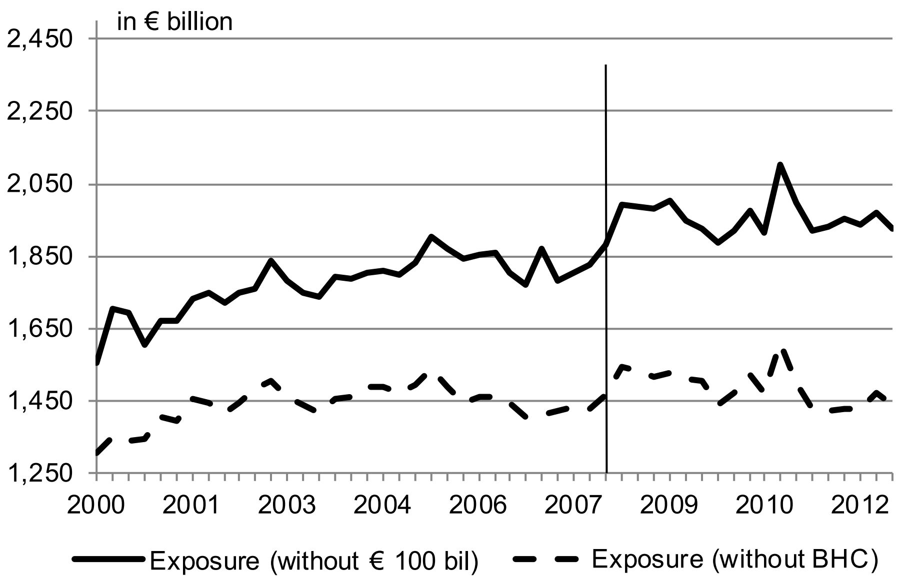
In contrast, $Crisis$ distinctively affects the lender and borrower preference indexes leading to a higher concentration of interbank lending and borrowing. It is unclear whether this is due to creditor banks tending to lend to a smaller number of banks and perhaps staying with those with which they have a stronger interbank relationship. As we do not observe the price for liquidity, it could also be the case that borrower banks shift their borrowing to banks that provide them with cheaper liquidity. Indeed, Bräuning and Fecht (2012) show some evidence that, at the height of the 2007 financial crisis, relationship lenders charged lower interest rates than spot lenders.

Regarding the actual interbank exposures, we do see a negative effect of $Crisis$ but not a decisively strong one. Though the $Euro\ crisis$ coefficient is a substantially higher one should keep in mind that on December 21st 2011 and on February 29th 2012 the ECB instituted the long-term refinancing operation (LTRO) programs in which banks could lend in total over a trillion euros for a period of up to three years. Following Gabrieli and Georg (2014) who point out that the striking increase in risk premia in the Eurozone money market in 2008Q3 was clearly subsequent to rather than before the change in the operational framework involving a switch from a regular variable-rate tender procedure to a fixed-rate full allotment policy, it is more likely that those exceptional measures are the cause rather than the outcome of the

[16] To draw conclusions about the economic effects, we estimate both the probit model's marginal effects at means (MEM) and its average marginal effects (AME) (Williams, 2011).

reduced interbank lending activity.[17] Nevertheless, aggregated interbank lending is remarkably stable over time (Gabrieli and Georg, 2014). Figure 1.1 shows the amount of quarterly interbank lending highly aggregated. In this regard, the solid line depicts interbank exposures without quarterly bank-to-bank exposures of € 100 billion, and more and the dashed line shows aggregate interbank lending without exposures between banks belonging to the same BHC.[18] The beginning of the aggregated crisis period is indicated by the vertical bar in 2007:Q3.

FIGURE 1.1 AGGREGATED INTERBANK LENDING



This figure shows the amount of quarterly interbank lending in a highly aggregated form, where the solid line depicts interbank exposures excluding quarterly bank to bank exposures of € 100 billion and more and the dashed line shows aggregate interbank lending excluding exposures between banks belonging to the same bank holding company (BHC). The beginning of the aggregated crisis period is indicated by the vertical bar at 2007Q3. It is noteworthy that there is an upwards shift of excessive high bank-to-bank exposures of more than €100 billion since 2007Q3. All of these cases are conducted between parent banks and their affiliated mortgage banks. But as there is in some quarters of the crisis period only one such observation, we refrain from showing these data points. In general, excessive bank-to-bank exposures of more than €100 billion peak in 2008Q4 with an amount of €290 billion.

[17] Unreported robustness tests show that in the full allotment period (2008:Q4) itself the likelihood of interbank participation significantly drops between 1.6 and 7 percent but we do not detect reduced interbank market exposures in that nor in the preceding quarters. Hence, from an aggregated point of view in the case of Germany one could question the need to change the operational framework. Especially as the Italian Interbank market was not affected by the 2007 financial crisis either (Affinito, 2012).

[18] It is noteworthy that there is an upwards shift of excessive high bank-to-bank exposures of more than € 100 billion since 2007:Q3. All of these cases are conducted between parent banks and their affiliated mortgage banks. But as there is in some quarters of the crisis period only one such observation, we refrain from showing these data points. In general, excessive bank-to-bank exposures of more than € 100 billion peak in 2008:Q4 with an amount of € 290 billion.

Although we do not adjust for price changes, it can be seen, however, that interbank exposures are surprisingly stable over time and actually rise to some extent even in distinct periods of aggregate turmoil. Nevertheless, there is indeed a decrease in interbank exposures after 2008:Q3 and 2010:Q4, i.e. following the non-standard measures taken by the ECB.

TABLE 1.3 BASELINE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RHS / LHS	Credit relation		Exposure change		LPI		BPI	
Crisis	-0.159 ***	-	-0.037 **	-	0.473 ***	-	0.131 ***	-
	(-25.80)	-	(-2.47)	-	(10.82)	-	(5.33)	-
Commercial Paper crisis	-	-0.191 ***	-	-0.028 *	-	0.329 ***	-	0.110 ***
	-	(-27.70)	-	(-1.86)	-	(8.83)	-	(5.02)
Lehman crisis	-	-0.094 ***	-	0.017	-	0.656 ***	-	0.249 ***
	-	(-11.86)	-	(0.91)	-	(10.85)	-	(6.95)
Euro crisis	-	-0.174 ***	-	-0.135 ***	-	0.713 ***	-	-0.034
	-	(-20.72)	-	(-6.20)	-	(9.51)	-	(-0.73)
Total relation span	0.057 ***	0.057 ***	-0.009 ***	-0.008 ***	0.058 ***	0.055 ***	0.015 ***	0.017 ***
	(73.60)	(73.53)	(-13.29)	(-11.27)	(18.94)	(18.51)	(4.64)	(5.16)
Exposure $_{t-1}$	0.224 ***	0.224 ***	-0.220 ***	-0.220 ***	0.514 ***	0.514 ***	0.365 ***	0.365 ***
	(591.97)	(591.41)	(-35.87)	(-35.88)	(48.30)	(48.36)	(29.38)	(29.39)
Reciproc exposure	-0.012 ***	-0.012 ***	0.019 ***	0.019 ***	0.055 ***	0.055 ***	0.024 ***	0.024 ***
	(-16.26)	(-16.36)	(14.06)	(13.98)	(17.15)	(17.19)	(8.81)	(8.72)
BHC dummy	0.656 ***	0.655 ***	1.510 ***	1.511 ***	5.814 ***	5.812 ***	4.737 ***	4.741 ***
	(7.20)	(7.20)	(9.47)	(9.48)	(5.23)	(5.23)	(4.73)	(4.74)
Size creditor $_{t-1}$	0.148 ***	0.148 ***	0.063 ***	0.066 ***	-2.160 ***	-2.184 ***	1.232 ***	1.248 ***
	(50.70)	(50.63)	(6.85)	(7.20)	(-46.34)	(-46.33)	(15.00)	(15.09)
Size borrower $_{t-1}$	0.124 ***	0.124 ***	0.432 ***	0.433 ***	0.782 ***	0.773 ***	-1.433 ***	-1.426 ***
	(37.41)	(37.43)	(42.33)	(42.43)	(19.94)	(19.66)	(-31.36)	(-31.20)
LAR creditor $_{t-1}$	-0.001 ***	-0.001 ***	-0.022 ***	-0.022 ***	0.043 ***	0.043 ***	-0.019 ***	-0.019 ***
	(-5.16)	(-5.14)	(-29.39)	(-29.42)	(12.42)	(12.42)	(-8.13)	(-8.03)
LAR borrower $_{t-1}$	0.001 ***	0.001 ***	0.018 ***	0.018 ***	0.017 ***	0.015 ***	-0.022 ***	-0.022 ***
	(5.25)	(5.27)	(26.01)	(26.27)	(9.82)	(8.71)	(-7.60)	(-7.36)
LIQR creditor $_{t-1}$	0.005 ***	0.005 ***	-0.012 ***	-0.013 ***	0.047 ***	0.050 ***	-0.043 ***	-0.045 ***
	(15.89)	(15.50)	(-14.23)	(-15.32)	(14.16)	(14.86)	(-12.05)	(-12.65)
LIQR borrower $_{t-1}$	0.002 ***	0.002 ***	-0.012 ***	-0.013 ***	-0.014 ***	-0.011 ***	-0.008 ***	-0.010 ***
	(8.26)	(8.12)	(-15.79)	(-16.88)	(-6.31)	(-5.29)	(-2.88)	(-3.54)
CAPR creditor $_{t-1}$	-0.001 ***	-0.001 ***	-0.008 ***	-0.007 ***	0.005	0.002	0.006 ***	0.008 ***
	(-2.81)	(-2.76)	(-5.46)	(-4.72)	(0.50)	(0.17)	(2.60)	(3.23)
CAPR borrower $_{t-1}$	-0.003 ***	-0.003 ***	-0.015 ***	-0.014 ***	-0.026 ***	-0.030 ***	-0.016 ***	-0.014 ***
	(-6.69)	(-6.59)	(-11.54)	(-10.46)	(-8.49)	(-9.41)	(-3.39)	(-2.93)
ROA(rw) creditor $_{t-1}$	0.002	0.002	-0.002	-0.001	0.001	-0.006	-0.020 ***	-0.019 ***
	(1.59)	(1.51)	(-0.56)	(-0.31)	(0.05)	(-0.33)	(-3.27)	(-3.14)
ROA(rw) borrower $_{t-1}$	0.004 **	0.004 **	0.029 ***	0.030 ***	0.003	-0.003	0.043 ***	0.043 ***
	(2.30)	(2.24)	(5.71)	(5.82)	(0.39)	(-0.41)	(2.61)	(2.63)
lambda	-	-	5.668 ***	5.667 ***	4.254 ***	4.252 ***	2.953 ***	2.952 ***
	-	-	(112.74)	(112.69)	(45.49)	(45.58)	(28.96)	(28.98)
constant	-7.663 ***	-7.663 ***	-8.017 ***	-8.101 ***	20.472 ***	21.248 ***	0.936	0.420
	(-65.24)	(-65.22)	(-23.60)	(-23.81)	(13.91)	(14.27)	(0.43)	(0.19)
Bank group controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Obs	2,496,756	2,496,756	1,188,579	1,188,579	1,188,579	1,188,579	1,188,579	1,188,579
Pseudo R-squared	0.764	0.764	-	-	-	-	-	-
R-squared overall	-	-	0.35103	0.35116	0.61424	0.61415	0.70840	0.70837
R-squared between	-	-	0.34973	0.34984	0.53940	0.53914	0.67086	0.67076
R-squared within	-	-	0.50055	0.50050	0.02777	0.02812	0.02252	0.02276

This table presents the estimation results of the baseline Heckman Two-Step Correction Model. In the first step, the left-hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1 and 2). The LHS variable for the second step is either "Exposure change" in log differences (Column 3 and 4), the lender preference index "LPI" (Column 5 and 6) or the borrower preference index "BPI" (7 and 8). The first group of right-hand side variables (RHS) capture the effects of the 2007 financial crisis period by two differect crisis specifications. Columns 1, 3, 5 and 7 show results of the aggregated crisis period, where the "Crisis" variable is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. Columns 2, 4, 6 and 8 present results where the crisis period is split up into a "Commercial Paper crisis" (2007Q3-2008Q3), a "Lehman crisis" (2008Q4-2009Q4) and a "Euro crisis" period (2010Q1-2012Q3). The corresponding variables are dummy variables that take the value one in the definied period and zero otherwise. The second group of the RHS variables account for the banks' relationship intensity. "Total relation span" counts the number of sustained quarters bank C and bank B interact with each other, either as creditors or borrowers. "Exposure $_{t-1}$" is the log pre-quarter exposure from the creditor bank C to borrower bank B, "Reciproc exposure" is the log reciprocal exposure from bank B to bank C, and the "BHC dummy" variable takes the value one if both banks belong to same bank holding company and zero otherwise. The third group of the RHS variables control for bank characteristics. We use the banks' balance sheet items with a one quarter lag and delete spurious outliers at the 1 percent level except "Size" which is the banks' log assets. Finally, we account for the creditor's and borrower's distinct bank groups, respectively. *p<0.10, **p<0.05, ***p<0.01

1.4.1.1 DETERMINANTS OF RELATIONSHIP BANKING

Besides the effects of the 2007 financial crisis period, we are particularly interested in the determinants that potentially foster bank-to-bank relationships. In this regard, all relationship proxies have a positive impact on the probability of renewing the lending relationship as well as on the concentration measures, except $Reciproc\ exposure$. In particular, belonging to same BHC strongly enhances the probability of a credit relationship and also the amount lent. Unreported marginal effects show an increase of up to 25% in the probability. Longer and stronger interbank relations in the past, on the other side, only impact positively on the probability of continuing lending, but do not lead to higher exposures. In fact, the opposite is true, implying that banks tend to hesitate to terminate relationships once they are established and instead prolong lending but on a reduced level, possibly avoiding risk concentration. In contrast, reciprocal lending shows the exact opposite results. Though it is negatively related to the probability of forming a lending relationship between a specific pair of a creditor bank C and a borrower bank B, reciprocal lending from the initial borrower B to creditor C leads to significantly higher exposures from C to B in the first place. The first result regarding the lower probability of forming a credit relationship due to reverse lending is not exactly odd, as it is possible to argue that borrower banks generally hesitate to lend during the same quarter in which they actually borrow. The second result however could be an initial indication that reverse relationship banking has a positive effect owing to the fact that it signals the bank's own soundness. Another possible explanation might be a swap in maturities. Unfortunately, information on maturities is not directly available in our data.

1.4.1.2 BANK-SPECIFIC CHARACTERISTICS

Creditor and borrower bank specific variables reveal unexpected results insofar as higher capital ($CAPR$) and liquidity ($LIQR$) do not to lead to higher interbank exposures. In general, better capitalized banks seem to avoid participating in the interbank market, maybe because they tend to engage in more profitable retail business rather than interbank lending activities and also have different ways of financing. Indeed, creditor banks with higher loans to assets ratios (LAR) are less likely to participate in the interbank market and provide less lending as well, while consequently borrowing more. Results regarding the creditor and borrower bank's liquid assets are to some extent more puzzling, but, though they are statistically significant, they are economically negligible. In contrast, parameter estimates of $Size$ indicate that larger banks are more likely to establish interbank lending relationships and that they receive and provide more interbank financing. As the borrower bank's coefficient is around seven times larger than the coefficient of the lender, it seems to be the case that this is not only due to the simple fact that larger banks are faced, on the one hand, with higher financing needs and, on the other hand, are also capable of providing more lending. For one thing, these results might reflect different business models. Descriptive statistics (Table 1.1 Panel A) already indicate that typically small banks, such as savings and cooperative banks, which can be characterized as retail deposit gathering institutions step in as interbank creditors, while larger banks such as big, regional and Landesbanken are mostly liquidity recipients. Nonetheless, it could also be the case that larger banks benefit from "too-big-to-fail" as there is a substantially higher likelihood of these banks being bailed out.[19] In quantitative terms, a borrower bank's one SD increase in $Size$ enhances its interbank market borrowing capacity by around 70 percentage points. Not surprisingly, higher profitability ($ROA(rw)$) also enhances the probability as well as the amount a bank can borrow via the interbank market. Results regarding the concentration measures are in line with common expectations, as for instance larger banks lending to or borrowing from a larger number of counterparties.

Finally, the highly significant and positive coefficient of the inverse mills ratio $lambda$ signifies that simple OLS would indeed produce upwardly biased estimates.

[19] See discussion in FSB (2021).

1.4.2 INTERBANK RELATIONS AND RISK IN TIMES OF AGGREGATE MARKET TURMOIL

Results of the previous section reveal a remarkably stable interbank market, which was, in fact, affected to a high degree statistically but, on an aggregated level, not economically by the ongoing 2007 financial crisis. Considering the non-standard measures of the ECB providing nearly inexhaustible cheap liquidity and even changing its monetary policy instruments because of some banks' inability to roll over their interbank position, it could be asked how the above results fit into this reality. To shed some light on this question, we expand our baseline Heckit models which consists of the probit model (3) in the first and the corresponding OLS model (6) in the second step by interaction terms (8) and (10), that is we interact the aggregated $Crisis$ variable with our relationship proxies and risk measures. Regarding the latter, we do only report the results for the non-performing loans to total loans ratio ($NPLR$). As a robustness check, we utilize the bank's $Z - score$ and for a sub-period since 2008:Q1 the bank's PD as well, but qualitatively results do not change.[20]

Panel A of Table 1.4 shows the parameter estimates of these models, while the interaction term models' corresponding marginal effects at representative values ($Crsis = 1|0$) are shown in panel B. In both panels, columns (1) and (2) present results of the extended probit model where the dependent dummy variable is *Credit relationship*, and columns (3) and (4) present results of the corresponding extended OLS model with *Exposure change* in log differences as the dependent variable.

Regarding the effects of relationship banking on interbank exposures in times of aggregate uncertainty, columns (1) and (3) of Panel B present the marginal effects of the relationship variables for the interaction term model of Panel A, that is the marginal effects of a longer, more intense and reciprocal interbank relationship in the aggregated crisis and the non-crisis

[20] Though PD parameter estimates show negative signs, only creditor banks exhibit a statistically significant reduction of interbank exposures. One possible explanation for these weak results might be given by Behn et al. (2014), who show that the introduction of Basel II-type, model-based capital regulation affected the validity of banks' internal risk estimates. They find that for the same firm (in our case bank) in the same year, both reported PDs and risk-weights are significantly lower, while estimation errors and loan losses are significantly higher for loans under the new regulatory approach. Thus, risk estimates for loans under the model-based approach systematically underestimate actual default rates. Also, results of the quadratic term model show a considerable decreasing effect of higher PDs for both creditor and borrower banks.

period. Generally, the effects of relationship banking on interbank exposures are qualitatively the same as those in the baseline model. Though banks hesitate to terminate bank-to-bank relationships once they have been established, it does not determine persistent interbank lending, as unlike to Affinito (2012), we do not detect a significantly positive effect of relationship banking in the crisis period. Although longer and more intense relations in the past do slightly increase the probability of renewing interbank lending relations in both the crisis and the non-crisis period, we do not detect any positive effects regarding the amount lent. Only reciprocal lending again increases interbank exposures from the initial creditor bank. Moreover, the positive effect is in fact two times larger in the crisis than during the non-crisis period. Whether this is actually due the fact that the initial borrower bank signals its own soundness, since reverse lending is even more important in crisis periods than in non-crisis periods or whether this is due to maturity swaps in this period is a matter for future research.

The most striking result, however, is that—in contrast to Martinez-Peria and Schmukler (2001) and others who claim that, in periods of aggregate distress, information about fundamentals is diluted—we show that the exact opposite is true with regard to the 2007 financial crisis. Columns (2) and (4) of Panel B present the marginal effects of the interaction term risk model of Panel A. Results reveal that the risk coefficient for borrower banks is more than five times larger in the crisis than during the non-crisis period. In other words, a one SD increase in risk reduces interbank exposures by around 18.7 percentage points during the crisis compared with a rather moderate decrease of 3.4 percentage points in the non-crisis period. Additionally, more risky creditor banks reduce their exposures less in the crisis than in the non-crisis periods and, in fact, are, overall, more likely to engage in the interbank market in times of aggregate distress.[21] Unreported results regarding the concentration measures show that riskier borrower banks lend from more counterparties as the BPI coefficient is statistical highly significant negative.

[21] In unreported robustness tests we also examine the effect of quadratic terms of our risk measure and find a more concave risk-exposure relationship for borrower and a convex one for creditor banks, which confirms an increasing effect of risk for borrower banks and a diminishing effect for creditor banks.

All in all, results uncover a so far undocumented ability of the interbank market to distinguish between banks of different quality in times of aggregate distress. As only the worst performing banks have been rationalized by the interbank market, regulators should be reluctant to step in as a lender of last resort to avoid failures in liquidity reallocation fostering moral hazard.[22] Moreover, relationship banking does not stabilize interbank lending during periods of aggregate turmoil, as hard information seems to dominate soft information.

[22] Indeed, unreported results show that in the full allotment period (2008:Q4), that is the period where the ECB switched its operational framework from a regular variable-rate tender procedure to a fixed-rate full allotment policy, the markets' sensitivity to risk was rather impaired, as risk has a significantly negative impact on interbank borrowing outside the full allotment period and an insignificant one at that time. Nevertheless, this effect was not permanent, as banks generally exhibit a stronger sensitivity to risk in the crisis period than in the non-crisis period.

TABLE 1.4 INTERBANK RELATIONS & RISK IN TIMES OF AGGREGATE MARKET TURMOIL

PANEL A	(1)	(2)	(3)	(4)
RHS / LHS	Credit relation		Exposure change	
Crisis	0.010 *	-0.143 ***	-0.346 ***	0.028
	(1.66)	(-13.41)	(-6.85)	(1.28)
Total relation span	0.091 ***	0.058 ***	-0.007 ***	-0.008 ***
	(78.65)	(73.65)	(-8.48)	(-11.07)
ln Exposure (lagged)	0.220 ***	0.224 ***	-0.259 ***	-0.237 ***
	(492.61)	(553.74)	(-41.74)	(-36.97)
ln Reciproc exposure	-0.018 ***	-0.016 ***	0.013 ***	0.018 ***
	(-22.66)	(-19.69)	(8.94)	(12.75)
Crisis x Total relation span	-0.045 ***	-	-0.006 ***	-
	(-36.59)	-	(-5.85)	-
Crisis x Exposure $_{t-1}$	0.003 ***	-	0.019 ***	-
	(4.53)	-	(5.83)	-
Crisis x Reciproc exposure	0.001	-	0.011 ***	-
	(0.49)	-	(7.91)	-
NPLR creditor $_{t-4}$	-	-0.009 ***	-	-0.018 ***
	-	(-8.25)	-	(-5.88)
NPLR borrower $_{t-4}$	-	-0.009 ***	-	-0.010 ***
	-	(-8.08)	-	(-3.51)
Crisis x NPLR creditor $_{t-4}$	-	0.017 ***	-	0.007 *
	-	(9.14)	-	(1.81)
Crisis x NPLR borrower $_{t-4}$	-	-0.020 ***	-	-0.045 ***
	-	(-9.84)	-	(-10.48)
constant	-7.535 ***	-7.657 ***	-7.609 ***	-7.697 ***
	(-64.46)	(-61.74)	(-22.17)	(-21.35)
Baseline variables	**Yes**	**Yes**	**Yes**	**Yes**
Obs	2,496,756	2,302,387	1,188,579	1,095,082
Pseudo R-squared	0.767	0.769	-	-
R-squared overall	-	-	0.34881	0.35578
R-squared between	-	-	0.34602	0.34746
R-squared within	-	-	0.49959	0.50432

PANEL B	(1)	(2)	(3)	(4)
Marginal effects	Credit relation		Exposure change	
Total relation span				
at Crisis = 1	0.004 ***	-	-0.013 ***	-
	(53.04)	-	(-15.27)	-
at Crisis = 0	0.007 ***	-	-0.007 ***	-
	(83.50)	-	(-8.48)	-
Exposure $_{t-1}$				
at Crisis = 1	0.019 ***	-	-0.240 ***	-
	(241.06)	-	(-36.99)	-
at Crisis = 0	0.018 ***	-	-0.259 ***	-
	(285.09)	-	(-41.74)	-
Reciproc exposure				
at Crisis = 1	-0.002 ***	-	0.024 ***	-
	(-13.38)	-	(13.70)	-
at Crisis = 0	-0.002 ***	-	0.013 ***	-
	(-22.88)	-	(8.94)	-
NPLR creditor $_{t-1}$				
at Crisis = 1	-	0.001 ***	-	-0.010 ***
	-	(4.98)	-	(-2.90)
at Crisis = 0	-	-0.001 ***	-	-0.018 ***
	-	(-8.22)	-	(-5.88)
NPLR borrower $_{t-1}$				
at Crisis = 1	-	-0.002 ***	-	-0.055 ***
	-	(-15.62)	-	(-14.11)
at Crisis = 0	-	-0.001 ***	-	-0.010 ***
	-	(-8.09)	-	(-3.51)
Obs	2,496,756	2,302,387	1,188,579	1,095,082

Panel A of this table presents the estimation results of the baseline Heckman Two-Step Correction Model augmented first by interaction terms between the aggregated "Crisis" variable and the bank-to-bank relationship proxies and second by interaction terms between the "Crisis" variable and a risk measure, namely the non-performing loans to asset ratio (NPLR) with a one year lag. The "Crisis" variable is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. Panel B shows the marginal effects at representative values for these interaction term variables. In the first step of the Heckit Model, the left-hand side variable (LHS) is "Credit relationship", which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Columns 1 and 2 in Panel A and B). The LHS variable for the second step is "Exposure change" in log differences (Columns 3 and 4 in Panel A and B). For the the right-hand side variables (RHS) we use all variables of the baseline regression model augmented by the interaction terms described above. *p<0.10, **p<0.05, ***p<0.01

1.4.3 IDIOSYNCRATIC SHOCKS AND THE 2007 FINANCIAL CRISIS

One major result of the previous section is that we find that, even during times of aggregate market turmoil and high uncertainty, the intensity of interbank relations reacts to the risk characteristics of the participating banks. This result suggests that idiosyncratic factors might be important drivers of interbank market outcomes. Hence, in this section we expand the analysis by exploring the role of a wide range of idiosyncratic bank shocks that capture banks' most important determinants. As described in Section 1.3.2, we run a set of regression analyses where the idiosyncratic shock variable changes in two dimensions. First, with regard to the potential shock we want to analyze that is, a shock of the bank's capitalization, credit quality, liquidity, profitability and risk. Second, the idiosyncratic shock variable alters regarding the strength of the shock that is whether it is a moderate or a more serious one, i.e. a heavy slip from one quarter to another of several deciles in the underlying variable's distribution.[23] Overall, the basic idea is to somewhat stress test not the bank's balance sheets to an unfavorable macroeconomic scenario, but the interbank relations in order to detect breaking points, which, in turn, destabilize the interbank market and to account for their non-linear behavior.

1.4.3.1 IDIOSYNCRATIC SHOCKS AND INTERBANK MARKET STABILITY

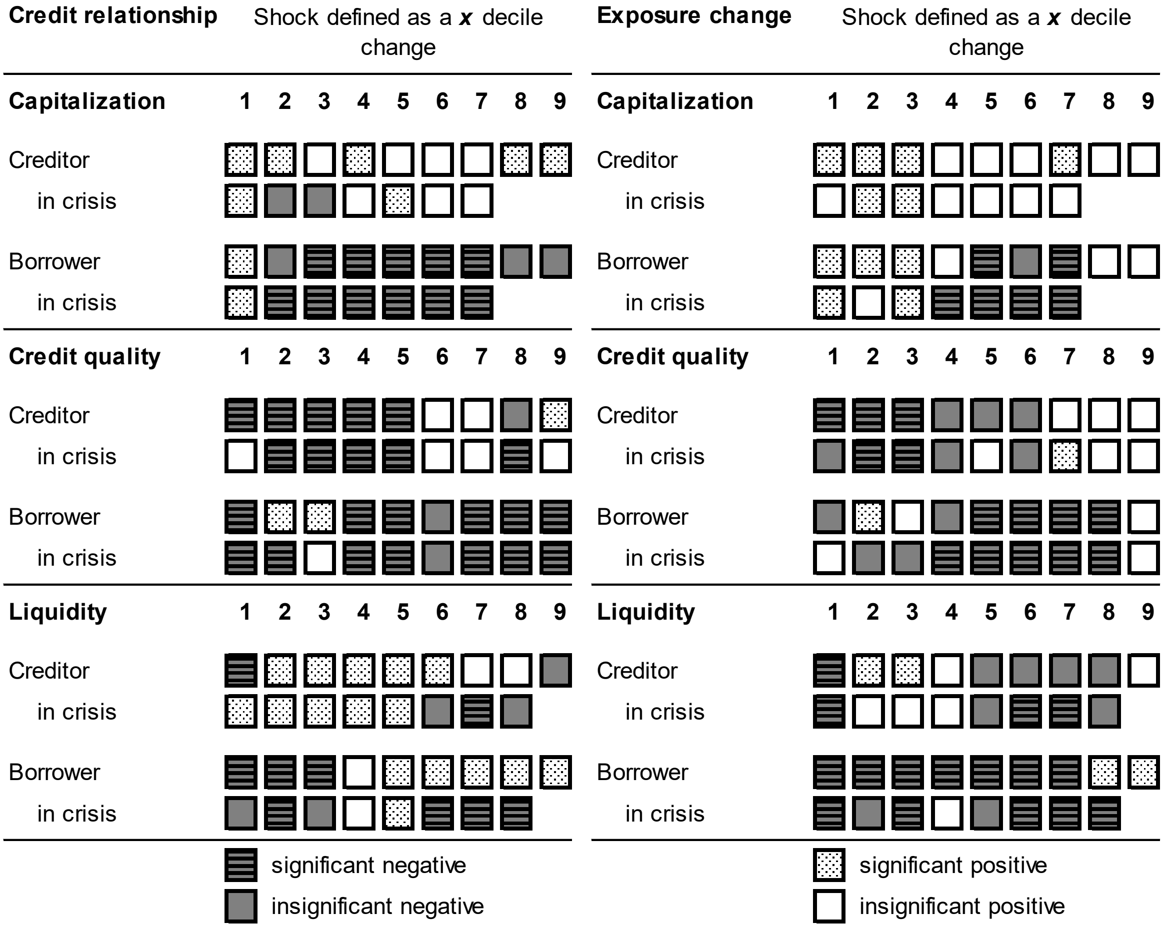
The outcome of this extensive procedure is illustrated in Figure 1.2, where every tile depicts both the sign and the significance of the regression model's bank-specific shock variables.[24] In detail, it depicts the parameter estimates of bank-specific shocks regarding the creditor, respectively borrower bank's capitalization, credit quality and liquidity, with the dashed grey tiles representing significantly negative coefficients and the dotted white tiles denoting significantly positive coefficients. We present results only for these idiosyncratic shocks as they

[23] It is important to point out that the distribution of each of the underlying idiosyncratic shock variables is computed at a yearly frequency, as definitions of what constitutes an adequate or unfavourable level regarding those variables may change over time.
[24] Underlying regression results of all idiosyncratic shocks tested are reported in the Appendix.

are the most important ones, severely affecting interbank relations and lending.[25] Generally, the left-hand side of Figure 1.2 shows the results of the first step of the Heckman selection method and the right-hand side shows the results of the second step. Moreover, parameter estimates of the idiosyncratic shock variables of the baseline models (3) and (6) expanded by the creditor and borrower bank-specific shock variables (11) are presented in the first and third lines and marginal effects at representative values ($Crisis = 1|0$) of the idiosyncratic shock variables of the baseline models (3) and (6) expanded by the interaction term (12) are shown in the second and fourth line marked by "*in crisis*".

[25] Similar to results of our baseline model in Section 1.4.1, lower profitability does not affect interbank stability at all. Even after very heavy declines in profitability from one quarter to another, creditor banks do not reduce interbank lending nor do borrower banks face problems prolonging their interbank positions. Higher risk in terms of shocks regarding the banks' Z-score or PD did not impair interbank relationships in the recent crisis either.

FIGURE 1.2 MAIN IDIOSYNCRATIC SHOCKS



This figure illustrates the parameter estimates of the baseline Heckman Two-Step Correction Model augmented by a creditor and borrower bank-specific shock and an interaction term of the idiosyncratic shock and the "Crisis" variable, which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The bank-specific shock variable is an alternating dummy variable that takes the value one if there is a bad or unfavorable change in the distribution of the underlying shock variable of 1 (2,…, 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left-hand side variable (LHS) is "Credit relationship", which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise. The LHS variable for the second step is "Exposure change" in log differences. For the the right-hand side variables (RHS) we use all variables of the baseline regression model augmented by the idiosyncratic shock variable and the interaction term between the shock and the "Crisis" variable. Generally, the left-hand side of the figure shows results of the first step of the Heckman selection method, and the right-hand side results of the second step. Parameter estimates of the idiosyncratic shock variables of the baseline Heckit model augmented by the those shock variables are presented in the first and third lines, respectively. Marginal effects at representative values (Crisis=1|0) of the idiosyncratic shock variables of the baseline model augmented by the interaction term are illustrated in the second and fourth lines marked by “in crisis”. The figure illustrates parameter estimates of idiosyncratic shocks regarding the creditor and borrower bank’s capitalization, credit quality and liquidity, while the dashed grey tiles represent significantly negative coefficients and the dotted white tiles significantly positive coefficients.

Starting with idiosyncratic shocks regarding the banks’ capitalization, it can be seen that, similar to results of the bank characteristics in the baseline model presented in Section 1.4.1, lower capital ratios do not affect creditors’ interbank exposure. In fact, even the most severe creditor specific capital shocks do not affect the probability of continuing lending nor the amount lent.[26] Idiosyncratic borrower capital shocks do show a different behavior, however, revealing two important insights. First, borrower-specific capital shocks affect both the probability of continuing an interbank lending relation and the actual exposure itself. Second, results show like in Section 1.4.2, some kind of revised risk perception as the capital shocks' negative effect is triggered earlier in the crisis period. Nevertheless, while even moderate capital deteriorations in the distribution from one quarter to another have a significantly negative impact on the probability of continuing an interbank relation, we do not detect an actual reduction in interbank exposures before a borrower banks' capital ratio slips during the crisis period four deciles in its yearly distribution or, in other words, after an idiosyncratic shock of the strength *four*. In quantitative terms, borrower banks suffer from capital write-offs not before generally losing 38% of their regulatory capital, or 43% in the crisis period.[27] The actual economic effects of such a severe idiosyncratic capital shock are presented in Table 1.5, where Panel A shows the parameter estimation results of the baseline Heckit models (3) and (6) expanded by the interaction term (12), and Panel B depicts the corresponding marginal effects at representative values ($Crisis = 1|0$). In this regard, columns (1) and (2) present results of the interaction term model where the idiosyncratic shock variable is defined as a negative one decile change in the bank's capital ratio's distribution from one quarter to another. In columns (3) and (4) the shock is defined as a two decile change, and in the model presented in columns (5) and (6) the shock dummy variable takes the value one if the capital ratio slips four deciles or more, and zero otherwise. Results show a looming negative effect of borrower-specific capital shocks, starting with a slight decrease in the probability of continuing lending relationship in the case of a moderate shock of the strength *two*. The outcome of the actual breaking point is presented in Column (6) of Panel B, where we detect a reduction in lending of around 66 percentage points after a capital shock of the strength *four*. Summing up, interbank relations are remarkably resistant with regard to bank-specific capital shocks. That is, only severe capital-write offs of

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[26] We detect negative effects only for creditor banks that are in the worst decile of the yearly capital distribution.

[27] The mean regulatory capital reduction for a borrower bank in the case of an idiosyncratic shock of the size five is 7.79 percentage points, which refers to a capital reduction in relative terms of 38.18% regarding a mean capital ratio of 20.4%. In contrast, the mean capital ratio of a borrower bank in the crisis period is 23.77% and the capital reduction in the case of an idiosyncratic shock of the size four is 10.12 percentage points, which amounts to a relative capital reduction of 42.57%.

around 40% actually impair lending relationships. Most notable is the fact that idiosyncratic capital shocks affect interbank stability solely via the borrower side and even more so in periods of aggregate turmoil. In contrast, creditor banks do not reduce their interbank market activity independently of their level of capitalization.

TABLE 1.5 IDIOSYNCRATIC CAPITAL SHOCK X CRISIS

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	one decile change		two decile change		four decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Crisis	-0.173 ***	-0.080 ***	-0.171 ***	-0.096 ***	-0.176 ***	-0.098 ***
	(-29.40)	(-5.62)	(-30.69)	(-6.94)	(-31.80)	(-7.13)
Shock CAPR creditor	0.035 ***	0.032 ***	0.060 ***	0.057 **	0.088 **	0.147
	(7.90)	(3.34)	(5.98)	(2.57)	(2.30)	(1.31)
Shock CAPR borrower	0.033 ***	0.089 ***	0.015 *	0.082 ***	-0.014	0.200 ***
	(7.70)	(9.68)	(1.77)	(4.07)	(-0.46)	(2.66)
Crisis x shock CAPR creditor	0.017 **	-0.013	-0.088 ***	0.026	-0.080	0.032
	(2.02)	(-0.78)	(-3.84)	(0.56)	(-0.92)	(0.15)
Crisis x shock CAPR borrower	-0.013	-0.048 ***	-0.094 ***	-0.054	-0.404 ***	-0.855 ***
	(-1.58)	(-2.71)	(-5.11)	(-1.36)	(-5.09)	(-2.77)
Baseline variables	**Yes**		**Yes**		**Yes**	
constant	-7.731 ***	-8.986 ***	-7.728 ***	-9.012 ***	-7.724 ***	-8.997 ***
	(-66.86)	(-26.83)	(-66.87)	(-26.90)	(-66.84)	(-26.86)
Obs	2,589,854	1,227,972	2,589,854	1,227,972	2,589,854	1,227,972
Pseudo R-squared	0.763	-	0.763	-	0.763	-
R-squared overall	-	0.35102	-	0.35111	-	0.35112
R-squared between	-	0.34545	-	0.34548	-	0.34548
R-squared within	-	0.50090	-	0.50097	-	0.50097

PANEL B	(1)	(2)	(3)	(4)	(5)	(6)
Marginal effects	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Shock CAPR creditor						
at Crisis = 1	0.004 ***	0.019	-0.002	0.083 **	0.001	0.179
	(7.11)	(1.33)	(-1.38)	(2.01)	(0.11)	(1.00)
at Crisis = 0	0.003 ***	0.032 ***	0.006 ***	0.057 **	0.008 **	0.147
	(7.83)	(3.34)	(5.84)	(2.57)	(2.22)	(1.31)
Shock CAPR borrower						
at Crisis = 1	0.002 **	0.042 ***	-0.006 ***	0.027	-0.030 ***	-0.655 **
	(2.55)	(2.79)	(-4.93)	(0.79)	(-6.18)	(-2.19)
at Crisis = 0	0.003 ***	0.089 ***	0.001 *	0.082 ***	-0.001	0.200 ***
	(7.65)	(9.68)	(1.76)	(4.07)	(-0.46)	(2.66)
Obs	2,589,854	1,227,972	2,589,854	1,227,972	2,589,854	1,227,972

Panel A of this table shows the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower bank-specific shock and the "Crisis" variable, which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The bank-specific shock variable is an alternating dummy variable that takes the value one if there is a bad or unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left-hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A and B). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A and B). For the the right-hand side variables (RHS) we use all variables of the baseline regression model augmented by the interaction term between the idiosyncratic shock and the "Crisis" variable. Panel B shows the models' corresponding marginal effects at representative values whereas the table generally depicts estimation results of idiosyncratic shocks of the strengths one, two and four, that is an unfavourable change in the underlying variable's distribution from one quarter to another of one, two and four deciles, respectively. *p<0.10, **p<0.05, ***p<0.01

Idiosyncratic liquidity shocks show results which are quite similar to those of shocks regarding the banks' capitalization. Again, creditor banks seem to be remarkably resistant to liquidity drains, but in contrast, even small bank-specific liquidity shocks affect borrower banks negatively, i.e. reducing interbank lending. Table 1.6 presents regression results of interaction term models with the idiosyncratic shock variable alternating from a one decile change in columns (1) and (2), over a two decile change in columns (3) and (4), up to a bank-specific shock of the strength *three* in columns (5) and (6), i.e. a three decile change in the yearly distribution of the creditor, and the borrower liquidity ratio from one quarter to another, respectively. In general, we detect a higher reduction in interbank exposures, the stronger the idiosyncratic shock is. However, most interestingly, effects are nearly four times larger in the non-crisis period than in the actual crisis period. For instance, an idiosyncratic shock in the crisis period of the strength *three*, i.e. a loss of around 34% in the borrower banks' liquid assets reduces interbank exposures by eleven percentage points. In contrast, a bank-specific shock of the same strength in the non-crisis period leads to reduction in interbank exposures of nearly 44 percentage points. One possible explanation for liquidity shocks affecting interbank lending less in the non-crisis than in the actual crisis period might be the role played by the central bank in flooding the market with huge amounts of liquidity and acting as the central counterparty in large parts of the money market (Bräuning and Fecht, 2012).

TABLE 1.6 IDIOSYNCRATIC LIQUIDITY SHOCK X CRISIS

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	one decile change		two decile change		three decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Crisis	-0.227 ***	-0.079 ***	-0.210 ***	-0.087 ***	-0.214 ***	-0.086 ***
	(-36.34)	(-5.53)	(-35.84)	(-6.33)	(-37.21)	(-6.32)
Shock LIQR creditor	0.036 ***	0.064 ***	0.142 ***	0.053 ***	0.145 ***	0.060 **
	(8.54)	(7.50)	(20.53)	(3.30)	(12.84)	(2.12)
Shock LIQR borrower	-0.065 ***	-0.161 ***	-0.052 ***	-0.201 ***	-0.075 ***	-0.438 ***
	(-11.80)	(-14.76)	(-5.16)	(-9.09)	(-3.94)	(-9.68)
Crisis x shock LIQR creditor	0.017 **	-0.092 ***	-0.083 ***	-0.040	-0.077 ***	-0.060
	(2.17)	(-6.39)	(-6.44)	(-1.62)	(-3.41)	(-1.34)
Crisis x shock LIQR borrower	0.055 ***	0.113 ***	-0.001	0.185 ***	0.065 **	0.328 ***
	(5.86)	(6.60)	(-0.08)	(5.75)	(2.14)	(4.81)
Baseline variables	**Yes**		**Yes**		**Yes**	
constant	-7.426 ***	-7.848 ***	-7.446 ***	-7.778 ***	-7.429 ***	-7.815 ***
	(-69.75)	(-23.99)	(-69.89)	(-23.74)	(-69.76)	(-23.84)
Obs	2,981,661	1,421,140	2,981,661	1,421,140	2,981,661	1,421,140
Pseudo R-squared	0.760	-	0.760	-	0.760	-
R-squared overall	-	0.35346	-	0.35314	-	0.35333
R-squared between	-	0.35820	-	0.35709	-	0.35823
R-squared within	-	0.50303	-	0.50289	-	0.50296

PANEL B	(1)	(2)	(3)	(4)	(5)	(6)
Marginal effects	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Shock LIQR creditor						
at Crisis = 1	0.004 ***	-0.027 **	0.005 ***	0.012	0.006 ***	0.000
	(8.07)	(-2.37)	(5.20)	(0.65)	(3.42)	(0.01)
at Crisis = 0	0.003 ***	0.064 ***	0.014 ***	0.053 ***	0.014 ***	0.060 **
	(8.49)	(7.50)	(19.56)	(3.30)	(12.13)	(2.12)
Shock LIQR borrower						
at Crisis = 1	-0.001	-0.048 ***	-0.004 ***	-0.015	-0.001	-0.109 **
	(-1.27)	(-3.65)	(-4.02)	(-0.64)	(-0.40)	(-2.10)
at Crisis = 0	-0.006 ***	-0.161 ***	-0.005 ***	-0.201 ***	-0.007 ***	-0.438 ***
	(-12.03)	(-14.76)	(-5.26)	(-9.09)	(-4.05)	(-9.68)
Obs	2,981,661	1,421,140	2,981,661	1,421,140	2,981,661	1,421,140

Panel A of this table shows the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower bank-specific shock and the "Crisis" variable, which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The bank-specific shock variable is an alternating dummy variable that takes the value one if there is a bad or unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left-hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A and B). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A and B). For the the right-hand side variables (RHS) we use all variables of the baseline regression model augmented by the interaction term between the idiosyncratic shock and the "Crisis" variable. Panel B shows the models' corresponding marginal effects at representative values whereas the table generally depicts estimation results of idiosyncratic shocks of the strengths one, two and three that is an unfavourable change in the underlying variable's distribution from one quarter to another of one, two and three deciles, respectively. *p<0.10, **p<0.05, ***p<0.01

The banks' level of capitalization and liquidity has been an important and intensively discussed issue and problems of undercapitalization and insufficient liquidity have been addressed at the international level not only by Basel III, for example, but also at national and European levels by compelling banks to hold higher capital and liquidity buffers. Nevertheless, we reveal another, so far broadly underexplored issue which plays a part in destabilizing interbank market stability, namely the banks' credit quality. In contrast to idiosyncratic capitalization and liquidity shocks, shocks regarding the banks' credit quality impair interbank relations not just from one side of the lending relationship but also from the other one. On the one hand, creditor banks withdraw from the interbank market by reducing lending and, on the other hand, borrower banks are becoming less financed as well. Table 1.7 provides some detailed results on the interaction models' parameter estimates, where columns (1) and (2) depict shocks of the strength one, columns (3) and (4) show shocks of the strength four, and columns (5) and (6) contain shocks of the strength eight. In line with results on the banks' capitalization, idiosyncratic credit quality shocks affect borrower banks distinctly more during the crisis period than in the non-crisis period. Similar to capitalization shocks, we see a looming effect of credit quality shocks first affecting the probability of continuing the interbank lending relation, and, in the case of a slip of three deciles in the distribution of the underlying variable, an increasing reduction of interbank exposures starting with a lending cut of eleven percentage points, which ultimately adds up to a reduction of more than 75 percentage points in the case of a severe idiosyncratic shock of the strength *eight*.[28]

[28] These results are to some extent mirrored by the ones of the quadratic term models which show for creditor banks a convex and for borrower banks a more concave relationship between the non-performing loans to total loans ratio and interbank exposure indicating a decreasing effect for the former and an increasing effect for the latter.

TABLE 1.7 IDIOSYNCRATIC CREDIT QUALITY SHOCK X CRISIS

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	one decile change		four decile change		eight decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Crisis	-0.162 ***	-0.050 ***	-0.151 ***	-0.029 **	-0.158 ***	-0.034 **
	(-23.77)	(-3.20)	(-24.39)	(-1.97)	(-25.53)	(-2.31)
Shock NPLR creditor	-0.028 ***	-0.071 ***	0.005	-0.103	0.127 **	-0.029
	(-4.97)	(-6.03)	(0.20)	(-1.64)	(2.34)	(-0.21)
Shock NPLR borrower	-0.005	-0.022 **	0.135 ***	0.300 ***	0.406 ***	0.351 **
	(-0.77)	(-1.97)	(4.86)	(6.15)	(3.32)	(2.16)
Crisis x shock NPLR creditor	0.029 ***	0.053 ***	-0.089 ***	0.100	-0.243 ***	0.158
	(3.09)	(3.12)	(-2.86)	(1.46)	(-2.85)	(0.87)
Crisis x shock NPLR borrower	-0.008	0.023	-0.267 ***	-0.410 ***	-0.619 ***	-1.127 ***
	(-0.86)	(1.43)	(-7.98)	(-7.39)	(-4.58)	(-5.31)
Baseline variables	**Yes**		**Yes**		**Yes**	
constant	-7.661 ***	-8.033 ***	-7.669 ***	-8.025 ***	-7.660 ***	-7.996 ***
	(-65.21)	(-23.65)	(-65.25)	(-23.61)	(-65.19)	(-23.54)
Obs	2,496,756	1,188,579	2,496,756	1,188,579	2,496,756	1,188,579
Pseudo R-squared	0.764	-	0.764	-	0.764	-
R-squared overall	-	0.35109	-	0.35093	-	0.35105
R-squared between	-	0.34978	-	0.34955	-	0.34974
R-squared within	-	0.50058	-	0.50053	-	0.50056
PANEL B	(1)	(2)	(5)	(6)	(7)	(8)
Marginal effects	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Shock NPLR creditor						
at Crisis = 1	0.000	-0.017	-0.007 ***	-0.003	-0.009 *	0.128
	(0.15)	(-1.38)	(-4.32)	(-0.09)	(-1.77)	(1.08)
at Crisis = 0	-0.002 ***	-0.071 ***	0.000	-0.103	0.012 **	-0.029
	(-5.01)	(-6.03)	(0.20)	(-1.64)	(2.22)	(-0.21)
Shock NPLR borrower						
at Crisis = 1	-0.001 *	0.001	-0.010 ***	-0.110 ***	-0.016 ***	-0.775 ***
	(-1.75)	(0.11)	(-7.16)	(-4.09)	(-3.90)	(-5.60)
at Crisis = 0	-0.000	-0.022 **	0.013 ***	0.300 ***	0.044 ***	0.351 **
	(-0.78)	(-1.97)	(4.59)	(6.15)	(2.81)	(2.16)
Obs	2,496,756	1,188,579	2,496,756	1,188,579	2,496,756	1,188,579

Panel A of this table shows the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower bank-specific shock and the "Crisis" variable, which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The bank-specific shock variable is an alternating dummy variable that takes the value one if there is a bad or unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left-hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A and B). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A and B). For the the right-hand side variables (RHS) we use all variables of the baseline regression model augmented by the interaction term between the idiosyncratic shock and the "Crisis" variable. Panel B shows the models' corresponding marginal effects at representative values whereas the table generally depicts estimation results of idiosyncratic shocks of the strengths one, four and eight that is an unfavourable change in the underlying variable's distribution from one quarter to another of one, four and eight deciles, respectively. *p<0.10, **p<0.05, ***p<0.01

1.4.3.2 IDIOSYNCRATIC SHOCKS AND RELATIONSHIP BANKING

So far, we have demonstrated that idiosyncratic shocks heavily disturb interbank lending relations and can potentially impair market stability itself. As in Section 1.4.2, one can ask whether relationship banking in the form of a longer and more intensive interbank relationship in the past can help to overcome the negative effects of idiosyncratic shocks. To answer this question, we further expand both steps of the baseline Heckman Correction models (3) and (6) by the interaction term (13), that is, we interact the creditor and borrower bank-specific shocks with our relationship proxy variables.

In contrast to Cocco et al. (2009), Affinito (2012) and others who present empirical evidence that relationship banking indeed helped to overcome market turmoil in the recent financial crisis, our results show that hard information dominates soft information. Tables 1.8 to 1.10 show parameter estimates of the interaction term models, where columns (1) and (2) present the regression coefficients and columns (3) and (4) the corresponding marginal effects at representative values $(idiosyncratic\ shock = 1|0)$.[29]

Table 1.8 shows that the negative effects of a capital shock of the strength *five* cannot be undone either by a longer or a more intensive interbank relation in the past or even by reciprocal lending. It should be borne in mind that an idiosyncratic capital shock of that strength is the weakest possible shock that impairs interbank lending in general. Results of more severe shocks are analogous to those presented and imply that, in contrast to the literature on bank-firm customer relationships which predicts that banks ensure the availability of credit to customer firms when these firms are in trouble, does not hold in a bank-bank context. As the interbank market is able to distinguish between banks of different quality even in times of aggregate distress, hard information seems to dominate soft information.

[29] We report marginal effects at representative values only for cases where the idiosyncratic shock exhibits an interbank lending reduction for the first time, i.e. in its weakest definition.

TABLE 1.8 IDIOSYNCRATIC CAPITAL SHOCK X RELATIONSHIP

	(1)	(2)		(3)	(4)
Shock definied as a			five decile change		
RHS / LHS	Credit relation	Exposure change	**Marginal effects**	Credit relation	Exposure change
Crisis	-0.176 ***	-0.099 ***	Total relation span		
	(-31.91)	(-7.21)	at Shock Creditor = 1	0.013 ***	0.037
Shock CAPR creditor	-0.027	2.672 ***	at Shock Borrower = 1	(5.49)	(1.09)
	(-0.41)	(3.92)	at Shock Creditor = 1	0.014 ***	0.059 ***
Shock CAPR borrower	-0.175 ***	-0.706	at Shock Borrower = 0	(7.27)	(3.19)
	(-2.85)	(-1.14)	at Shock Creditor = 0	0.005 ***	-0.034
Total relation span	0.057 ***	-0.012 ***	at Shock Borrower = 1	(5.39)	(-1.20)
	(74.19)	(-18.81)	at Shock Creditor = 0	0.005 ***	-0.012 ***
ln Exposure (lagged)	0.224 ***	-0.216 ***	at Shock Borrower = 0	(75.35)	(-18.81)
	(599.89)	(-35.71)			
ln Reciproc exposure	-0.012 ***	0.019 ***	ln Exposure (lagged)		
	(-16.11)	(13.99)	at Shock Creditor = 1	0.015 ***	-0.388 ***
Shock CAPR creditor	0.102 ***	0.071 ***	at Shock Borrower = 1	(13.80)	(-6.46)
x Total relation span	(4.58)	(3.82)	at Shock Creditor = 1	0.016 ***	-0.445 ***
Shock CAPR borrower	0.003	-0.022	at Shock Borrower = 0	(16.68)	(-9.92)
x Total relation span	(0.28)	(-0.78)	at Shock Creditor = 0	0.017 ***	-0.159 ***
Shock CAPR creditor	-0.041 ***	-0.229 ***	at Shock Borrower = 1	(18.85)	(-3.93)
x ln Exposure (lagged)	(-3.55)	(-5.15)	at Shock Creditor = 0	0.019 ***	-0.216 ***
Shock CAPR borrower	0.000	0.056	at Shock Borrower = 0	(383.79)	(-35.71)
x ln Exposure (lagged)	(0.02)	(1.41)			
Shock CAPR creditor	-0.047 ***	-0.042 *	ln Reciproc exposure		
x ln Reciproc exposure	(-2.80)	(-1.68)	at Shock Creditor = 1	-0.004 **	-0.052
Shock CAPR borrower	0.007	-0.028	at Shock Borrower = 1	(-2.26)	(-1.34)
x ln Reciproc exposure	(0.47)	(-0.97)	at Shock Creditor = 1	-0.005 ***	-0.023
Baseline variables	**Yes**		at Shock Borrower = 0	(-3.40)	(-0.92)
constant	-7.725 ***	-8.993 ***	at Shock Creditor = 0	-0.000	-0.009
	(-66.86)	(-26.85)	at Shock Borrower = 1	(-0.37)	(-0.32)
			at Shock Creditor = 0	-0.001 ***	0.019 ***
Obs	2,589,854	1,227,972	at Shock Borrower = 0	(-16.17)	(13.99)
Pseudo R-squared	0.763	-			
R-squared overall	-	0.35113	Obs	2,589,854	1,227,972
R-squared between	-	0.34541			
R-squared within	-	0.50097			

This table presents the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower bank-specific shock and the relationship proxie variables as well as the interaction terms' corresponding marginal effects at representative values. The shock variable is an alternating dummy variable that takes the value one if there is a bad or unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. Proxie variables that account for the banks' relationship intensity are as follows. "Total relation span" counts the number of sustained quarters bank C and bank B interact with each other, either as creditors or borrowers, "Exposure t - 1" is the log pre-quarter exposure from the creditor bank C to borrower bank B and "Reciproc exposure" is the log reciprocal exposure from bank B to bank C In the first step of the Heckit Model, the left-hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1 and 3). The LHS variable for the second step is "Exposure change" in log differences (Column 2 and 4). For the the right-hand side variables (RHS) we use all variables of the baseline regression model augmented by the interaction terms of the bank-specific shock variable and the relationship proxies whereas the table presents estimation results of an idiosyncratic shock of the strength five, that is an unfavourable change in the underlying variable's distribution from one quarter to another of five deciles. *p<0.10, **p<0.05, ***p<0.01

Likewise, Table 1.9 presents results of the case where a creditor or a borrower bank is hit by an idiosyncratic liquidity shock of the strength one, which represents a slip of one decile in the underlying variable's yearly distribution. Though we do not detect a significant positive effect of relationship banking in terms of a longer and more intensive relationship, we do again present some evidence that reciprocal lending has a number of benefits if the borrower bank has been hit by such an idiosyncratic liquidity shock. A one SD increase in reciprocal lending that is lending from the initial borrower bank B to the creditor bank C, increases interbank lending by between six and 13 percentage points in the first place.

TABLE 1.9 IDIOSYNCRATIC LIQUIDITY SHOCK X RELATIONSHIP

	(1)	(2)		(3)	(4)
Shock definied as a			one decile change		
RHS / LHS	Credit relation	Exposure change	**Marginal effects**	Credit relation	Exposure change
Crisis	-0.214 ***	-0.077 ***	Total relation span		
	(-37.42)	(-5.73)	at Shock Creditor = 1	0.005 ***	-0.013 ***
Shock LIQR creditor	0.065 ***	0.511 ***	at Shock Borrower = 1	(43.25)	(-11.92)
	(16.19)	(15.22)	at Shock Creditor = 1	0.006 ***	-0.011 ***
Shock LIQR borrower	-0.011 **	-0.481 ***	at Shock Borrower = 0	(59.85)	(-12.76)
	(-2.17)	(-11.13)	at Shock Creditor = 0	0.004 ***	-0.009 ***
Total relation span	0.059 ***	-0.007 ***	at Shock Borrower = 1	(50.72)	(-9.80)
	(77.56)	(-10.89)	at Shock Creditor = 0	0.005 ***	-0.007 ***
ln Exposure (lagged)	0.223 ***	-0.213 ***	at Shock Borrower = 0	(78.41)	(-10.89)
	(561.53)	(-37.29)			
ln Reciproc exposure	-0.013 ***	0.017 ***	ln Exposure (lagged)		
	(-17.67)	(13.25)	at Shock Creditor = 1	0.020 ***	-0.216 ***
Shock LIQR creditor	0.003 ***	-0.004 ***	at Shock Borrower = 1	(199.15)	(-33.29)
x Total relation span	(3.13)	(-5.38)	at Shock Creditor = 1	0.020 ***	-0.239 ***
Shock LIQR borrower	-0.012 ***	-0.002 **	at Shock Borrower = 0	(280.85)	(-40.55)
x Total relation span	(-14.61)	(-2.52)	at Shock Creditor = 0	0.019 ***	-0.190 ***
Shock LIQR creditor	-0.001	-0.026 ***	at Shock Borrower = 1	(226.82)	(-29.99)
x ln Exposure (lagged)	(-1.11)	(-11.65)	at Shock Creditor = 0	0.019 ***	-0.213 ***
Shock LIQR borrower	0.001	0.023 ***	at Shock Borrower = 0	(375.80)	(-37.29)
x ln Exposure (lagged)	(1.22)	(8.28)			
Shock LIQR creditor	-0.014 ***	-0.012 ***	ln Reciproc exposure		
x ln Reciproc exposure	(-14.21)	(-13.03)	at Shock Creditor = 1	-0.002 ***	0.010 ***
Shock LIQR borrower	0.007 ***	0.005 ***	at Shock Borrower = 1	(-15.71)	(5.84)
x ln Reciproc exposure	(7.62)	(5.04)	at Shock Creditor = 1	-0.002 ***	0.005 ***
Baseline variables	**Yes**		at Shock Borrower = 0	(-25.53)	(3.14)
constant	-7.441 ***	-7.821 ***	at Shock Creditor = 0	-0.001 ***	0.022 ***
	(-69.88)	(-24.04)	at Shock Borrower = 1	(-5.93)	(14.48)
			at Shock Creditor = 0	-0.001 ***	0.017 ***
Obs	2,981,661	1,421,140	at Shock Borrower = 0	(-17.71)	(13.25)
Pseudo R-squared	0.760	-			
R-squared overall	-	0.35405	Obs	2,981,661	1,421,140
R-squared between	-	0.35979			
R-squared within	-	0.50283			

This table presents the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower bank-specific shock and the relationship proxie variables as well as the interaction terms' corresponding marginal effects at representative values. The shock variable is an alternating dummy variable that takes the value one if there is a bad or unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. Proxie variables that account for the banks' relationship intensity are as follows. "Total relation span" counts the number of sustained quarters bank C and bank B interact with each other, either as creditors or borrowers, "Exposure t - 1" is the log pre-quarter exposure from the creditor bank C to borrower bank B and "Reciproc exposure" is the log reciprocal exposure from bank B to bank C In the first step of the Heckit Model, the left-hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1 and 3). The LHS variable for the second step is "Exposure change" in log differences (Column 2 and 4). For the the right-hand side variables (RHS) we use all variables of the baseline regression model augmented by the interaction terms of the bank-specific shock variable and the relationship proxies whereas the table presents estimation results of an idiosyncratic shock of the strength one, that is an unfavourable change in the underlying variable's distribution from one quarter to another of one decile. *p<0.10, **p<0.05, ***p<0.01

The positive effect of reciprocal lending also shows up in cases where either the creditor or the borrower bank is hit by a shock regarding its credit quality. Those results are presented in Table 1.10. As idiosyncratic shocks regarding the banks credit quality affect interbank lending from both sides of the interbank lending relationship, Panel A in Table 1.10 presents estimation results and the corresponding marginal effects of a credit quality shock of the strength *one* which affects creditor banks in particular and Panel B shows results of a shock the strength *five* when borrower banks also start to suffer from an exceptionally strong increase in their non-performing loans to assets ratio (*NPLR*). In this regard, a one SD increase in reciprocal lending increases interbank lending to the stressed borrowing bank by between 16 and 22 percentage points and by between 12 and 14 percentage points even when it is the creditor bank that is in stress.

TABLE 1.10 IDIOSYNCRATIC CREDIT QUALITY SHOCK X RELATIONSHIP

PANEL A	(1)	(2)		(3)	(4)
Shock definied as a			one decile change		
RHS / LHS	Credit relation	Exposure change	**Marginal effects**	Credit relation	Exposure change
Crisis	-0.157 ***	-0.033 **	Total relation span		
	(-25.41)	(-2.23)	at Shock Creditor = 1	0.004 ***	-0.008 ***
Shock NPLR creditor	0.013 **	-0.007	at Shock Borrower = 1	(41.03)	(-8.31)
	(2.48)	(-0.17)	at Shock Creditor = 1	0.004 ***	-0.009 ***
Shock NPLR borrower	0.024 ***	0.114 ***	at Shock Borrower = 0	(49.55)	(-10.21)
	(4.68)	(2.67)	at Shock Creditor = 0	0.005 ***	-0.008 ***
Total relation span	0.061 ***	-0.009 ***	at Shock Borrower = 1	(53.87)	(-9.59)
	(69.16)	(-12.49)	at Shock Creditor = 0	0.005 ***	-0.009 ***
ln Exposure (lagged)	0.224 ***	-0.217 ***	at Shock Borrower = 0	(70.80)	(-12.49)
	(514.45)	(-35.16)			
ln Reciproc exposure	-0.013 ***	0.018 ***	ln Exposure (lagged)		
	(-15.86)	(12.57)	at Shock Creditor = 1	0.020 ***	-0.233 ***
Shock NPLR creditor	-0.011 ***	-0.000	at Shock Borrower = 1	(189.75)	(-34.29)
x Total relation span	(-12.81)	(-0.15)	at Shock Creditor = 1	0.020 ***	-0.222 ***
Shock NPLR borrower	-0.003 ***	0.001	at Shock Borrower = 0	(230.68)	(-33.76)
x Total relation span	(-2.96)	(1.28)	at Shock Creditor = 0	0.019 ***	-0.228 ***
Shock NPLR creditor	0.002 ***	-0.005 *	at Shock Borrower = 1	(228.58)	(-35.21)
x ln Exposure (lagged)	(2.76)	(-1.75)	at Shock Creditor = 0	0.019 ***	-0.217 ***
Shock NPLR borrower	-0.002 ***	-0.011 ***	at Shock Borrower = 0	(334.70)	(-35.16)
x ln Exposure (lagged)	(-3.00)	(-3.97)			
Shock NPLR creditor	0.007 ***	0.003 ***	ln Reciproc exposure		
x ln Reciproc exposure	(6.07)	(2.98)	at Shock Creditor = 1	-0.001 ***	0.023 ***
Shock NPLR borrower	-0.005 ***	0.003 **	at Shock Borrower = 1	(-7.96)	(12.89)
x ln Reciproc exposure	(-4.39)	(2.42)	at Shock Creditor = 1	-0.001 ***	0.021 ***
Baseline variables	**Yes**		at Shock Borrower = 0	(-5.37)	(12.46)
constant	-7.662 ***	-8.083 ***	at Shock Creditor = 0	-0.002 ***	0.020 ***
	(-65.14)	(-23.78)	at Shock Borrower = 1	(-15.00)	(12.72)
			at Shock Creditor = 0	-0.001 ***	0.018 ***
Obs	2,496,756	1,188,579	at Shock Borrower = 0	(-15.95)	(12.57)
Pseudo R-squared	0.764	-			
R-squared overall	-	0.35103	Obs	2,496,756	1,188,579
R-squared between	-	0.34973			
R-squared within	-	0.50047			

This table presents the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower bank-specific shock and the relationship proxie variables as well as the interaction terms' corresponding marginal effects at representative values. The shock variable is an alternating dummy variable that takes the value one if there is a bad or unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. Proxie variables that account for the banks' relationship intensity are as follows. "Total relation span" counts the number of sustained quarters bank C and bank B interact with each other, either as creditors or borrowers, "Exposure t - 1" is the log pre-quarter exposure from the creditor bank C to borrower bank B and "Reciproc exposure" is the log reciprocal exposure from bank B to bank C In the first step of the Heckit Model, the left-hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1 and 3). The LHS variable for the second step is "Exposure change" in log differences (Column 2 and 4). For the the right-hand side variables (RHS) we use all variables of the baseline regression model augmented by the interaction terms of the bank-specific shock variable and the relationship proxies whereas the table presents in Panel A estimation results of an idiosyncratic shock of the strength one, that is an unfavourable change in the underlying variable's distribution from one quarter to another of one decile and in Panel B results of an idiosyncratic shocks of the strength five. *p<0.10, **p<0.05, ***p<0.01

All in all, results show that relationship banking is not distinctively capable of overcoming bank-specific, i.e. self-induced problems, as hard information seems to dominate. Only reciprocal lending does, to some extent, increase interbank lending activity, maybe due to signaling effects or maturity swaps.

1.5 Robustness Tests

We employ a broad range of sensitivity analyses to assess the robustness of our findings. In general, we conduct various robustness checks regarding our overall dataset, such as the level at which we correct for outliers, the overall sample that we analyze, and the utilized merger correction procedure. We also conduct robustness checks on the definition of our main variables of interest and the models' distinct specification for testing.

1.5.1 Observations and Sample

We start with sensitivity analyses regarding the overall structure of our database. For the first set of control variables, namely bank characteristics, we delete outliers except for *Size* at the 1% level, but rerun our specifications without carrying out any outlier correction measures. In general, we utilize varying sets of control variables, such as alternative capital, liquidity and profitability ratios and specifications without bank group controls, or without any set of control variables at all. Regarding the sample size, we rerun the models for private banks only, that is, without *Landesbanken*, savings and cooperative banks and central institutions of cooperative banks. Furthermore, we rerun the models for a sub-period since 2008 where we are able to utilize the banks' estimates of their counterparty's *probability of default (PD)*. Results qualitatively do not change. Finally, a number of bank mergers took place between the first quarter of 2000 to the third quarter of 2012. Therefore, we carry out a merger correction procedure by creating a new separate bank after the merger takes place. Generally, the duration of the relationships still amounts to nearly three years, which should be a sufficient amount of time to overcome asymmetric information due to relationship banking (Rochet and Tirole, 1996). Nevertheless, results are robust to alternative specifications.

1.5.2 VARIABLES OF INTEREST

1.5.2.1 RELATION, CRISIS AND RISK MEASURES

Second, regarding our main variables of interest, such as the relationship proxies, we use varying lags especially for those utilized in the baseline specification with contemporaneous values. Furthermore, beyond splitting the aggregated crisis period into different sub-crisis periods like the Commercial Paper crisis (2007:Q3-2008:Q3), the Lehman crisis (2008:Q4-2009:Q4) and the Euro crisis (2010:Q1-2012:Q3) and varying the starting points of these crises periods, we analyze a set of periods of special interest; for instance, periods in which the ECB switched its operational framework from a regular variable-rate tender procedure to a fixed-rate full allotment policy. Results show that in the full allotment period in 2008:Q4 itself the likelihood of interbank participation drops significantly by between 1.6 and 7 percent, but we do not detect reduced interbank market exposures in that period or in the preceding quarters. Regarding the risk measure, we utilize not only the non-performing loans to total loans ratio (*NPLR*) but also the bank's Z-score, such as the bank's PD for a sub-period since 2008:Q1.

1.5.2.2 IDIOSYNCRATIC SHOCKS

Above and beyond that, as we identify idiosyncratic shocks to be the most important determinants of interbank market stability, we examine a broad range of model specifications and modify the definition of an idiosyncratic shock in several ways. First, we redefine idiosyncratic shocks so that a shock is associated only with a drop into the second quartile of the distribution of the underlying shock variable. In other words, the shock dummy variable does not take the value one in those cases where the borrower or the creditor bank experiences a quarter-to-quarter slip, say, in their capital or liquidity ratio distribution from a high to a moderate point, but at least into the 50th percentile. Second, we extend our models by a dummy variable that takes the value one if a bank is already in the worst decile of the underlying variable's distribution, as those banks by definition do not exhibit an idiosyncratic shock. Results do not differ substantially from the ones presented; at the most, effects are to some extent even more pronounced. Finally, we examine the effect of quadratic terms, which do indeed display a non-linear behavior. For instance, we find a more concave risk-exposure relationship for borrower banks and a convex risk-exposure relationship for creditor banks, confirming an increasing effect of risk for borrower banks and a diminishing effect for creditor banks.

Alongside the main idiosyncratic shocks presented, which severely affect interbank relations and lending, we also examine shocks of creditor banks' and borrower banks' Z-scores, PD and profitability (Appendix section 1.7, Figure 1.A1). Similar to results of our baseline model in Section 1.4.1, lower profitability does not affect interbank stability, at all. Even after extremely sharp declines in profitability from one quarter to another creditor banks do not reduce interbank lending nor do borrower banks face problems in prolonging their interbank positions. Higher risk in terms of shocks regarding the banks' Z-score did not impair interbank relationships in the recent crisis either. Similar to liquidity shocks, results show a difference between the crisis and the non-crisis periods as lower Z-scores destabilize interbank lending more in the non-crisis period than in the actual crisis period. In fact, lower Z-scores only reduce interbank lending in the non-crisis period (Appendix section 1.7, Table 1.A10). Results regarding higher probabilities of default are to some extent sketchy, as we only detect interbank exposure reductions of up to 7.4 percentage points after a creditor, or borrower PD shock of the size of one (Appendix section 1.7, Table 1.A5). One possible explanation might give Behn et al. (2014), who show that the introduction of Basel II-type, model-based capital regulation affected the validity of banks' internal risk estimates. Also, results of the quadratic term model show a considerable decreasing effect of higher PDs for both creditor and borrower banks.

1.6 CONCLUSION

Though the importance of interbank relations for the distribution of liquidity is well recognized, the main drivers that foster the persistence and the strength of interbank relations—or trigger their collapse—are as of yet unknown. In this study, we present novel evidence of the microeconomic determinants of banks' bilateral positions. In particular, while existing research is mostly concerned with the effects of aggregate shocks, such as the 2007 Commercial Paper crisis or the Lehman insolvency, on the functioning of interbank relations, we focus on the so far underexplored importance of idiosyncratic bank shocks that is shocks with regard to distinct individual bank's balance sheet positions. By disentangling the effects and the inherently differing information content of aggregate and idiosyncratic shocks, we provide evidence of whether some banks' inability to roll over their interbank positions in the recent financial crisis was due to a failure of the interbank market in reallocating liquidity efficiently within the banking sector itself, i.e. a frozen interbank market, or rather to revised bank-level risk perceptions that lead to a stressed money market.

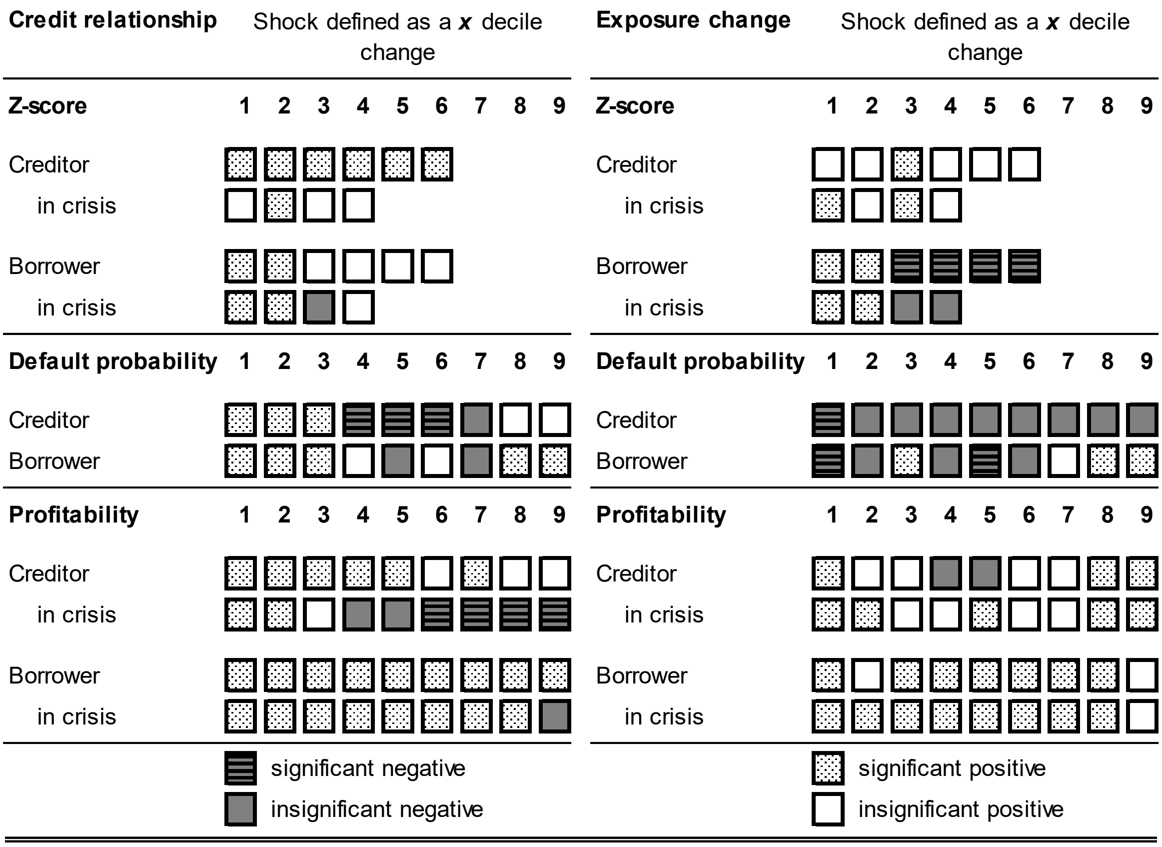
Our results clearly confirm the latter proposition. Though detecting a statistically significant but small reduction in the bank-to-bank exposures due to the crisis we clearly identify idiosyncratic shocks to be substantially more important for the recent disruptions on the interbank market. Indeed, banks avoid terminating interbank relationships, but, economically and statistically, they reduce their exposures based on hard information about their peers.

Moreover, identifying idiosyncratic shocks as the main driver disrupting interbank lending, we also analyze the effects of risk taking and reciprocal behavior on the banks' bilateral exposures and test whether relationship banking can outweigh the negative effects induced by bank-specific shocks. Unlike earlier studies which find that relationship banking helps to overcome financial instability, we show distinct evidence that, except reciprocal lending, this is not the case for the German interbank market. Neither longer nor more intense interbank relationships in the past contain the negative effects of either aggregate or idiosyncratic shocks regarding the banks' capital, credit quality or liquidity.

Summing up, our results show that the inability of some banks to roll over their interbank position and the ensuing financial market turmoil were not due to a failure of the interbank market *per se* but rather due to bank-specific shocks affecting the banks' capital, liquidity and credit quality. Most importantly, the results uncover a so far undocumented ability of the interbank market to distinguish between banks of different quality in times of aggregate distress.

1.7 APPENDIX

FIGURE 1.A1 MINOR IDIOSYNCRATIC SHOCKS



This figure illustrates the parameter estimates of the baseline Heckman Two-Step Correction Model augmented by a creditor and borrower bank-specific shock and an interaction term of the idiosyncratic shock and the "Crisis" variable, which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The bank-specific shock variable is an alternating dummy variable that takes the value one if there is a bad or unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left-hand side variable (LHS) is "Credit relationship", which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise. The LHS variable for the second step is "Exposure change" in log differences. For the the right-hand side variables (RHS) we use all variables of the baseline regression model augmented by the idiosyncratic shock variable and the interaction term between the shock and the "Crisis" variable. Generally, the left-hand side of the figure shows results of the first step of the Heckman selection method, and the right-hand side results of the second step. Parameter estimates of the idiosyncratic shock variables of the baseline Heckit model augmented by the those shock variables are presented in the first and third lines, respectively. Marginal effects at representative values (Crisis=1|0) of the idiosyncratic shock variables of the baseline model augmented by the interaction term are illustrated in the second and fourth lines marked by “in crisis”. The figure illustrates parameter estimates of idiosyncratic shocks regarding the creditor and borrower bank’s capitalization, credit quality and liquidity, while the dashed grey tiles represent significantly negative coefficients and the dotted white tiles significantly positive coefficients.

TABLE 1.A1 IDIOSYNCRATIC CAPITAL SHOCKS

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	one decile change		two decile change		three decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Crisis	-0.172 ***	-0.090 ***	-0.176 ***	-0.097 ***	-0.177 ***	-0.097 ***
	(-30.99)	(-6.58)	(-31.79)	(-7.05)	(-31.97)	(-7.09)
Shock CAPR creditor	0.040 ***	0.028 ***	0.040 ***	0.063 ***	0.012	0.092 ***
	(10.57)	(3.46)	(4.45)	(3.20)	(0.71)	(2.61)
Shock CAPR borrower	0.029 ***	0.075 ***	-0.006	0.068 ***	-0.093 ***	0.118 ***
	(7.77)	(9.58)	(-0.84)	(3.92)	(-6.14)	(3.32)
Baseline	Yes		Yes		Yes	
constant	-7.731 ***	-8.982 ***	-7.724 ***	-9.008 ***	-7.725 ***	-9.005 ***
	(-66.86)	(-26.81)	(-66.85)	(-26.89)	(-66.86)	(-26.88)
Obs	2,589,854	1,227,972	2,589,854	1,227,972	2,589,854	1,227,972
Pseudo R-squared	0.763	-	0.763	-	0.763	-
R-squared overall	-	0.35100	-	0.35112	-	0.35116
R-squared between	-	0.34544	-	0.34548	-	0.34548
R-squared within	-	0.50090	-	0.50097	-	0.50099

PANEL B	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	four decile change		five decile change		six decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Crisis	-0.176 ***	-0.099 ***	-0.176 ***	-0.099 ***	-0.176 ***	-0.099 ***
	(-31.94)	(-7.18)	(-31.91)	(-7.21)	(-31.90)	(-7.21)
Shock CAPR creditor	0.072 **	0.155	0.094	0.183	0.050	0.379
	(2.09)	(1.62)	(1.59)	(1.04)	(0.66)	(1.46)
Shock CAPR borrower	-0.075 ***	0.110	-0.136 **	-0.436 *	-0.284 ***	-0.409
	(-2.70)	(1.49)	(-2.56)	(-1.89)	(-4.35)	(-1.49)
Baseline	Yes		Yes		Yes	
constant	-7.724 ***	-8.999 ***	-7.725 ***	-8.991 ***	-7.724 ***	-8.994 ***
	(-66.85)	(-26.86)	(-66.87)	(-26.84)	(-66.85)	(-26.85)
Obs	2,589,854	1,227,972	2,589,854	1,227,972	2,589,854	1,227,972
Pseudo R-squared	0.763	-	0.763	-	0.763	-
R-squared overall	-	0.35113	-	0.35112	-	0.35112
R-squared between	-	0.34550	-	0.34549	-	0.34548
R-squared within	-	0.50097	-	0.50097	-	0.50097

This table shows the estimation results of the baseline Heckman Two-Step Correction Model a creditor and borrower specific idiosyncratic shock variable. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and C). For the the right hand side variables (RHS) we use all variables of the baseline regression model augmented by the idiosyncratic shock variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A1 CONTINUED

PANEL C	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	seven decile change		eight decile change		nine decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.176 ***	-0.099 ***	-0.176 ***	-0.099 ***	-0.176 ***	-0.099 ***
	(-31.88)	(-7.20)	(-31.93)	(-7.22)	(-31.92)	(-7.21)
Shock CAPR creditor	0.088	0.539 *	0.602 **	0.576	1.249 ***	2.343
	(0.83)	(1.70)	(2.45)	(0.88)	(5.15)	(1.09)
Shock CAPR borrower	-0.729 ***	-1.237 ***	-0.234	0.136	-0.186	0.228
	(-7.44)	(-2.86)	(-1.20)	(0.30)	(-0.86)	(0.44)
Baseline	Yes		Yes		Yes	
constant	-7.724 ***	-8.989 ***	-7.726 ***	-8.993 ***	-7.727 ***	-8.994 ***
	(-66.85)	(-26.83)	(-66.87)	(-26.84)	(-66.88)	(-26.85)
Obs	2,589,854	1,227,972	2,589,854	1,227,972	2,589,854	1,227,972
Pseudo R-squared	0.763	-	0.763	-	0.763	-
R-squared overall	-	0.35112	-	0.35112	-	0.35111
R-squared between	-	0.34546	-	0.34548	-	0.34547
R-squared within	-	0.50098	-	0.50097	-	0.50097

This table shows the estimation results of the baseline Heckman Two-Step Correction Model a creditor and borrower specific idiosyncratic shock variable. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and C). For the the right hand side variables (RHS) we use all variables of the baseline regression model augmented by the idiosyncratic shock variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A2 IDIOSYNCRATIC CREDIT QUALITY SHOCKS

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	one decile change		two decile change		three decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Crisis	-0.157 ***	-0.032 **	-0.160 ***	-0.035 **	-0.159 ***	-0.036 **
	(-25.32)	(-2.15)	(-25.80)	(-2.39)	(-25.59)	(-2.41)
Shock NPLR creditor	-0.016 ***	-0.047 ***	-0.028 ***	-0.082 ***	-0.062 ***	-0.053 ***
	(-3.55)	(-5.39)	(-3.70)	(-5.50)	(-5.28)	(-2.60)
Shock NPLR borrower	-0.008 *	-0.011	0.024 ***	0.042 ***	0.035 ***	0.028
	(-1.75)	(-1.27)	(3.13)	(3.12)	(3.00)	(1.45)
Baseline	Yes		Yes		Yes	
constant	-7.662 ***	-8.036 ***	-7.662 ***	-8.013 ***	-7.663 ***	-8.012 ***
	(-65.21)	(-23.65)	(-65.23)	(-23.60)	(-65.20)	(-23.59)
Obs	2,496,756	1,188,579	2,496,756	1,188,579	2,496,756	1,188,579
Pseudo R-squared	0.764	-	0.764	-	0.764	-
R-squared overall	-	0.35109	-	0.35104	-	0.35103
R-squared between	-	0.34979	-	0.34975	-	0.34976
R-squared within	-	0.50057	-	0.50054	-	0.50054

PANEL B	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	four decile change		five decile change		six decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Crisis	-0.156 ***	-0.034 **	-0.157 ***	-0.032 **	-0.160 ***	-0.033 **
	(-25.25)	(-2.32)	(-25.40)	(-2.13)	(-25.82)	(-2.24)
Shock NPLR creditor	-0.057 ***	-0.027	-0.033 *	-0.014	0.028	-0.068
	(-3.68)	(-1.06)	(-1.72)	(-0.49)	(1.19)	(-1.27)
Shock NPLR borrower	-0.066 ***	-0.026	-0.070 ***	-0.142 ***	-0.012	-0.248 ***
	(-4.11)	(-1.10)	(-3.49)	(-4.67)	(-0.44)	(-4.57)
Baseline	Yes		Yes		Yes	
constant	-7.658 ***	-8.010 ***	-7.661 ***	-8.021 ***	-7.663 ***	-8.002 ***
	(-65.18)	(-23.58)	(-65.22)	(-23.61)	(-65.21)	(-23.56)
Obs	2,496,756	1,188,579	2,496,756	1,188,579	2,496,756	1,188,579
Pseudo R-squared	0.764	-	0.764	-	0.764	-
R-squared overall	-	0.35101	-	0.35103	-	0.35107
R-squared between	-	0.34968	-	0.34971	-	0.34979
R-squared within	-	0.50055	-	0.50056	-	0.50056

This table shows the estimation results of the baseline Heckman Two-Step Correction Model a creditor and borrower specific idiosyncratic shock variable. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and C). For the the right hand side variables (RHS) we use all variables of the baseline regression model augmented by the idiosyncratic shock variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A2 CONTINUED

PANEL C	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	seven decile		eight decile		nine decile	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.159 ***	-0.035 **	-0.159 ***	-0.035 **	-0.160 ***	-0.037 **
	(-25.72)	(-2.38)	(-25.71)	(-2.35)	(-25.81)	(-2.48)
Shock NPLR creditor	0.020	0.107	-0.004	0.063	0.150 **	0.148
	(0.65)	(1.57)	(-0.08)	(0.70)	(2.12)	(1.12)
Shock NPLR borrower	-0.097 **	-0.435 ***	-0.134 ***	-0.614 ***	-0.333 *	0.141
	(-2.33)	(-4.38)	(-2.58)	(-5.10)	(-1.93)	(0.95)
Baseline	Yes		Yes		Yes	
constant	-7.661 ***	-8.006 ***	-7.660 ***	-8.001 ***	-7.662 ***	-8.017 ***
	(-65.21)	(-23.57)	(-65.20)	(-23.56)	(-65.24)	(-23.60)
Obs	2,496,756	1,188,579	2,496,756	1,188,579	2,496,756	1,188,579
Pseudo R-squared	0.764	-	0.764	-	0.764	-
R-squared overall	-	0.35105	-	0.35106	-	0.35103
R-squared between	-	0.34974	-	0.34974	-	0.34973
R-squared within	-	0.50056	-	0.50057	-	0.50055

This table shows the estimation results of the baseline Heckman Two-Step Correction Model a creditor and borrower specific idiosyncratic shock variable. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and C). For the the right hand side variables (RHS) we use all variables of the baseline regression model augmented by the idiosyncratic shock variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A3 IDIOSYNCRATIC LIQUIDITY SHOCKS

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	one decile change		two decile change		three decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Crisis	-0.215 ***	-0.082 ***	-0.216 ***	-0.083 ***	-0.215 ***	-0.084 ***
	(-37.59)	(-6.07)	(-37.74)	(-6.14)	(-37.67)	(-6.22)
Shock LIQR creditor	0.041 ***	0.031 ***	0.115 ***	0.039 ***	0.125 ***	0.040 *
	(11.80)	(4.49)	(19.59)	(3.12)	(12.68)	(1.80)
Shock LIQR borrower	-0.044 ***	-0.115 ***	-0.053 ***	-0.119 ***	-0.049 ***	-0.302 ***
	(-9.81)	(-13.63)	(-6.44)	(-7.25)	(-3.27)	(-8.74)
Baseline	Yes		Yes		Yes	
constant	-7.434 ***	-7.846 ***	-7.441 ***	-7.802 ***	-7.429 ***	-7.828 ***
	(-69.81)	(-23.98)	(-69.85)	(-23.82)	(-69.76)	(-23.88)
Obs	2981661	1421140	2981661	1421140	2981661	1421140
Pseudo R-squared	0.760	-	0.760	-	0.760	-
R-squared overall	-	0.35343	-	0.35317	-	0.35334
R-squared between	-	0.35820	-	0.35731	-	0.35826
R-squared within	-	0.50300	-	0.50289	-	0.50296

PANEL B	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	four decile change		five decile change		six decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Crisis	-0.215 ***	-0.085 ***	-0.216 ***	-0.085 ***	-0.216 ***	-0.085 ***
	(-37.68)	(-6.26)	(-37.74)	(-6.28)	(-37.75)	(-6.31)
Shock LIQR creditor	0.161 ***	0.008	0.203 ***	-0.105	0.225 ***	-0.096
	(10.08)	(0.19)	(8.01)	(-1.60)	(5.25)	(-0.78)
Shock LIQR borrower	0.031	-0.385 ***	0.182 ***	-0.497 ***	0.199 **	-0.770 ***
	(1.13)	(-5.80)	(4.45)	(-3.88)	(2.45)	(-3.74)
Baseline	Yes		Yes		Yes	
constant	-7.429 ***	-7.821 ***	-7.430 ***	-7.829 ***	-7.428 ***	-7.831 ***
	(-69.76)	(-23.86)	(-69.77)	(-23.89)	(-69.76)	(-23.90)
Obs	2981661	1421140	2981661	1421140	2981661	1421140
Pseudo R-squared	0.760	-	0.760	-	0.760	-
R-squared overall	-	0.35340	-	0.35347	-	0.35352
R-squared between	-	0.35844	-	0.35856	-	0.35858
R-squared within	-	0.50297	-	0.50299	-	0.50300

This table shows the estimation results of the baseline Heckman Two-Step Correction Model a creditor and borrower specific idiosyncratic shock variable. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and C). For the the right hand side variables (RHS) we use all variables of the baseline regression model augmented by the idiosyncratic shock variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A3 CONTINUED

PANEL C	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	seven decile change		eight decile change		nine decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.216 ***	-0.085 ***	-0.216 ***	-0.085 ***	-0.216 ***	-0.085 ***
	(-37.78)	(-6.29)	(-37.78)	(-6.31)	(-37.78)	(-6.32)
Shock LIQR creditor	0.031	-0.295	0.020	-0.211	-0.431	0.073
	(0.39)	(-1.41)	(0.15)	(-0.66)	(-1.62)	(0.20)
Shock LIQR borrower	0.369 **	-0.920 **	0.927 ***	0.876 *	1.091 ***	1.548 ***
	(2.49)	(-2.26)	(4.26)	(1.87)	(3.88)	(4.43)
Baseline	Yes		Yes		Yes	
constant	-7.426 ***	-7.838 ***	-7.427 ***	-7.843 ***	-7.425 ***	-7.845 ***
	(-69.77)	(-23.92)	(-69.80)	(-23.94)	(-69.73)	(-23.94)
Obs	2981661	1421140	2981661	1421140	2981661	1421140
Pseudo R-squared	0.760	-	0.760	-	0.760	-
R-squared overall	-	0.35354	-	0.35353	-	0.35353
R-squared between	-	0.35866	-	0.35865	-	0.35866
R-squared within	-	0.50300	-	0.50299	-	0.50299

This table shows the estimation results of the baseline Heckman Two-Step Correction Model a creditor and borrower specific idiosyncratic shock variable. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,…, 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and C). For the the right hand side variables (RHS) we use all variables of the baseline regression model augmented by the idiosyncratic shock variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A4 IDIOSYNCRATIC Z-SCORE SHOCKS

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	one decile change		two decile change		three decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Crisis	-0.162 ***	-0.039 ***	-0.159 ***	-0.037 **	-0.159 ***	-0.037 **
	(-26.16)	(-2.61)	(-25.79)	(-2.47)	(-25.77)	(-2.48)
Shock Z-score creditor	0.013 **	0.004	0.078 *	0.044	0.298 ***	0.668 **
	(2.20)	(0.33)	(1.92)	(0.32)	(3.07)	(2.36)
Shock Z-score borrower	0.053 ***	0.086 ***	0.242 ***	0.122 *	0.046	-0.282 **
	(9.71)	(7.70)	(8.21)	(1.75)	(0.88)	(-2.41)
Baseline	Yes		Yes		Yes	
constant	-7.667 ***	-8.011 ***	-7.662 ***	-8.020 ***	-7.663 ***	-8.015 ***
	(-65.26)	(-23.58)	(-65.22)	(-23.61)	(-65.25)	(-23.60)
Obs	2,496,756	1,188,579	2,496,756	1,188,579	2,496,756	1,188,579
Pseudo R-squared	0.764	-	0.764	-	0.764	-
R-squared overall	-	0.35099	-	0.35101	-	0.35104
R-squared between	-	0.34961	-	0.34975	-	0.34974
R-squared within	-	0.50052	-	0.50055	-	0.50055

PANEL B	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	four decile change		five decile change		six decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Crisis	-0.159 ***	-0.037 **	-0.159 ***	-0.037 **	-0.159 ***	-0.037 **
	(-25.77)	(-2.48)	(-25.79)	(-2.48)	(-25.78)	(-2.48)
Shock Z-score creditor	0.401 ***	0.335	0.565 ***	0.131	0.839 ***	-0.026
	(2.73)	(0.94)	(2.94)	(0.53)	(3.50)	(-0.09)
Shock Z-score borrower	0.098	-0.342 ***	0.072	-0.321 **	0.069	-0.315 **
	(1.49)	(-2.68)	(1.08)	(-2.55)	(1.04)	(-2.50)
Baseline	Yes		Yes		Yes	
constant	-7.664 ***	-8.019 ***	-7.664 ***	-8.019 ***	-7.662 ***	-8.019 ***
	(-65.26)	(-23.61)	(-65.25)	(-23.61)	(-65.24)	(-23.61)
Obs	2,496,756	1,188,579	2,496,756	1,188,579	2,496,756	1,188,579
Pseudo R-squared	0.764	-	0.764	-	0.764	-
R-squared overall	-	0.35104	-	0.35104	-	0.35104
R-squared between	-	0.34974	-	0.34973	-	0.34973
R-squared within	-	0.50056	-	0.50056	-	0.50056

This table shows the estimation results of the baseline Heckman Two-Step Correction Model a creditor and borrower specific idiosyncratic shock variable. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A and B). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A and B). For the the right hand side variables (RHS) we use all variables of the baseline regression model augmented by the idiosyncratic shock variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A5 IDIOSYNCRATIC PD SHOCKS

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	one decile change		two decile change		three decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Shock PD creditor	0.033 ***	-0.074 ***	0.103 ***	-0.007	0.055 **	-0.030
	(3.07)	(-3.16)	(5.90)	(-0.17)	(2.20)	(-0.46)
Shock PD borrower	0.014 *	-0.065 ***	0.094 ***	-0.038	0.131 ***	0.097 **
	(1.65)	(-3.31)	(6.37)	(-1.35)	(5.88)	(2.32)
Baseline	Yes		Yes		Yes	
constant	-8.967 ***	-6.904 ***	-8.950 ***	-6.867 ***	-8.965 ***	-6.907 ***
	(-44.49)	(-12.15)	(-44.38)	(-12.08)	(-44.48)	(-12.17)
Obs	807480	388437	807480	388437	807480	388437
Pseudo R-squared	0.768	-	0.768	-	0.768	-
R-squared overall	-	0.34000	-	0.33973	-	0.33994
R-squared between	-	0.33615	-	0.33578	-	0.33629
R-squared within	-	0.51617	-	0.51610	-	0.51610

PANEL B	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	four decile change		five decile change		six decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Shock PD creditor	-0.160 ***	-0.037	-0.156 *	-0.288	-0.195 *	-0.275
	(-2.61)	(-0.29)	(-1.74)	(-1.48)	(-1.81)	(-1.20)
Shock PD borrower	0.033	-0.048	-0.114	-0.846 **	0.012	-0.083
	(0.67)	(-0.27)	(-1.61)	(-2.50)	(0.08)	(-0.18)
Baseline	Yes		Yes		Yes	
constant	-8.975 ***	-6.925 ***	-8.970 ***	-6.911 ***	-8.973 ***	-6.930 ***
	(-44.53)	(-12.18)	(-44.50)	(-12.15)	(-44.53)	(-12.19)
Obs	807480	388437	807480	388437	807480	388437
Pseudo R-squared	0.768	-	0.768	-	0.768	-
R-squared overall	-	0.33983	-	0.33981	-	0.33981
R-squared between	-	0.33603	-	0.33594	-	0.33597
R-squared within	-	0.51616	-	0.51617	-	0.51617

This table shows the estimation results of the baseline Heckman Two-Step Correction Model a creditor and borrower specific idiosyncratic shock variable. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and C). For the the right hand side variables (RHS) we use all variables of the baseline regression model augmented by the idiosyncratic shock variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A5 CONTINUED

PANEL C	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	seven decile change		eight decile change		nine decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Shock PD creditor	-0.121	-0.187	0.204	-0.453	0.152	-1.231
	(-0.94)	(-0.51)	(0.86)	(-0.81)	(0.48)	(-1.27)
Shock PD borrower	-0.194	0.109	0.577 **	1.777 ***	1.000 ***	2.658 ***
	(-0.77)	(0.21)	(1.98)	(3.57)	(2.69)	(4.16)
Baseline	Yes		Yes		Yes	
constant	-8.972 ***	-6.931 ***	-8.974 ***	-6.931 ***	-8.975 ***	-6.930 ***
	(-44.52)	(-12.19)	(-44.54)	(-12.19)	(-44.54)	(-12.19)
Obs	807480	388437	807480	388437	807480	388437
Pseudo R-squared	0.768	-	0.768	-	0.768	-
R-squared overall	-	0.33981	-	0.33980	-	0.33981
R-squared between	-	0.33595	-	0.33593	-	0.33594
R-squared within	-	0.51617	-	0.51617	-	0.51617

This table shows the estimation results of the baseline Heckman Two-Step Correction Model a creditor and borrower specific idiosyncratic shock variable. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and C). For the the right hand side variables (RHS) we use all variables of the baseline regression model augmented by the idiosyncratic shock variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A6 IDIOSYNCRATIC PROFITABILITY SHOCKS

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	one decile change		two decile change		three decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Crisis	-0.159 ***	-0.064 ***	-0.161 ***	-0.067 ***	-0.161 ***	-0.067 ***
	(-26.77)	(-4.36)	(-27.22)	(-4.60)	(-27.19)	(-4.59)
Shock ROA(rw) creditor	0.042 ***	0.027 ***	0.022 ***	-0.018	0.024 **	-0.031
	(10.09)	(2.96)	(2.99)	(-1.11)	(2.55)	(-1.35)
Shock ROA(rw) borrower	0.043 ***	0.072 ***	0.044 ***	0.021	0.090 ***	0.081 ***
	(10.09)	(7.96)	(5.75)	(1.30)	(9.73)	(4.07)
Baseline	Yes		Yes		Yes	
constant	-7.700 ***	-8.342 ***	-7.692 ***	-8.340 ***	-7.689 ***	-8.326 ***
	(-66.52)	(-24.72)	(-66.47)	(-24.72)	(-66.44)	(-24.69)
Obs	2,517,087	1,198,084	2,517,087	1,198,084	2,517,087	1,198,084
Pseudo R-squared	0.759	-	0.759	-	0.759	-
R-squared overall	-	0.34995	-	0.35001	-	0.34999
R-squared between	-	0.33696	-	0.33694	-	0.33679
R-squared within	-	0.50094	-	0.50097	-	0.50095

PANEL B	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	four decile change		five decile change		six decile change	
RHS / LHS	Credit relation	Exposure change	Credit relation	Exposure change	Credit relation	Exposure change
Crisis	-0.162 ***	-0.067 ***	-0.162 ***	-0.068 ***	-0.162 ***	-0.069 ***
	(-27.27)	(-4.61)	(-27.33)	(-4.66)	(-27.32)	(-4.74)
Shock ROA(rw) creditor	0.028 **	-0.031	0.063 ***	-0.021	0.006	0.025
	(2.24)	(-1.09)	(3.82)	(-0.49)	(0.25)	(0.35)
Shock ROA(rw) borrower	0.096 ***	0.090 ***	0.123 ***	0.173 ***	0.103 ***	0.235 ***
	(8.30)	(3.84)	(8.33)	(5.07)	(5.55)	(4.71)
Baseline	Yes		Yes		Yes	
constant	-7.686 ***	-8.322 ***	-7.689 ***	-8.312 ***	-7.686 ***	-8.304 ***
	(-66.40)	(-24.69)	(-66.43)	(-24.67)	(-66.42)	(-24.66)
Obs	2,517,087	1,198,084	2,517,087	1,198,084	2,517,087	1,198,084
Pseudo R-squared	0.759	-	0.759	-	0.759	-
R-squared overall	-	0.35002	-	0.35001	-	0.35011
R-squared between	-	0.33676	-	0.33674	-	0.33700
R-squared within	-	0.50096	-	0.50094	-	0.50096

This table shows the estimation results of the baseline Heckman Two-Step Correction Model a creditor and borrower specific idiosyncratic shock variable. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,…, 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and C). For the the right hand side variables (RHS) we use all variables of the baseline regression model augmented by the idiosyncratic shock variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A6 CONTINUED

PANEL C	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	seven decile change		eight decile change		nine decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.162 ***	-0.070 ***	-0.162 ***	-0.071 ***	-0.161 ***	-0.067 ***
	(-27.31)	(-4.79)	(-27.33)	(-4.85)	(-27.20)	(-4.60)
Shock ROA(rw) creditor	0.060 *	0.149	0.052	0.426 **	0.080	0.653 **
	(1.91)	(1.33)	(1.30)	(2.42)	(1.00)	(1.99)
Shock ROA(rw) borrower	0.160 ***	0.435 ***	0.245 ***	1.077 ***	0.174 **	0.103
	(6.09)	(6.24)	(8.19)	(9.76)	(2.10)	(0.27)
Baseline	Yes		Yes		Yes	
constant	-7.686 ***	-8.284 ***	-7.684 ***	-8.263 ***	-7.692 ***	-8.347 ***
	(-66.42)	(-24.62)	(-66.40)	(-24.56)	(-66.48)	(-24.74)
Obs	2,517,087	1,198,084	2,517,087	1,198,084	2,517,087	1,198,084
Pseudo R-squared	0.759	-	0.759	-	0.759	-
R-squared overall	-	0.35013	-	0.35017	-	0.35008
R-squared between	-	0.33698	-	0.33741	-	0.33714
R-squared within	-	0.50094	-	0.50096	-	0.50100

This table shows the estimation results of the baseline Heckman Two-Step Correction Model a creditor and borrower specific idiosyncratic shock variable. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,…, 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and C). For the the right hand side variables (RHS) we use all variables of the baseline regression model augmented by the idiosyncratic shock variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A7 IDIOSYNCRATIC CAPITAL SHOCKS X CRISIS

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	one decile change		two decile change		three decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.173 ***	-0.080 ***	-0.171 ***	-0.096 ***	-0.176 ***	-0.099 ***
	(-29.40)	(-5.62)	(-30.69)	(-6.94)	(-31.85)	(-7.19)
Shock CAPR creditor	0.035 ***	0.032 ***	0.060 ***	0.057 **	0.017	0.039
	(7.90)	(3.34)	(5.98)	(2.57)	(0.92)	(0.90)
Shock CAPR borrower	0.033 ***	0.089 ***	0.015 *	0.082 ***	-0.091 ***	0.118 ***
	(7.70)	(9.68)	(1.77)	(4.07)	(-5.17)	(2.72)
Crisis x shock CAPR creditor	0.017 **	-0.013	-0.088 ***	0.026	-0.025	0.186 ***
	(2.02)	(-0.78)	(-3.84)	(0.56)	(-0.58)	(2.62)
Crisis x shock CAPR borrower	-0.013	-0.048 ***	-0.094 ***	-0.054	-0.010	0.001
	(-1.58)	(-2.71)	(-5.11)	(-1.36)	(-0.29)	(0.02)
Baseline	Yes		Yes		Yes	
constant	-7.731 ***	-8.986 ***	-7.728 ***	-9.012 ***	-7.724 ***	-9.011 ***
	(-66.86)	(-26.83)	(-66.87)	(-26.90)	(-66.85)	(-26.90)
Obs	2,589,854	1,227,972	2,589,854	1,227,972	2,589,854	1,227,972
Pseudo R-squared	0.763	-	0.763	-	0.763	-
R-squared overall	-	0.35102	-	0.35111	-	0.35117
R-squared between	-	0.34545	-	0.34548	-	0.34549
R-squared within	-	0.50090	-	0.50097	-	0.50099

PANEL B	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	four decile change		five decile change		six decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.176 ***	-0.098 ***	0.042	0.214	-0.176 ***	-0.099 ***
	(-31.80)	(-7.13)	(0.59)	(0.85)	(-31.85)	(-7.19)
Shock CAPR creditor	0.088 **	0.147	0.120 *	0.103	0.066	0.473
	(2.30)	(1.31)	(1.90)	(0.39)	(0.74)	(1.43)
Shock CAPR borrower	-0.014	0.200 ***	0.196	-0.071	-0.015	0.287
	(-0.46)	(2.66)	(1.60)	(-0.21)	(-0.20)	(1.00)
Crisis x shock CAPR creditor	-0.080	0.032	-0.762 ***	-1.431 ***	-0.064	-0.302
	(-0.92)	(0.15)	(-6.13)	(-2.72)	(-0.38)	(-0.59)
Crisis x shock CAPR borrower	-0.404 ***	-0.855 ***			-0.762 ***	-1.977 ***
	(-5.09)	(-2.77)			(-5.04)	(-2.94)
Baseline	Yes		Yes		Yes	
constant	-7.724 ***	-8.997 ***	-7.728 ***	-8.991 ***	-7.725 ***	-8.994 ***
	(-66.84)	(-26.86)	(-66.89)	(-26.84)	(-66.86)	(-26.85)
Obs	2,589,854	1,227,972	2,589,854	1,227,972	2,589,854	1,227,972
Pseudo R-squared	0.763	-	0.763	-	0.763	-
R-squared overall	-	0.35112	-	0.35111	-	0.35112
R-squared between	-	0.34548	-	0.34545	-	0.34546
R-squared within	-	0.50097	-	0.50098	-	0.50098

This table shows the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower specific idiosyncratic shock and the "Crisis" variable which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A and B and Column 1 in Panel C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A and B and Column 2 in Panel C). For the the right hand side variables (RHS) we use all variables of the baseline model augmented the interaction term between the idiosyncratic shock and the "Crisis" variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A7 CONTINUED

PANEL C	(1)	(2)
Shock definied as a	seven decile change	
RHS / LHS	Credit-relation	Exposure-change
Crisis	-0.176 ***	-0.099 ***
	(-31.87)	(-7.19)
Shock CAPR creditor	0.047	0.828
	(0.33)	(1.61)
Shock CAPR borrower	-0.520 ***	0.122
	(-3.94)	(0.24)
Crisis x shock CAPR creditor	0.107	-0.621
	(0.52)	(-1.00)
Crisis x shock CAPR borrower	-0.304	-2.084 ***
	(-1.58)	(-2.64)
Baseline	Yes	
constant	-7.724 ***	-8.991 ***
	(-66.85)	(-26.84)
Obs	2,589,854	1,227,972
Pseudo R-squared	0.763	-
R-squared overall	-	0.35112
R-squared between	-	0.34546
R-squared within	-	0.50098

This table shows the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower specific idiosyncratic shock and the "Crisis" variable which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A and B and Column 1 in Panel C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A and B and Column 2 in Panel C). For the the right hand side variables (RHS) we use all variables of the baseline model augmented the interaction term between the idiosyncratic shock and the "Crisis" variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A8 IDIOSYNCRATIC CREDIT QUALITY SHOCKS X CRISIS

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	one decile change		two decile change		three decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.162 ***	-0.050 ***	-0.151 ***	-0.025 *	-0.153 ***	-0.031 **
	(-23.77)	(-3.20)	(-23.85)	(-1.70)	(-24.42)	(-2.06)
Shock NPLR creditor	-0.028 ***	-0.071 ***	-0.029 ***	-0.107 ***	-0.007	-0.081 *
	(-4.97)	(-6.03)	(-2.79)	(-4.13)	(-0.44)	(-1.86)
Shock NPLR borrower	-0.005	-0.022 **	0.097 ***	0.175 ***	0.137 ***	0.227 ***
	(-0.77)	(-1.97)	(8.74)	(7.55)	(6.09)	(5.29)
Crisis x shock NPLR creditor	0.029 ***	0.053 ***	0.002	0.044	-0.087 ***	0.040
	(3.09)	(3.12)	(0.16)	(1.38)	(-3.80)	(0.82)
Crisis x shock NPLR borrower	-0.008	0.023	-0.122 ***	-0.196 ***	-0.131 ***	-0.247 ***
	(-0.86)	(1.43)	(-8.27)	(-6.92)	(-5.06)	(-5.15)
Baseline	Yes		Yes		Yes	
constant	-7.661 ***	-8.033 ***	-7.677 ***	-8.033 ***	-7.672 ***	-8.021 ***
	(-65.21)	(-23.65)	(-65.32)	(-23.65)	(-65.26)	(-23.61)
Obs	2496756	1188579	2496756	1188579	2496756	1188579
Pseudo R-squared	0.764	-	0.764	-	0.764	-
R-squared overall	-	0.35109	-	0.35095	-	0.35097
R-squared between	-	0.34978	-	0.34969	-	0.34966
R-squared within	-	0.50058	-	0.50051	-	0.50052

PANEL B	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	four decile change		five decile change		six decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.151 ***	-0.029 **	-0.155 ***	-0.031 **	-0.159 ***	-0.032 **
	(-24.39)	(-1.97)	(-25.06)	(-2.11)	(-25.72)	(-2.18)
Shock NPLR creditor	0.005	-0.103	0.051 *	-0.088	0.044	-0.082
	(0.20)	(-1.64)	(1.72)	(-1.10)	(1.26)	(-0.89)
Shock NPLR borrower	0.135 ***	0.300 ***	0.070	0.085	0.030	0.091
	(4.86)	(6.15)	(1.19)	(0.79)	(0.46)	(0.74)
Crisis x shock NPLR creditor	-0.089 ***	0.100	-0.117 ***	0.091	-0.024	0.021
	(-2.86)	(1.46)	(-3.08)	(1.06)	(-0.52)	(0.18)
Crisis x shock NPLR borrower	-0.267 ***	-0.410 ***	-0.156 **	-0.247 **	-0.049	-0.389 ***
	(-7.98)	(-7.39)	(-2.49)	(-2.19)	(-0.68)	(-2.84)
Baseline	Yes		Yes		Yes	
constant	-7.669 ***	-8.025 ***	-7.664 ***	-8.024 ***	-7.663 ***	-8.005 ***
	(-65.25)	(-23.61)	(-65.24)	(-23.62)	(-65.20)	(-23.57)
Obs	2496756	1188579	2496756	1188579	2496756	1188579
Pseudo R-squared	0.764	-	0.764	-	0.764	-
R-squared overall	-	0.35093	-	0.35100	-	0.35108
R-squared between	-	0.34955	-	0.34969	-	0.34978
R-squared within	-	0.50053	-	0.50055	-	0.50056

This table shows the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower specific idiosyncratic shock and the "Crisis" variable which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and Panel C). For the the right hand side variables (RHS) we use all variables of the baseline model augmented the interaction term between the idiosyncratic shock and the "Crisis" variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A8 CONTINUED

PANEL C	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	seven decile change		eight decile change		nine decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.158 ***	-0.035 **	-0.158 ***	-0.034 **	-0.159 ***	-0.037 **
	(-25.60)	(-2.37)	(-25.53)	(-2.31)	(-25.78)	(-2.49)
Shock NPLR creditor	0.039	-0.034	0.127 **	-0.029	0.222 **	-0.019
	(0.91)	(-0.33)	(2.34)	(-0.21)	(2.42)	(-0.08)
Shock NPLR borrower	0.174 *	0.064	0.406 ***	0.351 **	0.051	0.080
	(1.81)	(0.39)	(3.32)	(2.16)	(0.21)	(0.32)
Crisis x shock NPLR creditor	-0.030	0.220	-0.243 ***	0.158	-0.112	0.257
	(-0.51)	(1.60)	(-2.85)	(0.87)	(-0.92)	(0.89)
Crisis x shock NPLR borrower	-0.315 ***	-0.601 ***	-0.619 ***	-1.127 ***	-0.532 *	0.100
	(-2.95)	(-3.03)	(-4.58)	(-5.31)	(-1.68)	(0.37)
Baseline	Yes		Yes		Yes	
constant	-7.662 ***	-8.006 ***	-7.660 ***	-7.996 ***	-7.662 ***	-8.016 ***
	(-65.22)	(-23.57)	(-65.19)	(-23.54)	(-65.24)	(-23.60)
Obs	2496756	1188579	2496756	1188579	2496756	1188579
Pseudo R-squared	0.764	-	0.764	-	0.764	-
R-squared overall	-	0.35105	-	0.35105	-	0.35103
R-squared between	-	0.34974	-	0.34974	-	0.34974
R-squared within	-	0.50056	-	0.50056	-	0.50055

This table shows the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower specific idiosyncratic shock and the "Crisis" variable which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and Panel C). For the the right hand side variables (RHS) we use all variables of the baseline model augmented the interaction term between the idiosyncratic shock and the "Crisis" variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A9 IDIOSYNCRATIC LIQUIDITY SHOCKS X CRISIS

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	one decile change		two decile change		three decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.227 ***	-0.079 ***	-0.210 ***	-0.087 ***	-0.214 ***	-0.086 ***
	(-36.34)	(-5.53)	(-35.84)	(-6.33)	(-37.21)	(-6.32)
Shock LIQR creditor	0.036 ***	0.064 ***	0.142 ***	0.053 ***	0.145 ***	0.060 **
	(8.54)	(7.50)	(20.53)	(3.30)	(12.84)	(2.12)
Shock LIQR borrower	-0.065 ***	-0.161 ***	-0.052 ***	-0.201 ***	-0.075 ***	-0.438 ***
	(-11.80)	(-14.76)	(-5.16)	(-9.09)	(-3.94)	(-9.68)
Crisis x shock LIQR creditor	0.017 **	-0.092 ***	-0.083 ***	-0.040	-0.077 ***	-0.060
	(2.17)	(-6.39)	(-6.44)	(-1.62)	(-3.41)	(-1.34)
Crisis x shock LIQR borrower	0.055 ***	0.113 ***	-0.001	0.185 ***	0.065 **	0.328 ***
	(5.86)	(6.60)	(-0.08)	(5.75)	(2.14)	(4.81)
Baseline	Yes		Yes		Yes	
constant	-7.426 ***	-7.848 ***	-7.446 ***	-7.778 ***	-7.429 ***	-7.815 ***
	(-69.75)	(-23.99)	(-69.89)	(-23.74)	(-69.76)	(-23.84)
Obs	2981661	1421140	2981661	1421140	2981661	1421140
Pseudo R-squared	0.760	-	0.760	-	0.760	-
R-squared overall	-	0.35346	-	0.35314	-	0.35333
R-squared between	-	0.35820	-	0.35709	-	0.35823
R-squared within	-	0.50303	-	0.50289	-	0.50296

PANEL B	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	four decile change		five decile change		six decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.215 ***	-0.085 ***	-0.215 ***	-0.086 ***	-0.215 ***	-0.084 ***
	(-37.50)	(-6.24)	(-37.65)	(-6.34)	(-37.66)	(-6.24)
Shock LIQR creditor	0.167 ***	0.040	0.233 ***	-0.155 *	0.280 ***	0.092
	(9.29)	(0.81)	(8.17)	(-1.73)	(5.95)	(0.65)
Shock LIQR borrower	0.032	-0.456 ***	0.162 ***	-0.667 ***	0.366 ***	-0.446 **
	(0.98)	(-5.94)	(3.29)	(-4.94)	(4.09)	(-2.21)
Crisis x shock LIQR creditor	-0.028	-0.113	-0.139 **	0.149	-0.319 ***	-0.786 ***
	(-0.72)	(-1.38)	(-2.27)	(1.26)	(-2.88)	(-2.74)
Crisis x shock LIQR borrower	-0.005	0.245	0.060	0.636 *	-0.733 ***	-1.362 **
	(-0.10)	(1.64)	(0.70)	(1.93)	(-4.08)	(-2.17)
Baseline	Yes		Yes		Yes	
constant	-7.429 ***	-7.819 ***	-7.429 ***	-7.825 ***	-7.429 ***	-7.833 ***
	(-69.76)	(-23.86)	(-69.77)	(-23.88)	(-69.78)	(-23.91)
Obs	2981661	1421140	2981661	1421140	2981661	1421140
Pseudo R-squared	0.760	-	0.760	-	0.760	-
R-squared overall	-	0.35341	-	0.35347	-	0.35352
R-squared between	-	0.35844	-	0.35853	-	0.35858
R-squared within	-	0.50297	-	0.50298	-	0.50300

This table shows the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower specific idiosyncratic shock and the "Crisis" variable which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A and B and Column 1 and 3 in Panel C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A and B and Column 2 and 4 in Panel C). For the the right hand side variables (RHS) we use all variables of the baseline model augmented the interaction term between the idiosyncratic shock and the "Crisis" variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A9 CONTINUED

PANEL C	(1)	(2)	(3)	(4)
Shock definied as a	seven decile change		eight decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.216 ***	-0.085 ***	-0.216 ***	-0.085 ***
	(-37.74)	(-6.25)	(-37.77)	(-6.31)
Shock LIQR creditor	0.128	-0.015	0.033	-0.227
	(1.35)	(-0.06)	(0.23)	(-0.61)
Shock LIQR borrower	0.832 ***	0.138	1.004 ***	1.174 **
	(4.51)	(0.35)	(4.67)	(2.27)
Crisis x shock LIQR creditor	-0.375 **	-0.698	-0.125	0.106
	(-2.19)	(-1.62)	(-0.41)	(0.17)
Crisis x shock LIQR borrower	-1.197 ***	-2.615 ***	-2.083 ***	-1.873 ***
	(-4.17)	(-2.58)	(-4.56)	(-3.03)
Baseline	Yes		Yes	
constant	-7.428 ***	-7.840 ***	-7.428 ***	-7.843 ***
	(-69.80)	(-23.93)	(-69.80)	(-23.94)
Obs	2981661	1421140	2981661	1421140
Pseudo R-squared	0.760	-	0.760	-
R-squared overall	-	0.35354	-	0.35353
R-squared between	-	0.35865	-	0.35865
R-squared within	-	0.50299	-	0.50299

This table shows the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower specific idiosyncratic shock and the "Crisis" variable which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A and B and Column 1 and 3 in Panel C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A and B and Column 2 and 4 in Panel C). For the the right hand side variables (RHS) we use all variables of the baseline model augmented the interaction term between the idiosyncratic shock and the "Crisis" variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A10 IDIOSYNCRATIC Z-SCORE SHOCKS X CRISIS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Shock definied as a	one decile change		two decile change		three decile change		four decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.173 ***	-0.059 ***	-0.162 ***	-0.037 **	-0.159 ***	-0.037 **	-0.159 ***	-0.037 **
	(-27.16)	(-3.89)	(-26.14)	(-2.49)	(-25.77)	(-2.48)	(-25.77)	(-2.48)
Shock Z-score creditor	0.014 *	-0.026	-0.012	0.107	0.358 ***	0.600 *	0.513 ***	0.341
	(1.90)	(-1.60)	(-0.24)	(0.55)	(3.25)	(1.86)	(3.12)	(0.81)
Shock Z-score borrower	0.005	0.017	0.001	0.001	0.054	-0.269 **	0.099	-0.333 ***
	(0.66)	(1.04)	(0.03)	(0.01)	(1.04)	(-2.29)	(1.50)	(-2.61)
Crisis x shock Z-score creditor	-0.004	0.067 ***	0.228 ***	-0.139	-0.274	0.405	-0.477	0.139
	(-0.31)	(2.73)	(2.85)	(-0.51)	(-1.15)	(0.61)	(-1.29)	(0.20)
Crisis x shock Z-score borrower	0.112 ***	0.143 ***	0.670 ***	0.356 **	-0.241	-1.292	-0.030	-1.638
	(10.01)	(6.38)	(10.44)	(2.52)	(-0.61)	(-1.10)	(-0.05)	(-0.69)
Baseline	Yes		Yes		Yes		Yes	
constant	-7.663 ***	-7.993 ***	-7.651 ***	-8.011 ***	-7.663 ***	-8.014 ***	-7.664 ***	-8.018 ***
	(-65.22)	(-23.53)	(-65.12)	(-23.57)	(-65.25)	(-23.59)	(-65.25)	(-23.61)
Obs	2496756	1188579	2496756	1188579	2496756	1188579	2496756	1188579
Pseudo R-squared	0.764	-	0.764	-	0.764	-	0.764	-
R-squared overall	-	0.35093	-	0.35093	-	0.35104	-	0.35104
R-squared between	-	0.34930	-	0.34967	-	0.34974	-	0.34975
R-squared within	-	0.50051	-	0.50052	-	0.50055	-	0.50055

This table shows the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower specific idiosyncratic shock and the "Crisis" variable which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3, 5 and 7). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4, 6 and 8). For the the right hand side variables (RHS) we use all variables of the baseline model augmented the interaction term between the idiosyncratic shock and the "Crisis" variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A11 IDIOSYNCRATIC PROFITABILITY SHOCKS X CRISIS

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	one decile change		two decile change		three decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.164 ***	-0.080 ***	-0.166 ***	-0.078 ***	-0.164 ***	-0.072 ***
	(-26.75)	(-5.39)	(-27.73)	(-5.26)	(-27.43)	(-4.92)
Shock ROA(rw) creditor	0.033 ***	-0.000	0.013	-0.053 ***	0.030 ***	-0.053 *
	(6.68)	(-0.01)	(1.54)	(-2.71)	(2.73)	(-1.93)
Shock ROA(rw) borrower	0.040 ***	0.056 ***	0.009	-0.022	0.050 ***	0.045 *
	(8.27)	(5.13)	(0.94)	(-1.14)	(4.52)	(1.85)
Crisis x shock ROA creditor	0.030 ***	0.079 ***	0.029 *	0.109 ***	-0.018	0.070
	(3.26)	(4.12)	(1.78)	(3.09)	(-0.83)	(1.44)
Crisis x shock ROA borrower	0.010	0.056 ***	0.101 ***	0.118 ***	0.123 ***	0.107 **
	(1.01)	(2.82)	(6.22)	(3.49)	(6.14)	(2.54)
Baseline	Yes		Yes		Yes	
constant	-7.697 ***	-8.319 ***	-7.690 ***	-8.341 ***	-7.689 ***	-8.322 ***
	(-66.48)	(-24.65)	(-66.45)	(-24.73)	(-66.43)	(-24.69)
Obs	2517087	1198084	2517087	1198084	2517087	1198084
Pseudo R-squared	0.759	-	0.759	-	0.759	-
R-squared overall	-	0.34993	-	0.34999	-	0.34998
R-squared between	-	0.33693	-	0.33674	-	0.33650
R-squared within	-	0.50094	-	0.50097	-	0.50095

PANEL B	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	four decile change		five decile change		six decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.164 ***	-0.073 ***	-0.162 ***	-0.071 ***	-0.163 ***	-0.071 ***
	(-27.54)	(-5.01)	(-27.22)	(-4.84)	(-27.38)	(-4.86)
Shock ROA(rw) creditor	0.056 ***	-0.062 *	0.113 ***	-0.108 **	0.102 ***	0.014
	(3.74)	(-1.74)	(5.65)	(-2.06)	(3.58)	(0.14)
Shock ROA(rw) borrower	0.021	0.007	0.079 ***	0.154 ***	-0.026	0.122 *
	(1.43)	(0.24)	(4.05)	(3.96)	(-0.93)	(1.79)
Crisis x shock ROA creditor	-0.083 ***	0.085	-0.142 ***	0.267 ***	-0.223 ***	0.026
	(-2.95)	(1.42)	(-3.97)	(2.79)	(-4.81)	(0.19)
Crisis x shock ROA borrower	0.193 ***	0.207 ***	0.103 ***	0.041	0.239 ***	0.210 **
	(8.10)	(4.36)	(3.46)	(0.55)	(6.42)	(2.15)
Baseline	Yes		Yes		Yes	
constant	-7.686 ***	-8.322 ***	-7.690 ***	-8.307 ***	-7.690 ***	-8.305 ***
	(-66.39)	(-24.70)	(-66.44)	(-24.67)	(-66.44)	(-24.67)
Obs	2517087	1198084	2517087	1198084	2517087	1198084
Pseudo R-squared	0.759	-	0.759	-	0.759	-
R-squared overall	-	0.34999	-	0.35004	-	0.35010
R-squared between	-	0.33634	-	0.33654	-	0.33661
R-squared within	-	0.50097	-	0.50095	-	0.50096

This table shows the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower specific idiosyncratic shock and the "Crisis" variable which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,…, 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and C). For the the right hand side variables (RHS) we use all variables of the baseline model augmented the interaction term between the idiosyncratic shock and the "Crisis" variable. *p<0.10, **p<0.05, ***p<0.01

TABLE 1.A11 CONTINUED

PANEL C	(1)	(2)	(3)	(4)	(5)	(6)
Shock definied as a	seven decile change		eight decile change		nine decile change	
RHS / LHS	Credit-relation	Exposure-change	Credit-relation	Exposure-change	Credit-relation	Exposure-change
Crisis	-0.162 ***	-0.072 ***	-0.163 ***	-0.073 ***	-0.161 ***	-0.067 ***
	(-27.36)	(-4.94)	(-27.48)	(-5.02)	(-27.15)	(-4.61)
Shock ROA(rw) creditor	0.162 ***	0.120	0.163 ***	0.285	0.264 ***	0.300
	(4.30)	(0.89)	(3.21)	(1.28)	(2.90)	(0.71)
Shock ROA(rw) borrower	0.037	0.177 *	0.028	0.315	0.272 ***	0.035
	(0.99)	(1.84)	(0.70)	(1.63)	(2.79)	(0.07)
Crisis x shock ROA creditor	-0.271 ***	0.081	-0.273 ***	0.321	-0.627 ***	1.058
	(-4.08)	(0.34)	(-3.33)	(0.91)	(-3.51)	(1.64)
Crisis x shock ROA borrower	0.272 ***	0.534 ***	0.447 ***	1.325 ***	-0.311 *	0.304
	(5.27)	(3.84)	(7.50)	(5.67)	(-1.67)	(0.42)
Baseline	Yes		Yes		Yes	
constant	-7.688 ***	-8.282 ***	-7.683 ***	-8.246 ***	-7.694 ***	-8.344 ***
	(-66.43)	(-24.62)	(-66.37)	(-24.51)	(-66.50)	(-24.73)
Obs	2517087	1198084	2517087	1198084	2517087	1198084
Pseudo R-squared	0.759	-	0.759	-	0.759	-
R-squared overall	-	0.35012	-	0.35015	-	0.35009
R-squared between	-	0.33663	-	0.33705	-	0.33713
R-squared within	-	0.50095	-	0.50096	-	0.50101

This table shows the estimation results of the baseline Heckman Two-Step Correction Model augmented by an interaction term of a creditor and borrower specific idiosyncratic shock and the "Crisis" variable which is a dummy variable that takes the value one from 2007Q3 onwards and zero otherwise. The shock variable is an alternating dummy variable that takes the value one if there is a bad respectively unfavorable change in the distribution of the underlying shock variable of 1 (2,..., 9) decile(s) from one quarter to another and zero otherwise, whereas we portioned the distribution into 10 equal percentiles. In the first step of the Heckit Model, the left hand side variable (LHS) is "Credit relationship" which is a dummy variable that takes the value one if there is a distinct credit relationship from a creditor bank C to a borrower bank B and zero otherwise (Column 1, 3 and 5 of Panel A, B and C). The LHS variable for the second step is "Exposure change" in log differences (Column 2, 4 and 6 of Panel A, B and C). For the the right hand side variables (RHS) we use all variables of the baseline model augmented the interaction term between the idiosyncratic shock and the "Crisis" variable. *p<0.10, **p<0.05, ***p<0.01

2 Central Bank Funding and Credit Risk-Taking[30]

2.1 Introduction

The broader liquidity support programs, which the European Central Bank (ECB)[31] employed in order to counteract the macroeconomic consequences of the global financial crisis of 2007-2008 and the sovereign debt crisis of 2010-2012, went way beyond the operational scope of classical monetary policy in several directions. For example, the ECB extended the pool of eligible collateral and introduced a full allotment strategy. Most notably, in the framework of its long-term refinancing operations (LTROs), the ECB substantially increased the maturity spectrum of central bank refinancing, providing loans to banks in the euro area with a maturity of 12, 18 and 36 months.[32] These non-standard refinancing operations motivated recent research to revisit the issue of how monetary policy affects bank lending. For example, García- Posada and Marchetti (2016), Carpinelli and Crosignani (2017), Jasova et al. (2018) and Andrade et al. (2019) show that the interventions have been successful in increasing bank lending volumes, thus counteracting contractions in aggregate credit and investment. While the results of these studies are therefore consistent with the finding of the traditional literature on the bank lending channel that lax monetary policy positively affects bank lending volumes (e.g.,

[30] This chapter is based in Bednarek et al. (2020) and Bednarek et al. (2021 A)

[31] Strictly speaking, the Eurosystem—and not the ECB—is responsible for conducting monetary policy in the euro area. In this chapter, however, we use ECB as a synonym for the Eurosystem to avoid confusions with the term European System of Central Banks.

[32] The details on the ECB’s refinancing operations are provided in Section 2.2.

Kashyap and Stein, 2000, Kakes and Sturm, 2002; Gambacorta, 2005; Disyatat, 2011), they neglect the potential adverse impact of the non-standard central bank interventions on financial stability, which can be derived from the literature on the risk-taking channel of monetary policy (Jiménez et al., 2014 and Ioannidou et al., 2015).

More generally, no attention has been devoted to the question of how the ECB's recent monetary policy operations affect the riskiness of bank lending, and to what extent this relationship is conditional on the maturity of central bank refinancing and the characteristics of banks. In this chapter, we address this gap in the literature by examining the effects of the ECB's central bank funds on bank loan supply to borrowers with different ex-ante risk levels. We focus on the effect of the maturity extension and explicitly differentiate between short-term (less than one year) and long-term (more than one year) central bank funding (CBF).

Theoretically, the link between central bank lending and credit risk-taking can work through various channels. Specifically, theory suggests that central bank liquidity injections, in the presence of bank agency problems, can generate adverse risk effects (i) by increasing aggregate liquidity in the banking system and reducing lenders' incentives to monitor their borrowers (Acharya and Naqvi, 2012), and (ii) by reducing interest rates, thereby inducing banks to search for yield (Rajan, 2006). In a frictionless world without uncertainty, short- and long-term liquidity provisions are equivalent in their effects on bank risk-taking because banks can rollover short-term loans indefinitely. However, if future central bank accommodation is uncertain, short-term liquidity exposes banks to rollover risk and, consequently, disciplines bank managers and reduces their risk-taking incentives (Calomiris and Kahn, 1991). Long-term liquidity provisions, in contrast, insulate banks in the long-run from the need to turn to private funding sources and from related rollover risk. We thus expect that the risk-augmenting effects of central bank funding are stronger if central banks provide funding with long-term maturity.

To empirically explore the relationship between the bank-level amounts of central bank funding and credit risk-taking, we employ comprehensive bank-firm-level data based on the German credit register over the period 2009:Q1-2014:Q4. "Although some degree of national differentiation in financial developments is a normal feature of a monetary union, heterogeneity in financial conditions across the euro area ha[d] increased significantly, as some countries ha[d] been affected more substantially by the financial crisis" (ECB, 2012). In this regard, Germany is an ideal laboratory for examining the adverse effects of the expansionary monetary policy operations because the "non-standard measures were taken to support the functioning of the transmission mechanism, by bringing back liquidity to dysfunctional markets. Over time, the ECB's non-standard measures—while being open to banks in all countries—have been used more intensively in the financially troubled countries of the euro area [i.e. Ireland, Greece, Portugal and, subsequently, Spain and Italy]. The cross-country differences in the use of these measures largely reflect heterogeneity in the financial conditions across the euro area and have supported the effective conduct of the single monetary policy".[33] Therefore, in contrast to the recent literature (e.g., García-Posada and Marchetti, 2016; Acharya et al., 2017; Carpinelli and Crosignani, 2017; Jasova et al., 2018; Andrade et al., 2019), our analysis does not evaluate whether the expansionary policies achieved their intended targets in terms of restoring monetary policy transmission overall, and especially in the crisis regions of the euro area; instead, it explores the adverse effects with regard to higher bank risk-taking that they generated for the financial systems in the rest of the euro area which were not "hit by a severe recessions that aggravated problems in public finances and adversely affected banks' balance sheets" (ECB, 2012).

An empirical challenge when examining the effects of central bank funding is that the amounts of CBF on banks' balance sheets are endogenous to banks' lending behavior. We thus pursue an instrumental variable regression to isolate the exogenous component of central bank funding and to identify the effect of CBF on credit risk-taking. Specifically, we employ banks' pre-crisis exposures to industries and countries most affected by the global financial crisis as instruments for CBF. As we will show, both variables are relevant predictors of CBF (because for banks with higher exposures like that the availability of interbank borrowing is limited, which is replaced by central bank funds) and at the same time they are likely to fulfill

[33] See in detail the ECB (2012) monthly bulletin on the "Heterogeneity in euro area financial conditions and policy conditions".

the exclusion restriction. We further, following the standard approach in the credit register literature, restrict our sample to firms with multiple bank relationships and include firm-time fixed effects. Thus, we examine whether a firm which borrows from several banks experiences the highest credit growth from those banks with the most significant amounts of CBF on their balance sheets. Since this comparison is across banks for the same firm, firm-specific demand shocks are absorbed by the firm-time fixed effects and we are able to identify credit supply side effects (Khwaja and Mian, 2008). We also include bank-time fixed effects in our analysis to control for time-varying heterogeneity on the bank-level, such as bank size and general risk-taking incentives (see, e.g., Jiménez et al., 2014).

Our analysis provides four main findings. First, we document that higher central bank funding leads to increased bank loan supply, especially so to ex-ante riskier firms. In economic terms, a 1-pp increase in central bank funding raises banks' quarterly loan growth rate vis-à-vis ex-ante riskier firms (proxied by the interest coverage ratio) by 0.4-0.8 pp, which is 1.5-1.9 pp higher than the corresponding value of credit to safer firms. This is an economically significant effect, since the average credit growth rate in our sample is equal to -2.84%. Second, we show that this effect does not depend on idiosyncratic bank characteristics, such as size, liquidity and capitalization. This finding is important from a policy perspective, since it suggests that the macroprudential surveillance of the banking sector and the choice of macroprudential instruments should not only place a special focus on specific bank types, but it should—instead—take the banking sector as a whole into account in order to minimize the risk-increasing implications of an expansionary monetary policy. Third, we document that especially long-term CBF is associated with an increase in banks' loan supply to ex-ante riskier firms. The attendant coefficient is 30% larger than the corresponding coefficient of total CBF in our benchmark specification, suggesting that the link between the new monetary policy instruments and financial stability risk works through an increase in the maturity of central bank funds, which is one of the main features of the current expansionary monetary policy stance. Finally, we show that the documented shift in bank lending behavior leads to an ex-post deterioration of bank balance sheets (higher non-performing loans and lower capitalization), but also supports the real economy by raising firm-level investments and employment. In this sense, our results are indicative of the typical trade-off of lax monetary policy: the goal of achieving positive real economic outcomes commonly comes at the cost of potentially aggravated financial stability.

Our results contribute to the existing literature in several dimensions. Showing that the post-crisis monetary policy operations increase bank loan supply and economic activity, we add to the literature on the bank lending channel and the real effects of financial intermediation (e.g., Jiménez et al., 2014; Ioannidou et al., 2015; Cingano et al., 2016; Daetz et al., 2017; Acharya et al., 2018; Bentolila et al., 2018). Specifically, we contribute to the literature on the transmission of the ECB's recent monetary policy measures to credit supply (e.g., García-Posada and Marchetti, 2016; Carpinelli and Crosignani, 2017; Jasova et al., 2018; Andrade et al., 2019). As already mentioned, relative to these studies, this chapter does not focus on overall credit supply but mainly on the quality composition of banks' loan portfolios, and explicitly differentiates between different maturities of central bank refinancing. We are thus able to identify the side effects of expansionary monetary policy in terms of risk-taking. In this sense, our study is also related to Todorov (2020), who shows that the ECB's Corporate Sector Purchase Program announcement increased prices, liquidity and debt issuance in the European corporate bond market, especially so for longer-maturity, lower-rated bonds, and for more credit-constrained, lower-rated firms. This chapter also connects to the recent literature investigating the impact of non-conventional US monetary policy, notably of the Federal Reserve's large-scale asset purchase programs, on bank lending volumes and risk (e.g., Di Maggio et al., 2016; Chakraborty et al., 2017; Darmouni and Rodnyansky, 2017; Kandrac and Schlusche, 2017; Kurtzman et al., 2017), which—by construction of those programs—is unable to differentiate between different maturities of central bank funds. We thereby finally add to the literature on the implications of bank funding maturities for the risk-taking incentives of banks (e.g., Calomiris and Kahn, 1991; Diamond and Rajan, 2001; Huang and Ratnovski, 2011; López-Espinosa et al., 2012).

The remainder of this chapter is organized as follows. In Section 2.2, we describe the data and introduce the empirical methodology. The main estimation results are presented in

Section 2.3. In Section 2.4, we examine the effects of the different maturities of central bank funding. Section 2.5 explores the ex-post impact of central bank funding on bank and firm balance sheets. We perform several robustness checks in Section 2.6. Section 2.7 concludes.

2.2 DATA AND METHODOLOGY

2.2.1 THE ECB'S REFINANCING OPERATIONS

In this section, we provide an overview of the ECB's refinancing operations, focusing on the long-term refinancing operations (LTROs), and to what extent they affected the German banking system. Prior to the global financial crisis of 2007-2008, the ECB's longest tender offered was three months. With the onset of the crisis, the ECB expanded the size and the maturity of its refinancing operations. Essentially, there have been three LTROs during our sample period of 2009:Q1 to 2014:Q4. The first LTRO with a maturity of twelve months and an interest rate of only 1% was settled in June 2009. It provided banks with an additional liquidity of 442 billion Euro. Against the backdrop of the European sovereign debt crisis, the ECB further extended the maturity of its refinancing operations. In December 2011, it announced its first LTRO with a three-year maturity and an interest rate of 1% and, in February 2012, it announced a second three-year refinancing operation that provided 800 euro area banks with an additional liquidity of 529.5 billion Euro.[34]

[34] A detailed description of the respective refinancing operation, including the amounts allotted and the number of bidders, can be found on the following ECB website: https://www.ecb.europa.eu/mopo/implement/omo/html/top_history.en.html.

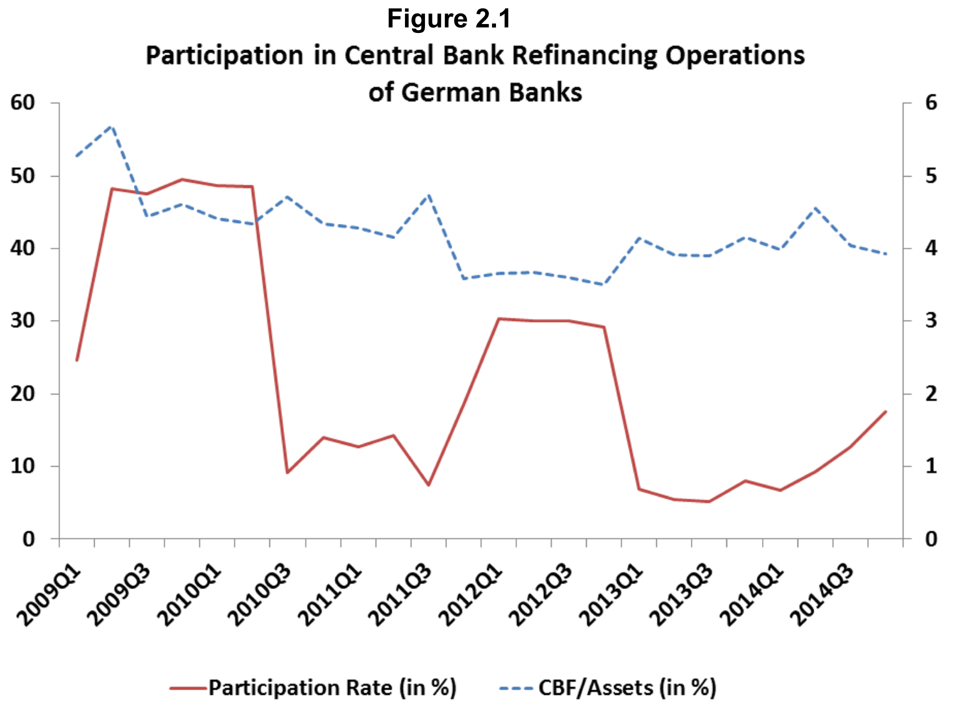


Figure 2.1: This graphs shows the time series evolution of the average share of banks in our sample that participate in the ECB's refinancing operations (left axis) and, within the sample of participating banks, the average share of central bank funding (CBF) in banks' total assets (right axis). The vertical lines display the announcement of long-term refinancing operations by the ECB.

At the time when the first LTRO was settled, the German real economy has already started to recover from the global financial crisis and had an annualized real GDP growth rate of 0.3% in 2009:Q3, which was the first positive value since 2008:Q1. The annualized inflation rate (all items non-food and non-energy) in Germany has also recovered to a value of 1.3%. The following two LTROs were mainly conducted to counteract the real economic implications of the European sovereign debt crisis. As the ECB (2012) states "[…] the refinancing operations, and in particular the three-year LTROs, have supported sovereign bond markets, as some banks decided to use part of the liquidity to buy government bonds". Again, Germany was largely unaffected by this crisis: the average inflation rate over the period 2011:Q4 to 2012:Q1, when the three-year LTROs were announced, was equal to 1.1%; in addition, real GDP growth reached a value of almost 0.7%. These facts suggest that, though the different LTROs were calibrated at the European level to restore monetary policy transmission, to stabilize credit supply and to increase aggregate inflation rates, they were triggered above all by the weak macroeconomic fundamentals in the euro area periphery. Examining the effects of the ECB's refinancing operations on German banks in turn allows us to identify the potential side effects of the new monetary instruments in terms of credit risk-taking.

As can be seen from Figure 2.1, a substantial number of German banks participate in the ECB's refinancing operations: on average, more than 10% of banks in Germany obtain funding from the ECB. Due to the size concentration of the German banking system, these banks account for 63% of the banking system's aggregate total assets. The share of banks obtaining funding from the ECB even increases significantly whenever long-term refinancing operations are in place. For instance, the share of German banks participating in central bank operations is equal to 50% in 2009:Q2, the time when the first LTRO was settled. Figure 2.1 also illustrates that the average share of central bank funding relative to total assets for banks participating in refinancing operations is equal to 4% and remains relatively stable over time, emphasizing the importance of central bank funding for German banks. Nevertheless, in absolute values, CBF was demanded by and allotted largely to banks in the euro area periphery (ECB, 2012).

2.2.2 DATA

We construct a unique bank-to-firm level data set at quarterly frequency, containing information on German bank lending behavior over the period 2009:Q1 to 2014:Q4. The main source of this data set is the Deutsche Bundesbank's credit register that comprises broadly defined bank-firm-level exposures, including traditional loans, bonds, off-balance sheet positions and exposures from derivative positions.[35] Financial institutions in Germany are required to report to the credit register if their exposure to an individual borrower or the sum of exposures to borrowers belonging to one hypothetical borrower unit exceeds a threshold of 1 million Euro.[36] A borrower unit comprises legally and/or economically independent borrowers that are legally and/or economically highly connected to each other, e.g., due to (major) ownership relations (>=50%),

[35] The credit register only contains bonds that do not belong to a bank's trading stock.
[36] Prior to 2014, this threshold was equal to 1.5 million Euro. However, as the actual reporting threshold is distinctly lower (see arguments below), this threshold reduction does not lead to jumps in our credit variable.

profit transfer agreements etc. Consequently, the actual reporting threshold is distinctively lower. On average, the German credit register captures about two thirds of German bank loans.[37]

We supplement this credit registry data with supervisory information on bank balance sheets (e.g., banks' amounts of central bank funding, total assets, profitability, liquid assets, equity and non-performing loans).[38] As Bundesbank data about non-financial borrowers is scarce and limited to general information, such as a company's industrial sector and the location of its head office, we also match firm-level accounting variables to our data set, provided by Bureau van Dijk's Amadeus database. This match is non-trivial because the German credit register and the Amadeus database do not share a common identifier. To match firms from these databases, we rely on the following algorithm. First, we match by the unique commercial register number, when it is available. Second, for observations without this identifier, we rely on Stata's reclink command, a module to probabilistically match records.[39] In this step, we match firms either by their name and zip code or by their name and city with a minimum matching reliability of 0.99. Third, we match firms that are not matched in the first two steps by hand.[40] All in all, we are able to merge the accounting data from Amadeus for almost 60% of the German non-financial firms included in the credit register.

We correct our sample for mergers between banks by creating a new separate bank identifier after the merger takes place. We further exclude non-commercial banks (e.g., investment funds and special purpose banks), as their reaction to the ECB's monetary policy is likely to differ from the behavior of commercial banks. After these adjustments, we obtain a sample of more than 800,000 bank-firm-quarter observations.

[37] Further details on the credit register can be found in Schmieder (2006), Hayden et al. (2007) and Ongena et al. (2012), among others. The Bundesbank also maintains a website with working papers based on its credit register.

[38] We match the end of the quarter values of these variables to the data in the credit register. Two balance sheet items, i.e., non-performing loans and returns on equity, only come at annual frequency.

[39] Blasnik, Michael, (2010), RECLINK: Stata module to probabilistically match records: http://EconPapers.repec.org/RePEc:boc:bocode:s456876.

[40] We matched 4,143 firms by the commercial register number, 23,010 firms by Stata's reclink command and 1,038 firms by hand.

2.2.3 ECONOMETRIC SPECIFICATION

We examine the relationship between central bank funding and credit risk-taking estimating the following model:

$$\Delta\text{Exposure}_{bft} = \alpha_{ft} + \mu CBF_{b,t-1} + \beta\left(CBF_{b,t-1} * Risk_{f,t-1}\right) + \theta X_{b,t-1} + \epsilon_{bft} \qquad (2.1)$$

The dependent variable in equation (1) is the log change in the credit exposure of bank b to firm f between time t-1 and t.[41]

The main regressor is the bank-level share of CBF, defined as central bank funding over total assets. Following the theoretical literature reviewed in the introduction, we further expect the effects of the recent monetary policy operations to be most distinct for long-term central bank funds. We thus also present specifications where we disaggregate total CBF into short-term (maturity of less than one year) and long-term (maturity of at least one year) central bank funds.

In addition, we interact these variables with several firm risk indicators in order to focus on the effects of CBF on credit risk-taking. Our main firm-level risk measure is the interest coverage ratio (EBIT/interest expenses). A higher ratio indicates a better financial health and increases firms' ability to meet interest obligations from operating earnings, thus decreasing firms' probability of default. For instance, in its recent financial stability report, the IMF (2018) argues that interest coverage ratios have a strong monotonic relationship with firm risk and credit ratings. It is therefore widely used as a firm risk proxy in the empirical literature (e.g., Duchin and Sosyura, 2014; Acharya et al., 2017 and te Kaat, 2018). In addition to the interest coverage ratio, we provide robustness tests using the leverage ratio (debt/equity) and firm size (the logarithm of total assets) as further risk variables.[42] Using these variables, we calculate

[41] When these exposures are equal to 0, we also set the corresponding logarithms to 0. Otherwise, we would obtain many missing values (see Jiménez et al., 2014 for a similar strategy).

[42] Furthermore, based on Bednarek et al. (2021 A) we replicate results with the Altman Z-score (Altman, 1968; and Altman et al., 2017) as the main borrower-specific risk measure and the banks' cross-border interbank deposits relative to total assets in 2006 as an instrument for CBF in Tables 2.A.4 to 2.A.7 (consistent with Carpinelli and Crosignani, forthcoming).

firm risk dummies, which are equal to one if a firm's interest coverage or size is lower, and a firm's leverage is higher than the respective median in the same year and industry.[43] [44]

Due to the granularity of the credit register data we exploit, we further restrict our sample to firms with multiple bank relationships and include firm-time fixed effects, α_{ft}. Thus, we examine whether one firm borrowing from several banks experiences the highest credit growth from those banks with the most significant amounts of CBF on their balance sheets. Since this comparison is across banks for the same firm, firm-specific demand shocks are absorbed by the firm-time fixed effects and we are able to identify credit supply side effects (see Khwaja and Mian, 2008).[45]

X includes the following bank-level controls: bank size (the log of total assets), the loan-to-asset ratio, the return on equity, the ratio of liquid assets to total assets, the regulatory capital ratio (regulatory capital to risk-weighted assets) and the share of non-performing loans relative to total loans. The choice of controls is consistent with other studies based on the German credit register (e.g., Behn et al., 2014; Bednarek et al., 2015 and Behn et al., 2016), which find that smaller banks with lower loan-to-asset ratios, less (regulatory) capital and less non-performing loans increase their lending most significantly.

These bank covariates, however, only control for observable heterogeneity across banks. In order to control for unobservable time-varying heterogeneity on the bank-level, e.g., banks' general risk-taking sensitivity, our benchmark specification replaces the set of bank-level controls with bank-time fixed effects (α_{bt}), following Jiménez et al. (2014) and Behn et al. (2016), among others. The regression equation is then specified as follows:

$$\Delta \text{Exposure}_{bft} = \alpha_{ft} + \alpha_{bt} + \psi\left(CBF_{b,t-1} * Risk_{f,t-1}\right) + \epsilon_{bft} \qquad (2.2)$$

[43] Our results are robust to alternative thresholds, e.g., if we define firms in the top 10% of the respective risk distribution risky.

[44] We use firm risk dummies instead of the continuous variables because the latter have significant standard deviations and can take extreme values so that our analysis would be affected by outliers (IMF, 2018).

[45] We can employ this identification strategy because 92% of firms in the German credit register borrow from more than one bank. Our results are broadly independent of controlling for loan demand by including firm-year or firm-quarter fixed effects, respectively.

The bank-time fixed effects absorb the overall effect of central bank funding (μ), but still allow an estimate of the interaction between bank-level CBF and the risk characteristics of borrowing firms.[46]

2.2.4 IDENTIFICATION VIA INSTRUMENTAL VARIABLES

As banks simultaneously decide on lending volumes and funding modes, CBF is not exogenous with respect to bank lending behavior. We thus pursue an instrumental variable regression to isolate the exogenous component of central bank funding and to establish causation from CBF to credit risk-taking. We select suitable instruments for CBF based on the literature on the dynamics of banks' interbank exposures, which argues that, especially during episodes of financial distress, the availability and the costs of interbank borrowing are sensitive to banks' asset quality. More specifically, banks with lower and more volatile asset quality receive less interbank credit and experience higher interest rate spreads (e.g., Afonso et al., 2011; Angelini et al., 2011 and Bednarek et al., 2015). They thus replace private interbank funding with central bank loans.

Following this literature, we solve the endogeneity issue by instrumenting banks' CBF volumes by a proxy for asset quality—banks' 2006 exposures to the manufacturing, agriculture and mining industry normalized by banks' total credit exposures.[47] As can be seen from Figure 2.A.1 of the Appendix, these industries were most adversely affected by the global financial crisis, i.e., they experienced the most significant drop in value added after 2008. In addition, the value added growth rates of these industries during and in the aftermath of the global financial crisis are clearly characterized by higher volatility than the growth rates of other industries.[48] Therefore, banks with a high exposure to these industries experience a significant

[46] In all of our regressions, the standard errors are clustered at the bank-firm level to allow the observations to be correlated within bank-firm relationships.

[47] The results are robust to measuring banks' industry exposures for alternative pre-crisis years. Moreover, results are robust to taking the banks' pre-crisis share of cross-border interbank borrowing as an instrument for CBF, also (consistent with Carpinelli and Crosignani, forthcoming).

[48] As the manufacturing, agriculture and mining sector is more open to international trade, this evidence is consistent with di Giovanni and Levchenko (2009), who show that export dependent industries are more volatile.

deterioration in (and heightened uncertainty regarding) their asset quality, which is likely to restrain their access to private funds and increases the incentives to use CBF.

Although we explore the effects of CBF on bank lending behavior over the 2009-2014 period, we measure banks' exposures to the manufacturing, agriculture and mining industry time-invariantly for the year 2006. This is beneficial for at least two reasons. First, we thereby mitigate concerns related to reverse causality. Second, it strengthens the exclusion restriction of the IV regressions, since banks' asset quality in 2006 is less likely to have a direct effect on bank lending between 2009 and 2014.

However, in the presence of relationship lending, bank-firm exposures are very persistent and, consequently, the exclusion restriction could be violated despite the time lag. For instance, relationship lending implies that banks over the 2009-2014 period might roll over credit to firms in the manufacturing, agriculture and mining industry that they also maintained a credit relationship with in 2006, in which case our instrument would have a direct effect on the dependent variable, and not only via higher central bank funding. In order to confirm the validity of the exclusion restriction, we also present a specification that abstracts from relationship lending by restricting the sample to new bank-firm relationships, i.e., relationships that did not exist prior to 2009.

Table 2.A.1 shows the estimates of the first-stage regression of CBF on the aforementioned instrument. The attendant results indicate that the pre-crisis exposures to the manufacturing, agriculture and mining industry are valid instruments for central bank funding, that is, the first-stage F-statistic testing the hypothesis that the coefficient on the instrument is equal to zero clearly exceeds the threshold of 10. Thus, in addition to the exclusion restriction, the instrument relevance condition is also satisfied in our analysis.

In Section 2.4, we disaggregate total CBF into short-term and long-term central bank funds. For this purpose, we instrument short-term CBF by the aforementioned variable, i.e. the banks' 2006 exposures to the manufacturing, agriculture and mining industry. As previously shown, these industries have the most volatile value added growth rates and, consequently, experience the most significant boom-bust episodes, also during the 2009-2014 period. This implies that banks with a high exposure to these industries demand predominantly short-term CBF, instead of long-term CBF, because the deterioration in asset quality—and hence the difficulties of accessing private funding sources—are only temporary as opposed to permanently.[49] In addition, we use banks' pre-crisis GIIPS exposures (again scaled by banks' total credit exposure) as instruments for long-term CBF. In contrast to exposures to the manufacturing, agriculture and mining industry, which only signal temporary reductions in banks' asset quality, GIIPS exposures signal persistently lower asset quality and potentially limited access to private funding sources because the economic decline in these countries did not abate until 2014.[50] Due to this persistent deterioration in asset quality, these banks are more likely to replace private funding sources with long-term refinancing from the central bank. This conjecture is corroborated in column (3) of Appendix Table 2.A.1: GIIPS exposures are indeed a strong predictor of long-term CBF, with a first-stage F-statistic well above 10.[51]

2.2.5 Summary Statistics

Table 2.1 presents the definitions and descriptive statistics for the variables employed in our analysis. On average, German banks reduce their loan supply vis-à-vis German firms, indicated by the negative average growth rate of bank loan exposures (-2.84%). However, the 5th and 95th percentile of the distribution point to significant differences across bank-firm relationships. The average amount of CBF relative to total assets is equal to 1.19%.[52] Yet, there are also several banks with substantial amounts of total CBF exceeding six percent of their total assets. For these banks, the relevance of long-term CBF is higher than the one of short-term CBF (3.99% vs 3.26%). Table 2.1 also shows that there is a large cross-bank variation in the

[49] This result is broadly consistent with Craig and Dinger (2014), who show that banks with higher loan volatility (e.g., due to increased exposures to volatile industries) in general prefer short-term over long-term funding in order to being able to adjust their liability side more quickly to changes on the asset side.

[50] One could argue that banks with higher GIIPS exposures are generally more prone to excessive risk-taking, thus violating the exclusion restriction of our instrument. However, our results are qualitatively unchanged if we scale GIIPS exposures by banks' total exposure to emerging market economies. Since, in this case, GIIPS exposures are scaled by another variable that potentially captures an increased risk-taking sensitivity, we are confident that our instrument for long-term CBF (GIIPS exposure/total credit exposure) does not proxy for banks' general sensitivity to excessive risk-taking. The attendant results are available upon request.

[51] In those regressions where we differentiate between short-term and long-term CBF, overidentification is no issue since we use one instrument per regressor.

[52] In contrast to Figure 2.1, this average refers to all banks in the sample, and not just those with positive amounts of central bank refinancing.

exposures (i) to the manufacturing, agriculture and mining industry and (ii) to firms in Greece, Ireland, Italy, Portugal and Spain.

Turning to the set of bank-level controls, Table 2.1 indicates that the average loan-to-asset ratio is equal to 58.5%, the average liquidity ratio is equal to 20.9%, pre-tax operating income over equity has an arithmetic mean of 16.2%, the average regulatory capital ratio is equal to 19.0% and the non-performing loans on average are equal to 3.9%.

Finally, we also report the summary statistics for the firm-level variables. The firm risk dummies have average values close to 0.5, which is a consequence of their definitions. ΔEMPL, ΔK and ΔTFP are firm-level growth in the number of employees, capital stock and total factor productivity. These variables are employed in order to study real effects (see Section 2.5 for further details on their calculation and the empirical identification strategy). Their average values are equal to 4.3%, 14.2% and -0.01%, respectively.

In Table 2.2, we depict the number of banks in our sample, disaggregated into the different banking groups. It shows that, overall, we have more than 1,500 banks in our sample. In addition, most of the sample banks are either cooperative or savings banks. Nevertheless, the largest banks (big/multinational banks, head institutes of cooperative and savings banks, private banks) have the highest representation in our bank-firm-level data because they maintain credit relationships with a larger number of firms.[53]

[53] For further information, see Bundesbank's statistical supplements: https://www.bundesbank.de/en/publications/statistics/statistical- supplements.

Table 2.1: Summary Statistics of the Baseline Variables

	Unit	Observations *bank-time*	*firm-time*	*bank-firm-time*	$5th$	Mean	$95th$	Description
Dependent Variable								
ΔEXPOSURE	%	-	-	839,423	-65.79	-2.84	57.53	The growth rate in credit from bank b to firm f
Bank-Level Variables								
CBF (TOTAL)	%	30,158	-	-	0	1.19	6.23	Central bank funding/total assets
CBF (SHORT)	%	30,158	-	-	0	0.52	3.26	Central bank funding with a maturity of strictly less than one year/total assets
CBF (LONG)	%	30,158	-	-	0	0.67	3.99	Central bank funding with a maturity of at least one year/total assets
EXPOSURE (INDUSTRY)	%	30,158	-	-	0	5.74	16.62	Banks' 2006 exposure to agriculture, manufacturing and mining over total exposure
EXPOSURE (GIIPS)	%	30,158	-	-	0	3.11	11.60	Banks' 2006 exposure to the GIIPS over total exposure
SIZE	ln(x)	30,158	-	-	18.96	20.74	22.98	The logarithm of total assets
LOAN-TO-ASSET	%	30,153	-	-	28.63	58.46	81.20	Total loans to non-banks/total assets
LIQUIDITY	%	30,158	-	-	7.67	20.93	50.36	Liquid Assets/total assets
PROFITABILITY	%	29,432	-	-	2.95	16.19	40.84	Pre-tax operating income/equity
CAPITAL	%	29,309	-	-	11.79	18.96	28.37	Total capital (regulatory)/risk-weighted assets
NPL	%	27,844	-	-	0.44	3.90	8.60	Non-performing loans/total loans
Firm-Level Variables								
RISK (INTEREST)	0/1	-	52,290	-	0	0.50	1	Dummy=1 if EBIT/interest expenses<median in the same industry-year pair
RISK (LEVERAGE)	0/1	-	78,009	-	0	0.49	1	Dummy=1 if debt/equity>median in the same industry-year pair
RISK (SIZE)	0/1	-	86,576	-	0	0.50	1	Dummy=1 if total assets<median in the same industry-year pair
ΔEMPL	%	-	76,601	-	-22.05	4.27	40.55	Growth in the number of employees
ΔK	%	-	83,342	-	-39.59	14.15	87.53	Growth in fixed assets
ΔTFP	%	-	43,242	-	-0.41	-0.01	0.38	TFP growth, obtained by estimating a production function as in Wooldridge (2009)

ΔEXPOSURE is the log difference in credit volumes from bank b to firm f at time t. CBF (total) is the bank-level share of central bank funding in total funding. CBF(short) and CBF (long) are the shares of short-term (<1 year) and long-term (>=1 year) central bank funding over total assets. EXPOSURE(GIIPS) and EXPOSURE (INDUSTRY) are banks' credit exposures to the GIIPS or to the manufacturing, agriculture and mining industry, relative to the total bank exposure. We further add the following bank controls: size (log of total assets), the loan-to-asset ratio, liquid assets over total assets, the return on assets, the regulatory capital-to-asset ratios and non- performing loans over total loans. The 3 firm risk dummies are equal to 1 if a firm's interest coverage or size is lower, and a firm's leverage is higher than the corresponding median in the same year and industry. ΔEMPL, ΔK and ΔTFP are firm-level growth in the number of employees, fixed assets and total factor productivity.

Table 2.2: The Number of Banks and Observations by Banking Group

Bank Type	Number of Banks	Number of Bank-Firm Observations
Big (Multinational) Banks	5	166,816
Head Institutes of Cooperative and Savings Banks	12	156,537
Smaller Private Banks	231	171,449
Savings Banks	434	230,680
Cooperative Banks	904	113,941
Σ	1,586	839,423

2.3 RESULTS

2.3.1 BASELINE RESULTS

In this section, we present the estimation results with regard to the relation between CBF and the volume and riskiness of bank lending. While Table 2.3 depicts the second-stage results of the estimation of equations (1) and (2), the corresponding first-stage estimates are shown in Table 2.A.1 of the Appendix.

Column (1) of Table 2.3 presents the results of a regression of credit growth on the shares of central bank funding (without interacting them with the firm risk dummies). The positive coefficient of CBF indicates that higher amounts of central bank funding lead to increased credit growth rates—a result that has already been established in the extant literature (e.g., Carpinelli and Crosignani, 2017; Andrade et al., 2019). We thus continue focusing on the composition of banks' loan portfolios by interacting CBF with the firm risk dummy presented in Section 2.2 (which defines firms with low EBIT relative to their interest expenses as risky).

Whereas the estimate of CBF is statistically insignificant in column (2), the corresponding interaction term is positive and statistically significant at the 5% level. This result points to the existence of significant risk-taking effects of CBF: additional central bank liquidity does not increase lending to ex-ante safer firms (the estimate of CBF is insignificant and even negative); instead it raises the credit supply to riskier firms. In economic terms, a 1-pp increase in central bank funding raises banks' quarterly loan growth rate vis-à-vis ex-ante riskier firms by 0.56

pp,[54] which is non-trivial given that the average loan growth rate in our sample is equal to -2.84% (see Table 2.1).

[54] This is the sum of the coefficients CBF and CBF $*$ RISK.

Table 2.3: Baseline Results

	no risk interaction	*with risk interaction*	*time-varying instrument*	*new bank-firm relationships*	*benchmark (with bank-time FE)*
	(1)	(2)	(3)	(4)	(5)
	ΔEXPOSURE	ΔEXPOSURE	ΔEXPOSURE	ΔEXPOSURE	ΔEXPOSURE
CBF	0.742***	-0.922	-1.090*	-3.031*	-
	(0.26)	(0.57)	(0.57)	(1.75)	
CBF * RISK	-	1.482**	1.907***	3.449*	1.718**
		(0.70)	(0.67)	(1.94)	(0.75)
SIZE	-0.111***	-0.147***	-0.143***	-0.224***	-
	(0.04)	(0.06)	(0.06)	(0.08)	
LOAN-TO-ASSET	-0.017***	-0.021***	-0.021***	-0.018***	-
	(0.00)	(0.01)	(0.01)	(0.01)	
LIQUIDITY	-0.003	-0.037***	-0.037***	-0.054***	-
	(0.01)	(0.01)	(0.01)	(0.01)	
PROFITABILITY	0.002	-0.003	-0.002	-0.001	-
	(0.01)	(0.01)	(0.01)	(0.01)	
CAPITAL	-0.035***	-0.044***	-0.042***	-0.058***	-
	(0.01)	(0.01)	(0.01)	(0.02)	
NPL	-0.114***	-0.082**	-0.085**	-0.084	-
	(0.03)	(0.04)	(0.04)	(0.05)	
Firm-Time FE	YES	YES	YES	YES	YES
Bank-Time FE	NO	NO	NO	NO	YES
Observations	762,296	449,044	449,044	309,660	468,953
R^2	0.102	0.092	0.092	0.095	0.133

This table shows our baseline specification results. The dependent variable is the log change in the exposure of bank b to firm f at time t. The main regressor is the instrumented amount of central bank funding over total assets (column (1)) and its interaction with a firm risk dummy (equal to one if a firm's interest coverage is below the median in the same year/industry, columns (2)-(5)). In most regressions, we employ banks' 2006 exposure to the manufacturing, agriculture and mining industry as instrument. Only in column (3), we use the interaction of industry exposure and time dummies as the instrument. We add firm-time fixed effects and the following bank controls: size (ln of total assets), the loan-to-asset ratio, liquid assets in total assets, the return on assets, the regulatory capital-to-asset ratios and non-performing loans in total loans. In column (4), we limit the analysis to bank-firm relationships that did not exist prior to 2007. In column (5), we replace the bank controls with bank-time fixed effects. Standard errors are clustered at the bank-firm relationship level and shown in parentheses.

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

Our instrumental variable (the 2006 bank-level exposure to the manufacturing, agriculture and mining industry) is time-invariant although bank-level central bank funding varies over time. An advantage of a time-invariant instrument measured before the sample period is that it mitigates concerns related to reverse causality. Yet, following the methodology proposed in Braggion et al. (2017), we also interact the time-invariant instrument with time dummies in the first stage. This procedure gives us an idea whether the effect of our instrument (i.e., the exposure to the manufacturing, agriculture and mining industry) on central bank funding varies over time and in which years this effect is stronger. Figure 2.A.2 of the Appendix shows the estimated first-stage effects of our instrument on bank-level central bank funding, as well as the corresponding 99% confidence interval. It indicates that the first-stage point estimates are remarkably constant over time and that 2011:Q4 is the only quarter where the effect of our instrument on CBF is statistically insignificant. Thus, banks' exposures to the manufacturing, agriculture and mining industry are significant determinants of CBF during almost all quarters of our sample. The associated second-stage results are shown in column (3) of Table 2.3 and document that our previous estimates are robust to interacting the time-invariant instrument with time dummies. If anything, this procedure increases the economic and statistical significance of the main coefficients. In the remainder of this chapter, we refrain from interacting our instruments with time dummies. The following results are, therefore, rather on the conservative side.

In order for the 2006 exposures to the manufacturing, agriculture and mining industry to be valid instruments, the exclusion restriction must be satisfied. Particularly, the pre-crisis industry exposures should have no direct effect on bank lending during the 2009-2014 period, but only affect it via central bank funding (as a substitute for the restricted access of these banks to private funding). As argued in Section 2.4, this assumption could be violated in the presence of relationship lending, i.e., if banks (in the post-crisis period) roll over credit to firms that they also maintained a credit relationship with in 2006. To abstract from relationship lending and confirm the validity of the exclusion restriction, we next restrict the sample to new bank-firm relationships, that is, that did not exist in the pre-crisis period. Column (4) indicates that

CBF still raises banks' risk-taking incentives, as can be gauged from the statistically significant interaction term. Economically, a 1-pp increase in central bank loans raises the credit growth differential between riskier and safer firms by more than 3.4 pp, validating the identifying assumption of our IV regressions. Across the specifications of columns (1)-(4), we find bank lending to be negatively associated with bank size, liquidity, loan-to-asset ratios, capital ratios and non-performing loans. The sign and magnitude of the attendant coefficients are in line with other studies based on the German credit register (e.g., Behn et al., 2014; Bednarek et al., 2015 and Behn et al., 2016). However, as these bank covariates only control for observable heterogeneity across banks, we next replace the set of bank-level controls with bank-time fixed effects in order to control for both observable and unobservable time-varying heterogeneity on the bank-level. This specification, spelled out in equation (2), constitutes our benchmark regression. The attendant results, reported in column (5), document that the disproportionate effect of CBF on the increased loan supply to ex-ante riskier firms is robust to including bank-time fixed effects (with a t-statistic on the corresponding interaction between CBF and firm risk being equal to 2.29).

Summing up, the results of Section 2.3.1 show that CBF significantly raises the average volume of bank loan supply. This increase in lending is driven by increased loan volumes channeled towards ex-ante riskier firms, highlighting the potential adverse side effects of monetary policy on financial system stability.

2.3.2 ARE THE RESULTS DRIVEN BY CERTAIN TYPES OF BANKS?

In this section, we exploit the cross-sectional dimension of our data by examining whether our baseline results are driven by certain types of banks. The results of this exercise provide us with insights for a better understanding of the transmission channels of monetary policy. The results also derive indications on whether micro- and macroprudential surveillance should monitor certain types of banks more intensively than others in the wake of lax monetary policy.

Following the recent literature on the impact of non-conventional monetary policy in the euro area (e.g., García-Posada and Marchetti, 2016 and Carpinelli and Crosignani, 2017), we examine the interaction of CBF with the following observable bank characteristics: liquidity, capitalization and size. For our analysis of credit risk-taking, the choice of these covariates is also justified by the theoretical literature, which argues that large, poorly capitalized and high-liquidity banks might be more prone to excessive risk-taking. For instance, due to "too-big-to-fail" guarantees, bank investors monitor large banks less intensively than smaller banks, thus raising large banks' incentives to invest in risky projects (Boyd and Gertler, 1993; Stern and Feldman, 2009; Hovakimian et al., 2012; Wheelock and Wilson, 2012 and Kaufman, 2015). In addition, as shown by Hovakimian and Kane (1996), Holmstrom and Tirole (1997) and Duran and Lozano-Vivas (2014), poor bank capitalization is a proxy for excessive risk-shifting incentives, mainly because poorly capitalized banks do not fully internalize their risk of default. Finally, excessive bank risk-taking can also increase in bank liquidity, which shields loan officers from penalties associated with failed investments and, as a consequence, raises their risk-taking incentives (Acharya and Naqvi, 2012).

In order to test whether our baseline results are amplified by these bank characteristics, we interact our main variable of interest, the double interaction between CBF and firm risk, with bank dummies that are equal to one if bank liquidity and capitalization are above the median of the full sample distribution of liquidity ratios and capitalization, respectively, and if bank size is in the top 5% of the full sample distribution of total assets.[55] [56]

Columns (1)-(3) of Table 2.4 indicate that our baseline results are independent of the different bank characteristics, as can be gauged from the statistically significant double interaction CBF*RISK and the insignificant triple interaction between CBF, RISK and the respective bank dummy. These results suggest that our baseline results are not driven by the implications of "too-big-to-fail" implicit bail-out guarantees or by risk-shifting incentives of the banking system, in which cases we should have obtained an overproportional effect for the largest, most

[55] The results are robust to alternative thresholds and to defining the respective thresholds employing the year-by-year distribution of total assets, capitalization and liquidity.

[56] The deviating choice of the threshold for bank size is driven by the fact that the largest 5% of banks (about 60 banks) are overrepresented in our sample in terms of the number of bank-firm observations (see Table 2.2).

weakly capitalized and highest-liquidity banks of our sample. Instead, our results indicate that central bank refinancing induces all types of banks to increase their credit supply towards ex-ante riskier firms (i.e., firms with higher interest expenses), which is consistent with a general "search for yield" behavior of the banking system.

Table 2.4: Exploring the Role of Different Bank Characteristics

	(1) ΔEXPOSURE	(2) ΔEXPOSURE	(3) ΔEXPOSURE
CBF * RISK	1.908**	1.440*	1.320*
	(0.82)	(0.81)	(0.77)
CBF * RISK * LIQUIDITY	-2.285		
	(2.70)		
CBF * RISK * CAPITAL		1.146	
		(2.91)	
CBF * RISK * SIZE			-0.023
			(1.89)
RISK * LIQUIDITY	2.803		
	(2.78)		
RISK * CAPITAL		-1.110	
		(3.39)	
RISK * SIZE			-0.682
			(2.42)
Bank-Time FE	YES	YES	YES
Firm-Time FE	YES	YES	YES
Observations	468,953	449,200	468,953
R^2	0.133	0.129	0.133

The table examines whether our baseline results are amplified by certain bank types. To this end, we interact CBF * RISK sequentially with bank dummies, equal to 1 if bank liquidity and capitalization are above the median of the distribution (columns (1)-(2)), respectively, and if bank size is in the top 5% of the distribution of total assets (column (3)). The dependent variable is the ln change in the exposure of bank b to firm f in quarter t. The key regressor is the instrumented amount of central bank funding over total assets, in its interaction with a firm risk dummy that is equal to 1 if firms' interest coverage is lower than the median in the same year and industry. We employ banks' 2006 exposures to the manufacturing, agriculture and mining industry as instruments. We also include firm-time and bank-time fixed effects. Standard errors clustered at the bank-firm level are reported in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Overall, this evidence is important from a policy perspective, since it suggests that the macroprudential surveillance of the banking sector and the choice of potential macroprudential instruments should not only focus on specific bank types, but it should—instead—take the banking sector as a whole into account in order to minimize the risk-increasing implications of lax monetary policy. Particularly, in the light of our findings, comprehensive macroprudential policy tools, such as dynamic provisioning schemes or a countercyclical capital buffers (CCyB), appear more suitable than instruments that mainly tackle specific institutions or sets of institutions, which, for instance, comprise capital buffers that are calibrated with regard to a bank's systemic significance or other observable bank characteristics.[57]

2.4 LONG-TERM VS SHORT-TERM CENTRAL BANK FUNDS

In Section 2.3, we have established a robust relationship between the bank-level amounts of central bank funding and greater lending to ex-ante risky firms, which is largely independent of the different bank characteristics. In this section, we focus on the extended maturity of CBF as the main feature of the recent ECB's loose monetary policy measures, and examine whether bank risk-taking is predominantly driven by longer-term CBF. Such a finding would be consistent with the theoretical literature, which shows that only short-term funding serves as a disciplining device for bank managers; in contrast, the availability of longer-term funding reduces banks' exposure to rollover risk and increases banks' risk- taking incentives (Calomiris and Kahn, 1991).

To this end, we continue differentiating between short-term central bank funds, with a maturity below one year, and long-term central bank funds, which have a maturity of at least one year. Following the discussion of instruments in Section 2.2.4, we instrument these variables with banks' exposures to (i) the manufacturing, agriculture and mining industry and (ii) Greece, Ireland, Italy, Portugal and Spain.

In column (1) of Table 2.5, we only examine the effect of short-term CBF. The insignificant coefficient corresponding to the interaction between short-term CBF and firm risk indicates that central bank funds with a shorter maturity do not lead to increased credit risk-taking. In contrast, long-term CBF leads to a disproportionate increase in bank lending to ex-ante

[57] An example on the effectiveness in terms of bank credit supply of such a wider reaching macroprudential policy tool is provided in Jiménez et al. (2017), who study the effect of countercyclical bank capital buffers, introduced in Spain in mid-2000 and modified in 2004 (to be consistent with IFRS). One additional advantage of wider reaching macroprudential policy tools, relative to those instruments that mainly tackle specific banks, is that they reduce both the feasibility of regulatory arbitrage and potential distributive effects across banks.

riskier firms (column (2)). This effect is not only statistically, but also economically significant: a 1-pp increase in long-term CBF raises the quarterly growth of banks' credit supply to riskier relative to safer firms by 2.03 pp. Thus, the economic effect is distinctively larger than the corresponding one of total CBF in our benchmark specification. This result is also robust to including short-term and long-term CBF simultaneously (column (3)), suggesting that our baseline results of Section 2.3 are driven by central bank funds with long-term maturity. We therefore document that the link between lax monetary policy and financial stability risk works through an increase in the maturity of central bank funds. This result is consistent with the theoretical literature arguing that agency problems between bank managers and investors are more severe the longer is the maturity of banks' liabilities (Calomiris and Kahn, 1991). It is further in line with recent evidence by Todorov (2020), who shows that the ECB's purchase programme not only loosened credit-constraints for lower-rated firms, but especially so at the long-term end of the maturity spectrum.

Table 2.5: The Different Effects of Long-Term vs Short-Term CBF

	(1) ΔEXPOSURE	(2) ΔEXPOSURE	(3) ΔEXPOSURE
CBF (SHORT) * RISK	1.287		-1.919
	(2.65)		(2.59)
CBF (LONG) * RISK		2.025**	2.216***
		(0.82)	(0.82)
Bank-Time FE	YES	YES	YES
Firm-Time FE	YES	YES	YES
Observations	468,953	468,953	468,953
R^2	0.134	0.133	0.155

This table presents the different effects of short-term (maturity of less than one year) and long- term (maturity exceeding one year) CBF. The dependent variable is the ln change in the exposure of bank b to firm f in quarter t. The key regressor is the instrumented amount of central bank funding in total assets, in its interaction with a firm risk dummy, equal to 1 if a firm's interest coverage is lower than the median in the same year and industry. We use banks' 2006 exposures to the manufacturing, agriculture and mining industry, and GIIPS as instruments. We also add firm-time and bank-time fixed effects. The standard errors are clustered at the bank-firm level and shown in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

2.5 The Ex-Post Effects of Central Bank Refinancing

Previously, we have shown that central bank funds lead to an increased credit supply towards ex-ante riskier firms. This change in credit allocation, however, does not necessarily imply adverse effects on financial system stability and/or the real economy, since (i) a riskier credit allocation of banks does not need to lead to higher ex-post bank risk (ex-ante riskier firms do not need to default ex-post) and (ii) ex-ante riskier firms obtaining the additional credit may increase their investments, employment and total factor productivity, thus contributing to an improvement in economic dynamics and reducing the ex-post riskiness of credit recipients. In Section 2.5, by identifying these ex-post effects of the ECB's post-crisis monetary policy operations at the bank-level (Section 2.5.1) and firm-level (Section 2.5.2), we finally evaluate the impact of monetary policy on financial stability and the real economy.

2.5.1 Bank-Level Effects on Non-Performing Loans and Capitalization

We start investigating whether central bank refinancing also affects the ex-post risk of banks. To this end, we regress two main bank risk variables—the ratio of non-performing loans over total loans and the risk-weighted regulatory capital ratio—on the share of central bank funding over total assets, which again is instrumented by banks' 2006 exposures to the manufacturing, mining and agriculture industry.[58] As can be seen from columns (1)-(2) of Table 2.6, higher CBF leads to an increase in non-performing loans and a decrease in banks' capitalization. These effects are statistically significant and economically relevant: a 1-pp increase in CBF is associated with a 2.7 pp increase in the ratios of non-performing loans (given a mean of 3.9%) and a 1.9 pp decrease in the capital-to-asset ratios (given a mean of 19%). Therefore, we show that central bank refinancing does not only lead to a shift in credit towards ex-ante riskier firms, but that it also spills over to higher ex-post risk of banks, highlighting the financial stability risk arising from the ECB's recent monetary policy measures.

[58] For these regressions, the exclusion restriction of our instrument could be violated, as banks' 2006 exposure to industries most affected by the global financial crisis is likely to have a direct effect on banks' non-performing loans. Yet, all of the following results are robust to plain OLS regressions (results not reported).

Table 2.6: The Ex-Post Effects of CBF

	Bank-Level	*Bank-Level*	*Firm-Level*	*Firm-Level*	*Firm-Level*
	(1)	(2)	(3)	(4)	(5)
	NPL	CAPITAL	ΔEMPL	ΔK	ΔTFP
CBF	2.732**	-1.885*	0.963***	2.538***	0.003
	(1.11)	(1.00)	(0.27)	(0.88)	(0.00)
Time FE	YES	YES	YES	YES	YES
Observations	27,656	29,115	76,601	83,342	43,242

This table examines the ex-post effects of CBF. In column (1)-(2), the dependent variables are banks' non-performing over total loans and the regulatory risk-weighted capital ratio. The main regressor is central bank loans in total assets that is instrumented with banks' 06 exposures to the manufacturing, mining and agriculture sector. In columns (3)-(5), the dependent variables are firms' growth in employment, fixed assets and TFP. The main regressor is the weighted share of central bank loans in total assets of banks which the respective firm borrows from (instrumented as before).All regressions add time fixed effects. The robust standard errors are shown in parenthesis.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

2.5.2 FIRM-LEVEL EFFECTS ON EMPLOYMENT, INVESTMENT AND TFP

After having established that lax monetary policy in the euro area seems to increase financial stability risk, Section 2.5.2 studies the real economic (ex-post) implications of CBF at the firm-level. This is important in order to evaluate whether the ECB's monetary policy was not only successful in boosting the real economy in the crisis-hit regions of Southern Europe, as shown by García-Posada and Marchetti (2016), Carpinelli and Crosignani (2017), Jasova et al. (2018) and Andrade et al. (2019), but also in countries less affected by the global financial and sovereign debt crisis, such as Germany. For this purpose, we employ three key firm-level outcomes. Following Blattner et al. (2018), we make use of the log difference in employment (the number of employees) and fixed assets (as a proxy for capital investments) as the dependent variables. Further, as in Duval et al. (2017) or Doerr (2018), among others, we also calculate firm-level TFP growth, which we obtain by estimating a production function on firm- level data for each industry (2-digit NAICS code) separately, employing the approach of Wooldridge (2009). Specifically, we regress firm-level real value added (in logs) on labor input (log of the real wage bill) and capital input (log of the real book value of fixed assets), where value added and the wage bill are deflated by the two-digit industry price deflators from OECD STAN and the capital stock is deflated by the price of investment goods.[59] We then obtain TFP as the residual from this regression. Afterwards, these firm-level outcome variables are regressed on the predicted, weighted shares of CBF relative to total assets of those banks that the respective firm f borrows from.[60]

Table 2.6 indicates that firms borrowing from banks with higher CBF increase both their employment and investments, as can be gauged from the highly statistically significant coefficients on CBF in columns (3) and (4). In economic terms, a 1-pp increase in the share of CBF of borrowing banks is associated with a 0.96 pp higher firm-level employment growth and a 2.54 pp higher growth in the capital stock. These are also economically significant effects, as the in-sample average employment growth rate is equal to 4.3% and the average growth rate in fixed assets is equal to 14.2%.[61] In contrast, TFP growth is not affected significantly by central bank refinancing (column (5)). Particularly, firms that borrow from banks with higher CBF do not have ex-post higher TFP growth than firms borrowing from banks with lower values of CBF.

These results provide evidence that, even in a country less affected by the financial and sovereign debt crisis, the ECB's monetary policy instruments had a sizable effect on investments and employment. In contrast, despite the positive effect on both firm-level input factors, firms' TFP growth did not increase, which suggests that the effect of CBF on real output growth is likely to manifest only in the short-run. In addition, for proper cost-benefit analysis of the impact of monetary policy in a country less affected by the financial crisis, such as Germany, the positive employment and investment effects should be weighed up against the deterioration of bank balance sheets, as documented in Section 2.5.1, and also take potential spillover effects from the euro area periphery into account.

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[59] All of these variables are winsorized at the 1% level before taking logs.

[60] To obtain those predicted values, we again use banks' 2006 exposure to the manufacturing, mining and agriculture industry. The applied weights are the bank-firm level exposures from the German credit registry.

[61] The high average growth rate in fixed assets can be explained by few outliers. We obtain qualitatively, though economically smaller effects when dropping the top 1%, 5% or 10% of the distribution. The results are readily available upon request.

2.6 Robustness Checks

In this section, we present several robustness checks. Particularly, we estimate our regressions via OLS, drop some type of banks and firms from our sample and employ alternative firm risk proxies.

In the first test, we estimate equation (2) via OLS. As can be seen from Table 2.A.2, higher CBF still raises the loan volumes of ex-ante riskier firms disproportionately more (column (1)). While this effect is statistically significant at the 5% level, the economic magnitude of the OLS coefficient is distinctly smaller than the corresponding effect in our IV estimations. This result suggests that bank-level central bank funding is clearly endogenous to other covariates and, as a consequence, needs instrumentation.

We continue dropping banks from our data set that Bundesbank classifies as big (multinational) banks (see Table 2.2 for the distribution of banks across bank types) because these banks can use funds raised by the parent bank or by branches in other (non-euro area) countries, insulating them to some extent from the effects of monetary policy in the euro area.[62] Column (2) shows that this adjustment does not affect our coefficient estimates either.

As the next step, we drop firms in the manufacturing, agriculture and mining industry from the sample. This is important in order to provide further evidence on the satisfaction of the exclusion restriction in our analysis. Specifically, under the assumption that banks with higher 2006 exposures to the manufacturing, agriculture and mining industry have a general tendency of lending to these three industries, banks' pre-crisis exposures to these industries can have a direct effect on our dependent variable (credit growth) when firms in these industries are included in our sample. As a consequence, dropping firms in these industries allows us to circumvent this concern, and we are able to rule out a direct association between our instrument and the dependent variable. As can be seen from column (3) of Table 2.A.2, even after excluding firms in the manufacturing, agriculture and mining industry, higher CBF is related to increased bank lending to ex-ante riskier firms. Again, the corresponding estimate is

[62] See Table 2.2 (Section 2.2.5) for more information regarding the distribution of banks across distinct banking groups.

not only statistically but also economically significant: a 1-pp increase in CBF raises the quarterly credit growth rates of riskier firms by 2.8 pp more than those of safer firms. We thus provide further evidence for the validity of one of the main identifying assumptions underlying our IV analysis.

Finally, we use alternative proxies for firm risk—firms' leverage ratio and firm size. Firms with higher leverage are more prone to asset substitution, undertaking more projects with a higher incidence to fail (e.g., Ben-Zion and Shalit, 1975; Jensen and Meckling, 1976 and Carling et al., 2007). Also, these firms are more likely to default because of their worse loss-absorbing capacity. Firm size (the logarithm of total assets) has also been shown to be an appropriate firm risk proxy, as larger firms are typically better established and more diversified (Carling et al., 2007 and Paligorova and Santos, 2017). As in our previous regressions, we use these variables to calculate firm risk dummies, which are equal to one if a firm's size is lower, and a firm's leverage is higher than the respective median in the same year and industry. Table 2.A.3 demonstrates that higher CBF is associated with a stronger increase in the credit supply to smaller and highly levered firms. The economic magnitude of these effects is similar to our baseline estimates. Thus, our baseline results are robust to using alternative firm risk variables.

2.7 CONCLUSION

Following the global financial crisis of 2007-2008, central banks around the world have expanded the pool of monetary policy instruments and introduced long-term refinancing operations. For instance, the ECB provided central bank funding with a maturity of three years to banks in the euro area. However, while an extensive strand of the literature examines the effects of these monetary policy operations on the volume of bank lending, their impact on the quality of banks' loan portfolios is to date underexplored in the existing empirical literature.

Using a comprehensive bank-firm-level data set based on the German credit register during 2009:Q1- 2014:Q4, we overcome this gap by examining the link between central bank funding and bank lending to firms with different ex-ante risk. We argue that Germany with its sound financial and economic conditions is an ideal laboratory for this analysis, since the ECB's expansionary monetary policy was conducted "to support the functioning of the transmission mechanism, by bringing back liquidity to dysfunctional markets" (ECB, 2012), we are able to focus on the side effects of the loose monetary policy operations.

Instrumenting banks' central bank funding by their pre-crisis exposures to industries and countries most affected by the global financial and euro area sovereign debt crisis, we find higher central bank funds to increase bank lending to ex-ante riskier firms. We further establish that this effect (i) is driven by the ECB's maturity extensions and (ii) is independent of idiosyncratic bank characteristics, such as size, liquidity or capitalization, so that any macroprudential surveillance of the banking sector and the choice of macroprudential instruments should not only focus on specific bank types, but instead take the banking sector as a whole into account.

Finally, we show that the documented shift in bank lending behavior increases banks' ex-post risks (higher non-performing loans and lower capitalization), but at the same time leads to higher firm-level investments and employment. Therefore, our results highlight the typical trade-off of lax monetary policy that the goal of boosting the real economy commonly comes at the cost of potentially aggravated financial stability.

2.8 APPENDIX

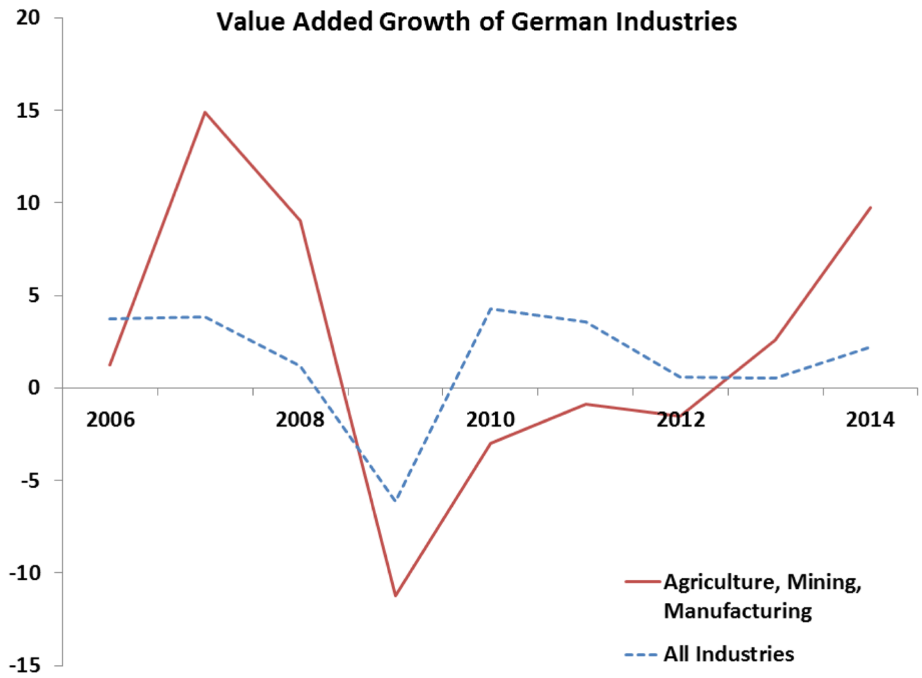

Figure 2.A.1: This graphs shows the time series evolution of the average value added growth (in %) of all industries in Germany, as well as of the agriculture, mining and manufacturing industry only. The data are provided by the OECD.

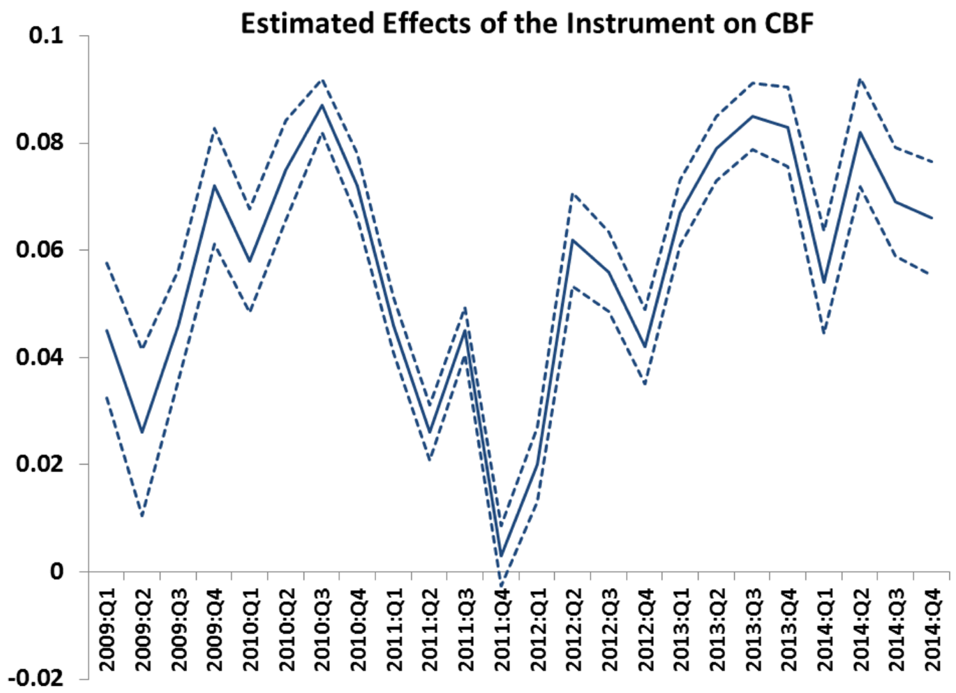

Figure 2.A.2: This graphs shows the time series evolution of the estimated effect of the instrument—banks' 2006 exposures to the agriculture, mining and manufacturing industry—on bank-level central bank funding over total assets, as well as the corresponding 99% confidence interval.

Table 2.A.1: First-Stage Estimates

	(1) CBF (TOTAL)	(2) CBF (SHORT)	(3) CBF (LONG)
EXPOSURE (INDUSTRY)	0.056***	0.021***	-
	(0.00)	(0.00)	
EXPOSURE (GIIPS)	-	-	0.007***
			(0.00)
Bank-Level Controls	YES	YES	YES
Firm-Time FE	YES	YES	YES
Observations	762,296	762,296	762,296
R^2	0.371	0.323	0.328
p (First-Stage F-Statistics)	0.00	0.00	0.00

This table depicts the first-stage estimates of a regression of central bank funding over total assets (also disaggregated into two maturitry bands) on the pre-crisis exposure to the manufacturing, agriculture and mining industries and to GIIPS. We further add firm-time fixed effects and the bank controls of Table 1. The standard errors are shown in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.A.2: Robustness Test (1)

	OLS	*without largest banks*	*without mining, agriculture and manufacturing*
	(1) ΔEXPOSURE	(2) ΔEXPOSURE	(3) ΔEXPOSURE
CBF * RISK	0.180**	1.187*	2.783*
	(0.08)	(0.72)	(1.56)
Bank-Time FE	YES	YES	YES
Firm-Time FE	YES	YES	YES
Observations	468,953	364,488	277,298
R^2	0.134	0.165	0.153

This table presents the outcomes of several robustness checks. In column (1), we run ordinary least squares regressions. Column (2) drops multinational banks from the sample. In column (3), we drop from the analysis firms in the manufacturing, agriculture and mining sector. The dependent variable is the log change in the exposure of bank b to firm f in quarter t. The key regressor is the instrumented amount of central bank funding over total assets in its interaction with a firm risk dummy equal to 1 if a firm's interest coverage is lower than the median in the same year and industry. We employ banks' 06 exposures to the manufacturing, agriculture and mining industry as instruments. We further add firm-time and bank-time fixed effects.Standard errors are shown in parentheses and clustered at the bank-firm level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.A.3: Robustness Test (2)

	(1) ΔEXPOSURE	(2) ΔEXPOSURE
CBF * RISK (LEVERAGE)	1.575**	-
	(0.76)	
CBF * RISK (SIZE)	-	2.680*
		(1.56)
Bank-Time FE	YES	YES
Firm-Time FE	YES	YES
Observations	614,919	601,069
R^2	0.140	0.142

In this robustness test, we use alternative firm risk proxies. Particularly, we define firms risky if their leverage is higher, or their size is smaller than the respective median in the same year /industry. The dependent variable is the log change in the exposure of bank b to firm f at time t. The key regressor is the instrumented amount of central bank funding in total assets, interacted with the aforementioned firm risk dummies. We use banks' 06 exposure to the manufacturing,agriculture and mining industry as instrument for central bank funds. We add firm-time and bank-time fixed effects and the standard errors are reported in parentheses and clustered at the bank-firm level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.A.4: Robustness Test (3)

	benchmark	*new bank-firm relationships*	*time-varying instrument*	*IHS transformed*	*short- vs long-term funds*
	(1)	(2)	(3)	(4)	(5)
	ΔEXPOSURE	ΔEXPOSURE	ΔEXPOSURE	ΔEXPOSURE	ΔEXPOSURE
CBF * RISK	1.785***	1.728**	1.784***	1.873***	-
	(0.67)	(0.86)	(0.67)	(0.70)	
CBF(SHORT) * RISK	-	-	-	-	-9.583**
					(4.54)
CBF(LONG) * RISK	-	-	-	-	7.114**
					(3.14)
Firm-Time FE	YES	YES	YES	YES	YES
Bank-Time FE	YES	YES	YES	YES	YES
Observations	472,920	324,804	472,920	438,472	472,920
First-Stage F-Statistic	42.5	23.8	42.5	44.1	8.1

This table shows our baseline specification results. The dependent variable is the log change in the credit exposure of bank b to firm f at time t. The main regressor is the bank-level share of central bank funding over total assets in its interaction with a firm risk dummy (equal to one if a firm's Z-score is below the median in the same year/industry). We use the interaction between banks' 2006 shares of cross-border interbank deposits to total assets and the firm risk dummy as instrument. We add firm-time and bank-time fixed effects. In column (2), we limit the analysis to bank-firm relationships, which did not exist prior to 2007. Column (3) interacts the shares of cross-border interbank deposits to total assets with time dummies in the first stage. In column (4), the credit volumes are IHS transformed before calculating their first differences. Column (5) distinguishes between short-term (<1 year) and long-term ($>=1$ year) CBF, using short-term and long-term interbank deposits as instrument in the first stage. Standard errors, clustered at the bank-firm level, are shown in parentheses.

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 2.A.5: Robustness Test (4)

	(1) ΔEXPOSURE	(2) ΔEXPOSURE	(3) ΔEXPOSURE
CBF * RISK	1.791**	0.520***	1.808***
	(0.57)	(0.20)	(0.684)
CBF * RISK * LIQUIDITY	3.842		
	(5.80)		
CBF * RISK * CAPITAL		0.358	
		(1.345)	
CBF * RISK * SIZE			1.941
			(6.12)
RISK * LIQUIDITY	-5.801		
	(9.08)		
RISK * CAPITAL		0.698	
		(1.63)	
RISK * SIZE			2.239
			(5.72)
Bank-Time FE	YES	YES	YES
Firm-Time FE	YES	YES	YES
Observations	472,920	452,962	472,920
First-Stage F-Statistic	26.3	120.9	28.0

The table examines whether our baseline results are amplified by certain bank types. To this end, we interact CBF * RISK sequentially with bank dummies, equal to 1 if bank liquidity and bank size are in the lowest 25% of the distribution and if bank capitalization is in the top 25% of the distribution. The dependent variable is the log change in the credit exposure of bank b to firm f in quarter t. We use the interactions between cross-border interbank deposits to total assets, the firm risk dummy and the respective bank characteristic as instrument for the triple interaction. We also include firm-time and bank-time fixed effects. Standard errors, clustered at the bank-firm level, are in parentheses.

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 2.A.6: Robustness Test (5)

	Bank-Level	*Bank-Level*	*Bank-Level*	*Firm-Level*	*Firm-Level*	*Firm-Level*
	(1) NPL	(2) LLP	(3) RISK DEN.	(4) ΔEMPL	(5) ΔK	(6) ΔTFP
CBF	1.009*	0.496**	6.687***	0.009*	0.042**	-0.000
	(0.54)	(0.21)	(2.14)	(0.01)	(0.02)	(0.00)
Bank Controls	YES	YES	YES	-	-	-
Time FE	YES	YES	YES	YES	YES	YES
Industry FE	-	-	-	YES	YES	YES
Observations	27,364	27,364	28,872	72,835	79,056	40,831
First-Stage F-Statistic	8.5	12.7	8.5	-	-	-

The table examines the ex-post effects of CBF. In columns (1)-(3), the dependent variables are banks' non-performing over total loans, loan loss provisions over total loans and risk density (risk-weigthed over total assets). The key regressor is the one-year lag of CBF to assets, instrumented with banks' cross-border interbank deposits in 2006. In columns (4)-(6), the dependent variables are firm growth in employment, fixed assets and TFP. The main regressor in these specifications is the predicted, weighted share of CBF over total assets of banks that a firm borrows from. All estimations add time dummies. Industry fixed effects at the one-letter division level are added to the firm regressions. The bank regressions include the following set of bank controls: size (log of total assets), loans over assets, liquid to total assets, the return on equity, regulatory capital over risk-weighted assets and non-performing loans. The robust standard errors are shown in parenthesis.

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 2.A.7: Robustness Test (6)

	Safer Firms			*Riskier Firms*		
	(1) ΔEMPL	(2) ΔK	(3) ΔTFP	(4) ΔEMPL	(5) ΔK	(6) ΔTFP
CBF	-0.003	0.015	-0.0002*	0.024*	0.051***	0.0002*
	(0.01)	(0.01)	(0.00)	(0.01)	(0.02)	(0.00)
Time FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Observations	23,341	24,654	21,163	22,727	24,649	19,656

In this table, we investigate the ex-post effects of CBF, separately for safer (Z-Score dummy=0) and riskier firms (dummy=1). The dependent variables are firm growth in employment, fixed assets and TFP. The main regressor is the one-year lag of the predicted, weighted shares of CBF to total assets of banks, which a firm borrows from. The regressions include time and industry fixed effects at the one-letter division level. Robust standard errors are shown in parenthesis. * $p<0.10$, ** $p<0.05$, *** $p<0.01$

3 INSTITUTIONAL OWNERSHIP, CORPORATE GOVERNANCE AND PRICE REACTIONS TO CORPORATE INSIDER TRADING[63]

3.1 INTRODUCTION

Trading activity of corporate insiders commands widespread attention in the financial community. Usually insiders possess more information about their company than do outside shareholders, above all small ones. However, what and how much information do insiders convey to the capital market via their trades and how do market participants assess them? In addition, how does a company’s corporate governance affect insiders and market participants and how does one measure the level of corporate governance in the first place? These questions have motivated a growing literature on the relationship between abnormal returns after insider trades and the company's level of corporate governance which could impact the insider's trading credibility. In this regard, the identification and quantification of feasible instruments to measure a company’s corporate governance quality is a difficult task and resulted in a heterogeneous number of governance proxies. Some of those measures are easier to track than others, with institutional ownership being more largely available and feasible to utilize than for instance information on companies' charter or corporate bylaws, e.g. voting rights or management provisions, or even compensation schemes which are available for a limited number of

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[63] This chapter is based on Bednarek (2011) and Bednarek et al. (2016).

top managers only. Hence, one of our main contributions is that in contrast to previous empirical studies that focus on a limited scope of governance measures we analyze how a comprehensive set of different corporate governance facets affect insider trades' information content in a comprehensive framework. That is, motivated by addressing the big issue of endogeneity, we merge the most salient governance measures in literature, namely companies' ownership structure, governance provisions and compensation scheme. In doing so we do not only answer the question what and how much information insiders convey to the capital market via their trades in a more comprehensive manner, but above all we are able to provide evidence on which of those proxies might be the most straightforward and adequate governance measure.

In general, as insiders possess exclusive information about their company it is possible that they gain benefits from their knowledge at the expense of the company's outside shareholders. Therefore insider trading can discourage uninformed outsiders from investing in a company because of the adverse selection problem resulting from information asymmetries and thereby damage the firm value (Manove, 1989; Ausubel, 1990; and Fischer,1992). Likewise, Fried (1998) and Bebchuk et al. (2003) present abnormal trading profits made by corporate insiders as agency costs. Nevertheless, despite the danger of rent extraction, by trading shares of their firm, insiders also communicate signals about the future value of the firm to the market and serve as a proxy for markets' adjustment towards the fundamental firm value. Hence, the main argument in favor of insider trading is that it communicates the insiders' superior information to the capital market and leads to more efficient stock prices (Manne, 1996; Carlton et al., 1983; and Dye, 1984). In support of the informational role of insider trades Leland (1992) shows that when insider trading is allowed share prices are higher and Piotroski et al. (2004) document that insider trading increases the relative amount of firm-specific information incorporated in stock prices. In addition, Aktas (2008) find that price discovery is faster on insider trading days.

Consequently, there are two dimensions of evaluating trades by corporate insiders. First, by looking at insider trading as a channel of rent extraction and second, by considering the information role of insider trades (Fidrmuc et al., 2013). Moreover, it is important to distinguish between buy and sell trades. While an insider purchase conveys positive information about a firm's prospects, because the signal is costly and therefore credible as the insider put her own wealth at stake, it is less clear what information an insider sale conveys. On the one hand, it may convey unfavorable information about the firm's prospects, but on the other hand an insider sale may be less informative if it is made to meet liquidity or diversification needs, especially when managers receive large part of their compensation in equity. The latter effect may soften the negative news conveyed to the market. In a nutshell: 'Insiders have many reasons to sell shares but the main reason to buy shares is to make money' (Lakonishok et al., 2001).

In this context, proper corporate governance can restrain selfish managerial decisions that are detrimental to the firm and an ample body of literature shows that firms benefit from good corporate governance in general. Strong corporate governance has been documented to impact positively on share prices in the long run (Gompers et al., 2003; and Cremers et al., 2005), to decrease agency costs (Shleifer et al., 1997) and to curtail opportunistic insider trading (Fidrmuc et al., 2006; Rozanov, 2008; and Ravina et al., 2010). Hence, it is straightforward to conclude that corporate governance affects the information content of insider trades and their subsequent market reaction, as well. For instance, Fidrmuc et al. (2013) find as insider purchases convey more information to outside shareholders when shareholders are more protected against expropriation that market participants are willing to trade on more firm-specific information because they are protected from insider self-dealing.

Extending the present literature on corporate governance and trading by corporate insiders, we consider three different facets of corporate governance that potentially impact the credibility of insider trades and their subsequent market reaction in one extensive framework. First, we analyze how stock price responses after insider trades depend on firms' institutional investors and the insider's position within the company. As institutional investors can exert direct influence on management's activities through their ownership and indirect influence by their ability to trade shares, they are likely to actively monitor the firm and thereby improve corporate governance. However, Bushee (1998) finds that the strength of this monitoring role which leads to a better governance varies across different types of institutional investors. In this regard we make use of Brian Bushee's classification database to distinguish on the one hand between eight distinct institutional investor types and on the other hand we classify the institutional investors into three groups regarding their investment dedication. Second, we analyze if corporate governance provisions restricting shareholder rights and therefore entrenching the management affect the information content of insider trades. In this regard we make use of the so called Entrenchment Index by Bebchuk et al. (2009). Third, as executive compensation is seen as one of the most important vehicles keeping the interest of companies' executives and shareholders aligned, we use Compustat's ExecuComp as well as Edmans et al. (2009) scaled Wealth-Performance Sensitivity (WPS) Database to check how individual characteristics of insiders like their compensation properties, gender, age, share ownership or non-firm wealth affect the magnitude of the subsequent market reaction to insiders' executed trades. By analyzing those facets our results contribute to the literature as follows. First, as there is still an ongoing debate in the academic literature whether to treat insider trading as rent extraction by insiders or as signals for firm value changes, our results strongly confirm the latter notion. Second, we highlight the view that insider buy and sell trades are not two sides of the same coin. In cases of insider buy trades we see lower abnormal returns for companies with higher levels of corporate governance indicating that insiders do not convey new or credible favorable information to the capital market via their buy trades. It seems to be the case that all positive information are already incorporated into stock prices before the insider trade takes place. As Leuz et al. (2003) suggest, high governance levels may improve financial transparency by mitigating insiders' ability and motivation to distort information disclosures, so that higher information precision and more information incorporated in prices just before insiders' trades, is associated with lower price adjustments following insider transactions. In other words, a better pre-event information environment implies that the incremental information revealed by the trade is smaller and therefore good corporate governance has a negative effect on the market's subsequent reaction to an insider trade. Vice versa, for firms with weaker corporate governance there is likely a greater level of information asymmetry such that an insider trade is more revealing than if there had been little information asymmetry in the first place. However, the opposite is true in the case of sell trades. Insiders of companies with higher levels of corporate governance convey credible bad signals to the capital market when they sell shares. In firms with better corporate governance insiders' actions are more transparent, credible and trustworthy. Sell trades by insiders who consume only small private benefits of control, whose incentives are therefore better aligned with the shareholders', send more credible signals by trading in their firm's stock which cause a larger reaction to insider sell trades. Consequently, as argued in Morck et al. (2000), investors read more into insiders' actions and are more likely to act upon firm specific information, in this case the negative information content of sell trades. Third, we show that institutional ownership even on an aggregate level is a sufficient measure to proxy a company's corporate governance level. Results for institutional investors that because of their investment dedication and type exhibit distinctively higher incentives to enforce proper corporate governance standards show similar outcomes as results for the aggregated level of institutional ownership. Moreover, information on corporate bylaws that make it difficult or expensive for outside investors to effect changes with regard to the top management and board of directors do not provide additional information. Hence, as information on companies' bylaws and on investors' investment dedication and type are scarce, respectively associated with higher costs because one has to gather that information one can refrain from that and instead proxy the governance level with the aggregate measure of institutional ownership.

The remainder of this chapter is organized as follows. Subsection 3.2 develops the hypotheses to be tested. Data and methodology are presented in Section 3.3. Section 3.4 analyzes the empirical results. Finally, we provide in Section 3.5 some robustness checks and discuss the implications of the results and conclude in Section 3.6.

3.2 Corporate Governance Hypotheses

Insiders not only have direct access to restricted information, but they also have different incentives compared to outside investors (Holderness et al., 1988). For insiders, the performance of their shares may be of secondary importance if they derive substantial private benefits of control from their positions in the firm. As Fidrmuc et al. (2006) summarize, these benefits may consists of above market rate salaries, perquisites and prestige or reputation effects as results of other privileges. However, proper corporate governance can restrain wealth extraction and other selfish managerial decisions that are detrimental to the firm and improve the insiders' credibility. Consequently, corporate governance affects both the managers' motives to buy or sell shares of their own company and the market's subsequent reaction.

Therefore, we follow Fidrmuc et al. (2013) and analyze the link between corporate governance and abnormal stock price reactions following insider transactions by differentiating the expected effects to four different hypotheses. In detail, Table 3.1 summarizes the expected effects of abnormal returns as well as abnormal profits following trades by corporate insiders. Generally the hypotheses can be separated into two competing channels defining trades by corporate insiders as either signals for firm value changes or as rent extraction.

Regarding the first channel, i.e. exploring the informational role of insider transactions for market participants, Fidrmuc et al. (2013) propose the following set of opposing hypotheses. They in turn follow Leuz et al. (2003) suggesting that high governance levels may improve financial transparency by mitigating insiders' ability and motivation to distort information disclosures. Hence, higher information precision and more information incorporated in prices just before insiders' trades, is associated with lower price adjustments following insider transactions. In other words, a better pre-event information environment could imply that the incremental information revealed by the trade itself is smaller and therefore good corporate governance has a negative effect on the market's subsequent reaction to an insider trade. Vice versa, for firms with weaker corporate governance there is likely a greater level of information asymmetry such that an insider trade is more revealing than if there had been little information asymmetry in the first place. Therefore, the *Ex-ante Information Hypothesis (H.1)* predicts that strong corporate governance has a negative effect on post-trade abnormal returns with less positive returns after insider purchase and less negative ones after insider sale trades.

On the other hand, standard governance literature predicts that in firms with better corporate governance insiders' actions are more transparent, credible and trustworthy. Trades by insiders who consume only small private benefits of control, whose incentives are therefore better aligned with the shareholders' ones, can send more credible signals by trading in their firm's stock which may cause a larger reaction to insider trades. Consequently, as argued also in Morck et al. (2000), investors read more into insiders' actions and are more likely to act upon firm specific information. Similarly, Bailey et al. (2006) support the contention that market reaction is stronger in better governance systems as there is higher precision in the information disclosed upon trading because of more credible information. They find stronger reactions to earnings announcements after firms cross-list in the U.S. With regard to poorly governed firms, market participants consider insiders' actions as less credible and therefore less precise signals for price discovery. As insiders' actions in firms with better corporate governance are more credible and therefore convey more valuable information to the capital market, prices should adjust more after insider trades in such firms. Accordingly, the *Information Content Hypothesis (H.2)* predicts that strong corporate governance affects market reaction to insider purchases positively. However, the effect for insider sales could be different. Insiders may sell because they possess credible unfavorable information, but at the same time they might also sell because of liquidity and diversification reasons. The latter effect may soften the negative news conveyed to the market. Therefore Fidrmuc et al. (2013) conjecture that liquidity and diversification reasons ought to be more trusted in better corporate governance companies and therefore the mitigating effect is larger and market reaction following insider sales is less negative. In contrast to Fidrmuc et al. (2013), we do not negate the plausible effect of potentially more negative market reactions to insider sell trades of strong corporate governance firms because of more credible unfavorable information.

The second channel approaches insider trading as a mechanism for rent extraction. In this regard, better corporate governance might limit opportunistic trading on non-public information resulting in lower returns following insider trades. This so called *Monitoring Hypothesis (H.3)* predicts a negative relationship between the level of corporate governance and abnormal stock responses as well as insider trading profitability. Vice versa, we expect larger positive abnormal returns after purchase and more negative abnormal returns after sell trades as well as a higher abnormal insider trading profitability in companies with weaker corporate governance.

Alternatively, the *Substitution Hypothesis (H.4)* argues that strong corporate governance cuts insiders' direct private benefits extraction through profit diversion but does not reach as far as limiting insider trading activities. Therefore, insiders, who are not able to benefit from direct profit diversion, engage in profitable insider trading that provides them with an alternative source of wealth extraction. Insiders in weak corporate governance companies have more opportunities to divert corporate profits directly and therefore, in contrast to insiders in strong corporate governance firms, are not motivated that much to engage in profitable insider trading. This is reasonable when one thinks of insiders running relatively high risk of litigation, especially when they sell before important negative news to avoid large losses while incumbent shareholders who do not manage to sell out in time have to suffer share value losses (Brochet, 2010). Accordingly, the *Substitution Hypothesis (H.4)* predicts less positive abnormal returns after purchases and less negative abnormal returns after sales as well as less profitable insider trading in weak corporate governance firms.

After discussing the various channels by which the level of corporate governance might influence the market's perception of insider trades the question remains how to measure the actual quality of the companies' governance structure. The following two subsections summarize the most salient governance proxies and their expected effects on post trade abnormal market movements. In detail, subsection 3.2.1 focuses on a largely available and indirect governance measure, namely institutional ownership, whereas subsection 3.2.2 discusses how insider activities can be affected by the company's charter or corporate bylaws, e.g. anti-take-over provisions, as well as by the insiders' compensation scheme.

TABLE 3.1 HYPOTHESES

		CHANNEL I - INSIDER TRADING AS SIGNALS FOR FIRM VALUE CHANGES		**CHANNEL II** - INSIDER TRADING AS RENT EXTRACTION BY INSIDERS	
PANEL A					
EXPECTED EFFECT OF **ABNORMAL RETURNS** FOLLOWING INSIDER TRANSACTIONS		*H.1* *Ex-ante Information Hypothesis*	*H.2* *Information Content Hypothesis*	*H.3* *Monitoring Hypothesis*	*H.4* *Substitution Hypothesis*
Strong corporate governance	purchase trade	less positive	more positive	less positive	more positive
	sell trade	less negative	more/less negative	less negative	more negative
Weak corporate governance	purchase trade	more positive	less positive	more positive	less positive
	sell trade	more negative	less negative	more negative	less negative
PANEL B					
EXPECTED EFFECT OF **ABNORMAL PROFITS** FOLLOWING INSIDER TRANSACTIONS		*H.1* *Ex-ante Information Hypothesis*	*H.2* *Information Content Hypothesis*	*H.3* *Monitoring Hypothesis*	*H.4* *Substitution Hypothesis*
Strong corporate governance	purchase trade	-	-	less profitable	more profitable
	sell trade	-	-	less profitable	more profitable
Weak corporate governance	purchase trade	-	-	more profitable	less profitable
	sell trade	-	-	more profitable	less profitable

Panel A of this table illustrates the expected effects of abnormal returns following trades by corporate insiders and Panel B the expected effects of abnormal profits. Generally the hypotheses can be separated into two competing channels defining trades by corporate insiders as either signals for firm value changes or as rent extraction. Regarding the first channel, i.e. exploring the informational role of insider transactions for market participants, the *Ex-ante Information Hypothesis (H.1)* predicts that strong corporate governance has a negative effect on post-trade abnormal returns with less positive returns after insider purchase and less negative ones after insider sale trades, because of an improved pre-event information environment . In contrast, the *Information Content Hypothesis (H.2)* predicts that strong corporate governance affects market reaction to insider purchases positively, as investors read more into insiders' actions, because insiders' actions are more transparent, credible and trustworthy. But the effect for insider sales could be ambigious, as insiders may sell because they possess credible unfavorable information, or because of liquidity and diversification reasons. The second channel approaches insider trading as a mechanism for rent extraction. In this regard, better corporate governance might limit opportunistic trading on non-public in-formation resulting in lower returns following insider trades. This so called *Monitoring Hypothesis (H.3)* predicts a negative relationship between the level of corporate governance and abnormal stock responses as well as insider trading profitability. Alternatively, the *Substitution Hypothesis (H.4)* argues that strong corporate governance cuts insiders' direct private benefits extraction through profit diversion but does not reach as far as limiting insider trading activities. Hence, the hypothesis predicts less positive abnormal returns after purchases and less negative abnormal returns after sales as well as less profitable insider trading in weak corporate governance firms.

3.2.1 Institutional Ownership, Investor Dedication and Corporate Governance

Insider activities are not only affected directly by the company's charter or corporate by-laws. Prominently, Fidrmuc et al. (2006) introduced the notion of blockholder monitoring of insider trading. As larger shareholders have greater stakes in the company which give them both stronger incentives to monitor and larger voting power to effectively intervene, these shareholders will monitor the firm more closely (Admati et al.,1994; Maug, 1998; and Fidrmuc et al., 2006).

In this context, an important factor is the role of institutional investors, because they can exert direct influence on management's activities through their ownership and indirect influence by their pronounced ability to trade shares. Furthermore, in many countries like the US institutional investors have become the predominant players in the financial market, and due to the widespread privatization and the development of pension fund systems their ownership and influence is still growing worldwide (Gillan et al., 2003). Consequently, institutional investors can be expected to reduce information asymmetries and to have the potential to play an important role in monitoring the agency problems that exist between shareholders and the companies' management. For instance, Wahal et al. (2000) argue that institutional investors reduce pressures contributing to managerial myopia. In line with that view, Bushee (1998) finds evidence that relative to individual investors, the large stock holdings and sophistication of institutional investors allow them to monitor and discipline managers, ensuring that managers maximize the company's long-term value.

Regarding the market's subsequent price reaction to insider trading there are reasonable arguments for both an increase and a decrease as a consequence of higher levels of institutional ownership, i.e. better corporate governance. For instance, Bailey et al. (2006) and Chung et al. (2010) show that information asymmetries are in general smaller and prices reflect more public information in better corporate governance systems. Chung et al. (2010) show that better corporate governance improves liquidity, and Chung et al. (2010) confirm a positive link between liquidity and market efficiency. Thus, in the presence of higher institutional ownership we may expect a smaller market reaction to insider trading due to higher precision of information about the underlying firm value before insider trading takes place, but also due to better monitoring which curbs profitable insider trading on non-public information. In other words, less information is revealed through the trade itself. Vice versa, in the absence of institutional investors we may expect a bigger market reaction to insider trading. This notion fits to both the *Ex-ante Information Hypothesis (H.1)* and the *Monitoring Hypothesis (H.3)*. Hence, to distinguish between insider trading as a signal for firm value changes or as rent extraction we have to account for the insider trades' abnormal profitability and trading volume.

On the other hand, with better corporate governance, i.e. higher levels of institutional ownership, insider actions are more transparent, credible and trustworthy. Hence, market participants consider insiders' actions as more credible and therefore more precise signals for price discovery. Consistent with this view, Beekes et al. (2006) found that better governed firms made more informative disclosures within Australian firms and DeFond et al. (2007) find that the market's reaction to earnings announcements is generally stronger in better shareholder protection countries. Likewise, in a study of reported insider trades in 15 European countries and the US Fidrmuc et al. (2009) report a stronger reaction to insider purchase trades in countries with better governance institutions. Therefore, regarding our *Information Content Hypothesis (H.2)* we would expect higher abnormal returns subsequent to insider trades in the presence of higher institutional ownership, at least higher abnormal returns subsequent to purchase trades. However, in cases of insider sell trades the opposite could be true as market participants may assess them rather to be executed to meet the insider's liquidity and diversification needs rather than to exploit negative non-public information. In contrast, the *Substitution Hypothesis (H.4)* predicts strictly not only higher positive abnormal returns after insider purchase trades in firms with higher institutional ownership, but also more negative abnormal returns after sale trades as insiders may try to substitute direct private wealth extraction through more profitable insider trading based on non-public information.

However, Bushee (1998) also finds that the institutional investors' activity and the strength of their monitoring role which leads to a better governance may vary across different types of institutional investors. Institutions characterized by high turnover and momentum trading appear to encourage myopic behavior by managers, i.e. maximization of the company's short-term value. In line with that, Holderness et al. (1988) and Franks et al. (2001) show that major shareholders are not homogenous in terms of their monitoring quality, as their ability and incentives to monitor hinge on their type. Therefore, it could be the case that the effect on corporate governance by institutional investor ownership and the subsequent market reaction to insiders trades depends on distinct types of institutional investors and/or their investment dedication, i.e. whether they exhibit stronger preferences for a short- or long-term value maximization strategy.

3.2.2 Anti-takeover Provisions, Executive Compensation and Corporate Governance

In the context of companies' corporate governance level, important factors affecting the entrenchment of managers are corporate bylaws that make it difficult or expensive for outside investors to effect changes with regard to the top management and board of directors. Hence, the existence of such rules enables private benefits of control and leads to less monitoring from other market participants who might otherwise have had an interest to make significant investments and enforce changes in poorly managed firms. For instance, Ravina et al. (2010) provide evidence that governance rules impact the profitability of insider trades where they show that profits of insider trades are larger at firms with weak governance standards. Thus, corporate provisions that provide incumbents with protection from removal or the consequences of removal harm corporate governance. As first stressed by Manne (1965) such insulation might harm shareholders by weakening the disciplinary threat of removal and increases the danger of shirking, empire-building, and an extraction of private benefits like the above mentioned. To proxy the quality of corporate governance and analyze if corporate rules have an effect on the information content of insider trades we use the Entrenchment Index by Bebchuk et al. (2009).

Regarding the market's subsequent price reaction to insider trading there are again reasonable arguments for both an increase and a decrease as a consequence of less entrenching anti-takeover provisions, i.e. better corporate governance. We may expect a smaller market reaction to insider trading due to higher precision of information about the underlying firm value before insider trading takes place which would give support to the *Ex-ante Information Hypothesis (H.1)*, but also to the *Monitoring Hypothesis (H.3)* due to better monitoring which curbs profitable insider trading on non-public information.

However, with better corporate governance insider actions are also more transparent, credible and trustworthy. Hence, market participants could consider insiders' actions as more credible and therefore more precise signals for price discovery, which would support the *Information Content Hypothesis (H.2)*. Nevertheless, it could be also the case that we detect more pronounced abnormal returns after insider trades in companies with high levels of corporate governance because insiders of those companies engage in profitable insider trading that provides them with an alternative source of wealth extraction as they are not able to benefit from direct profit diversion and therefore which would support the *Substitution Hypothesis (H.4)*.

As mentioned above, keeping the interest of companies' executives and shareholder align is one of the key issues in corporate governance. In this context executive compensation is seen as one of the most important vehicles to merge both interests. But the level of compensation, and its components as the extent of pay-to-performance for the companies' executives is a topic of considerable controversy in the academic and public debate, especially as we observe a dramatic growth in compensation levels of large publicly traded companies since the 1980s (Frydman et al., 2010). The evidence regarding the impact of executive compensation on corporate governance and vice versa is quite ambiguous and its implication for the market's assessment of the insiders' transactions, as well. For one, high bonuses and option awards may let executives shift to a short-term value maximizing policy that possibly harm company's long-term performance. In contrast, insider ownership, as long as it is not too high to enable entrenchment, may result in a better alignment of executives' incentives with those of other shareholders (Jensen et al., 1976). Whether and how insider's individual characteristics affect the companies' corporate governance level is a matter of empirical research as one can imagine market reactions subsequent to insider trades of either direction.

3.3 DATA AND METHODOLOGY

3.3.1 DATA

The empirical analysis is based on the Thomson Financial insider trading database. It covers the period from 1992 to 2009 with more than 200,000 insiders of over 21,000 firms listed on US exchange. During this period, our dataset covers nearly 700,000 purchase and more than 1 million sale transactions. Stock and market return data are from CRSP, the number of analyst estimates from IBES and firm characteristics from Compustat.

We use data from 13F filings to account for the insider's position within the company to compute institutional ownership for each firm in a given year. Due to their large investments and their superior information gathering and processing abilities it is more likely that they actively monitor the companies' management and therefore perform an important role as a part of the internal corporate governance mechanism. Nevertheless, some institutions may face competitive pressures for strong short-term performance and/or stringent fiduciary responsibilities that can foster an excessive short-term focus (Bushee, 2001). Accordingly, such institutions are less interested in improving long-term corporate governance. To control for these considerations we make use of Brian Bushee's institutional investor classification data[64] and classify the institutions twofold. First, by their type, i.e. whether the particular institution is a bank trust (BNK), insurance company (INS), investment company (INV), independent investment advisor (IIA), corporate (private) pension fund (CPS), public pension fund (PPS), university and foundation endowment (UFE) or whether it has to be attributed to a miscellaneous

[64] See http://acct3.wharton.upenn.edu/faculty/bushee/IIclass.html

type of institution (MSC)[65]. Second, we classify the institutions into three groups of investment dedication, namely transient (TRA), dedicated (DED) and quasi-indexer (QIX) institutions. Transient institutions (TRA) are characterized as having high portfolio turnover and highly diversified portfolio holdings. They tend to be short-term focused investors whose interest in the firm's stock is focused on gaining short-term trading profits (Porter, 1992). The other two types of institutions classified by Bushee (1998), dedicated and quasi-indexers provide long-term, stable ownership to firms because they are geared toward longer-term dividend income or capital appreciation. Dedicated institutions are characterized by large average investments in portfolio firms and extremely low turnover, consistent with a "relationship investing" role and a commitment to provide long-term patient capital (Porter, 1992; and Dobrzynski, 1993). Quasi-indexers are also characterized by low turnover, but they tend to have diversified holdings, consistent with a passive, buy-and-hold strategy of investing portfolio funds in a broad set of firms (Porter, 1992). Because of the longer investment horizons of these two latter types of institutions, they should be less focused on near-term earnings and should have preferences that are insensitive to the distribution of short-term future value.[66]

As a measure of governance provisions limiting shareholder rights, we use the Entrenchment Index (E-Index) by Bebchuk et al. (2009).[67] The index is based on six governance provisions whereat a company is given a score between zero and six, based on the number of the provisions that the company has in the given year. Of these six provisions, four set constitutional limits on shareholder voting power, which is the primary power shareholders have, namely staggered boards, limits to shareholder amendments of the bylaws, supermajority requirements for mergers, and supermajority requirements for charter amendments. These four arrangements limit the extent to which a majority of shareholders can impose their will on the management. The two other provisions, poison pills and golden parachutes, are the most well-known and salient measures taken in preparation for a hostile offer. More specifically, those

[65] Among this category there are also law firms, individuals acting as institutions, and other miscellaneous institutions that are difficult to classify.
[66] For more details see Bushee (1998).
[67] See http://www.law.harvard.edu/faculty/bebchuk/data.shtml.

six governance provisions of the Entrenchment Index stem from the universe of the 24 governance provisions monitored by the Investor Responsibility Research Center (IRRC) which have been identified to be negatively correlated with firm value, as measured by Tobin's Q, as well as stockholders' return during the decade of the 1990s (Gompers et al., 2003). In this regard Bebchuk et al. (2009) identified a small set of the six company's provisions that both individually and on aggregate, are negatively correlated, monotonic and economically significant, with Tobin's Q. Their results suggest that these provisions used in the Entrenchment Index appear to be largely driving the correlation between the IRRC provisions and Tobin's Q. Hence, to the extent that the 18 provisions of the total 24 governance provisions monitored by the IRRC that are not in the Entrenchment Index represent noise, the Entrenchment index is useful by providing a measure of corporate governance quality that is not affected by the noise created by the inclusion of these other provisions.

In order to investigate the relation of executive compensation and insider trading, we use Compustat's ExecuComp database to control for a range of executives' compensation and characteristic variables. In detail, we analyze six salient compensation measures, namely the executive's total compensation[68], stock compensation[69], other compensation[70], salary, bonus and value of option awards. Regarding option awards we control for the option's sensitivity to a change in the price of the underlying (Delta) and the option's sensitivity of a change in volatility (Vega), as well. Furthermore, we use four more variables to characterize an executive more closely, i.e. the amount of the company's shares she owns, her age, gender and the

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[68] Total compensation for the individual year, comprised of the following: Salary, bonus, perquisites and other personal benefits, above market earnings on restricted stock, options/SARs or deferred compensation paid during the year but deferred by the officer, earnings on long-term incentive plan compensation paid during the year but deferred at the election of the officer, tax reimbursements, the dollar value of difference between the price paid by the officer for company stock and the actual market price of the stock under a stock purchase plan that is not generally available to shareholders or employees of the company (Note: This does not include value realized from exercising stock options), total value of restricted stock granted, total value of stock options granted (using Black-Scholes), long term incentive pay-outs, severance payments, debt forgiveness, imputed interest, payouts for cancellation of stock options, payment for unused vacation, tax reimbursements, signing bonuses, 401K contributions, life insurance premiums.

[69] Stock compensation for the individual year, comprised of the following: Fair value of all stock awards during the year as detailed in the Plan Based Awards whereat valuation is based upon the grant-date fair value as detailed in FAS 123R. Plus the value of restricted stock granted during the year (determined as of the date of the grant). Plus LTIP payments which is the amount paid out to the executive under the company's long-term incentive plan. These plans measure company performance over a period of more than one year (generally three years).

[70] Other compensation received by the executive including perquisites and other personal benefits, termination or change-in-control payments, contributions to defined contribution plans (e.g. 401K plans), life insurance premiums, gross-ups and other tax reimbursements, discounted share purchases etc.

amount of her non-firm wealth[71]. All of these measures of compensation and insider's characteristics may have a different impact on the company's managerial incentives. For instance, high bonuses and option awards may let executives shift to a short-term value maximizing policy that possibly harms the company's long-term performance and the overall level of corporate governance. In contrast, insider ownership, as long as it is not too high to enable entrenchment, may result in a better alignment of executives' incentives with those of other shareholders (Jensen et al.,1976). Finally, we make also use of Edmans et al. (2009) scaled Wealth-Performance Sensitivity (WPS) measure, which is independent of firm size and thus comparable across firms of different size and provides information on the elasticity of the company's market capitalization and the insider's wealth.[72]

3.3.2 METHODOLOGY

When measuring the reactions of share prices to insider trades, the event date can be defined as either the trading day or the reporting day. Both approaches have been used in previous studies. Seyhun (1986) and Friederich et al. (2002) use the trading day as their event day, Fidrmuc et al. (2006) use the reporting date, because in reality it might take a few days to obtain the information of an insider trade. Lakonishok et al. (2001) and Chang et al. (1998) use both approaches. Following Seyhun (1986) and Friederich et al. (2002) we determine the event date which is under scrutiny as the day of the insider's trade itself. The assumption that the information about insider transactions get quickly detected and incorporated into stock prices even without any disclosure is justified by Meulbroek (1992) who reports this happening in cases of illegal insider trading. Even if it is the case that trades are disclosed with a few days' lag, or that they were not detected by the market, this would only lower estimated abnormal returns and thus make our results more conservative.

[71] The estimates of the executive's non-firm wealth are provided by Dittmann and Maug: http://people.few.eur.nl/dittmann/data.htm. For further details see Dittmann et al. (2007).
[72] For further details see Edmans et al. (2009).

We use the Carhart (1997) four-factor model to compute buy and hold abnormal returns over a period of 1 and 6 months subsequent to insider trading. The Carhart four-factor model is the Fama-French three-factor model augmented by the momentum factor.[73] The firms' beta coefficients are estimated using if possible 5 years of monthly stock returns, but at least 24 months, with returns ending one month before the event date.

To examine the relationship between corporate governance and the market's subsequent reaction to insider trading we estimate several distinct fixed-effects regression models that base on the following equation:

$$AR_{ijt} = \alpha + \beta Corporate\ Governance_{it} + \gamma Insider_{jt} + \delta Controls_{it} + \theta Year_t + \epsilon_{ijt} \quad (3.1)$$

where AR applies for the computed abnormal returns of stock i traded by insider j using $t = 1$ and 6 calendar months as time windows, $Corporate\ Governance$ is a vector of the utilized corporate governance proxies at firm-level (institutional ownership, Entrenchment Index), $Insider$ is a vector capturing the insider's position within the company, the insider's trade frequency and trade volume as well as in section 3.4.3 her compensation scheme, age, gender and wealth-performance sensitivity. $Controls$ is a vector of firm and trade control variables[74] and finally $Year$ is a vector of year dummies. Models are estimated with clustered standard errors.

More specifically, as firm control variables we use among others a volatility index, namely the VXO from the Chicago Board Options Exchange (CBOE) which is a measure of implied volatility using 30-day S&P 100 index at-the-money options. In addition, we use a dummy variable which identifies whether trades occurred in a blackout period. In general, blackout periods are time intervals in which companies permit its executives and key employees to trade the firm's stock, e.g. periods prior to releases of financial information. The dummy variable is set

73 See Fama et al. (1993) and Carhart (1997) for more details.
74 We took the logarithm of the control variables and standardized them.

to one if the insider trades occurred within a period of two months preceding an earnings report. For instance, Bettis et al. (2000) found that spread was narrower during the blackout periods and trades conducted during this period were less profitable. Hillier et al. (2002) examined the effect of trading bans imposed by the London Stock Exchange Model Code in which a two month blackout period was in effect prior to a firm's earnings announcements. They found that although the timing of trades was affected, there was no effect on the performance or distribution of these trades. On the Amsterdam Stock Exchange where insiders were not allowed to trade in the two month window before the annual earnings announcement, Kabir et al. (1996) reported a drop in liquidity such that prices adjusted slower to earning news. Betzer et al. (2009) confirmed the need for exchange imposed blackout periods showing that in Germany where no such period exists, trades conducted before an earnings announcement had larger price impacts. Likewise to prior empirical literature we use also standard control variables like the company's book leverage, Tobin's Q, return on equity, market capitalization and the number of analysts covering the stock. The latter also serve as proxies for information asymmetry, e.g. higher information asymmetry is usually associated with smaller firms and companies with lower analyst coverage. Hence, it is appropriate to expect the positive effect of higher corporate governance to be stronger in these companies.

As data for the Entrenchment Index were only available for the years 1990, '93, '95, '98, 2000, '02, '04, '06, '07 and '08 we interpolated the missing data by using the company's last available Entrenchment Index value. Further, we winsorize our Institutional Holdings, ExecuComp and WPS Measure data at the 1 and 99% levels to reduce the effects of possibly spurious outliers.

Finally, to distinguish between our two different sets of hypotheses, we follow Fidrmuc et al. (2013) and compute the insiders' dollar abnormal profits (abnormal returns multiplied by the value of shares traded in USD) and the transaction volume[75] and estimate fixed-effects regression models that base on the following equations:

[75] Trade volume is calculated as follows,

$$AP_{ijt} = \alpha + \beta Corporate\ Governance_{it} + \gamma Insider_{jt} + \delta Controls_{it} + \theta Year_t + \epsilon_{ijt} \quad (3.2)$$

$$Transaction\ volume_{ijt} = \alpha + \beta Corporate\ Governance_{it} + \gamma Insider_{jt} + \delta Controls_{it} + \theta Year_t + \epsilon_{ijt} \quad (3.3)$$

where AP applies for the computed abnormal returns of stock i traded by insider j using $t = 1$ and 6 calendar months as time windows and $Transaction\ volume$ in percentage of the insider's stock wealth. Again, models are estimated with clustered standard errors.

As the first set of hypotheses, namely the *Ex-ante Information (H.1)* and the *Information Content Hypothesis (H.2)*, interprets insider trading as signals for firm value changes we should not detect statistically significant results in the abnormal profit regressions regarding our corporate governance proxies. The opposite is true following the second set of hypotheses, namely the *Monitoring Hypothesis (H.3)* and the *Substitution Hypothesis (H.4)*, stating that the link between corporate governance and abnormal returns following insider trades is due to the rent extraction behavior of insiders. If this is the case we should observe that the insider's abnormal trading profits and the insider's transaction value are both significantly related to our corporate governance proxies.

$$\frac{average\ transaction\ price_t * shares\ traded_j}{average\ transaction\ price_t * shares\ held_j} * 100 = \frac{average\ transaction\ value_{jt}}{Stock\ wealth_{jt}} * 100,$$

whereat we use the average transaction price because of multiple insider trades per day.

3.3.3 DESCRIPTIVE STATISTICS

Table 3.2 presents descriptive statistics of our final data, whereat Panel A provides information on the overall number of sample firms, insiders, insider buy, sell and bidirectional trades, descriptive statistics regarding our set of dependent variables and main regressors, i.e. the size of the institutional ownership in percentage of outstanding shares, aggregated as well as differentiated by particular types and investment dedications of institutional investors and descriptive statistics regarding the Entrenchment Index (E-Index) by Bebchuck et al. (2009). Panel B provides descriptive statistics of insider, trade and firm characteristics. And finally, Panel C provides information regarding the insiders' compensation and characterization data as well as Edmans' et al. (2009) scaled Wealth-Performance Sensitivity (WPS) measure.

In detail, Panel A shows that we track the trading behavior of more than 200,000 insiders of over 21,000 companies. As in most other empirical studies concerning corporate insider trading we detect considerably more sell than buy trades, specifically we analyze more than 695,000 buy and over 1.1 million sell trades. Hence, in total we analyze over 1.8 million insider transactions, where we treated multiple trades in the same direction on a single day as one order that was split up in several buy respectively sell trades. Furthermore, we followed Fidrmuc et al. (2013) and added up the amount of shares traded in the same direction (bought/sold) and then deduct the total amount of shares sold (bought) from the total amount of shares bought (sold).[76] To account for these cases we constructed the Bidirectional trade dummy variable that equals one if the insider purchased and sold on the same day. We detected nearly 6,000 of those cases. Regarding our dependent variables, i.e. computed abnormal stock returns over a period of one and six months, one can see that we detect considerable amplitudes ranging from -68% up to 110%. Abnormal insider profits over a period of six months range between -136,000 and US dollars (USD) 130,000, whereat the negative mean value can be interpreted—given the fact we detect more insider sell than buy trades—as a signal that

[76] In the original data we counted 1,109,788 single purchase and 2,917,390 single sell trades. After summing up all trades in the same direction there were 705,984 buy and 1,115,569 sell trades left. These trades were finally net summed.

insiders sell out in time avoiding losses that amount on average to nearly USD 10,000. Concerning institutional ownership, for most of the companies independent investment advisors (IIA) are the most important institutional investors. On average institutional ownership of independent investment advisors amounts to 27%, followed by bank trusts (BNK) and investment companies (INV). Shareholder ownership of insurance companies (INS), public (PPS) and corporate pensions funds (CPS), university and foundation endowments (UFE) and miscellaneous institutions (MSC) is substantial lower. Not surprisingly, most institutions are quasi-indexers (QIX), i.e. institutional investors that are characterized by low turnover, but diversified holdings, who exhibit a passive, buy-and-hold strategy of investing portfolio funds in a broad set of firms (Porter, 1992). The average share ownership of quasi-indexers amounts to nearly 19%. The investment of dedicated (DED) and transient (TRA) institutions is much smaller for most of the sample companies.

Panel B illustrates the composition, e.g. the job position within a company, and the trading behavior of the tracked insiders. In particular, we are able to distinguish between CEOs, Chairmen, Directors, Executive Directors, Executives and other insiders, whereat Executives and Directors are by far the largest insider groups. Not surprisingly, most trades are conducted by executives, directors, executive directors, followed with a huge distance by purchase and sell trades of CEOs and Chairmen. Most insiders' trading value comprises over USD 50,000 which accounts to about 10 percent of their own companies' stock wealth[77]. On average insiders execute more than two trades a month, with some insiders trading up to 14 times a month and 32 times in a quarter. Interestingly, we detect a considerable amount of trades during the so called blackout period, i.e. during time intervals in which companies usually permit its executives and key employees to trade the firm's stock, e.g. periods prior to releases of financial information.

Finally, Panel C of Table 3.2 provides descriptive statistics of the utilized ExecuComp and Wealth-Performance Sensitivity (WPS) data, which contain detailed information about the

[77] Stock wealth is calculated by multiplying the pre-trade amount of shares the insider possess with the corresponding transaction price of her order.

top five mangers in the respective company. Not surprisingly, there are substantial more transactions conducted by male than female mangers as there are nearly 20-times more male top executives than female ones. The executives' age ranges between 35 and 71 years. Most executives earn about USD 245,000 by fixed salary and USD 115,000 by flexible bonus. Stock compensation lies between zero and about USD 3.5 million and other compensation amounts up to USD 1.4 million. Total compensation amounts up to USD 12 million whereas the median executive earns nearly USD 600,000. Furthermore, top managers possess a substantial amount of non-firm wealth that amounts up to US$ 107 million and own up to 21% of their company's shares. Last, Edmans et al. (2009) Wealth-Performance Sensitivity (WPS) measure shows that for most insiders a one percent increase in market capitalization is associated with a 7.6 % increase in their wealth.

TABLE 3.2 DESCRIPTIVE STATISTICS

PANEL A	NUMBER OF OBSERVATIONS	MEAN	STAND. DEVIATION	1TH PERCENTILE	MEDIAN	99TH PERCENTILE
Firms	21,069	-	-	-	-	-
Insiders	203,605	-	-	-	-	-
Trades	1,808,778	-	-	-	-	-
Purchases	695,540	-	-	-	-	-
Sales	1,107,421	-	-	-	-	-
Bidirectional	5,817	-	-	-	-	-
Dependent variables (at trade-level)						
1 month abnormal returns (AR 1) (%)	1,802,961	0.09	19.48	-35.65	0.00	43.52
6 month abnormal returns (AR 6) (%)	1,802,961	-0.52	43.40	-67.89	0.00	108.33
6 month abnormal profits (AP 6) (1000 US$)	1,802,961	-9.78	64.06	-136.79	0.00	130.34
Main regressors (at firm-level)						
Inst. Ownership (%)	47,792	48.28	29.93	0.23	48.74	103.71
DED Ownership (%)	47,792	0.33	1.75	0.00	0.00	11.75
QIX Ownership (%)	47,792	18.72	20.37	0.00	10.98	65.13
TRA Ownership (%)	47,792	3.95	8.61	0.00	0.00	36.12
BNK Ownership (%)	47,792	7.81	6.66	0.00	6.45	25.82
INS Ownership (%)	47,792	2.70	3.20	0.00	1.70	14.60
INV Ownership (%)	47,792	7.00	7.13	0.00	4.86	25.98
IIA Ownership (%)	47,792	26.57	17.43	0.00	25.45	66.21
CPS Ownership (%)	47,792	0.25	0.50	0.00	0.01	3.07
PPS Ownership (%)	47,792	1.68	1.95	0.00	0.90	8.65
UFE Ownership (%)	47,792	0.09	0.28	0.00	0.00	2.08
MSC Ownership (%)	47,792	1.00	2.13	0.00	0.00	10.45
E-Index	16,700	2.53	1.35	0	3	5

Panel A of this table provides descriptive statistics of our overall sample, providing information on the numbers of insider purchase, sell and bidirectional trades, dependent variables and main regressors, i.e. the size of the institutional ownership differentiated by particular types and investment dedications of institutional investors, the Entrenchment Index (E-Index) by Bebchuck et al. (2009). Regarding the investor types and their investment dedication we make use of Bushee's institutional investor classification data and we classify the institutions into three groups of investment dedication, namely transient (TRA), dedicated (DED) and quasi-indexer (QIX) institutions. Furthermore, we distinguish the institutional investors by their type, i.e. whether the particular institution is a bank trust (BNK), insurance company (INS), investment company (INV), independent investment advisor (IIA), corporate (private) pension fund (CPS), public pension fund (PPS), university and foundation endowment (UFE) or whether it has to be attributed to a miscellaneous type of institution (MSC). Panel B provides descriptive statistics of insider, trade and firm characteristics. Finally, Panel C provides information regarding the insiders' compensation and characterization data as well as Edmans et al. (2009) scaled Wealth-Performance Sensitivity (WPS) measure.

TABLE 3.2 CONTINUED

PANEL B	NUMBER OF OBSERVATIONS	MEAN	STAND. DEVIATION	1TH PERCENTILE	MEDIAN	99TH PERCENTILE
Insider controls (at insider-level)						
CEO	2,265	-	-	-	-	-
Purchase trades	11,859	-	-	-	-	-
Sell trades	16,130	-	-	-	-	-
Bidirectional trades	91	-	-	-	-	-
Chairman	3,051	-	-	-	-	-
Purchase trades	19,498	-	-	-	-	-
Sell trades	28,230	-	-	-	-	-
Bidirectional trades	164	-	-	-	-	-
Director	59,761	-	-	-	-	-
Purchase trades	266,219	-	-	-	-	-
Sell trades	261,164	-	-	-	-	-
Bidirectional trades	1,593	-	-	-	-	-
Exec. Director	22,827	-	-	-	-	-
Purchase trades	111,382	-	-	-	-	-
Sell trades	209,470	-	-	-	-	-
Bidirectional trades	795	-	-	-	-	-
Executive	93,042	-	-	-	-	-
Purchase trades	144,649	-	-	-	-	-
Sell trades	423,954	-	-	-	-	-
Bidirectional trades	763	-	-	-	-	-
Other insiders	22,659	-	-	-	-	-
Purchase trades	141,933	-	-	-	-	-
Sell trades	168,473	-	-	-	-	-
Bidirectional trades	2,411	-	-	-	-	-
Trade controls (at trade-level)						
Trade volume						
% of insiders' stock wealth	1,110,128	106.38	431.91	0.01	10.09	3,590.43
1000 shares	1,802,961	41.18	148.23	0.01	5.00	1,196.02
1000 US$	1,802,961	523.16	1703.69	0.09	53.75	13,143.01
Trade frequency (month)	1,802,961	2.37	2.67	1	1	14
Trade frequency (quarter)	1,802,961	3.77	5.98	1	2	32
Blackout period						
Purchase trades	103,182	-		-	-	-
Sell trades	257,480	-		-	-	-
Bidirectional trades	1,487	-		-	-	-
Firm controls (at firm-year-level, standardized, ln)						
VXO	53,587	0.02	1.04	-1.25	-0.10	4.20
Book leverage	51,789	0.00	0.97	-1.24	-0.14	2.49
Market Cap	51,789	0.21	0.98	-1.84	0.17	2.61
Tobin's Q	51,789	-0.06	0.87	-0.83	-0.34	3.95
ROE	51,789	0.10	0.83	-4.51	0.28	0.75
Analysts	53,659	0.26	1.00	-1.38	0.31	2.28

Panel A of this table provides descriptive statistics of our overall sample, providing information on the numbers of insider purchase, sell and bidirectional trades, dependent variables and main regressors, i.e. the size of the institutional ownership differentiated by particular types and investment dedications of institutional investors, the Entrenchment Index (E-Index) by Bebchuck et al. (2009). Regarding the investor types and their investment dedication we make use of Bushee's institutional investor classification data and we classify the institutions into three groups of investment dedication, namely transient (TRA), dedicated (DED) and quasi-indexer (QIX) institutions. Furthermore, we distinguish the institutional investors by their type, i.e. whether the particular institution is a bank trust (BNK), insurance company (INS), investment company (INV), independent investment advisor (IIA), corporate (private) pension fund (CPS), public pension fund (PPS), university and foundation endowment (UFE) or whether it has to be attributed to a miscellaneous type of institution (MSC). Panel B provides descriptive statistics of insider, trade and firm characteristics. Finally, Panel C provides information regarding the insiders' compensation and characterization data as well as Edmans et al. (2009) scaled Wealth-Performance Sensitivity (WPS) measure.

TABLE 3.2 CONTINUED

PANEL C	NUMBER OF OBSERVATIONS	MEAN	STAND. DEVIATION	1TH PERCENTILE	MEDIAN	99TH PERCENTILE
ExecuComp variables (at insider-level)						
Female	1,134	-	-	-	-	-
Purchase trades	937	-	-	-	-	-
Sell trades	7,536	-	-	-	-	-
Bidirectional trades	9	-	-	-	-	-
Male	20,442	-	-	-	-	-
Purchase trades	26,233	-	-	-	-	-
Sell trades	178,198	-	-	-	-	-
Bidirectional trades	270	-	-	-	-	-
Age	15,936	49.37	7.90	35	49	71
Option Value (1000 US$)	21,576	401.46	1,459.69	0.00	0.00	6,294.12
Option Delta (1000 US$)	21,576	29.34	96.06	0.00	0.00	451.15
Option Vega (1000 US$)	21,576	617.80	2,263.63	0.00	0.00	9,179.64
Salary (1000 US$)	21,576	291.02	191.17	27.50	245.17	1,000.00
Bonus (1000 US$)	21,576	250.13	517.97	0.00	115.78	2,400.00
Stock Compensation (1000 US$)	21,576	195.63	702.13	0.00	0.00	3,494.25
Other Compensation (1000 US$)	21,576	93.91	272.50	0.00	22.00	1,408.51
Total Compensation (1000 US$)	21,576	1,268.96	2,413.54	58.03	596.87	11,764.39
Non-firm Wealth (1000 US$)	13,574	9,688.68	528,616.60	-17,532.85	1,376.68	106,670.10
Shares owned (%)	21,576	0.74	3.65	0.00	0.00	21.03
Edmans Wealth-Performance Sensitivity (WPS) measure (at insider-level)						
WPS	2,964	56.00	357.39	0.00	7.58	926.70

Panel A of this table provides descriptive statistics of our overall sample, providing information on the numbers of insider purchase, sell and bidirectional trades, dependent variables and main regressors, i.e. the size of the institutional ownership differentiated by particular types and investment dedications of institutional investors, the Entrenchment Index (E-Index) by Bebchuck et al. (2009). Regarding the investor types and their investment dedication we make use of Bushee's institutional investor classification data and we classify the institutions into three groups of investment dedication, namely transient (TRA), dedicated (DED) and quasi-indexer (QIX) institutions. Furthermore, we distinguish the institutional investors by their type, i.e. whether the particular institution is a bank trust (BNK), insurance company (INS), investment company (INV), independent investment advisor (IIA), corporate (private) pension fund (CPS), public pension fund (PPS), university and foundation endowment (UFE) or whether it has to be attributed to a miscellaneous type of institution (MSC). Panel B provides descriptive statistics of insider, trade and firm characteristics. Finally, Panel C provides information regarding the insiders' compensation and characterization data as well as Edmans et al. (2009) scaled Wealth-Performance Sensitivity (WPS) measure.

3.4 Empirical Results

This section presents the results of our event study with respect to the corporate governance hypotheses developed in section 3.2. Frist, we start by presenting how institutional ownership—as an indirect but straightforward and largely available governance measure—affects the information disclosure of corporate insider trading generally. In a second step, we dive deeper into the various facets of institutional ownership affecting corporate governance and distinguish institutional investors by their investment dedication and type. Last, we discuss how more direct measures of a company's corporate governance level, namely anti-takeover provisions and the insiders' compensation scheme, affect market returns and trading profitability.

Generally, we show results of the abnormal return regressions for one (AR 1) and six (AR 6) calendar months as time windows. To conserve space, we do report results of the abnormal profit regressions for a forecast horizon of six months (AR 6) only. This horizon is chosen because insiders in the US have to waive any profits from trading in their firm's shares earned over shorter horizons according to the so-called short-swing rule.

3.4.1 Institutional Ownership

Table 3.3 shows results of the daily insider trading regressions, whereat columns (1)-(4) report results for the case of insider buy trades and columns (5)-(8) present results for the case of insider sell trades. Besides the main variable of interest, the aggregated level of institutional ownership, the model contains a Bidirectional trade dummy variable which equals one if the insider purchases and sells on the same trading day and zero otherwise, variables that account for the position of the insider within the company, the insider's trading frequency during a month, in columns (1)-(3) and (5)-(7) the insider's trading volume in percentage of the insider's stock wealth and a distinct set of insider's firm-level control variables. For parsimonious reasons we do not report results for the latter. The independent variable in columns (1) and (5) are the buy and hold abnormal returns over a period of one month (AR 1) and in columns (2) and (6) over six months (AR 6), subsequent to insider trading. In columns (3) and (7) the independent variable are the insiders' six month dollar abnormal trading profits (AP 6) and finally in columns (4) and (8) the independent variable is the insider's individual trading volume.

In general, insiders that buy and sell trades on the same trading day seem to dilute the positive information content of their net sum purchase and the negative information content of their net sum sell trades. Results show that in cases of Bidirectional buy trades, i.e. cases where the insider bought more shares than she sold or in other words where the net sum of her trades on a single trading day is positive, market participants react significantly negative in the short run (AR 1). We see an analogous picture regarding Bidirectional sell trades, i.e. cases where the net sum of her trades on a single trading day is negative, as this kind of sell trades convey less credible bad information. Not surprisingly, significance of this somewhat indecisive trading behavior is low, respectively not existing in the case of Bidirectional sell trades.

Results regarding the insider's position within the company are in line with the view that market participants seem to mimic the insiders' trading behavior as insiders are able to forecast future stock price developments. Above all insider buy trades of companies' chairmen and other executives exhibit significant positive abnormal returns. As Chairmen are ultimately the most senior personnel within a company one would expect the coefficient to be larger and statistically more significant than the coefficients of the other positions within the company, as it is the case. The market seems to assess insider buy trades as positive information about the company's future value. The signal is costly and therefore credible as the insider put her own wealth at stake. Columns (5) and (6) show the same picture in the case of insider sell trades, i.e. insiders time their trades and are able to forecast future stock price developments. Abnormal returns are economically and statistical highly negative in the mid run (AR 6). Concerning abnormal profits we do not find insiders to be able to gain, respectively avoid losses based on their trades at a significance level of five much less one percent, even though trade volumes are highly significant for most insider positions within a company. Only abnormal profits for CEOs and directors are significant at a ten percent level in the case of buy trades, but those might be spurious results due to the general high number of observations driving significance over the edge. That leads to the conclusion that these insiders do not engage in opportunistic insider trading on non-public information to extract additional returns. This seems to be especially the case for insider sell trades, which is not surprisingly, given that those insiders receive a sizeable part of their salary in some way or another in the form of the company's stock. Hence, they would engage in insider sell trading activity as means of diversification. Another possibility is of course that due to their prominent position within the company those insiders are being more scrutinized and consequently more deterred or discouraged from engaging in profitable insider trading.

Controlling for other trading characteristics results indicate that the information content of insider trades rises with the insider's transaction volume, as one would expect. However, results are much more statistical significant in the case of insider sell trades, again, where the significance level jumps from ten to one percent. Hence, though as stated that insiders may have many reasons to sell shares the main reason to buy shares is to make money; it seems to be the case that market participants are much more incline to react significantly to sell than to buy trades. In contrast, trade frequency does not seem to enlarge the information content of insider trades, independent whether we utilize the monthly or in unreported robustness tests the quarterly trade frequency.

Finally, regarding our main variable of interest, institutional ownership as a proxy for a company's corporate governance quality, we extend the understanding of insider buy and sell trades by showing that they are actual not two sides of the same coin, contrary to what is often stated. In detail, abnormal returns following insider buy trades (columns 1 and 2) are significant negative. In other words, higher levels of institutional ownership lead to less positive abnormal returns following insider buy trades. This result is in line with two of our hypotheses, the Ex-ante Information (H.1) and the Monitoring Hypothesis (H.3). Both predict that strong corporate governance has a negative effect on post-trade abnormal returns. In the first case because of a better pre-event information environment implying that the incremental information revealed by the trade is smaller and in the latter case because of the insider's limited opportunities to trade opportunistically on non-public information. Hence, in order to discriminate between both hypotheses we first estimate the effects of institutional ownership on insider's abnormal trading profits (AP 6). Second, we estimate the effects of institutional ownership on the insider’s transaction volume (Trans. Vol.) which we expect to be larger if insiders try to extract rents via their trades. Latter would be rather a sufficient than a necessary condition. Higher transactions volumes might also be the result of institutional investors trying to align the executives' incentives with those of outside shareholders by means of higher flexible bonuses that take the form of equity participation rather than fixed cash salaries. Estimation results of the abnormal profit and transaction volume regressions are presented in columns (3) and (4), respectively.

In a nutshell, we do neither detect a significant positive relationship between the insider’s abnormal profits nor between the insiders trading volumes and the level of institutional ownership in the case of insider buy trades. Hence, results do not seem to support the view of insider trading as means of rent extraction by insiders. To the contrary, results tend to confirm the Ex-ante Information Hypothesis (H.1) stating that a higher level of corporate governance leads to a better pre-event information environment which results in less abnormal returns as the incremental positive information revealed by the trade is smaller for those companies.

As mentioned above purchase and sell trades are not two sides of the same coin. Following the Ex-ante Information Hypothesis (H.1) we would expect abnormal returns following insider sell trades to be less negative in cases of higher institutional ownership, i.e. better corporate governance. However, the opposite is true. Results in columns (5) and (6) show a strong negative relationship between abnormal the stock performance following insider sell trades and institutional ownership. Insiders of companies with higher institutional ownership are seen to be distinctively able to forecast future stock price developments. Hence, market participants sell out their shares in the short run, as well. This result mimics the ones regarding the insiders’ position within the company in the case of sell trades, which are perceived as significant negative events. Results of more negative abnormal returns following insider sell trades are in line with two of our hypotheses, again, namely the Information Content (H.2) and the Substitution Hypothesis (H.4). Both predict that strong corporate governance has a positive effect on post-trade abnormal returns, i.e. more negative abnormal returns in the case of insider sell trades. In the first case because insiders' actions in firms with better corporate governance are more credible and therefore convey more valuable (negative) information to the capital market. And in the latter case, because insiders in good corporate governance firms—not being able to benefit from direct profit diversion—engage in profitable insider trading that provides them with an alternative source of wealth extraction. In the case of sell trades, one would interpret the latter hypotheses as insiders significantly avoiding potential losses over and above losses non-insiders suffer. In line with results of insider buy trades we do find less support for the second strand of hypotheses interpreting insider trading as means of rent extraction. Although transactions volumes are statistically positive associated with higher institutional ownership, profitability is not. As mentioned, one explanation might be that companies with higher institutional ownership and better corporate governance have compensation schemes laying more emphasize on flexible equity bonuses rather than fixed cash salaries to better align the executives' incentives with those of outside shareholders. That in turn would result in higher sell volumes.

All in all, it seems to be the case that market participants engage in mimicking insider transactions of companies with proper corporate governance—approximated by aggregate level of institutional ownership—above all as a tool to limit the downside risk of a stock's price development. As stated by Lakonishok et al. (2001), insiders have many reasons to sell shares but the main reason to buy shares is to make money. It seems that market participants are more concerned of those other reasons, believing insiders in good corporate governance companies not to have distinctive possibilities to opportunistically divert corporate profits by buying the company's own stock. On the one hand, because positive information is already incorporated into stock prices and maybe on the other hand, because insiders in those companies are to some extent limited in their ability to trade on non-public information, as well. In contrast, sell trades are being more scrutinized negatively.

TABLE 3.3 INSTITUTIONAL OWNERSHIP

	PANEL A - BUY TRADES				PANEL B - SELL TRADES			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	AR 1	AR 6	AP 6	Trans. Vol.	AR 1	AR 6	AP 6	Trans. Vol.
Inst. Ownership	-0.031**	-0.222***	-0.657	0.036	-0.048***	-0.203***	-5.551	0.845***
	(-2.12)	(-3.80)	(-0.40)	(1.06)	(-7.01)	(-8.85)	(-1.28)	(4.06)
Bidirectional trade	-2.992**	-10.493	424.320*	43.164**	1.283*	3.987*	1131.708	21.590
	(-2.09)	(-1.60)	(1.90)	(2.37)	(1.86)	(1.87)	(1.42)	(0.74)
CEO	0.114	2.637	181.668*	8.216***	-0.231	-3.074***	161.918	-51.894***
	(0.15)	(0.94)	(1.68)	(3.21)	(-0.57)	(-2.90)	(0.63)	(-3.15)
Chairman	1.624**	2.518	169.626	-3.536	0.083	-2.209**	50.625	-82.820***
	(2.23)	(0.93)	(1.36)	(-1.61)	(0.24)	(-2.29)	(0.16)	(-5.51)
Director	0.039	-1.559	209.827*	20.290***	0.005	-2.149***	204.127	-5.139
	(0.07)	(-0.71)	(1.81)	(17.22)	(0.02)	(-2.95)	(0.81)	(-0.57)
Exec. Director	0.603	0.005	159.260	4.176***	-0.140	-2.810***	158.475	-21.709**
	(1.07)	(0.00)	(1.51)	(3.21)	(-0.54)	(-3.87)	(0.61)	(-2.21)
Executive	0.962*	1.682	160.608	20.600***	-0.242	-2.984***	197.053	123.162***
	(1.73)	(0.63)	(1.39)	(16.03)	(-0.97)	(-4.40)	(0.72)	(11.28)
Trade frequency	-0.175*	-0.623**	-2.698	-1.810***	0.025	-0.014	6.604	-10.332***
	(-1.96)	(-1.99)	(-0.61)	(-6.93)	(1.19)	(-0.24)	(0.83)	(-8.26)
Trade volume	0.001	0.006*	-0.295	-	-0.000*	-0.001***	0.077	-
	(1.24)	(1.75)	(-1.32)	-	(-1.94)	(-3.54)	(0.85)	-
constant	2.132	22.728***	-65.504	24.594***	4.924***	26.871***	371.182	43.756**
	(0.90)	(4.90)	(-0.53)	(9.18)	(7.78)	(12.24)	(0.87)	(2.26)
Year FE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Firm controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Obs	116,420	116,420	116,420	116,420	304,622	304,622	304,622	304,622
R-squared	0.009	0.027	0.001	0.015	0.010	0.049	0.001	0.023

This table shows results of daily insider trading regressions, whereas Panel A reports results for the case of insider buy trades and Panel B presents results for the case of insider sell trades. Besides the main variable of interest, the aggregated level of institutional ownership, the model contains a Bidirectional trade dummy variable which equals one if the insider purchases and sells on the same trading day and zero otherwise, variables that account for the position of the insider within the company, the insider's trading frequency during a month, in columns 1-3 and 5-7 the insider's trading volume in percentage of the insider's stock wealth and a distinct set of insider's firm-level control variables. The independent variable in columns 1 and 5 are the buy and hold abnormal returns over a period of one month (AR 1) and in columns 2 and 6 over six months (AR 6), subsequent to insider trading. In columns 3 and 7 the independent variable are the insiders' six month dollar abnormal trading profits (AP 6) and finally in columns 4 and 8 the independent variable is the insider's individual trading volume in percentage of the insider's stock wealth.
* p<0.10, ** p<0.05, *** p<0.01

3.4.2 INVESTOR DEDICATION AND TYPE

To analyze the relationship between institutional ownership, corporate governance and insider trading more closely we expand the previous analysis by disentangling the effects regarding on the one hand between various types of institutional investors and on the other hand regarding their investment dedication.

In detail, Table 3.4 presents in columns (1)-(8) of Panel A estimation results of insider buy trades and in columns (9)-(16) of Panel B of insider sell trades. As Bushee (2001) states, some institutional investors may face competitive pressures for strong short-term performance and/or stringent fiduciary responsibilities that can foster a focus on short-term value maximization. Therefore, such institutions are less likely to be interested in improving long-term corporate governance. To control for these considerations we make use of Brian Bushee's institutional investor classification data and classify the institutions twofold. First, we classify the institutions into three groups of investment dedication, namely dedicated (DED), quasi-indexer (QIX) and transient (TRA) institutions. Dedicated (DED) and quasi-indexer (QIX) investors provide according to Bushee (1998) long-term, stable ownership to firms because they are geared toward longer-term dividend income or capital appreciation. Moreover, dedicated institutions (DED) are characterized by large average investments in portfolio firms and extremely low turnover, consistent with a "relationship investing" role and a commitment to provide long-term patient capital (Porter, 1992; and Dobrzynski, 1993). Quasi-indexers (QIX) are also characterized by low turnover, but they tend to have diversified holdings, consistent with a passive, buy-and-hold strategy of investing portfolio funds in a broad set of firms (Porter, 1992). Because of the longer investment horizons of these types of institutions, they should be less focused on near-term earnings and should have preferences that are insensitive to the distribution of short-term future value. Instead, transient institutions (TRA) are characterized as having high portfolio turnover and highly diversified portfolio holdings. They tend to be investors focused on enhancing and gaining (trading) profits in the short-run (Porter, 1992). Second, we classify institutional investors by their type, i.e. whether the particular institution is a bank trust (BNK), insurance company (INS), investment company (INV), independent investment advisor (IIA), corporate (private) pension fund (CPS), public pension fund (PPS), university and foundation endowment (UFE) or whether it has to be attributed to a miscellaneous type of institution (MSC).

Analogous to Table 3.3, the independent variable in each distinct block are the buy and hold abnormal returns over a period of one (AR 1) and six (AR 6) months subsequent to insider trading, the insiders' six month dollar abnormal trading profits (AP 6) as well as the insider’s trading volume in percentage of her stock wealth. Moreover, in the first block of either buy and sell trades the first four columns present estimation results of models where the institutional ownership is separated regarding the investors' investment dedication (columns 1-4 and columns 9-12). And, in the second block of either trades institutional ownership is separated across different types of institutional investors (columns 5-8 and 13-16).

Likewise to the previous finding in subsection 3.4.1, results do not seem to support the view of insider trading as means of rent extraction by insiders. That is, we do not find a significant positive relationship between abnormal returns and abnormal profits as well as transaction values following buy trades and a significant negative relationship after insider sell trades. Furthermore, results confirm the notion of buy and sell trades not being just two sides of the same coin.

In detail, the first block of Table 3.4 (columns 1-4) shows that the effect of significant less positive abnormal returns following insider buy trades is strongest for the case of dedicated institutional investors (DED) who are characterized by large average investments in portfolio firms and extremely low turnover, consistent with a "relationship investing" role and a commitment to provide long-term patient capital (Porter, 1992; and Dobrzynski, 1993). Because of the longer investment horizons of these investors they should be less focused on near-term earnings and exhibit preferences that are insensitive to the distribution of short-term future value. Hence, we conjecture that they enhance the overall level of the firms' corporate governance the most. Moreover, results do not confirm any positive relationship between institutional ownership and the level of insider's trading profitability and/or the insiders' trading volume.

The second block of Table 3.4 (columns 5-8) separates institutional ownership by distinct types of institutional investors. Though an interpretation of these results is not as straight forward as in the latter case, the significant coefficients of insurance (INS) and investment companies (INV) confirm to some extent the notion that a better pre-information environment is associated with lower abnormal returns following insider buy trades in a better corporate governance environment. Especially insurance (INS) and investment companies (INV)—because of their legal and fiduciary responsibilities—have to convey proper information about the quality of their investments to the public, respectively their customers and regulatory authorities.

Hence, it is more likely that for those companies information precision is higher so that more information is incorporated in prices just before insider trades take place. Consistent with our previous results, we do not detect a significant positive relationship between the level of institutional ownership and abnormal insider trading profits or volumes. Hence, we tend to confirm the Ex-ante Information Hypothesis (H.1) stating that a higher level of corporate governance leads to a better pre-event information environment which results in less positive abnormal returns after insider buy trades as the incremental positive information revealed by the trade is smaller.

In the case of sell trades, results of the third block of Table 3.4 (columns 9-12) are most pronounced for institutional investors that exhibit a dedicated investment strategy (DED). Similar to the results of the previous section 3.4.1, coefficients indicate that because insiders' actions in firms with better corporate governance are more credible, they convey more valuable information—in this case negative ones—to the capital market so that prices adjust more for companies with better governance schemes. Hence, we tend to confirm the Information Content Hypothesis (H.2) in the case of insider sell trades, highlighting the fact that buy and sell trades are not two sides of the same coin. Moreover, though dedicated institutional ownership (DED) is associated with the strongest market reaction the effects for transient institutional investors (TRA) are three times larger than for quasi-indexers (QIX). While being short-term focused it seems to be the case that those institutional investors due to their focus and pressure on increasing a company's profitability in the short-run are able to force the management to adjust the company's operational procedures and governance schemes more decisively. These results support the notion that it is not a (passive) long-term ownership relation per se but rather the investor's clear investment dedication and focus that enhances the company's level of corporate governance keeping the interest of companies' executives and shareholders align, with a long-term investment horizon being more important than a short-term one.

The last block of Table 3.4 (columns 13-16) presents abnormal return regression results for sell trades where institutional ownership is separated into distinct types of investors. Except university and foundation endowments (UFE) results support the previous findings. It might be the case that university and foundation endowments investors (UFE) due to their overall very low ownership are not capable to enforce proper corporate governance standards, in contrast to bank trusts (BNK), insurance companies (INS), investment companies (INV) or independent investment advisors (IIA) that are the dominant institutional investors for most companies in our sample. Therefore, market participants are not treating trades in those cases as credible bad signals. Again, we do not detect any support for the notion that insider are able to significantly outperform the market.

All in all this section provides three important results. Frist, it confirms previous results that higher corporate governance levels seem to prevent or discourage insiders from engaging in insider trading as means of opportunistic rent extraction. Second, it confirms the notion of buy and sell trades not being just two sides of the same coin, as well. That is, a higher level of corporate governance leads to a better pre-event information environment which results in less positive abnormal returns after insider buy trades as the incremental positive information revealed by the trade is smaller. In contrast, sell trades in firms with better corporate governance are perceived to convey more valuable and negative information to the capital market so that prices adjust more for companies with better governance schemes. Third, results for institutional investors that in particular exhibit higher incentives to enhance a company's corporate governance—be it because of their clear investment dedication or type—mirror results of aggregate institutional ownership. Hence, as information on the former one is more scarce, respectively associated with higher costs because one has to gather distinct information about each institutional investor one can refrain from that and instead proxy the governance level with the aggregate measure also. From an econometric perspective, this has also the advantage of estimates being more precise due the higher number of observations.

TABLE 3.4 INVESTOR DEDICATION AND TYPE

PANEL A - BUY TRADES	Seperated by Investor Dedication				Seperated by Investor Type			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	AR 1	AR 6	AP 6	Trans. Vol.	AR 1	AR 6	AP 6	Trans. Vol.
DED Ownership	-0.169**	0.211	4.629	-0.245*	-	-	-	-
	(-2.55)	(0.77)	(0.74)	(-1.78)				
QIX Ownership	-0.018	0.019	0.036	-0.000	-	-	-	-
	(-1.50)	(0.33)	(0.03)	(-0.02)				
TRA Ownership	-0.043	0.120	0.581	-0.028	-	-	-	-
	(-1.24)	(0.52)	(0.34)	(-0.46)				
BNK Ownership	-	-	-	-	-0.037	-0.360	-5.430*	-0.024
					(-0.94)	(-1.40)	(-1.77)	(-0.23)
INS Ownership	-	-	-	-	-0.007	-0.608**	5.038	0.008
					(-0.11)	(-2.39)	(0.96)	-0.05
INV Ownership	-	-	-	-	-0.119***	-0.306**	2.786	0.245**
					(-3.49)	(-2.27)	(0.81)	-2.22
IIA Ownership	-	-	-	-	-0.006	-0.049	-0.380	0.036
					(-0.26)	(-0.28)	(-0.18)	-0.77
CPS Ownership	-	-	-	-	0.291	-2.906	-76.234*	-2.561*
					(0.93)	(-1.54)	(-1.74)	(-1.83)
PPS Ownership	-	-	-	-	-0.081	0.159	-0.768	0.499
					(-0.66)	(0.36)	(-0.06)	-1.63
UFE Ownership	-	-	-	-	0.514	-1.052	39.878	-1.347
					(1.07)	(-0.49)	(0.51)	(-1.07)
MSC Ownership	-	-	-	-	-0.094	-1.830	0.264	-0.213
					(-0.58)	(-1.00)	(0.05)	(-1.10)
constant	1.787	17.223***	-84.896	24.594***	1.759	21.727***	-53.356	24.974***
	(0.76)	(4.52)	(-0.78)	-9.18	(0.75)	(5.40)	(-0.44)	-9.23
Year FE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Insider controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Trade controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Firm controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Obs	116,420	116,420	116,420	116,420	116,420	116,420	116,420	116,420
R-squared	0.009	0.027	0.001	0.015	0.009	0.028	0.001	0.015

This table shows results of daily insider trading regressions, whereas Panel A reports results for the case of insider buy trades and Panel B presents results for the case of insider sell trades. The main variable of interest is the level of institutional ownership, whereas institutional investors are classified twofold. First, institutions are classified into three groups of investment dedication, namely dedicated (DED), quasi-indexer (QIX) and transient (TRA) institutions. Second, institutional investors are classified by their type, i.e. whether the particular institution is a bank trust (BNK), insurance company (INS), investment company (INV), independent investment advisor (IIA), corporate (private) pension fund (CPS), public pension fund (PPS), university and foundation endowment (UFE) or whether it has to be attributed to a miscellaneous type of institution (MSC). Besides those main variables of interest the model contains insider controls (a Bidirectional trade dummy variable which equals one if the insider purchases and sells on the same trading day and zero otherwise and variables that account for the position of the insider within the company), trade controls (the insider's trading frequency during the month and the insider's trading volume in percentage of the insider's stock wealth, except in columns 4, 8, 12 and 16) and a distinct set of insider's firm-level control variables. The independent variable in columns 1, 5, 9 and 13 are the buy and hold abnormal returns over a period of one month (AR 1) and in columns 2, 6, 10 and 14 over six months (AR 6), subsequent to insider trading. In columns 3,7, 11 and 15 the independent variable are the insiders' six month dollar abnormal trading profits (AP 6) and finally in columns 4, 8, 12 and 16 the independent variable is the insider's individual trading volume in percentage of the insider's stock wealth. * $p<0.10$, ** $p<0.05$, *** $p<0.01$

TABLE 3.4 CONTINUED

PANEL B - SELL TRADES	Seperated by Investor Dedication				Seperated by Investor Type			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Dependent variable	AR 1	AR 6	AP 6	Trans. Vol.	AR 1	AR 6	AP 6	Trans. Vol.
DED Ownership	-0.082**	-0.257***	-1.531	1.640*	-	-	-	-
	(-2.55)	(-2.67)	(-0.19)	(1.83)				
QIX Ownership	-0.016***	-0.066***	-2.092	0.415***	-	-	-	-
	(-4.35)	(-5.30)	(-1.15)	(3.80)				
TRA Ownership	-0.044***	-0.219***	-3.186	0.929***	-	-	-	-
	(-4.92)	(-7.18)	(-0.90)	(4.01)				
BNK Ownership	-	-	-	-	-0.032*	-0.186***	-8.731	-0.295
					(-1.79)	(-3.19)	(-0.87)	(-0.51)
INS Ownership	-	-	-	-	-0.146***	-0.386***	-5.475	1.521
					(-4.98)	(-3.69)	(-0.77)	-1.42
INV Ownership	-	-	-	-	-0.075***	-0.365***	-7.611	1.616***
					(-5.93)	(-7.63)	(-0.97)	-3.1
IIA Ownership	-	-	-	-	-0.042***	-0.186***	-5.174	0.890***
					(-4.07)	(-5.77)	(-1.37)	-3.41
CPS Ownership	-	-	-	-	-0.168	-0.306	-30.428	0.312
					(-1.03)	(-0.53)	(-0.46)	-0.05
PPS Ownership	-	-	-	-	0.025	0.167	19.804	2.628
					(0.37)	(0.85)	(1.28)	-1.26
UFE Ownership	-	-	-	-	0.635***	1.927**	42.875	0.765
					(2.84)	(2.49)	(0.53)	-0.09
MSC Ownership	-	-	-	-	0.011	-0.083	8.187	-0.169
					(0.26)	(-0.54)	(0.37)	(-0.14)
constant	2.484***	16.578***	76.476	43.756**	4.757***	26.846***	330.367	46.405**
	(5.47)	(10.63)	(0.33)	-2.26	(7.37)	(12.12)	(0.78)	-2.49
Year FE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Insider controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Trade controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Firm controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Obs	304,622	304,622	304,622	304,622	304,622	304,622	304,622	304,622
R-squared	0.01	0.047	0.001	0.023	0.011	0.05	0.001	0.023

This table shows results of daily insider trading regressions, whereas Panel A reports results for the case of insider buy trades and Panel B presents results for the case of insider sell trades. The main variable of interest is the level of institutional ownership, whereas institutional investors are classified twofold. First, institutions are classified into three groups of investment dedication, namely dedicated (DED), quasi-indexer (QIX) and transient (TRA) institutions. Second, institutional investors are classified by their type, i.e. whether the particular institution is a bank trust (BNK), insurance company (INS), investment company (INV), independent investment advisor (IIA), corporate (private) pension fund (CPS), public pension fund (PPS), university and foundation endowment (UFE) or whether it has to be attributed to a miscellaneous type of institution (MSC). Besides those main variables of interest the model contains insider controls (a Bidirectional trade dummy variable which equals one if the insider purchases and sells on the same trading day and zero otherwise and variables that account for the position of the insider within the company), trade controls (the insider's trading frequency during the month and the insider's trading volume in percentage of the insider's stock wealth, except in columns 4, 8, 12 and 16) and a distinct set of insider's firm-level control variables. The independent variable in columns 1, 5, 9 and 13 are the buy and hold abnormal returns over a period of one month (AR 1) and in columns 2, 6, 10 and 14 over six months (AR 6), subsequent to insider trading. In columns 3,7, 11 and 15 the independent variable are the insiders' six month dollar abnormal trading profits (AP 6) and finally in columns 4, 8, 12 and 16 the independent variable is the insider's individual trading volume in percentage of the insider's stock wealth. * p<0.10, ** p<0.05, *** p<0.01

3.4.3 ANTI-TAKEOVER PROVISIONS AND COMPENSATION SCHEME

In this subsection we extend our analyses even further and dive deep into companies' direct governance provisions and the insiders' compensation scheme. The outcome of this extensive procedure is presented in Table 3.5, whereat columns (1)-(8) of Panel A show results of insider buy trades and columns (9)-(16) of Panel B show results of insider sell trades. Similar to Tables 3.3 and 3.4, the independent variable in each distinct block are the buy and hold abnormal returns over a period of one (AR 1) and six (AR 6) months subsequent to insider trading, the insiders' six month dollar abnormal trading profits (AP 6) as well as the insider's trading volume in percentage of her stock wealth. Moreover, in the first block of either buy and sell trades the first four columns present estimation results for a subsample of firms where we are able to use the so called Entrenchment Index by Bebchuk et al. (2009) (columns 1-4 and columns 9-12). And, in the second block of either trades we present estimation results for a condensed sample of firms where we can track insiders via Compustat's ExecuComp data (columns 5,8 and 13,16). As shown in the previous section results are independent of the institutional ownership's aggregation level. Hence, we refrain for parsimonious reasons from showing estimation results where institutional ownership is decomposed by the investors' dedication or type.

Concerning the Entrenchment Index (E-index), the index is based on six governance provisions whereat a company is given a score between zero and six, based on the number of the provisions that the company exhibits in a given year. Of these six provisions, four set constitutional limits on shareholders' voting power, which is the primary power shareholders have, namely staggered boards, limits to shareholder amendments of the corporate bylaws, supermajority requirements for mergers, and supermajority requirements for charter amendments. These four arrangements limit the extent to which a majority of shareholders can impose their will on a company's management. The two other provisions, poison pills and golden parachutes, are the most well-known and salient measures taken in preparation for a hostile offer.

In other words, the first four provisions shield the companies' management from current owners forcing their will on the management, while the last two provisions shield the management from the will of potential future owners. Hence, the higher the index the worse the level of corporate governance.

By using Compustat's ExecuComp we are able to extend our model even further by adding six salient compensation measures, namely the executive's total compensation, stock compensation, other compensation, salary, bonus and value of option awards. Regarding option awards we control for the option's sensitivity to a change in the price of the underlying (Delta) and the option's sensitivity of a change in volatility (Vega), as well. Furthermore, we use four more variables to characterize an executive more closely, that is we control for the amount of company's shares she owns, her age, gender and the amount of her non-firm wealth.

We start by presenting results of aggregate institutional ownership as a proxy for a company's corporate governance quality. Even after controlling for anti-takeover provisions using the Entrenchment Index by Bebchuk et al. (2009) in columns (1)-(4) and (9)-(10) and broadening our analysis by insiders' individual compensation scheme and further characteristics in columns (5)-(8) and (13)-(16) results of the previous sections hold. Though not as pronounced as insider sell trades, abnormal returns following insider buy trades, presented in Panel A of Table 3.5, are significant negative. In other words, higher levels of institutional ownership lead to less positive abnormal returns following insider buy trades. Analogous to section 3.4.1 we do neither detect a significant positive relationship between the insider's abnormal profits nor between the insiders' trading volumes and the level of institutional ownership. Hence, our results do not support the view of insider trading as means of rent extraction by insiders but rather as signals for firm value changes. Consequently, results tend to confirm the view of insider trading as signals for firm value changes. That is, results confirm the Ex-ante Information Hypothesis (H.1) stating that a higher level of corporate governance leads to a better pre-event information environment resulting in less abnormal returns as the incremental positive information revealed by the trade is smaller for those companies.

In the case of insider sell trades results presented in Panel B of Table 3.5 tend to confirm the notion of insider trading as signals for firm value changes as well, rather than for rent extraction. That is, we do not find insiders significantly selling out in time. Furthermore results highlight again that insider buy and sell trades are not two sides of the same coin. Following the Ex-ante Information Hypothesis (H.1) we would expect abnormal returns following insider sell trades to be less negative in cases of higher institutional ownership, i.e. better corporate governance. But again, the opposite is true. Results in columns (9) and (10) as well as in columns (13) and (14) show a strong negative relationship between abnormal stock performance following insider sell trades and institutional ownership. That is in the case of insider sell trades our results support the Information Content Hypothesis (H.2) stating that actions in firms with better corporate governance are more credible and therefore convey more valuable, in this case negative, information to the capital market.

Concerning the other prominently discussed possible channel affecting a company's level of corporate governance, namely companies' governance provisions, our results provide evidence that those more granular data do not provide additional explanatory power with regard to the company's corporate governance quality. That is, with respect to the condensed Entrenchment Index by Bebchuk et al. (2009) we do not detect a significant relationship between the market's reaction subsequent to insider trades and the company's level of anti-takeover provisions. That is, as we control for institutional ownership the E-Index is insignificant, across the board, whether we analyze insiders' abnormal profits or transaction volumes. Consequently, as information on the E-Index is more scarce, respectively associated with higher costs because one has to gather distinct information about each company's provisions in a given year one can refrain from that and instead proxy the governance level with the aggregate measure of institutional ownership.

Finally, regarding the heavily condensed ExecuComp subsample results of the compensation variables and variables characterizing the insiders in more detail are mixed. In the case of insider buy trades results in Panel A of Table 3.5 (columns 5-9) show that insiders' total compensation, overall non-firm wealth and interestingly her gender does indeed predict future positive price developments. However, only in the case of total compensation we detect a statistically significant relationship at the one percent level. The other ones are significant at the 10 percent level, only. Moreover, in the case of female insiders and total compensation, we detect a positive relationship of abnormal profits, though at a 10 percent significance level, only. Non-firm wealth, however, is associated with abnormal profits at a significance level of one percent. In contrast, insiders with higher option values and other compensation components like perquisites and other personal benefits, termination or change-in-control payments etc. reduce the positive information content of their buy trades. In line with the previous results, we do not detect significant effects on trading volumes. Hence, results tend to confirm the notion of insider trades as signals for firm value changes rather than rent extraction by insider with insiders exhibiting high non-firm wealth as an exception. Whether those insiders are less discouraged to engage in opportunistic insider trading activities due to their higher outside wealth remains an open question. Nevertheless, given the statistically as well as economically mixed results we do not assess insider compensation characteristics overall as credible and feasible governance measures in this context. Even more so as results of insider sell trades presented in Panel B of Table 3.5 are even weaker in terms. That is, only insiders with higher salaries statistically highly significant tend to sell out in time. All other coefficient are either insignificant or exhibit the opposite than expected sign. However, this is not to say that companies' compensation schemes do not affect their governance quality. One main reason why results regarding the compensation variables do not yield more conclusive results might be the fact that the ExecuComp subsample only tracks the top five executives of generally larger companies. Those insiders are by definition not representative as they are the most important and heavily scrutinized insiders in general. Moreover, as they face the highest litigation risks in the case of any potentially wrongdoing their trading behavior is presumably more independent of firm characteristics like the level of corporate governance in any case.

All in all, even when we condense the sample the most, we are still able to confirm the same results as in the previous analyses regarding the relationship of insider trading, institutional ownership and corporate governance. First, even after extending the model by a comprehensive set of salient corporate governance measures it becomes evident higher corporate governance levels seem to prevent or discourage insiders from engaging in insider trading as means of opportunistic rent extraction. Second, it confirms the notion of buy and sell trades not being just two sides of the same coin. That is, a higher level of corporate governance leads to a better pre-event information environment which results in less positive abnormal returns after insider buy trades as the incremental positive information revealed by the trade is smaller. In contrast, sell trades in firms with better corporate governance are perceived to convey more valuable, negative information to the capital market so that prices adjust more for companies with better governance schemes.

TABLE 3.5 ANTI-TAKEOVER PROVISIONS AND COMPENSATION SCHEME

PANEL A - BUY TRADES	Entrechment Index				Executive Compensation			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	AR 1	AR 6	AP 6	Trans. Vol.	AR 1	AR 6	AP 6	Trans. Vol.
Inst. Ownership	-0.062**	-0.434	2.689	0.017	0.022	-0.003	1.523	-0.027
	(-2.52)	(-1.61)	(0.44)	(0.36)	(0.25)	(-0.01)	(1.09)	(-0.24)
E-Index	0.123	-4.657	18.862	0.728	-0.173	-2.155	-20.903	2.807
	(0.22)	(-0.94)	(0.68)	(0.71)	(-0.11)	(-0.49)	(-0.88)	(0.57)
Age	-	-	-	-	0.064	-0.078	0.779	-0.045
					(0.45)	(-0.31)	(0.44)	(-0.19)
Female	-	-	-	-	5.332	20.895*	91.778*	-2.764
					(1.44)	(1.82)	(1.72)	(-0.52)
Shares owned	-	-	-	-	0.091	0.458	-0.598	-1.061***
					(0.62)	(1.12)	(-0.17)	(-3.98)
Option Value	-	-	-	-	-0.001	-0.007**	-0.018	0.003
					(-1.21)	(-2.53)	(-0.67)	(0.78)
Option Delta	-	-	-	-	0.000	0.021	-0.188	-0.043**
					(0.03)	(0.99)	(-0.56)	(-2.08)
Option Vega	-	-	-	-	-0.000	0.001	0.002	0.000
					(-1.23)	(1.07)	(0.19)	(0.57)
Salary	-	-	-	-	-0.000	-0.006	-0.108	0.011
					(-0.01)	(-0.51)	(-1.57)	(0.89)
Bonus	-	-	-	-	-0.002	-0.005	0.019	-0.004
					(-1.37)	(-1.60)	(0.32)	(-0.90)
Stock Comp.	-	-	-	-	-0.001	-0.003	-0.026	-0.001
					(-1.05)	(-1.24)	(-1.43)	(-0.23)
Other Comp.	-	-	-	-	-0.004**	-0.013**	0.014	-0.003
					(-2.22)	(-2.44)	(0.19)	(-0.92)
Total Comp.	-	-	-	-	0.002***	0.005***	0.027*	0.000
					(2.89)	(2.70)	(1.88)	(0.19)
Non-firm Wealth	-	-	-	-	0.000*	0.000*	0.000***	0.000
					(1.80)	(1.92)	(2.95)	(0.48)
constant	9.518***	86.911*	-71.248	29.594***	3.508	41.454	214.506	134.152***
	(3.08)	(1.69)	(-0.19)	(6.42)	(0.31)	(1.48)	(0.96)	(6.05)
Year FE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Insider controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Trade controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Firm controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Obs	35,888	35,888	35,888	35,888	2,722	2,722	2,722	2,722
R-squared	0.02	0.049	0.003	0.019	0.081	0.212	0.111	0.019

This table shows results of daily insider trading regressions, whereas Panel A reports results for the case of insider buy trades and Panel B presents results for the case of insider sell trades. The main variables of interest are the aggregated level of institutional ownership, the Entrenchment Index (E-Index), the insider's compensation scheme as well as the insider's gender, age, share ownership and non-firm wealth. Concerning the E-index, the index is based on six governance provisions whereat a company is given a score between 0 and 6, based on the number of the provisions that the company has in a given year. Of these six provisions, four set constitutional limits on shareholders' voting power, namely staggered boards, limits to shareholder amendments of the bylaws, supermajority requirements for mergers, and supermajority requirements for charter amendments. The two other provisions, poison pills and golden parachutes, are measures taken in preparation for a hostile offer. Hence, the higher the index the worse is the level of corporate governance. Besides those main variables of interest the model contains insider controls (a Bidirectional trade dummy variable which equals one if the insider purchases and sells on the same trading day and zero otherwise and variables that account for the position of the insider within the company), trade controls (the insider's trading frequency during the month and the insider's trading volume in percentage of the insider's stock wealth, except in columns 4, 8, 12 and 16) and a distinct set of insider's firm-level control variables. The independent variable in columns 1, 5, 9 and 13 are the buy and hold abnormal returns over a period of one month (AR 1) and in columns 2, 6, 10 and 14 over six months (AR 6), subsequent to insider trading. In columns 3,7, 11 and 15 the independent variable are the insiders' six month dollar abnormal trading profits (AP 6) and finally in columns 4, 8, 12 and 16 the independent variable is the insider's individual trading volume in percentage of the insider's stock wealth. * $p<0.10$, ** $p<0.05$, *** $p<0.01$

TABLE 3.5 CONTINUED

PANEL B - SELL TRADES	Entrechment Index				Executive Compensation			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Dependent variable	AR 1	AR 6	AP 6	Trans. Vol.	AR 1	AR 6	AP 6	Trans. Vol.
Inst. Ownership	-0.025***	-0.102***	-14.347	0.819***	-0.036**	-0.110*	5.177*	0.341
	(-3.02)	(-3.36)	(-1.28)	(2.68)	(-2.01)	(-1.88)	(1.75)	(0.63)
E-Index	0.123	0.113	4.465	-3.722	0.219	-0.798	-16.510	-11.093
	(1.04)	(0.24)	(0.21)	(-0.66)	(0.96)	(-0.81)	(-0.45)	(-1.24)
Age	-	-	-	-	0.025	0.085*	-6.662	-0.919
					(1.40)	(1.76)	(-1.31)	(-0.64)
Female	-	-	-	-	0.367	-1.274	209.353	18.490
					(0.74)	(-0.76)	(0.75)	(0.19)
Shares owned	-	-	-	-	0.007	-0.039	-21.749	-9.490*
					(0.25)	(-0.58)	(-1.13)	(-1.92)
Option Value	-	-	-	-	-0.000	-0.000	0.025	-0.005
					(-1.17)	(-0.47)	(0.72)	(-0.36)
Option Delta	-	-	-	-	0.000	-0.005	0.262	0.058
					(0.35)	(-0.89)	(0.60)	(0.99)
Option Vega	-	-	-	-	0.000***	0.000**	0.008	-0.001
					(3.07)	(2.48)	(0.62)	(-0.44)
Salary	-	-	-	-	-0.001*	-0.002	-0.463***	0.041
					(-1.76)	(-1.08)	(-2.67)	(0.64)
Bonus	-	-	-	-	0.000**	0.000	0.114*	-0.000
					(2.43)	(0.49)	(1.76)	(-0.01)
Stock Comp.	-	-	-	-	0.000	-0.000	0.014	0.000
					(0.46)	(-0.41)	(0.43)	(0.02)
Other Comp.	-	-	-	-	0.000	0.001	0.128	-0.086
					(1.21)	(0.88)	(1.51)	(-1.47)
Total Comp.	-	-	-	-	-0.000	-0.000	-0.035	-0.000
					(-0.80)	(-0.83)	(-1.32)	(-0.01)
Non-firm Wealth	-	-	-	-	-0.000	-0.000	0.000	-0.000
					(-1.44)	(-1.22)	(1.50)	(-1.13)
constant	4.770***	28.098***	1515.654	119.858***	3.740	36.545***	2220.270	350.321**
	(4.69)	(7.51)	(1.3)	(2.96)	(1.42)	(4.55)	(1.37)	(2.23)
Year FE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Insider controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Trade controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Firm controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Obs	151,479	151,479	151,479	151,479	25,042	25,042	25,042	25,042
R-squared	0.012	0.056	0.003	0.025	0.016	0.075	0.012	0.036

This table shows results of daily insider trading regressions, whereas Panel A reports results for the case of insider buy trades and Panel B presents results for the case of insider sell trades. The main variables of interest are the aggregated level of institutional ownership, the Entrenchment Index (E-Index), the insider's compensation scheme as well as the insider's gender, age, share ownership and non-firm wealth. Concerning the E-index, the index is based on six governance provisions whereat a company is given a score between 0 and 6, based on the number of the provisions that the company has in a given year. Of these six provisions, four set constitutional limits on shareholders' voting power, namely staggered boards, limits to shareholder amendments of the bylaws, supermajority requirements for mergers, and supermajority requirements for charter amendments. The two other provisions, poison pills and golden parachutes, are measures taken in preparation for a hostile offer. Hence, the higher the index the worse is the level of corporate governance. Besides those main variables of interest the model contains insider controls (a Bidirectional trade dummy variable which equals one if the insider purchases and sells on the same trading day and zero otherwise and variables that account for the position of the insider within the company), trade controls (the insider's trading frequency during the month and the insider's trading volume in percentage of the insider's stock wealth, except in columns 4, 8, 12 and 16) and a distinct set of insider's firm-level control variables. The independent variable in columns 1, 5, 9 and 13 are the buy and hold abnormal returns over a period of one month (AR 1) and in columns 2, 6, 10 and 14 over six months (AR 6), subsequent to insider trading. In columns 3,7, 11 and 15 the independent variable are the insiders' six month dollar abnormal trading profits (AP 6) and finally in columns 4, 8, 12 and 16 the independent variable is the insider's individual trading volume in percentage of the insider's stock wealth. * p<0.10, ** p<0.05, *** p<0.01

3.5 Robustness Checks

In this section, we present several robustness checks. In particular, we make use of Edmans et al. (2009) scaled Wealth-Performance Sensitivity (WPS) measure, which is independent of firm size and thus comparable across firms of different size and provides information on the elasticity of the company's market capitalization and the insider's wealth. Moreover, we rerun our main regression models where we analyze insider-trading activity on a monthly instead of a daily frequency.

Table 3.6 shows results of the daily insider trading regressions, whereat columns (1)-(4) report results for the case of insider buy trades and columns (5)-(8) present results for the case of insider sell trades. Besides the main variable of interest, the aggregated level of institutional ownership, the model contains the WPS measure, the E-Index as well as insider, trade and firm control variables. The independent variable in columns (1) and (5) are the buy and hold abnormal returns over a period of one month (AR 1) and in columns (2) and (6) over six months (AR 6), subsequent to insider trading. In columns (3) and (7) the independent variable are the insiders' six month dollar abnormal trading profits (AP 6) and finally in columns (4) and (8) the independent variable is the insider's individual trading volume. Results show that the WPS measure is insignificant in most cases, only indicating that insiders who exhibit a higher sensitivity of their wealth and the company's market capitalization tend to sell out in time. However, this result is significant at the ten percent level only. However, market participants do not assess sell trades of those insiders as credible, negative signals. Results on institutional ownership corroborate findings of the previous sections. Moreover, in the case of this small subsample the E-Index is positive in the case of buy trades, but only at a ten level. Nevertheless, it tends to confirm the notion that buy trades of insider in better corporate governance firms are not perceived as creditable positive signals by the market participants.

Last, we show results of monthly instead of daily insider trading regressions where we analyze not all insider trades but just the insider's first one in a distinct month. The outcome of this exercise is presented in Table 3.7, whereat columns (1)-(9) of Panel A show results of insider buy trades and columns (10)-(18) of Panel B of insider sell trades. The independent variable in each distinct block are the buy and hold abnormal returns over a period of one (AR 1) and six (AR 6) months subsequent to insider trading, the insiders' six month dollar abnormal trading profits (AP 6). For parsimonious reasons we refrain from showing results for the insiders' trading volume in percentage of her stock wealth. Moreover, the first three columns of either buy and sell trades present estimation results for the case where institutional ownership is aggregated over all institutional investors whereas in the middle and last three columns institutional investors are categorized by their investment dedication as well as their type. That is, first, we classify the institutions into three groups of investment dedication, namely dedicated (DED), quasi-indexer (QIX) and transient (TRA) institutions. Dedicated (DED) and quasi-indexer (QIX) investors provide according to Bushee (1998) long-term, stable ownership to firms because they are geared toward longer-term dividend income or capital appreciation. Moreover, dedicated institutions (DED) are characterized by large average investments in portfolio firms and extremely low turnover, consistent with a "relationship investing" role and a commitment to provide long-term patient capital (Porter, 1992; and Dobrzynski, 1993). Quasi-indexers (QIX) are also characterized by low turnover, but they tend to have diversified holdings, consistent with a passive, buy-and-hold strategy of investing portfolio funds in a broad set of firms (Porter, 1992). Because of the longer investment horizons of these types of institutions, they should be less focused on near-term earnings and should have preferences that are insensitive to the distribution of short-term future value. Instead, transient institutions (TRA) are characterized as having high portfolio turnover and highly diversified portfolio holdings. They tend to be investors focused on enhancing and gaining (trading) profits in the short-run (Porter, 1992). Second, we classify institutional investors by their type, i.e. whether the particular institution is a bank trust (BNK), insurance company (INS), investment company (INV), independent investment advisor (IIA), corporate (private) pension fund (CPS), public pension fund (PPS), university and foundation endowment (UFE) or whether it has to be attributed to a miscellaneous type of institution (MSC). Results of this exercise are quite similar to ones presented in sections 3.4.1 and 3.4.2. First, it becomes evident that higher corporate governance levels seem to prevent or discourage insiders from engaging in insider trading as means of opportunistic rent extraction as abnormal profit coefficients are insignificant, respectively not significant positive in the case of buy trades and insignificant across the board in the case of sell trades. Second, results confirms the notion of buy and sell trades not being just two sides of the same coin. That is, in the case of buy trades a higher level of corporate governance leads to a better pre-event information environment which results in less positive abnormal returns as the incremental positive information revealed by the trade is smaller. That is, the coefficient of aggregated institutional ownership, as proxy for the level of corporate governance, is negative and significant at the five and even one percent level, in the case of abnormal returns six months subsequent to the insider trade. Moreover, when splitting up institutional investors regarding their investment dedication only the coefficient of dedicated investors remains significant negative at the five percent level, as well, reassuring that indeed aggregate institutional ownership is an adequate governance proxy. Regarding the different types of institutional investors only coefficients of insurance (INS) and investment companies (INV) are highly significant, again confirming to some extent the notion that a better pre-information environment is associated with lower abnormal returns following insider buy trades in a better corporate governance environment. Especially insurance (INS) and investment companies (INV)—because of their legal and fiduciary responsibilities—have to convey proper information about the quality of their investments to the public, respectively their customers and regulatory authorities. Hence, it is more likely that for those companies information precision is higher so that more information is incorporated in prices just before insider trades take place. In the case of sell trades, results confirm the notion that insider trades in firms with better corporate governance are perceived to convey more valuable, negative information to the capital market so that prices adjust more for companies with better governance schemes. That is, the coefficient of aggregated institutional ownership is negative and significant at the one percent level, in the case of abnormal returns of one and six months subsequent to the insider trade. Moreover, when splitting up institutional investors regarding their investment dedication dedicated investors exhibit the largest coefficient, followed by transient institutions and quasi- indexers. Similar to buy trades, institutional ownership of insurance (INS) and investment companies (INV) exhibits the largest coefficients, followed by independent investment advisor (IIA) and bank trusts (BNK). Only ownership of foundation endowments (UFE) is associated with positive abnormal returns.

All in all, our results are robust to a variety of different model alterations. First, corporate governance levels seem to prevent or discourage insiders from engaging in insider trading as means of opportunistic rent extraction. Second, we do find evidence that buy and sell trades differ substantially as we confirm the Ex-ante Information Hypothesis for insider buy trades and the Information Content Hypothesis for sell trades. That is, a higher level of corporate governance leads to a better pre-event information environment which results in less positive abnormal returns after insider buy trades as the incremental positive information revealed by the trade is smaller. In contrast, sell trades in firms with better corporate governance are perceived to convey more valuable, negative information to the capital market so that prices adjust more for companies with better governance schemes.

TABLE 3.6 WEALTH-PERFORMANCE SENSITIVITY (WPS)

	PANEL A - BUY TRADES				PANEL B - SELL TRADES			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	AR 1	AR 6	AP 6	Trans. Vol.	AR 1	AR 6	AP 6	Trans. Vol.
Inst. Ownership	-0.053	-0.698***	-3.010	-0.147	-0.041**	-0.061	7.367*	1.020
	(-0.76)	(-2.79)	(-0.88)	(-1.16)	(-2.04)	(-0.98)	(1.67)	(1.61)
WPS	0.003	0.002	0.235	-0.014	-0.001	-0.002	-0.588*	-0.069
	(1.23)	(0.25)	(1.26)	(-1.47)	(-0.76)	(-0.67)	(-1.71)	(-1.21)
E-Index	2.041*	0.749	-11.853	0.160	0.071	-0.318	-21.515	5.935
	(1.76)	(0.18)	(-0.33)	(0.09)	(0.26)	(-0.29)	(-0.46)	(0.51)
constant	-0.657	72.940***	582.311	24.133	2.070	14.700*	-777.193	-178.685*
	(-0.10)	(2.69)	(1.09)	(1.43)	(0.77)	(1.70)	(-0.73)	(-1.76)
Year FE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Insider controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Trade controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Firm controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Obs	2,221	2,221	2,221	2,221	14,502	14,502	14,502	14,502
R-squared	0.036	0.129	0.067	0.007	0.015	0.068	0.010	0.017

This table shows results of daily insider trading regressions, whereas Panel A reports results for the case of insider buy trades and Panel B presents results for the case of insider sell trades. The main variables of interest are the aggregated level of institutional ownership, the Entrenchment Index (E-Index) and Edmans Wealth-Performance Sensitivity measure (WPS). Concerning the E-index, the index is based on six governance provisions whereat a company is given a score between 0 and 6, based on the number of the provisions that the company has in a given year. Of these six provisions, four set constitutional limits on shareholders' voting power, namely staggered boards, limits to shareholder amendments of the bylaws, supermajority requirements for mergers, and supermajority requirements for charter amendments. The two other provisions, poison pills and golden parachutes, are measures taken in preparation for a hostile offer. Hence, the higher the index the worse is the level of corporate governance. Besides those main variables of interest the model contains insider controls (a Bidirectional trade dummy variable which equals one if the insider purchases and sells on the same trading day and zero otherwise and variables that account for the position of the insider within the company), trade controls (the insider's trading frequency during the month and the insider's trading volume in percentage of the insider's stock wealth, except in columns 4 and 8) and a distinct set of insider's firm-level control variables. The independent variable in columns 1 and 5 are the buy and hold abnormal returns over a period of one month (AR 1) and in columns 2 and 6 over six months (AR 6), subsequent to insider trading. In columns 3 and 7 the independent variable are the insiders' six month dollar abnormal trading profits (AP 6) and finally in columns 4 and 8 the independent variable is the insider's individual trading volume in percentage of the insider's stock wealth. * $p<0.10$, ** $p<0.05$, *** $p<0.01$

TABLE 3.7 INSTITUTIONAL OWNERSHIP - MONTHLY INSIDER TRADING

PANEL A - BUY TRADES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent variable	AR 1	AR 6	AP 6	AR 1	AR 6	AP 6	AR 1	AR 6	AP 6
Inst. Ownership	-0.033**	-0.225***	-1.791	-	-	-	-	-	-
	(-2.41)	(-5.31)	(-1.28)						
DED Ownership	-	-	-	-0.127**	0.181	5.399	-	-	-
				(-2.03)	(0.89)	(0.61)			
QIX Ownership	-	-	-	-0.017	-0.008	-1.350	-	-	-
				(-1.59)	(-0.23)	(-1.35)			
TRA Ownership	-	-	-	-0.043	0.017	-1.308	-	-	-
				(-1.53)	(0.12)	(-0.77)			
BNK Ownership							-0.018	-0.271	-5.489*
							(-0.46)	(-1.56)	(-1.87)
INS Ownership	-	-	-	-	-	-	-0.049	-0.598***	-0.025
							(-0.81)	(-2.71)	(-0.01)
INV Ownership	-	-	-	-	-	-	-0.117***	-0.322***	2.877
							(-3.80)	(-2.61)	(0.86)
IIA Ownership	-	-	-	-	-	-	-0.019	-0.127	-1.015
							(-0.95)	(-1.19)	(-0.55)
CPS Ownership	-	-	-	-	-	-	0.239	-1.159	-96.395
							(0.70)	(-0.88)	(-1.54)
PPS Ownership	-	-	-	-	-	-	-0.013	0.005	4.248
							(-0.10)	(0.01)	(0.27)
UFE Ownership	-	-	-	-	-	-	0.428	-0.076	4.328
							(0.94)	(-0.06)	(0.07)
MSC Ownership	-	-	-	-	-	-	0.062	-1.227	-6.848
							(0.48)	(-1.29)	(-1.00)
constant	3.491**	25.500***	50.957	3.032*	20.330***	20.267	3.183**	24.736***	57.638
	(2.18)	(4.23)	(0.34)	(1.92)	(3.51)	(0.14)	(1.99)	(4.49)	(0.39)
Year FE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Insider controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Trade controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Firm controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Obs	77,245	77,245	77,245	77,245	77,245	77,245	77,245	77,245	77,245
R-squared	0.010	0.031	0.001	0.010	0.030	0.001	0.010	0.032	0.001

This table shows results of monthly insider trading regressions, whereas Panel A reports results for the case of insider buy trades and Panel B presents results for the case of insider sell trades. Columns 1-3 and 10-13 present models where the main variable of interest is the aggregated level of institutional ownership. Columns 4-9 and 13-18 present models where main variable of interest is the level of institutional ownership, whereas institutional investors are classified twofold. First, in columns 4-5 and 13-15 institutions are classified into three groups of investment dedication, namely dedicated (DED), quasi-indexer (QIX) and transient (TRA) institutions. Second, in columns 7-9 and 16-19 institutional investors are classified by their type, i.e. whether the particular institution is a bank trust (BNK), insurance company (INS), investment company (INV), independent investment advisor (IIA), corporate (private) pension fund (CPS), public pension fund (PPS), university and foundation endowment (UFE) or whether it has to be attributed to a miscellaneous type of institution (MSC). Besides those main variables of interest the model contains insider controls (a Bidirectional trade dummy variable which equals one if the insider purchases and sells on the same trading day and zero otherwise and variables that account for the position of the insider within the company), trade controls (the insider's trading frequency during the quarter and the insider's trading volume in percentage of the insider's stock wealth) and a distinct set of insider's firm-level control variables. The independent variable in columns 1, 4, and 7 as well as in columns 10, 13 and 16 are the buy and hold abnormal returns over a period of one month (AR 1) and in columns 2, 5, and 8 as well as in columns 11, 14 and 17 over six months (AR 6), subsequent to insider trading. In columns 3, 6, and 9 as well as in columns 12, 15 and 18 the independent variable are the insiders' six month dollar abnormal trading profits (AP 6). * p<0.10, ** p<0.05, *** p<0.01

TABLE 3.7 CONTINUED

PANEL B - SELL TRADES	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Dependent variable	AR 1	AR 6	AP 6	AR 1	AR 6	AP 6	AR 1	AR 6	AP 6
Inst. Ownership	-0.042***	-0.177***	-7.010	-	-	-	-	-	-
	(-6.26)	(-8.35)	(-0.99)						
DED Ownership	-	-	-	-0.084***	-0.200**	-10.362	-	-	-
				(-2.63)	(-2.00)	(-0.85)			
QIX Ownership	-	-	-	-0.013***	-0.054***	-4.442	-	-	-
				(-3.53)	(-4.60)	(-1.51)			
TRA Ownership	-	-	-	-0.037***	-0.185***	-7.188	-	-	-
				(-4.06)	(-6.49)	(-1.44)			
BNK Ownership							-0.033*	-0.159***	-8.834
							(-1.91)	(-3.08)	(-0.63)
INS Ownership	-	-	-	-	-	-	-0.134***	-0.380***	-10.604
							(-4.17)	(-3.96)	(-1.10)
INV Ownership	-	-	-	-	-	-	-0.063***	-0.324***	-10.988
							(-5.11)	(-7.31)	(-0.90)
IIA Ownership	-	-	-	-	-	-	-0.036***	-0.160***	-6.363
							(-3.66)	(-5.74)	(-1.07)
CPS Ownership	-	-	-	-	-	-	-0.163	-0.870	-49.289
							(-1.07)	(-1.60)	(-0.52)
PPS Ownership	-	-	-	-	-	-	0.047	0.243	29.608
							(0.68)	(1.40)	(1.36)
UFE Ownership	-	-	-	-	-	-	0.593***	1.549**	64.288
							(2.90)	(2.55)	(0.56)
MSC Ownership	-	-	-	-	-	-	0.044	0.121	15.531
							(1.13)	(0.82)	(0.45)
constant	5.161***	27.294***	504.967	4.352***	15.553***	128.917	4.843***	26.776***	425.538
	(7.97)	(13.45)	(0.69)	(7.38)	(9.76)	(0.29)	(7.38)	(12.98)	(0.58)
Year FE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Insider controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Trade controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Firm controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Obs	182,441	182,441	182,441	182,441	182,441	182,441	182,441	182,441	182,441
R-squared	0.011	0.050	0.001	0.010	0.048	0.001	0.011	0.052	0.001

This table shows results of monthly insider trading regressions, whereas Panel A reports results for the case of insider buy trades and Panel B presents results for the case of insider sell trades. Columns 1-3 and 10-13 present models where the main variable of interest is the aggregated level of institutional ownership. Columns 4-9 and 13-18 present models where main variable of interest is the level of institutional ownership, whereas institutional investors are classified twofold. First, in columns 4-5 and 13-15 institutions are classified into three groups of investment dedication, namely dedicated (DED), quasi-indexer (QIX) and transient (TRA) institutions. Second, in columns 7-9 and 16-19 institutional investors are classified by their type, i.e. whether the particular institution is a bank trust (BNK), insurance company (INS), investment company (INV), independent investment advisor (IIA), corporate (private) pension fund (CPS), public pension fund (PPS), university and foundation endowment (UFE) or whether it has to be attributed to a miscellaneous type of institution (MSC). Besides those main variables of interest the model contains insider controls (a Bidirectional trade dummy variable which equals one if the insider purchases and sells on the same trading day and zero otherwise and variables that account for the position of the insider within the company), trade controls (the insider's trading frequency during the quarter and the insider's trading volume in percentage of the insider's stock wealth) and a distinct set of insider's firm-level control variables. The independent variable in columns 1, 4, and 7 as well as in columns 10, 13 and 16 are the buy and hold abnormal returns over a period of one month (AR 1) and in columns 2, 5, and 8 as well as in columns 11, 14 and 17 over six months (AR 6), subsequent to insider trading. In columns 3, 6, and 9 as well as in columns 12, 15 and 18 the independent variable are the insiders' six month dollar abnormal trading profits (AP 6). * p<0.10, ** p<0.05, *** p<0.01

3.6 CONCLUSION

By analyzing the most salient measures of corporate governance, namely the level of institutional ownership, anti-takeover provisions and top executives characterization and compensation variables we are able to reveal three important insights.

First, as there is still an ongoing debate in the academic literature whether to treat insider trading as rent extraction by insiders or as signals for firm value changes, our results strongly confirm the latter notion.

Second, we highlight the view that insider buy and sell trades are not two sides of the same coin. In cases of insider purchases we see lower abnormal returns for companies with higher levels of corporate governance indicating that insiders do not convey new or credible favorable information to the capital market via their buy trades. It seems to be the case that all positive information are already incorporated into stock prices before the insider trade takes place. Hence, in the case of an insider buy trade we support the so called Ex-ante Information Hypothesis (H.1). As Leuz et al. (2003) suggest, high governance levels may improve financial transparency by mitigating insiders' ability and motivation to distort information disclosures, so that higher information precision and more information incorporated in prices just before insiders' trades, is associated with lower price adjustments following insider transactions. In other words, a better pre-event information environment implies that the incremental information revealed by the trade is smaller and therefore good corporate governance has a negative effect on the market's subsequent reaction to an insider trade. Vice versa, for firms with weaker corporate governance there is likely a greater level of information asymmetry such that an insider trade is more revealing than if there had been little information asymmetry in the first place. However, the opposite is true in the case of sell trades. Insiders of companies with higher levels of corporate governance convey credible bad signals to the capital market when they sell shares. Accordingly, in the case of an insider sell trade we support the so called Information Content Hypothesis (H.2). In firms with better corporate governance insiders' actions are more transparent, credible and trustworthy. Sell trades by insiders who consume only small private benefits of control, whose incentives are therefore better aligned with the shareholders', send more credible signals by trading in their firm's stock which cause a larger reaction to insider sell trades. Consequently, as argued in Morck et al. (2000), investors read more into insiders' actions and are more likely to act upon firm specific information, in this case the negative information content of sell trades.

Third, we show that institutional ownership even on an aggregate level is a sufficient measure to proxy a company's corporate governance level. Results for institutional investors that because of their investment dedication and type exhibit distinctively higher incentives to enforce proper corporate governance standards show similar outcomes as results for the aggregated level of institutional ownership. Moreover, information on corporate bylaws that make it difficult or expensive for outside investors to effect changes with regard to the top management and board of directors do not provide additional information. Hence, as information on companies' bylaws and on investors' investment dedication and type are scarce, respectively associated with higher costs because one has to gather that information one can refrain from that and instead proxy the governance level with the aggregate measure of institutional ownership.

4 CAPITAL FLOWS, REAL ESTATE, AND LOCAL CYCLES: EVIDENCE FROM GERMAN CITIES, BANKS, AND FIRMS[78]

4.1 INTRODUCTION

Capital flows are procyclical at business cycle frequency and can affect output through multiple channels (e.g., Uribe and Schmitt-Grohe, 2017). As an asset class, real estate is also procyclical and has a large weight in economies' income and wealth (Davis and Van Nieuwerburgh, 2015).[79] Do real estate markets play a role in the transmission of capital flow shocks to output over the business cycle? What are the mechanisms? This chapter addresses these questions by studying the role of real estate markets in the transmission of capital flow shocks to output growth across German cities during the post-global (or great) financial crisis (GFC) episode of bank repatriation of foreign assets from Southern Europe.

Germany during the post-GFC period is an ideal laboratory to investigate the questions above. Before the GFC, German and other Northern European banks built up claims on the periphery that were far in excess of their respective countries' bilateral surpluses (Hale and Obstfeld, 2016). After the crisis, they reduced cross-border holdings of sovereign debt and increased their holdings of locally issued debt (Brutti and Saure, 2016). As Figure 4.1 shows, post-GFC, Germany strongly outperformed Southern Europe in terms of real GDP growth

[78] This chapter is based on Bednarek et al. (2019) and Bednarek et al. (2021 B)

[79] See the Data Appendix for selected stylized facts from the literature and our data set.

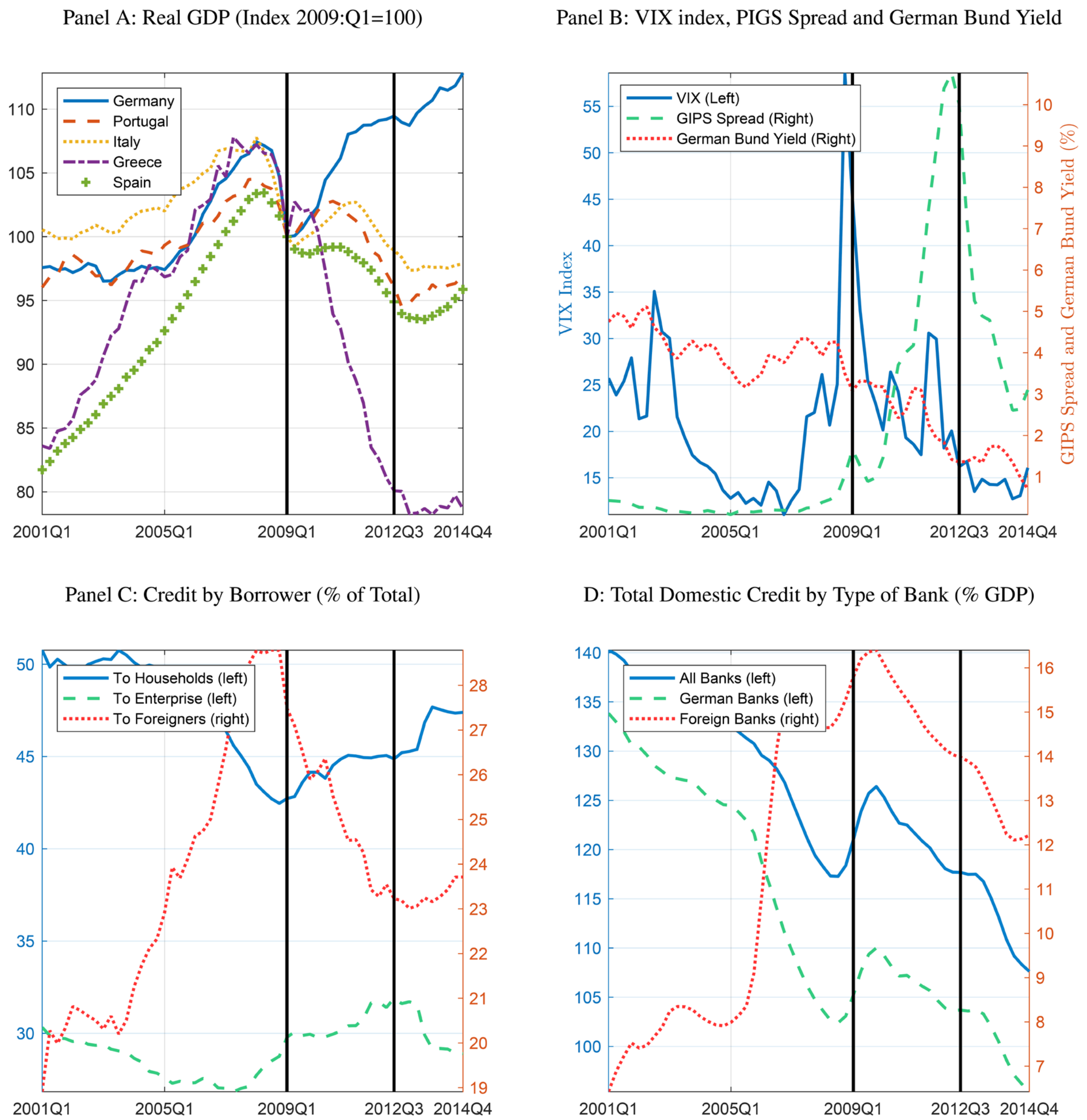
(Panel A), as Portugal, Italy, Spain and Greece were engulfed in a deep and persistent sovereign debt and banking crisis (Panel B). Banks rebalanced the composition of their loan portfolios toward domestic households and firms (Panel C). Interest rates fell dramatically (Panel B), the stock market soared (not reported), and Germany experienced the first property price boom in 20 years, with a cumulative increase during the 2009-2014 period exceeding 20 percent in both the residential and the commercial sector (Figure 4.2).

We find that the impact of a bank flow shock, as captured by the sovereign bond spread of Southern European countries over Germany (the so-called PIGS spread plotted in Figure 4.1 Panel B), is more significant in cities that are more exposed to tightness in local real estate markets. We estimate that, during the 2009-2014 period, for every 100-basis point increase in the PIGS spread, the most exposed German cities grow 15-25 basis points more than the least exposed ones. Moreover, the differential response of commercial property prices across cities to the bank flow shock can explain most of this growth differential. When we unpack the transmission mechanism, we find that firms with more real estate collateral, as measured by tangible fixed assets, receive more credit when banks repatriate foreign assets and retrench from Southern Europe. Firms with more collateral also invest and hire more, thereby contributing to higher output growth. During the episode that we study, however, we find no evidence that better credit access and higher investment by firms with more real estate collateral leads to capital misallocation.

To investigate the importance of real estate markets in the transmission of capital flows shocks to city output growth, we assemble a new database that includes aggregate, city-level and bank-firm-level data. At the aggregate level, we focus on bank flow data, based on BIS Locational Statistics, which is an important component of total capital flows (Bruno and Shin, 2014). Next, we construct a new matched city-level data set that, in addition to publicly available variables, includes a proprietary database on residential and commercial property price indexes from Bulwiengesa AG (a reputable German real estate data provider). Finally, to unpack the transmission mechanism, we construct a second novel bank-firm relationship level data set based on the German credit register, the Bundesbank supervisory database, and

Bureau van Dijk's Amadeus.

Figure 4.1 MACROECONOMIC BACKGROUND



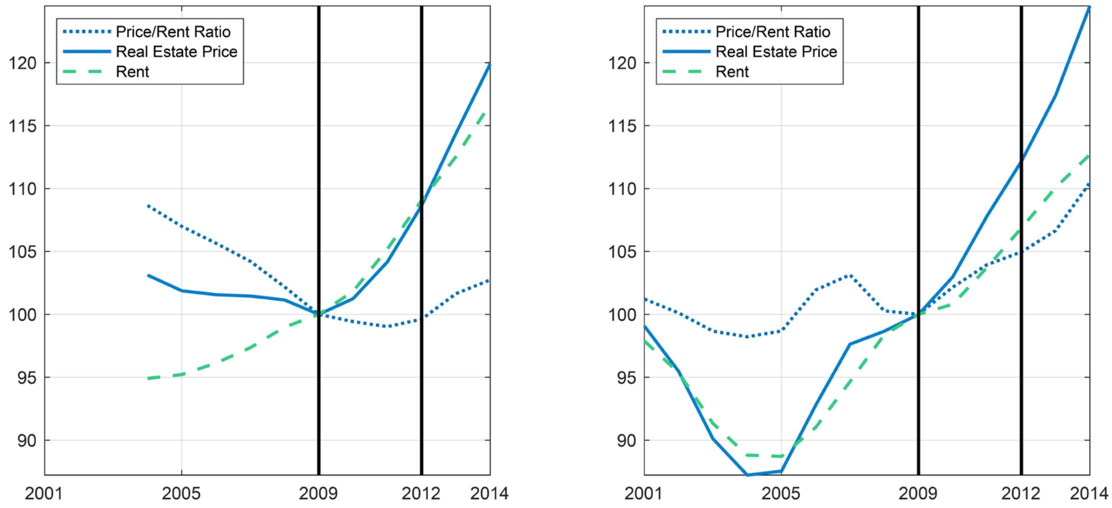
NOTE. Panel A plots real GDP for Germany, Portugal, Italy, Greece and Spain. Panel B plots the US VIX index of implied stock market volatility together with the PIGS Spread (the simple average of the 10-year sovereign bond yield spread over the German Bund for Portugal, Italy, Greece, and Spain), and 10-year German Bund yield. Panel C plots the share of total lending by German banks to different borrowers. Panel D plots total credit as a share of GDP extended by different type of banks. The vertical lines mark the beginning of the German recovery in 2009:Q1 and the "Whatever It Takes" speech by ECB Governor Draghi in 2012:Q3, respectively. See the Data Appendix for variable definitions and data sources.

To identify the importance of real estate markets in the transmission of bank flow shocks, we rely on identification by geographic variation, as for instance in Chaney, Sraer and Thesmar (2012), Favara and Imbs (2015), Mian, Sufi and Verner (2017), Hoffmann and Stewen (forthcoming), and Jorda et al. (2015) among others. We first establish that, during our sample period, the PIGS spread is closely associated with alternative measures of bank flows from the rest of the euro area, and particularly with banks' repatriation of gross foreign assets.[80] We show that this link is tight both at the national level and the individual-bank level. We also show that the PIGS Spread is associated with lower domestic lending-deposit spreads at the national level and lower firm borrowing costs at the firm level, consistent with the notion that, when banks repatriate foreign assets, they can expand the domestic credit supply, as the macroeconomic evidence in Panel C of Figure 4.1 shows. We then interact the PIGS spread, as a proxy for bank inflows from Southern Europe, with a measure of real estate market tightness (or exposure for brevity) that varies across cities quasi-randomly.

[80] Many studies use on the VIX index of stock market volatility, plotted in Panel B of Figure 4.1, as a driver of global bank flows, following the seminal work of Rey (2013) on the importance of the global financial cycle. In a similar vein, we use the PIGS spread as a way to characterize regional bank flows.

Figure 4.2 The German Real Estate Boom

Panel A: Residential Real Estate (Indexes, 2009=100)   Panel B: Commercial Real Estate (Indexes, 2009=100)



Note. Panel A plots national residential real estate prices, rent and price-to-rent indexes. Residential data are not available from 2001-2003. Panel B plots national commercial real estate prices, rent, and price-to-rent indexes. The vertical lines mark the beginning of the recovery in 2009:Q1 and the "Whatever It Takes" speech by ECB Governor Draghi in 2012:Q3, respectively. See the Data Appendix for variable definitions and data sources.

This exposure measure is the product of two variables: one affecting the city supply of real estate and the other the demand side of the market. The supply-side indicator is the gross share of land that cannot be developed for real estate purposes (henceforth the "share of non-developable area") in the spirit of Saiz (2010). The share of non-developable area is a good candidate instrument for real estate prices as land-use regulations and geography determine it. Unlike in the United States, however, variation across German cities in the gross share of non-developable area comes mostly from variation in land designated as forestland or for agricultural uses, rather than differences in the incidence of steep-slope terrains and water bodies. Moreover, land-use regulations are distributed rather uniformly in Germany. For relevance purposes, therefore, we will show that it is useful to complement this indicator with information on a source of random demand variation across cities. Indeed, in the chapter, we will argue that both components of our exposure measure are plausibly distributed quasi-randomly across cities, but neither of them predicts property prices as well as the interaction of the two, especially in the commercial sector.

The demand-side indicator that we propose to complement the share of non-developable area is the share of refugees in total refugees (henceforth the "share of refugees"), which is a novel instrument in the real estate literature. The share of refugees is a good candidate instrument because it exploits a policy framework in Germany that assigns refugee immigrants to cities (or municipalities) on a quasi-random basis. As we document in the chapter, in Germany, the city share of refugees is determined by government rules and regulations at the state and city level, which are well known to be applied strictly. We also argue that refugees have limited or no ability to impact the labor market in the short-term in Germany.

Yet, refugee immigrants can have a strong impact on local real estate markets.[81] As in other countries, in Germany, refugees are entitled to housing benefits, but are allocated across municipalities without taking pre-exiting levels of congestion into account. Moreover, the correlation between commercial and residential real estate prices is sizable in our data. This correlation, which is almost 0.4 in our panel data set, is similar to the one in the United States (see, for instance, Gyourko, 2009; and Chaney et al. ,2012), and is typically seen as driven by land prices and spatial linkages (Ahlfeldt, Redding, Sturm and Wolf, 2015; Mills, 1967; and Roback, 1982). The share of refugees, therefore, can be a relevant instrument also for commercial property prices. In fact, in the chapter we will show that in the commercial sector, the share of refugees is an even stronger predictor than in the residential one.

The main result of the chapter is that bank flow shocks, as captured by changes in the PIGS spread, have a larger impact on output growth in cities with tighter real estate markets, as proxied by our exposure measure. We estimate that, during the 2009-2014 period, for every 100-basis point increase in the PIGS spread, cities at the 90th percentile of the exposure distribution grow 15-25 basis points more than cities at the 10th percentile. Moreover, we find that most of this growth differential across cities can be accounted for by the differential response of commercial property prices across cities triggered by the PIGS spread change. We interpret this result as consistent with the working of a collateral channel on the firm side (e.g., Liu,

[81] For example, econometric evidence on the impact of Syrian refugees in the case of Turkey shows that the impact on local housing markets is large and statistically significant (Tumen, 2016).

Wang and Zha, 2013; Chaney et al., 2012; Gan, 2007; Schmalz et al., 2017; and Adelino et al., 2015 among others), and thus highlight the importance of commercial real estate in the transmission of capital flow shocks.

In the second part of the chapter, we open the black box of the transmission mechanism of bank flow shocks through commercial real estate, focusing on the role of collateral. As a proxy for real estate collateral, we use tangible fixed assets as a share of total assets, which are a sizable fraction of property, plants, and equipment assets (PPEs) in both Germany and the United States.[82] We study the role of collateral in bank credit allocation to firms, in firm employment and investment decisions, and in capital misallocation in response to the same bank flow shock that we considered in the first part of the chapter. To address endogeneity concerns, in this second part of the empirical analysis, we rely on the granular nature of our bank-firm-level data, adding a comprehensive set of control variables and on the implementation of a large set of robustness exercises.

Consistent with a large body of existing literature, we find that collateral plays a critical role in differential impact of the bank flow shocks across cities. Repatriation of foreign assets from Southern Europe leads German banks to increase domestic credit supply to firms and sectors with a relatively higher share of tangible fixed assets. We also show that firms with more tangible assets invest and hire more, thus contributing to the local economic expansion. Interestingly, however, this transmission is not associated with evidence of capital misallocation. We attribute the latter finding to the fact that the German post-GFC real estate boom is not associated with a credit boom (Panel D of Figure 4.1).

This chapter relates to the literature along multiple dimensions. First, the chapter contributes to the literature on the relationships between capital flows, the business cycle and house prices. Two large bodies of empirical and theoretical work focus on capital flows and

[82] See Rochdi (2015) and Chaney et al. (2012), respectively. Unfortunately, the German credit register does not contain information on collateral. Moreover, buildings, land and improvements, and construction in progress are not identified separately from PPE in Amadeus. However, one important advantage of Amadeus relative to the filings of public companies that would permit disentangling real estate holdings from other fixed tangible assets ore precisely, is that it covers not only publicly listed companies but also smaller and private firms. This is crucial has holding of real estate assets is heterogeneous across firm size and industry (again see Rochdi, 2015; and Chaney et al., 2012 for details).

the business cycle on the one hand, and capital flows and house prices on the other.[83] Our main contribution is to identify the causal role of real estate markets in the transmission of capital flow shocks to short-term output growth.[84] As far as we are aware, this is the first analysis that documents empirically with disaggregated data the mediating role of property prices in the transmission of capital flow shocks.

More specifically, several empirical papers document a positive correlation between the current account and house prices. For example, Aizenman and Jinjarak (2009) document a strong positive association between the current account and house prices, holding constant a number of country characteristics in a large panel of countries. We document a similarly close association between bank flows and commercial property prices. Cesa-Bianchi, Ferrero and Rebucci (2018) show that residential house prices co-move strongly with consumption growth conditional on a bank flow shock identified in the time series dimension and relate countries' consumption sensitivity to different characteristics. We exploit the quasi-random variation of our real estate market exposure measure to assess the differential impact of a bank flow shocks across cities causally. Favilukis, Ludvigson and Van Nieuwerburgh (2017) study theoretically the impact of capital flows in the United States and show that lower bond yields cannot explain the US residential house price boom. We focus on commercial real estate prices and provide disaggregated evidence that firm real estate collateral introduces additional channels of transmission of capital flow shocks. Caballero and Simsek (forthcoming) develop a model of transmission of a capital flow shock originating from repatriation of domestic assets as in our empirical analysis. We provide direct evidence speaking to these dynamics.

Second, this chapter relates to the literature on the impact of capital flows on credit supply, the real economy and house prices. Cetorelli and Goldberg (2011, 2012) show that global banks contracted their direct and indirect (interbank) cross-border lending during the GFC, leading to a reduction in credit supply in regions from which capital was pulled. We study the case of a country whose banks repatriated foreign assets during the GFC and establish

83 The first block is longstanding and voluminous. The second block is more recent and focused. For instance, Favilukis, Kohn, Ludvigson and Van Nieuwerburgh (2013) review both theory and evidence.

84 Note that the chapter is silent on the puzzling behavior of capital flows and their relationship with growth in the long run (e.g., Gourinchas and Jeanne, 2013).

that bank retrenchment led to an increase in domestic credit supply benefiting especially firms richer in real estate collateral. Employing bank-firm level from the Turkish credit registry, Baskaya, Di Giovanni, Kalemli-Ozcan, Peydro and Ulu (2017) and Baskaya, Giovanni, Kalemli-Ozcan and Ulu (2018) show that capital inflows increase the volume and reduce the price of domestic credit. We provide complementary and consistent evidence using credit register data for a major advanced economy and we also evaluate the transmission mechanism to firm outcomes, including misallocation. Mian, Sufi and Verner (2017) show that an aggregate credit supply expansion boosts local demand and amplifies the expansion phase of the business cycle, with higher GDP, employment, residential investment, and house prices. We document comparable dynamics for Germany following a similar identification strategy and we document the transmission mechanism at the bank-firm level.

Third, this chapter relates to the literature on the collateral channel and real estate prices. The underlying mechanism is that firms use pledgeable assets as collateral, typically land and buildings, to finance productive projects, residential housing and durable consumption. Fluctuations in real estate prices, therefore, can have sizable effects on aggregate investment, consumption and output. For instance, Iacoviello (2005) and Liu et al. (2013) develop quantitative general equilibrium models in the spirit of Kiyotaki and Moore (1997) of the collateral channel on the household and the firm side, respectively. Liu, Wang and Zha (2013), in particular, introduce land in firms' credit constraints and show that the model can explain the co-movement between land prices and business investments that the collateral channel from the household side cannot match. In this chapter, we show that commercial property price changes triggered by bank flow shocks can account for most of the differential impact of these shocks on city output growth, thus providing disaggregated evidence consistent with the working of a collateral channel on the firm side. Chaney, Sraer and Thesmar (2012) use firm-level data to show that an exogenous variation in property prices triggered by aggregate mortgage rate changes can have a sizable impact on corporate investment. Using comparable data and methodology, we find that these effects are quantitatively sizable in the transmission of bank flow shocks. Other studies with micro data showed that fluctuations in property prices can also have an impact on firm employment, exit and entry decisions, and capital structure (e.g., Schmalz et al., 2017; Cvijanovic, 2014; and Davis and Haltiwanger, 2019, respectively). We provide micro evidence on the transmission mechanism of bank flow shocks through similar effects on firm hiring and investment decision.

Fourth, this chapter contributes to the literature on capital misallocation in response to capital flow shocks or housing booms. Gopinath, Kalemli-Ozcan, Karabarbounis and Villegas-Sanchez (2017) show that, during the boom years before the GFC, cross-border bank flows led to misallocation and reduced total factor productivity in Southern Europe, but not in Northern Europe, including Germany. We investigate capital misallocation in Germany during the post-GFC cross-border bank retrenching episode. Chakraborty, Goldstein and MacKinlay (2018) find that banks that are active in buoyant housing markets substitute mortgages for corporate loans. As a result, the credit supply to firms tied to these banks shrinks and their investment contracts. Doerr (2018) shows that, when property and land prices increase, firms with larger real estate holdings hire, invest, and produce more, but are less productive than firms with smaller real estate holdings in a sample of US public companies. Both Chakraborty, Goldstein and MacKinlay (2018) and Doerr (2018) study housing booms with credit booms. We focus on a real estate boom without a credit boom. Similarly, Martin, Moral-Benito and Schmitz (2018) find that Spanish banks more exposed to a real estate bubble initially lend relatively more to housing firms than non-housing firms. However, as the bubble persists, the composition effect disappears because housing credit repayments raise banks' net worth, supporting the credit access of all firms. We show that a capital flow shock leads to a larger expansion in cities more exposed to real estate markets. In the absence of a credit boom, however, the bank flow shock does not appear to be associated with lower TFP growth and capital misallocation.

Fifth, the chapter speaks to the new literature on the role of foreign purchases of real estate in global cities like London, New York and Vancouver. Favilukis and Van Nieuwerburgh (2017) develop a heterogeneous spatial model of cities and show that an increase in out-of-town home buyers can drive up local real estate prices significantly. Consistent with their findings, we show that influxes of refugee immigrants predict property prices in both the residential and the commercial sector. Badarinza and Ramadorai (2018) use a “preferred habitat” framework to document that foreign risk can affect real estate valuations in global cities. We show that instability in Southern Europe was associated with bank retrenchment and impacted real estate valuations in Germany’s main cities.

Finally, other papers have used the government allocation of refugees for identification purposes. Dustmann, Vasiljeva and Piil Damm (forthcoming) and Eckert, Walsh and Hejlesen (2018) exploit the quasi-random nature of the refugee allocation in Denmark to study the impact of immigration on voting outcomes and the urban wage premium, respectively. We exploit the quasi-random distribution refugees to estimate the differential impact of bank flow shocks on city business cycles. As far as we are aware, this is the first analysis that uses the spatial distribution of refugees as an instrument for property prices.

The rest of the chapter is organized as follows. Section 4.2 describes our data. Section 4.3 outlines the empirical strategy and the research design, including a discussion of the proxy for bank flows and the instrumental variables that we use in the chapter. Section 4.4 reports the main result of the chapter on the role of real estate in the transmission of capital flow shocks.

The rest of the chapter unpacks the transmission mechanism in two separate steps. Section 4.5 explores the role of real estate collateral in the allocation of credit to individual firms and industries. Section 4.6 provides evidence on the differential impact of the capital flow shock on firm employment and investment decisions and investigates whether or not the transmission documented is associated with misallocation. Section 4.7 concludes. Details on the data we use and selected robustness checks are reported in an appendix at the end of the chapter.

4.2 DATA

To conduct the empirical analysis, we assembled a new and unique data set at the annual and quarterly frequency, from 2009:Q1 to 2014:Q4.[85] As a source of aggregate capital flow shocks, we focus on cross-border bank flows from the BIS Locational Statistics, or ”bank flows” for brevity, which is an important share of total flows (Bruno and Shin, 2014). In particular, as we motivate in detail in Section 4.3.1 below, we will focus on the component of bank flows predicted by the PIGS spread. In addition to official city-level statistics, the data set for the main results of the chapter includes an annual proprietary panel data set on residential and commercial property price indexes at the city level from Bulwiengesa AG. To study the details of the transmission mechanism, we then merge information on bank and firm characteristics from Bundesbank supervisory data and Bureau van Dijk’s Amadeus with individual bank-firm relationship data from the German credit register.

4.2.1 CITY-LEVEL DATA

Data on residential and commercial nominal property price indexes at the city level are proprietary from the research consultancy Bulwiengesa AG, accessed through the Bundesbank.[86] To construct nominal property price indexes by city and type of property, Bulwiengesa AG uses both valuation and transaction data from building and loan associations, research institutions, realtor associations, as well as the chambers of industry and commerce. As city-level CPI indexes are not available, we construct real property price indexes by using state-level official consumer price indexes. Germany is a diversified large economy and inflation was low and stable during the period we consider. Hence, using state-level CPI deflator is unlikely to influence our estimation results.

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[85] Appendix Table 4.A.1 defines all city and bank-firm-level variables that we use and describes their sources. Appendix Table 4.A.2 reports summary statistics for all variables. The Data Appendix also describes all the macroeconomic variables that we use.

[86] The Bundesbank relies on this provider for the publication of national indexes, also shared with the European Central Bank.

Both residential and commercial indexes are at the annual frequency. Residential indexes include the price of town houses, owner-occupied apartments and single-family detached homes. Commercial indexes include information on two segments of the market, retail and office buildings. The indexes are calculated at the city level as simple averages of the individual unit prices. Thus, they can be seen as common factors for city-level property prices—see, for instance, Pesaran (2015). We focus on the 79 urban areas or cities listed in Appendix Table 4.A.3. Bulwiengesa provides commercial real estate price data for 127 urban areas. In the German national accounts, however, some contiguous urban areas are aggregated under a single administrative district identifier. For instance, the city of Hanover and its hinterland were merged into one larger administrative district in 2001, which includes the city of Hanover itself and 20 other smaller municipalities. In our analysis, we focus on the 79 cities or areas whose geographical definition is the same as in the national accounts, so as to match data from the two sources exactly.

The dependent variable in the econometric specification of our main regressions is city real per capita GDP growth. As city-level GDP deflators are not available, we construct real GDP by using the same state-level official consumer price indexes used to deflate property prices indexes. We match real GDP and real estate price data with a number of other city-level variables. In particular, to construct our instrumental variable, we will use the gross share of land that cannot be developed relative to total area, calling this variable the "share of non-developable area" for brevity, and the share of refugees allocated by the government to a given city relative to the total number of refugees that entered the country, which we will call the "share of refugees" for brevity. Note here that, "asylum seekers" usually refers to individuals applying for asylum, and "refugees" refers to individuals whose asylum status has been approved and are entitled to the associated benefits, including housing benefits. In the German statistics, the total number of refugees includes (i) admitted refugees on a permanent basis, (ii) admitted refugees on a temporary basis, (iii) rejected asylum seekers that cannot be relocated, and (iv) a small fraction of asylum seekers not processed within the year. The matching of all city-level data is straightforward because based on a common city identifier across all variables.

The data are winsorized. Output growth is censored on the left hand side of the distribution at -10%, with very few city-year observations below this large negative value. We also winsorize the share of refugees by setting the value for Berlin and Hamburg, which have the highest average value in the sample, to the largest value in the third highest city, which is Munich. Note here that Berlin and Hamburg are two of the three German city states (Bremen being the third one), and are the two largest cities.[87] We note here that winsorizing output growth and the share of refugees at the 1% level in the panel would be insufficient, since our results would still be driven by some extreme city-year observations. Our empirical results, therefore, are not driven by outliers. On the contrary, as we shall see, our main result is stronger when we drop from the city sample the three city states.

4.2.2 Bank-Firm-Level Data

To explore the relationship among capital flows, bank lending behavior, firm decisions and commercial real estate prices, we match data from the German credit register over the period 2009:Q1-2014:Q4 with Bundesbank supervisory bank balance sheet data and firm-level data from Bureau van Dijk's Amadeus.

The German credit register contains information on bank exposure, including loans, bonds, off-balance sheet, and derivative positions (excluding trading book positions).[88] Financial institutions in Germany are required to report to the credit register if their exposure to an individual borrower, or the sum of the exposures to borrowers belonging to one legal entity, exceeds a threshold of 1 million euro. A legal borrowing entity comprises independent borrowers that are legally or economically connected to each other due to majority ownership (more than 50%), or due to profit transfer agreements. Consequently, the effective reporting threshold

[87] The sample average of the share of refugees and our exposure measure for all 79 cities is reported in Appendix Table 4.A.3.
[88] For a more detailed definition of bank exposure, see Section 14 of the German Banking Act: https: //www.bundesbank.de/Redaktion/EN/Downloads/Tasks/Banking_supervision/Acts_Regulations_Guidelines/banking_act.pdf?__blob=publicationFile.

is usually lower than 1 million euro.[89] A borrowing entity in the credit register, however, can have multiple bank relationships.[90] The German credit register captures about two-thirds of bank credit outstanding. That is, if we sum all loans reported in the credit register in a given quarter, this amounts to about two thirds of total credit outstanding as reported by German official bank balance sheet statistics.

We match credit register data with information on bank balance sheets from Bundesbank supervisory data.[91] Balance sheet data include total assets, liquid assets, the interbank-to-deposit funding ratio, the regulatory-capital ratio, non-performing loans, the return on assets and net and gross bank foreign assets. We also match firm-level accounting variables from the Bureau van Dijk's Amadeus with credit register data. In our analysis, we use firms' total assets (defined as the sum of current assets and non-current assets), tangible fixed assets (i.e., property, plant and equipment–PPE), total fixed assets, the equity-to-asset ratio, the return on assets, the number of employees and capital expenditure.

Our proxy for real estate collateral at the firm level, or collateral for brevity, which plays a critical role in the second part of our empirical analysis, is the share of tangible fixed assets in total assets. Unfortunately, the German credit registry does not include information on collateral. In addition, Amadeus data do not provide separate information on buildings, land and improvements, and construction in progress, the three categories of tangible fixed assets that are usually considered in the accounting definition of corporate real estate assets. However, for the United States, real estate is estimated to be a sizable fraction of total fixed assets, total assets, or firms' market values for publicly listed companies—see for instance Chaney et al. (2012) and Nelson, Potter and Wilde (2000). This ratio is usually assumed to be higher for private firms. Moreover, Laposa and Charlton (2002) estimate that European corporate holdings of real estate assets of publicly listed companies are even higher as a share of total assets than in the US due to the underdevelopment of the property management industry. Recent estimates of the share of real estate assets in total assets for German public companies, up to

[89] The official reporting threshold was lowered from 1.5 million to 1 million euro in 2014. Due to the relatively low effective reporting threshold, however, this reduction does not affect our results.
[90] Indeed, 92% of the firms in the German credit register borrow from more than one bank.
[91] We match the end-quarter values of these variables to the credit register data.

2013, show substantial variation across sectors and, unlike the United States, limited decline over time during the sample period we study (Rochdi, 2015). While the proxy variable we use is an imperfect measure of firm-level real estate collateral, one clear advantage of using total fixed tangible assets from Amadeus is that this variable is available not only for publicly listed companies, but also for smaller and private firms.

The data matching at the bank-firm level is challenging because the German credit register and the Amadeus database do not share a common identifier. We proceed as follows. First, we match by the unique commercial register number, when it is available. Second, for observations without this identifier, we rely on Stata's reclink command.[92] At this step, we match firms either by their name and zip code or by their name and city, with a minimum matching reliability of 0.99. We then match the remaining firms manually.[93] Overall, we can track the records of more than 44% of German firms included in the credit register during the sample period, slightly more than in previous studies using these data (see for instance Behn, Haselmann and Wachtel, 2016).

After the merge, we make two adjustments. First, we focus on commercial banks, excluding non-commercial entities, such as investment funds and special purpose vehicles, that are less likely to be involved in traditional lending, capturing the large majority of the credit institutions in this category. Second, we correct for outliers with respect to loan growth rates by trimming the top 1% of the distribution and values below -100% quarterly growth. The resulting sample after these adjustments comprises approximately 700,000 bank-firm-quarter observations, including multiple firm-bank relationships. Apppendix Table 4.A.2 reports summary statistics for all variables used in the analysis.

[92] See Blasnik et al. (2010), RECLINK: Stata module to probabilistically match records: http://EconPapers.repec.org/RePEc:boc:bocode:s456876.

[93] We matched 4,143 firms in the first step, 23,010 firms in the second step, and 1,038 firms by hand and hence more than 28,000 in total.

4.3 EMPIRICAL STRATEGY

Capital flows can affect the economy through multiple channels. Capital flow shocks can loosen domestic financial conditions and increase credit supply. Increased credit supply can stimulate real estate markets and property prices. Higher property prices can amplify the initial credit impulse through collateral channels on the household or the firm side, driving investment, employment, and other firm outcomes.[94]

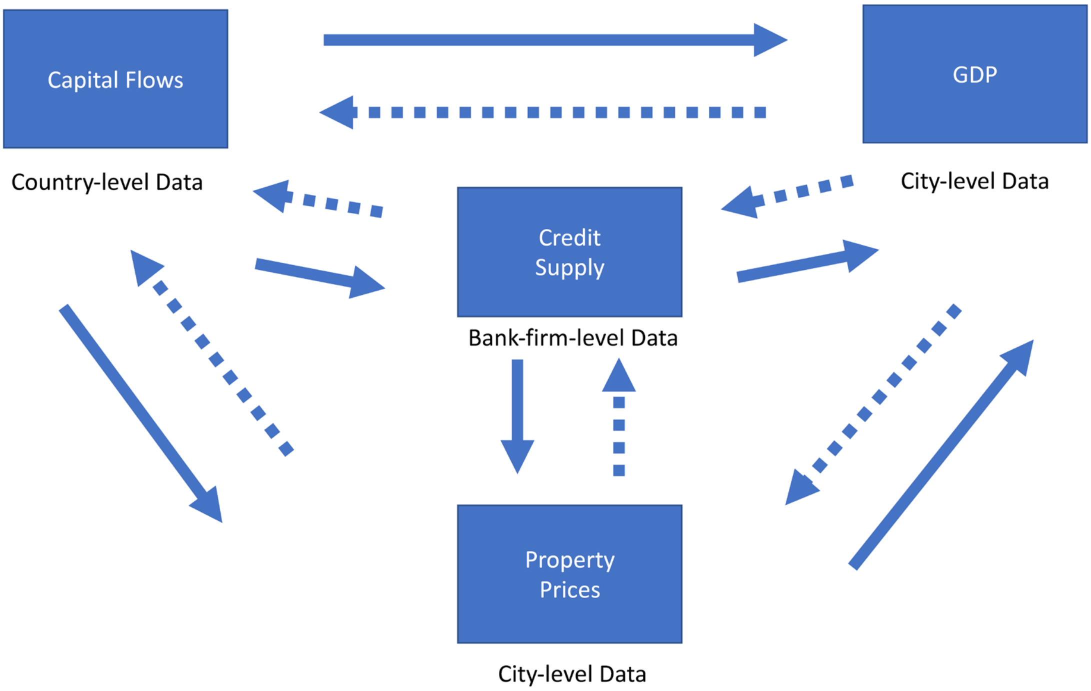
Figure 4.3 represents the multiplicity of channels through which capital flows can affect a city's economic activity at the business cycle frequency. The solid arrows represent causal linkages and the dashed arrows reverse causal effects. The top arrows represent the traditional push-pull view of the short-run association between capital flows and cyclical indicators of economic activity (e.g., Fratzscher, 2012). The inner loop emphasizes the role of credit in this transmission, which has been extensively studied in the literature. The outer loop, and its connection with the credit market, represents the possible role of real estate markets that we want to explore in this chapter.

The central hypothesis in our empirical analysis is that the tighter a city's real estate markets are, or the more exposed a city is to demand and supply shocks in these markets, the more significant the impact of bank flow shocks on the city's output growth. In a given local real estate market, all else equal, an exogenously higher demand or lower supply of real estate, or a combination of both, translates into a higher sensitivity of property prices to housing demand and supply shocks. Cities with tighter real estate markets, therefore, should be more sensitive to capital flow shocks than other cities, assuming that the transmission mechanism sketched above is at work. Moreover, consistent with macroeconomic models with borrowing constraints as in Kiyotaki and Moore (1997) in which real estate serves as collateral (Iacoviello, 2005; and Liu et al., 2013), our prior is that property prices should play an important role in the

[94] Among others, see Mian, Sufi and Verner (2017), Hoffmann and Stewen (forthcoming), Baskaya et al. (2018) and Baskaya et al. (2017) on capital flows and credit supply; see Favara and Imbs (2015), Di Maggio and Kermani (2017), Jorda et al. (2015) on credit and property prices; see Iacoviello (2005) and Liu et al. (2013) for general equilibrium models of amplification via real estate collateral and prices on the household or the firm side, respectively; see Chaney et al. (2012), Gan (2007), Ahlfeldt, Redding, Sturm and Wolf (2015), Cvijanovic (2014) and Adelino et al. (2015) on property price, collateral, and firm outcomes.

transmission.

Figure 4.3 TRANSMISSION MECHANISM: ROAD-MAP



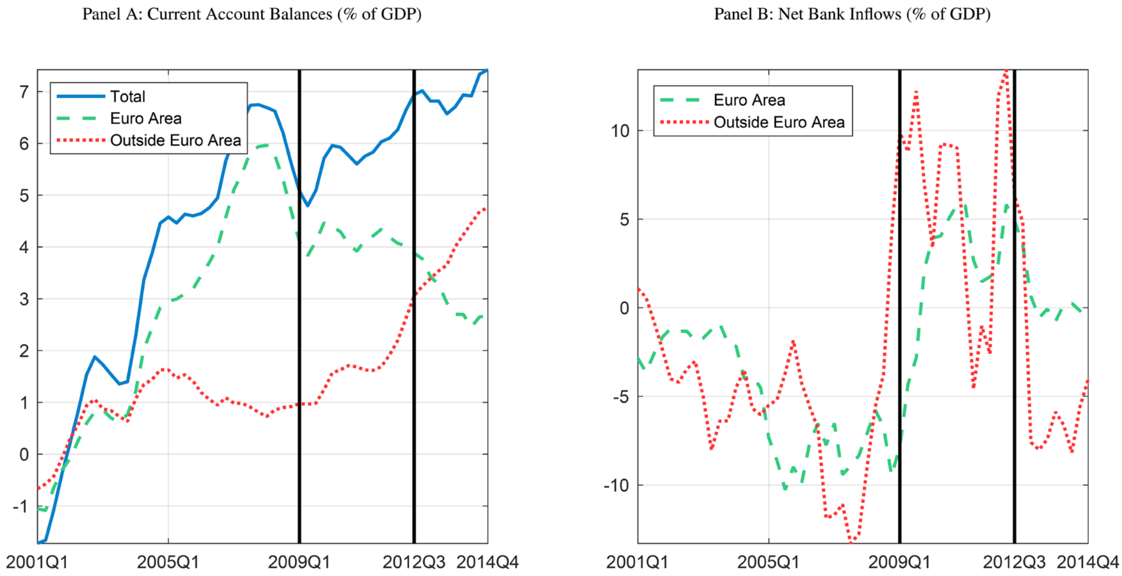
The econometric challenge, therefore, is to establish a causal effect of capital flows on output via property prices. Equipped with a valid instrument to estimate the impact of capital flow shocks on property prices, we can then use the predicted component of property price changes triggered by a capital flow shock to estimate the impact on city output growth. Taken together, these two steps can provide an estimate of the causal effects of capital flows shocks on city output growth through property price changes. The identification strategy in the first part of the analysis, based on city-level data, is one of identification by geographic variation as, for instance, in Mian et al. (2017), Chaney et al. (2012), and Hoffmann and Stewen (forthcoming). The research design, therefore, is grounded on (i) the availability of a well-defined aggregate or nation-wide measure of capital flows and (ii) the construction of an indicator of real estate market tightness (or exposure) that varies randomly across cities, which we discuss in more details below.

In the second part of the chapter, we want to open up the black box of the transmission mechanism. In particular, we study the role of real estate collateral in the allocation of the increased credit supply triggered by the capital flow shock. We also focus on firm employment and investment decisions, total factor productivity at the firm and industry level, and capital misallocation. The empirical strategy to address endogenity concerns, here, relies on the availability of matched bank-firm level data combined with suitable regression designs typically used in the empirical banking literature and the literature on firm behavior.

4.3.1 Measuring Capital Flows: Cross-border Bank Flows and the PIGS Spread

As measured by the current account surplus of the balance of payments, Germany experienced sizable net capital outflows rather than inflows throughout the period we consider (Figure 4.4, Panel A). The current account balance, therefore, is not a suitable measure for our empirical analysis. From this figure, however, we can also see that the current account surplus vis-a-vis the rest of the euro area started to decline during the GFC, and continued in that direction throughout the period we consider. In contrast, the current account surplus vis-a-vis the rest of the world outside the euro area became even larger after 2009:Q1. Moreover, Panel B of Figure 4.4 shows that the net foreign asset position of German BIS reporting banks changed dramatically during and after the GFC. In the rest of the chapter, therefore, we will focus on cross-border bank flows, labelled "bank flows" for brevity, which are an important component of total flows.

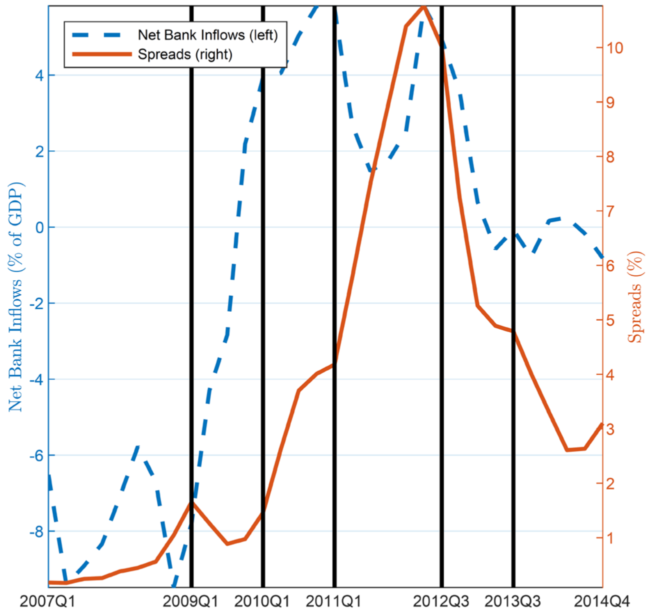
Figure 4.4 CURRENT ACCOUNT BALANCE AND NET BANK FLOWS



NOTE. Panel A plots the current account balance as a share of GDP, together with its breakdown vs. the rest of the euro area and outside the euro area. Panel B plots net bank vs. the rest of the euro area and vs. outside the euro based on BIS Locational Statistics. The vertical bars mark the beginning of the post-GFC recovery in 2009:Q1 and the "Whatever It Takes" speech by ECB Governor Draghi in 2012:Q3, respectively. See the Data Appendix for variable definitions and data sources.

Aggregate cross-border bank flow data pose their own challenges because subject to measurement errors and contaminated by foreign currency valuation effects difficult to account for. Moreover, our sample period is rather short from a time series perspective. An alternative measurement approach, often employed in the extant literature, is to use price-based indicators that co-move closely with quantity-based measures of bank flows. For instance, one indicator often employed to capture bank flows driven by global risk or risk aversion is the US VIX index of implied equity market volatility (e.g., Baskaya et al., 2018; Baskaya et al., 2017; Forbes and Warnock, 2012). Following this approach, and consistent with theoretical models of retrenchment transmission (Caballero and Simsek, forthcoming), as a proxy for bank flows, we use an indicator of financial instability and risk in Southern Europe, namely the average sovereign bond spread of Portugal, Italy, Greece, and Spain vs. Germany, henceforth called the PIGS spread. The PIGS spread is plotted in Figure 4.5, together with German bank flows vs. the rest of the euro area from Panel B of Figure 4.4. From this figure, we can see that the turning points in the PIGS spread correlate closely with net bank flows vs. the rest of the euro area and are also closely associated with the milestones of the sovereign debt and banking crisis in Southern Europe.

Figure 4.5 PIGS SPREAD, NET BANK FLOWS, AND THE EUROPEAN CRISIS



NOTE. The figure plots the PIGS spreads and Net Bank Inflows (% of GDP). The five vertical lines mark the following events: (1) the beginning of the German recovery in 2009:Q1; (2) Greek bonds downgraded to junk status and the Troika's launch of the 2010 110-billion euro bail-out; (3) 2011 downgrade and euro area leaders' disagreement on the rescue package for Greece; (4) "Whatever It Takes" speech by ECB Governor Draghi; and (5) interest rate cuts by the ECB. See the Data Appendix for variable definitions and data sources.

To quantify more precisely the relevance of the PIGS spread as predictor of bank flows, as the first step in our empirical analysis, we run a battery of regressions for alternative bank flow measures on the PIGS spread. The frequency is quarterly and the sample period is 2000:Q1-2014:Q4 to make sure that the spread can capture both phases of the boom-bust cycle. The estimated equation is specified as follows:

$$BF_t = \gamma * Spread_t + \varepsilon_t \tag{4.1}$$

where BF_t represents alternative measures of bank flows, and "$Spread_t$" denotes the PIGS spread. We distinguish between net flows from outside and inside the euro area. We then break down net flows from the rest of the euro area into gross inflows and outflows. Following Larrain and Stumpner (2017), we also examine the impact of the PIGS spread on the domestic lending-deposit interest rate spread. If the bank flows increase the domestic credit supply, we should observe a negative effect on the domestic lending-deposit spread. Finally, we use our bank-level data to evaluate the predictive ability of the PIGS spread for individual banks' gross foreign assets as a share of total assets, controlling for bank fixed effects. The last regression is important as concerns regarding reverse causation from bank flows to the PIGS spread are mitigated by the use of bank-level data.

Table 4.1 THE PIGS SPREAD AND BANK FLOWS

	Country-Level	Country-Level	Country-Level	Country-Level	Country-Level	Bank-Level
	(1) Net Bank Inflows Outside Eurozone	(2) Net Bank Inflows Inside Eurozone	(3) Gross Bank Inflows Inside Eurozone	(4) Gross Bank Outflows Inside Eurozone	(5) Lending-Deposit Spread	(6) Bank Share of Gross Foreign Assets
PIGS Spread$_t$	0.790	0.991***	-0.160	-1.151***	-0.115***	-0.246***
	(0.855)	(0.223)	(0.209)	(0.261)	(0.026)	(0.030)
Bank FE	-	-	-	-	-	Yes
Obs	60	60	60	60	48	89,651
R^2	0.033	0.216	0.009	0.238	0.247	0.844

NOTE. All regressions are based on quarterly data over the period 2000:Q1-2014:Q4, except for the regression in Column (5) for which the data are not available before 2003. The dependent variable in columns (1) and (2) is *net* bank flows into the German banking system from the rest of the world outside the euro area and from the rest of the euro area, respectively. In columns (3) and (4), the dependent variable is *gross* inflows and outflows from the rest of the euro area, respectively. In column (5), the dependent variable is the difference between the domestic lending and deposit interest rate. In column (6), the dependent variable is the share of individual banks' gross foreign assets over total assets. The regression in column (6) includes individual bank fixed effects. See the Data Appendixes for variable definitions and data sources. Heteroskedasticity-robust standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 4.1 reports the results. Columns (1) and (2) show that a higher PIGS spread is positively associated with net bank flows into Germany from both outside and inside the euro area. The relation, however, is statistically significant only for net bank flows originating from the rest of the euro area. The strength of the association is similar to what was found by Baskaya et al. (2018). The results in column (3) and (4) also illustrate that net bank flows are driven by lower gross bank outflows, rather than higher gross bank inflows. These regressions, therefore, taken together, suggest that a PIGS spread increase is associated with a repatriation of bank foreign assets from the rest of the euro area, which Forbes and Warnock (2012) call “retrenchment” of capital.

The evidence of retrenchment is further corroborated by column (6), which shows that a higher PIGS spread is associated with a smaller share of gross foreign assets in total bank assets at the level of individual banks. This last regression suggests that, in economic terms, a 100-basis points increase in the PIGS spread reduces banks’ share of foreign assets in total assets by almost 25 basis points. Put it differently, this estimate implies that, during the peak of the European crisis, the German banking system shifted lending from foreign to domestic borrowers amounting to about 1.6% of its aggregate balance sheet, or 1.9% of GDP.[95]

As shown in column (5), a higher PIGS spread is also associated with a lower domestic lending-deposit spread, suggesting that the German bank retrenchment episode we consider is associated with looser domestic financial conditions. Moreover, as we will report and discuss in Section 4.6, a higher PIGS spread leads to lower debt service costs at the firm level. This transmission, therefore, is in line with the hypothesis that a bank flow shock can loosen domestic financial conditions and increase the domestic credit supply.

Appendix Table 4.B.1 shows that these results are similar if we restrict the sample to the 2007-2014. The same table shows that the important result in column (6) of Table 4.1 is robust to adding a comprehensive set of macroeconomic and bank-level control variables. In unreported regressions, we also obtain essentially the same results as in column (6) above by using net, rather than gross, individual bank foreign assets.[96] Finally, the results are also unchanged if we include in the construction of the PIGS spread Ireland, or exclude Greece, as the sovereign bond spreads are highly correlated in crisis times.

[95] The PIGS spread averaged 6.5% during the acute phase of the European crisis, from 2010:Q1 to 2012:Q3, compared to a value close to zero right before the GFC. Hence, the impact of the crisis is quantified as 6.5%*0.246=1.60%. According to FRED data, total assets held by deposit money banks compared to GDP were approximately 120% in 2009. As a result, the estimated shift in banking assets is 1.60%*1.2=1.92% of GDP.

[96] All results not reported in the chapter are available from the authors on request.

In summary, this evidence documents that German banks experienced a sizable net inflow of capital from the rest of the Euro Area since the GFC, driven by German banks' repatriation of foreign assets, consistent with available evidence on the behaviour of Northern European banks before and after the GFC discussed in Section 4.1. The evidence also shows that the PIGS spread is a good predictor of bank flows. Based on these preliminary findings, in the rest of the chapter, we will use the PIGS spread as a our proxy for bank flows.

4.3.2 Identification: Non-Developable Area, Refugees, and Cities' Exposure to Real Estate Market Tightness

As we mentioned earlier, our aim is to identify the output growth impact of property price variation across cities triggered by an aggregate change in bank flows. For this purpose, we construct a measure of city exposure to real estate market tightness that varies quasi-randomly across cities. To construct this measure of tightness in the local real estate markets, our exposure measure, we propose to complement information on the supply side with an indicator capturing pressure on the demand side of the market. Specifically, our local real estate market tightness measure is the product of two variables: the gross share of land that cannot be developed relative to total land available, which we call the share of non-developable area, and the share of refugees allocated by government policy to a given city relative to the total number of refugees in the country, which we call the share of refugees. The first variable captures supply constraints due to geography and land-use regulations in the spirit of Saiz (2010). The second variable is an exogenous source of pressure on the demand side of the local real estate markets because refugees cannot chose where they locate in the short term. It is a potentially relevant instrument because asylum seekers need shelter and, if they reach refugee status, are encouraged and supported financially to find non-segregated housing solutions. So, we now discuss each of these two measures in more detail.

4.3.2.1 SUPPLY SIDE: THE SHARE OF NON-DEVELOPABLE AREA

Consistent with the notion of housing supply elasticity of Saiz (2010), in cities in which the share of (gross) developable area is lower, supply constraints due to land-use regulations and geography should bind more tightly. As a result, this variable should be associated with real estate price growth at the city level, but should be unrelated to short-term changes in the level of local economic activity because its distribution across cities is fixed in the short term and determined by geography and land-use regulations. Unlike the United States, however, variation across German cities in the gross share of non-developable area comes mostly from variation in land designated as forestland or for agricultural uses rather than differences in the incidence of steep-slope terrains and water bodies. Moreover, land-use regulations are distributed rather uniformly in Germany. For relevance purposes, therefore, it is useful to complement this indicator with information on sources of exogenous demand variation across cities.

4.3.2.2 DEMAND SIDE: THE SHARE OF REFUGEES

The share of refugees allocated to a given city relative to the total number of refugees is a good candidate instrument because, as we show below, it has an impact on real estate valuations across German municipalities. Note here, however, that we do not claim that refugees are one of the most important drivers of the German housing boom, but that, from a statistical point of view, they are both a good and exogenous predictor of real estate price increases. Specifically, in Germany, the city allocation of refugees is quasi-random with respect to local business cycle conditions. This is because refugees are allocated across states and cities according to federal laws and regulations governing asylum seeking and the granting of refugee status, and other state and local laws and regulations that determine their location and their benefit entitlements, including housing. Unlike other categories of migrants, therefore, refugees cannot settle freely across cities in Germany. Our identification strategy thus broadly follows Dustmann, Vasiljeva and Piil Damm (forthcoming) and Eckert, Walsh and Hejlesen

(2018), who exploit the quasi-random nature of the refugee allocation in Denmark to study the impact of immigration on voting outcomes and the urban wage premium, respectively.

The well-known federal Koenigsteiner Schluessel rule determines annually quotas for the distribution of refugees across German states based on state population (1/3) and tax revenue (2/3) of the previous two years.[97] This rule was established in 1949 and is used to allocate also other contributions or resources across states, such as the share of federal funding to universities and research institutions. Because of the dependency of this rule on past tax revenue, the state allocation of refugees could be endogenous to state business cycle conditions or to highly synchronized local economic conditions. As we can see from Table 4.2, however, the state rules governing the allocation of refugees across cities within state borders do not depend on tax revenue. Individual states have similar, but not identical allocation systems. Even though there is some heterogeneity, most determine the city-allocation of refugees based only on population, while some also use total area, and neither criteria depend on outcomes at business cycle frequency. In particular, no state uses lagged tax revenue although Brandenburg uses the number of employees as a secondary criterion. Berlin, Bremen and Hamburg are city states and, therefore, do not have independent within-state allocation criteria. Berlin and Hamburg are also among the largest cities and have the highest share of refugees (Appendix Table 4.A.3). However, they also have the highest share of refugees housed in large public facilities. In the empirical analysis, we will control for the special characteristics of these cities by conducting robustness to their exclusion from the sample. Moreover, cities or municipalities have no influence on the characteristics of the allocated refugees, such as the country of origin, skills and education, or other background. Finally, the predictability and efficiency of this system is well-known with small deviations from the assigned quota norms.

The allocation of refugees to a particular municipality is persistent over time, as refugees cannot easily relocate. Upon arrival, asylum seekers must apply for status at the assigned

[97] The main sources of information on the institutional details of German refugee policy on which we relied upon are Mueller (2013), Baier and Siegert (2018) and Nam and Steinhoff (2018).

federal office for immigration and refugees (BAMF). A first-round decision on status is supposed to be taken in one-to-six months. While an application is pending, asylum seekers are required to stay at the initial reception center and cannot leave the area without permission. Only if and when BAMF grants status, refugees can relocate. However, even after asylum is granted, if a refugee is not financially self-sufficient, the government continues to determine where subsidized shelter is provided. As many applications are initially rejected, and most asylum seekers appeal in the courts, which typically takes a year or more, refugees usually remain confined to their initial city assignment for much longer than the minimum time necessary to obtain status.

Table 4.2 WITHIN-STATE REFUGEE ALLOCATION CRITERIA AND HOUSING SOLUTION

State	Allocation Criteria	Refugees in Independent Accommodations
Baden-Württemberg	Population	35.0
Bavaria	Population	32.0
Berlin	NA	17.0
Brandenburg	Population, number of employees	30.0
Bremen	NA	60.0
Hamburg	NA	25.0
Hesse	Population	50.0
Lower Saxony	Population	67.0
Mecklenburg-Vorpommern	Population	71.0
North Rhine-Westphalia	Population, total area	63.0
Rhineland-Palatinate	Population	78.0
Saarland	Population	79.0
Saxony	Population	53.0
Saxony-Anhalt	Population	72.0
Schleswig-Holstein	Population	62.0
Thuringia	Population level in 1998	57.0

NOTE. This table reports the refugee allocation criteria across cites within *all* 16 German states, based on Müller (2013). The table also shows the share of refugees housed in independent accommodations, such as apartments and single-family homes, as opposed to large public facilities, based on data provided by Baier and Siegert (2018). Note that Berlin, Bremen and Hamburg are city states and, therefore, do not have independent within-state allocation criteria.

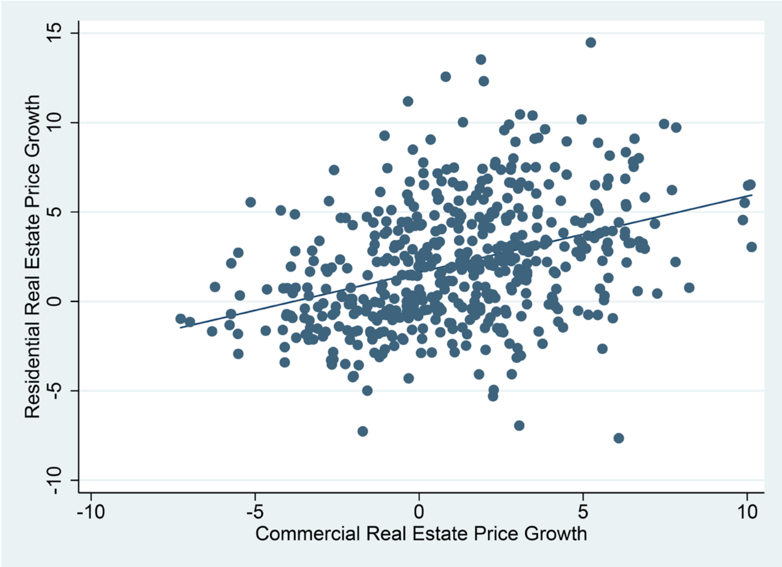
In Germany, during our sample period, refugees are unlikely to have had any impact on the labor market, even after they received status. The main reason is a legal requirement of working knowledge of the German language for formal employment in most jobs that was in place until changes were introduced with new legislation in 2015 and 2016. The law also entailed preferences toward applicants from Germany and the rest of the European Union, as well as other restrictions on residence permits for refugees who did not complete vocational training.[98] During the period of time considered in this chapter, the rate of employment of refugees was only 10-20% in the first year after arrival, and still well below 50% after five years. Most of these jobs, however, are temporary and low-skill.

There are several reasons why the city share of refugees can be a relevant instrument for property prices in both the residential and the commercial sector. First, municipalities must provide both short-term housing for asylum seekers and long-term affordable options for refugees who cannot self-sustain financially, ultimately putting demand pressure on the fixed supply of land available for all uses. Once asylum seekers reach status, refugees who cannot self-sustain are housed in collective living facilities or they are granted the right to independent accommodation depending on the public interest and individual circumstances (Table 4.2). The decision is at the discretion of the local government. As we can see from Table 4.2, a minimum of 30 percent of the refugees are housed in independent accommodations, with peaks at 75-80 percent if we exclude the city states of Berlin and Hamburg, which house only 17 and 25 percent of their refugees in independent accommodations, respectively.

Second, as the existing rules for the allocation of refugees across cities do not take into account population density, or other characteristics of the receiving cities linked to housing scarcity and land scarcity, the allocation rules may put disproportionate pressure on cities already facing excess demand for social housing, commercial spaces, or other real estate supply shortages. Not surprisingly, as we shall see, when we use population density instead of our share of refugees, we find similar results.

[98] Refugees are not allowed to work during the first 3 months after arrival. Between month 4 and 15, they are only allowed to work if the Federal Employment Agency agrees that no other German is equally suitable for the job and that the wage offered is comparable to the market rate. Between month 16 and the end of the third year, they are allowed to work only if their wage is deemed market comparable. Starting with the 4th year, they can work without restrictions.

Figure 4.6 COMMERCIAL AND RESIDENTIAL REAL ESTATE PRICES CHANGES: CITY-LEVEL COMOVEMENT



NOTE. The figure is a scatter plot of commercial and residential real estate price changes over the 2009-2014 period (corr=37%, p value=0). One observation is a city-year. See the Data Appendix for variable definitions and sources.

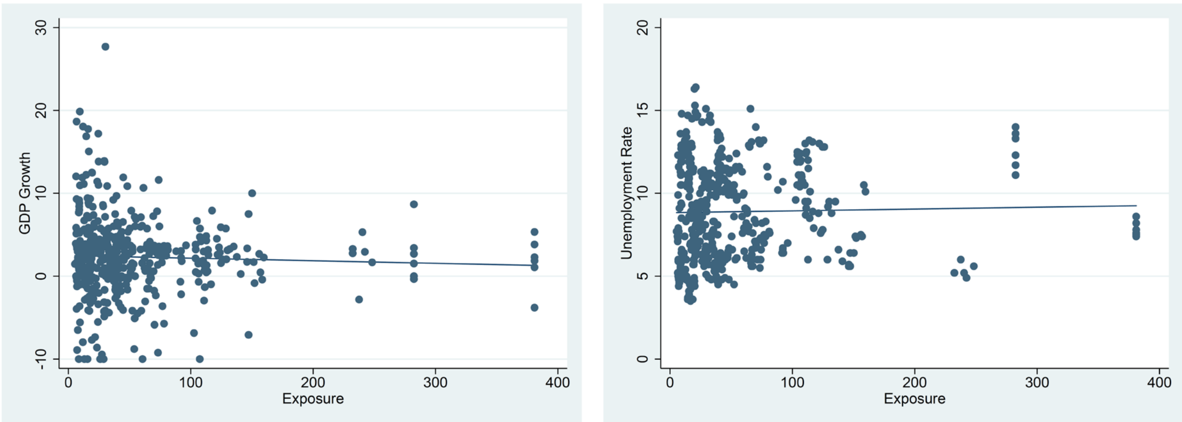
Third, the residential and commercial markets are highly correlated, competing for land and city space that is in fixed supply in the short-term. The share of refugees, therefore, can be a relevant instrument also for the commercial sector. Figure 4.6 shows that commercial and residential property price changes are highly correlated in Germany over our sample period, as in the United States.[99] Land value, which is a large component of both residential and commercial valuations (Davis and Van Nieuwerburgh, 2015), urban transportation costs and spatial dynamics are possible drivers of this correlation (see Ahlfeldt et al., 2015; Mills, 1967; and Roback, 1982).

[99] For evidence on this correlation in the United States see, for instance, Gyourko (2009) and Chaney et al. (2012).

4.3.3 Relevance and Orthogonality Conditions of the Exposure Measure

The relevance condition for our exposure measure, will be tested formally with the first-stage regression of the econometric specification that we use in the next section. The exclusion restriction for our exposure measure cannot be tested formally. Nonetheless, Figure 4.7 illustrates clearly that there is no correlation between our measure of real estate market tightness and city GDP growth or the city unemployment rate, in line with the assumptions made and the details of the institutional background discussed above. Additional not-reported scatter plots show that the two separate components of the exposure measure are also uncorrelated with GDP growth and the unemployment rate. In the case of the refugee component of the exposure measure, in particular, neither the state nor the city distribution of refugees is correlated with the distribution of output growth rates. We also find no association between the share of refugees and the rate of growth of employment calculated by aggregating firm-level data at the city level.

Figure 4.7 Exposure, GDP growth, and the Unemployment Rate



Note. The figure plots the association between city-level real estate exposure and GDP growth (corr=-4%, p value=36%), and the unemployment rate (corr=2%, p value=61%), respectively, over the 2009-2014 period. One observation is a city-year.

Overall, the evidence reported and the details of the institutional background to the Germany policy framework for the allocation of refugees across cities suggest that our exposure measure is a good candidate instrumental variable for property price changes since it can only affect city output growth through its impact on the real estate prices. In the next section, therefore, we will use this instrumental variable interacted with the PIGS spread to investigate the role of real estate markets, and property price changes more specifically, in the transmission of bank flow shocks to city output growth.

4.4 Bank Flows, Real Estate Markets, and City Business Cycles

The hypothesis in the chapter is that higher property prices, triggered by aggregate capital flow shocks, may have stronger impact on output growth in cities with tighter real estate markets. In this section, we investigate this hypothesis empirically, for both the residential and the commercial sector, exploiting the quasi-random city variation of our measure of real estate market tightness to achieve identification. Our "instrument" is the interaction of the aggregate bank flow change, as captured by the PIGS spread, with the city-level measure of exposure. While the PIGS spread could be endogenous to economic conditions in individual German cities, its interaction with the exposure measure, whose city distribution is assumed to be unrelated to local economic conditions, provides an exogenous source of variation in the bank flow shock intensity that can be related to city differences in economic performance.

4.4.1 Reduced-Form Estimates

Equipped with a proxy measure for bank flows and a measure of city exposure to real estate market tightness, following Mian, Sufi and Verner (2017), we start by investigating the role of real estate markets in the transmission of bank flow shocks to city output growth by estimating the following city-level reduced-form regression:

$$\Delta GDP_{c,t} = \alpha_c + \alpha_t + \beta * (Spread_{t-1} * Exposure_{c,t-1}) + \gamma * Exposure_{c,t-1} + \varepsilon_{c,t} \quad (4.2)$$

where $GDP_{c,t}$ is log real GDP per capita in city c at time t, $Spread_{t-1}$ is our proxy for bank inflows at time t −1, and $Exposure_{c,t-1}$ is our proxy for local real estate market tightness. The latter is assumed to be distributed quasi-randomly across cities. Even though bank inflows, and hence the PIGS spread, might be endogenous to business conditions in some German cities, once interacted with our exposure measure, the differential impact of the PIGS spread across cities, as measured by the β regression coefficient in equation (4.2), is well identified. Hence, this regression examines the extent to which a city's sensitivity to the aggregate state of the PIGS spread differs based on the extent of the real estate market tightness.

Table 4.3 displays the results based on the full sample. As a benchmark, Column (1) reports an estimate of the linear association between bank flows, as captured by the PIGS spread level, and city output growth. Columns (2)-(4) report the estimated β coefficient that can be interpreted as a causal effect under our identification assumptions. These regressions include the interaction term between the spread and the exposure measure, as well as the level of the spread and the exposure. In Columns (3) and (4), the regression is saturated with fixed and time effects to control for city-specific factors and common shocks, such as city size and common factors across cites in the German business cycle. City size is particularly important because larger cities tend to grow disproportionately more due to agglomeration forces.

The estimated coefficient on the PIGS spread in Column (1) is negative, but not significant statistically. The estimated β coefficient on the interaction term is positive and has the same magnitude in Columns (2), (3) and (4). This suggests that a bank flow shock has a positive causal effect on output growth, with an impact that is larger in more exposed cities. Clearly, the magnitude of the β estimate is robust to the inclusion of city and time fixed effects.

The estimated β coefficient on the interaction term is not estimated precisely in the full sample of Table 4.3, even though the statistical significance does not decrease once we saturate the regression with fixed and time effects. However, Table 4.4 shows that, if we drop from the sample the three city states (i.e., Berlin, Bremen, and Hamburg), the estimated β coefficient on the interaction term becomes highly significant statistically and doubles in size across the three specifications in Columns (2), (3), and (4). This result is important not only because it addresses possible endogeneity concerns raised by the dependency of the allocation rule for the city states on lagged tax revenue (see Table 4.2 and the discussion in Section 4.3), but also because Berlin and Hamburg have the highest share of refugees in the sample (see Appendix Table 4.A.3).[100]

The estimated coefficients in Columns (2)-(4) of Tables 4.3 and 4.4 point to an economically sizable role of real estate markets in the transmission of capital flow shocks. Our estimates imply that, for every 100-basis points increase in the PIGS spread, output growth in cities at the 90th percentile of the exposure distribution is between 12.4 and 24.8 basis points higher than in cities at the 10th percentile, depending whether we evaluate this impact with or without city states. Cities at the 90th percentile of the distribution have an exposure value of 138, compared for instance with 380, 280 and about 240 in Hamburg, Berlin, and Munich, respectively. Thus, the output growth effect of a 100-basis points PIGS spread change is 13.8=(100*138*0.001) or 27.6=(100*138*0.002) basis points, depending on whether we use the estimated value of the β coefficient in Table 4.3 or 4.4. In contrast, cities at the 10th percentile have an exposure value of 14. Hence, in this case, the impact is a mere 1.4=(100*14*0.001) or 2.8=(100*14*0.002) basis points, respectively. This roughly means a tenth to a quarter percentage point more growth in cities in which real estate markets are tighter for every 100 basis points of PIGS spread increase. Considering the 300-basis points average PIGS spread increase during the acute phase of the European crisis, as observed on average between 2009 and 2012, these estimates imply that cities most exposed to real estate markets might have grown almost a full percentage point more per year than least exposed cities during that period.

[100] In unreported regressions, we obtain an estimated β coefficient of the same size, statistically significant at the 5% level when we drop Berlin, Hamburg and Munich, leaving low-exposure Bremen in the sample.

Table 4.3 BANK FLOWS, REAL ESTATE EXPOSURE, AND CITY CYCLES: REDUCED FORM ESTIMATES WITH CITY STATES

	(1)	(2)	(3)	(4)
	ΔGDP	ΔGDP	ΔGDP	ΔGDP
Spread$_{t-1}$	-0.043	-0.101*	-0.102	-
	(0.043)	(0.058)	(0.064)	
Spread$_{t-1}$ $\times$ Exposure$_{t-1}$		0.001*	0.001*	0.001*
		(0.001)	(0.001)	(0.001)
Exposure$_{t-1}$		-0.008**	0.059	0.036**
		(0.004)	(0.036)	(0.017)
Time FE	No	No	No	Yes
City FE	No	No	Yes	Yes
Obs	466	466	466	466
R^2	0.001	0.005	0.127	0.461

NOTE. The regressions are based on annual city-level data over the period 2009-2014. The dependent variable is real GDP per capita growth. The regressors are the lagged values of the PIGS spread, the city-level exposure measure, and the interaction between the two. The regression in column (3) also includes city fixed effects, while the regression in column (4) includes both city and time fixed effects. Heteroskedasticity-robust standard errors clustered at the city level are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 4.4 BANK FLOWS, REAL ESTATE EXPOSURE, AND CITY CYCLES: REDUCED FORM ESTIMATES WITHOUT CITY STATES

	(1)	(2)	(3)	(4)
	ΔGDP	ΔGDP	ΔGDP	ΔGDP
Spread$_{t-1}$	-0.049	-0.139**	-0.148**	-
	(0.044)	(0.064)	(0.071)	
Spread$_{t-1}$ $\times$ Exposure$_{t-1}$		0.002**	0.002***	0.002***
		(0.001)	(0.001)	(0.001)
Exposure$_{t-1}$		-0.014***	0.058*	0.035**
		(0.005)	(0.034)	(0.017)
Time FE	No	No	No	Yes
City FE	No	No	Yes	Yes
Obs	448	448	448	448
R^2	0.001	0.007	0.131	0.459

NOTE. The regressions are the same as in Table 4.3, but the sample excludes the city states of Berlin, Bremen and Hamburg. Heteroskedasticity-robust standard errors clustered at the city level are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

The results in Table 4.3 are robust to a number of other changes, most of which are reported in Appendix Table 4.B.2. The results are consistent with the baseline above, with an even larger estimated β coefficient, if we replace the share of refugees with population density in the construction of the exposure measure (Column 1). We obtain similar results when we use a time-invariant city-level share of refugees, evaluated at the beginning of the sample in 2009, to rule out the possibility that the results are driven by within-city rather than between-city variation (Column 2). The findings are further similar if we replace the share of non-developable area with an alternative indicator of supply tightness across cities, the change in building permits from the pre-boom period of 2000-2008 to the post-boom period of 2009-2014 (Column 3). In this case, the impact is estimated more precisely, but is quantitatively smaller.

The exposure measure could be seen as a triple interaction. In additional unreported regressions, in addition to the interaction term between the PIGS spread and the exposure measure, we include, separately, the interaction of the spread with the share of refugees and with the gross share of non-developable area. In these regressions, the only variable that is significant is the interaction between the PIGS spread and the exposure measure. This is clear evidence on the merits of interacting a supply-side and demand-side indicator of tightness in local real estate markets.

4.4.2 TWO-STAGE LEAST SQUARE ESTIMATES

The reduced form estimate of equation (4.2) yields evidence on the generic importance of real estate market tightness for output growth, but is silent on the specific role that property prices may play. So, we now turn to the mediating role of property price changes in the transmission of bank flow shocks more specifically. To this end, following Chaney et al. (2012), we regress city output growth on property prices instrumenting the latter with the interaction of the PIGS spread with our exposure measure.[101] The specification is:

$$\Delta GDP_{c,t} = \alpha_c + \alpha_t + \beta * REP_{c,t-1} + \varepsilon_{c,t} \quad (4.3)$$

[101] Chaney et al. (2012) interact Saiz (2010) housing supply elasticity (our exposure) with the aggregate mortgage interest rate (our spread) and then use the predicted component of local real estate prices to estimate their mediating effect on firm investments.

$$\mathrm{REP}_{c,t-1} = \alpha_c + \alpha_{t-1} + \gamma * \left(Spread_{t-1} * Exposure_{c,t-1}\right) + \eta_{c,t-1} \qquad (4.4)$$

where $\mathrm{REP}_{c,t-1}$ is either the residential real estate price index (RREP) or the commercial index (CREP), and $Spread_{t-1} * Exposure_{c,t-1}$ is the instrument. For robustness, we run the model also in terms property price changes, denoted with ∆RREP and ∆CREP, respectively. In this specification, bank flows, as captured by the PIGS spread, can affect city output growth via city property price variations predicted by the bank flows, with a strength that depends on the tightness of the local real estate market.

4.4.2.1 FIRST STAGE

Tables 4.5 and 4.6 report the first-stage results for equation (4) specified in levels and changes, respectively. The estimates in Columns (1) and (2) are based on the full sample of cities for residential and commercial prices indexes, respectively. Columns (3) and (4) drop the three city states. All regressions are saturated with time and fixed effects.

The results with property price levels show that our exposure measure is a good predictor of property prices in both the residential and commercial sectors, with F-statistics well above the norm even after controlling for time and fixed effects. For commercial prices (Column 4), the results are even stronger both quantitatively and statistically when we drop the city states. For residential prices (Column 3), however, the F-statistics deteriorates below acceptable levels when we drop the city states. This is problematic, as it suggests that the relevance of our instrument for residential prices depends on the extreme values of the share of refugees of Berlin and Hamburg.

For robustness and consistency, we also run the regression (4.4) in terms of property price changes rather than levels. Table 4.6 shows that the estimates are quite robust for the commercial sector (Columns 2 and 4), with even higher F-statistics when we drop city states, and only a slightly lower value when we run the regression on the full sample. The F-statistics, however, confirms that the instrument is weak in the case of the residential sector (Columns 1 and 3). The instrument performs better, and the estimated coefficient becomes significant at the 5 percent level, when we drop the city states (Column 3), but remains weak by conventional standards. The relevance of our instrument for the residential sector weakens further when we drop Berlin, Hamburg, and Munich from the sample, while it is essentially unchanged for the commercial sector in this case (results not reported).

4.4.2.2 SECOND STAGE

Tables 4.7 and 4.8 report the second-stage estimation results for the regression model in equation (4.3)-(4.4) specified in terms of property price levels and changes, respectively. In Columns (1) and (2), the city sample is complete. In Columns (3) and (4), the sample excludes the city states. All regressions are saturated with time and fixed effects.

The results in Table 4.7 suggest that both commercial and residential property prices variations predicted by changes in the PIGS spread affect city output growth, although the magnitude of the impact is seemingly larger in the residential sector (Columns 1 and 2). When we drop the city states (Columns 3 and 4), however, the impact in the commercial sector becomes strongly significant statistically, while it looses significance in the residential sector, despite more than doubling in size. In light of the statistical evidence on the first stage in Table 4.5, we interpret these results as suggesting solid robustness to outliers for the commercial sector, but a weak instrument problem for the residential sector.

The second-stage results are similar when we estimate equation (4.3) in terms of property price changes (Table 4.8). In particular, the effects on the residential sector (Columns 1 and 3) become even larger, but remain statistical insignificant. In contrast, in the commercial sector, the estimated coefficients become not only larger and also more precisely estimated in the sample without city states (Columns 2 and 4), confirming their robustness.

We saw earlier that, based on the reduced-form estimate of our model, a 100 basis points PIGS spread increase leads to a higher real GDP growth in cities most exposed to real estate market tightness ranging from a tenth to a quarter of a percentage point relative to cities least exposed. The second stage estimates reported in Table 4.7 and 4.8 suggest that commercial property price increases triggered by PIGS spread changes can account for all of this difference. To see this, multiply the first stage coefficient in Column (2) of Table 4.5 by the second-stage estimate in Column (2) of Table 4.7. The resulting product is very close to the point estimate in Column (4) of Table 4.3. The latter is indicative of the fact that commercial property prices are at the heart of the transmission mechanism of the bank flow shock in cities more exposed to real estate market tightness, consistent with the working of a collateral channel on the firm side (e.g., Liu et al., 2013).

Table 4.5 PROPERTY PRICE LEVELS AND EXPOSURE:
FIRST-STAGE RESULTS

	Full sample	Full Sample	Without City States	Without City States
	(1)	(2)	(3)	(4)
	RREP	*CREP*	*RREP*	*CREP*
$\text{Spread}_{t-1} \times \text{Exposure}_{t-1}$	0.005^{***}	0.008^{***}	0.005^{*}	0.011^{***}
	(0.001)	(0.001)	(0.003)	(0.002)
Time FE	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
F-Statistic	17.9	27.7	2.9	21.8
Obs	466	466	448	448
R^2	0.703	0.730	0.683	0.738

NOTE. The table reports the estimation results for the first-stage estimation of equation 4. They are based on annual city-level data from 2009 to 2014. The dependent variables are the residential and commercial real estate price indexes. The regressor is the lagged value of the PIGS spread interacted with the lagged value of the exposure measure. All regressions include city and time fixed effects. Columns (1) and (2) are based on the full sample of cities for residential and commercial prices indexes, respectively. Columns (3) and (4) drop the 3 city states. The hetroskedasticity-robust standard errors clustered at the city level are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 4.6 PROPERTY PRICE CHANGES AND EXPOSURE: FIRST-STAGE RESULTS

	Full sample	Full Sample	Without City States	Without City States
	(1)	(2)	(3)	(4)
	$\Delta RREP$	$\Delta CREP$	$\Delta RREP$	$\Delta CREP$
$\text{Spread}_{t-1} \times \text{Exposure}_{t-1}$	0.001^{*}	0.004^{***}	0.002^{**}	0.006^{***}
	(0.001)	(0.001)	(0.001)	(0.001)
Time FE	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
F-Statistic	2.9	21.4	4.6	39.5
Obs	466	466	448	448
R^2	0.558	0.517	0.557	0.528

NOTE. This table reports the same estimates as in Table 4.5 but in terms of property price changes. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

In sum, the evidence reported in this section establishes that (i) tighter real estate markets as captured by our exposure measure are associated with a stronger impact of bank inflows on local economic activity, and (ii) commercial property price differences across cities triggered by bank flow shocks can explain the most part of this differential impact. We find similar effects working through the residential sector when we estimate the regression model with the full city sample, but the results are sensitive to the exclusion of the city states, whose allocation rules depend on lagged revenue, or the exclusion of the three cities with the highest share of refugees. In fact, when we estimate the model without the city states, our instrument loses its relevance for residential property prices. In light of this, when we open up the black box of the transmission mechanism underlying the estimated differential impact of bank flow shocks across cities, in the rest of the chapter, we will focus on the commercial sector, exploring the collateral channel on the firm side.

Table 4.7 CITY OUTPUT GROWTH AND PROPERTY PRICE LEVELS: 2SLS

	Full sample	Full Sample	No City States	No City States
	(1)	(2)	(3)	(4)
	ΔGDP	ΔGDP	ΔGDP	ΔGDP
$RREP_{t-1}$	0.235**		0.517	
	(0.11)		(0.326)	
$CREP_{t-1}$		0.165**		0.221***
		(0.082)		(0.077)
Time FE	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Obs	466	466	448	448
R^2	0.404	0.453	0.216	0.439

NOTE. This table reports 2SLS estimates for equation 3. The regressions are based on annual city-level data from 2009 to 2014. The dependent variable is real percapita GDP growth. The main regressors are the commercial and residential real estate price indexes, instrumented by the interaction term between PIGS spread and the exposure measure. All regressions include city and time fixed effects. The heteroskedasticity-robust standard errors clustered at the city level are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 4.8 CITY OUTPUT GROWTH AND PROPERTY PRICE CHANGES: 2SLS

	Full sample	Full Sample	No City States	No City States
	(1)	(2)	(3)	(4)
	ΔGDP	ΔGDP	ΔGDP	ΔGDP
$\Delta RREP_{t-1}$	1.122		1.295	
	(0.839)		(0.781)	
$\Delta CREP_{t-1}$		0.287*		0.443***
		(0.169)		(0.166)
Time FE	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Obs	466	466	448	448
R^2	0.147	0.437	0.034	0.414

NOTE. This table reports the same estimates as in Table 4.7, but in terms of property price changes. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

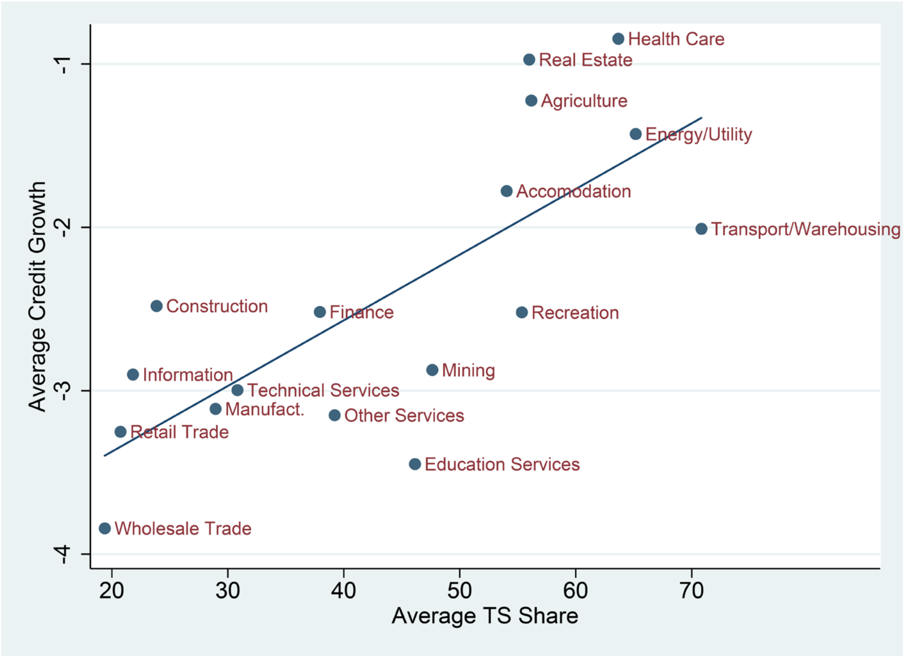
4.5 Bank Flows, Real Estate Collateral, and Credit Supply

In this section, we study the role of real estate collateral for credit supply to firms triggered by a bank flow shock. Figure 4.8 plots average credit growth during the 2009-2014 period by 2-digit NAICS classification against the average share of tangible assets in the same sector (TS). The figure shows that, on average during this period, all sectors experienced a sharp credit contraction, consistent the aggregate picture in Panel D of Figure 4.1. However, it also suggests a positive and tight association between faster (slower) credit growth (decline) and the availability of real estate collateral, with sectors typically using land and structures more intensively, such as Agriculture, Real Estate itself, Transport and Warehousing, Accommodation and Recreation, experiencing higher (lower) credit growth (decline).

Consistent with micro evidence on the role of collateral in financial contracting (e.g., Benmelech et al. , 2005; and Benmelech and Bergman, 2008), we conjecture that an increase in the domestic credit supply associated with repatriation of foreign assets should benefit more firms and sectors with more real estate collateral, as this form of lending is safer and easier to screen, price and monitor. This hypothesis also accords with more directly related evidence on the impact of capital flow shocks on the domestic credit supply reviewed in Section 4.1.

We saw earlier that a higher PIGS spread is associated with a reduction in German bank holdings of foreign assets in the rest of the euro area and a lower aggregate domestic lending-deposit spreads. Here, we focus on the allocation of domestic credit at the bank-firm level associated with changes in the PIGS spread. As we discussed in Section 4.2, our bank-firm level proxy for real estate collateral is the share of tangible fixed assets in total assets, or "share of tangible assets" for brevity. To address endogeneity concerns, in this step of the empirical analysis, we rely on the microeconomic nature of our bank-firm-relationship data, assuming that no such individual relationship can affect the PIGS spread, and that the quantity of real estate collateral at the bank-firm-relationship level is predetermined with respect to lending decisions, controlling for loan demand with fixed effects as we explain in more details below.

Figure 4.8 CREDIT GROWTH AND REAL ESTATE COLLATERAL BY SECTOR



NOTE. The figure plots average credit growth against average tangible fixed assets over total assets (TS), by industry. The industry classification corresponds to the 2-digit NAICS code, with the following adjustments listed in Appendix Table 4.A.4 together with the corresponding average sector shares of tangible assets: Manufacturing equals codes 31-33; Retail Trade equals codes 44-45; Transport and Warehousing equal codes 48-49; and Technical Services equal codes 54-56. The correlation between the two variables is 75% with a p-value of 0. The sample period is 2009-2014.

4.5.1 FIRM-LEVEL CREDIT ALLOCATION

In order to assess the role of real estate collateral in the credit allocation to firms, following Behn, Haselmann and Wachtel (2016), who use German credit register data to study the impact of capital regulation on credit supply, we estimate the following reduced-form regression:

$$\Delta \mathrm{L}_{i,j,t} = \alpha_{i,t} + \alpha_{j,year} + \beta * \left(SPREAD_{t-1} * TS_{j,t-4}\right) + \varepsilon_{i,j,t} \qquad (4.5)$$

where $\Delta \mathrm{L}_{i,j,t}$ is the log-change in loan volume of bank i to firm j in quarter-year t, and $(SPREAD_{t-1} * TS_{j,t-4})$ is a lagged interaction term between the PIGS spread and firm j's share of tangible assets, $TS_{j,t-4}$.[102] In order to control for unobserved time-varying heterogeneity at the bank level, we include bank-year-quarter fixed effects ($\alpha_{i,t}$). To control for year-on-year changes in firm loan demand, and also for the location of firm headquarters that might influence firm credit access, we include firm-year fixed effects ($\alpha_{j,year}$). Finally, by clustering the standard errors at the bank-firm level, we allow the observations to be correlated across bank-firm relationships. The main coefficient of interest is β that captures the differential strength of credit access across firms in response to the bank flow shock.

Table 4.9 summarizes the baseline results, as in equation (4.5), and a number of robustness checks. The positive and highly statistically significant estimate of β in Column (1) suggests that a higher PIGS spread leads to more bank lending to firms with more real estate collateral, controlling for loan demand with firm-year fixed effects. The magnitude of this effect is economically significant: a 100-basis points PIGS spread increase raises (slows) the quarterly rate of credit growth (decline) of high-TS firms (at the 75th percentile of the distribution) by 74 basis points more than the corresponding growth rate of low-TS firms (at the 25th percentile).[103]

Column (2) of Table 4.9 interacts the PIGS spread with average share of tangible assets across industries.[104] The motivation behind this specification is that industry-specific characteristics can affect the level and nature of firms' real estate asset holdings (see, for instance, Rochdi, 2015). In addition, the average industry share of tangible assets is less likely to be endogenous with respect to other firm characteristics or lending at the bank-firm level—see, for instance, Campello and Giambona (2011) and the literature cited therein. Column (2) indicates that our results are robust to using the industry average of tangible assets. In particular, we find that banks shift credit towards firms in industries with higher shares of tangible assets.

The specification in Column (3) holds the firm share of tangible assets fixed at its 2008 level and inflates it with the city-level commercial real property price index, assuming that firms

[102] The tangible asset ratio is lagged by four quarters because firm-level data are at the annual frequency.
[103] We calculate these magnitudes as follows. The 25th percentile of the distribution of TS is 8.74%. The corresponding value for the 75th percentile is 65.52%. Thus, the credit growth difference between both types of firms is: (65.52-8.74)*0.013=0.74
[104] The results are virtually unchanged if we use the median industry value instead.

own most of their real estate assets in the city where their headquarters are located, in a manner similar to Chaney et al. (2012) and Doerr (2018). Again, we find that banks shift their credit supply towards firms with more real estate collateral, even though the β coefficient is now estimated slightly less precisely. This is likely to be the case due to the lower number of observations in this experiment, as the variable CREP is not available for all cities and rural areas covered by the German credit registry, leading to a sample size that is roughly half the one used in the baseline.

Table 4.9 BANK FLOWS, REAL ESTATE COLLATERAL, FIRM CREDIT ACCESS

	(1) ΔL	(2) ΔL	(3) ΔL	(4) ΔL	(5) ΔL
$\text{Spread}_{t-1} \times \text{TS}_{t-4}$	0.013***				
	(0.003)				
$\text{Spread}_{t-1} \times \text{TS}_{\text{Industry},t-4}$		0.014***			
		(0.003)			
$\text{Spread}_{t-1} \times (\text{TS}_{2008} * \text{CREP}_{t-4})$			0.011**		
			(0.005)		
$\text{Spread}_{t-1} \times \text{TS}_{t-4} \times \text{Interbank}_{t-1}$				0.467**	
				(0.231)	
$\text{TS}_{t-4} \times \text{Interbank}_{t-1}$				-3.832**	
				(1.813)	
$\text{Spread}_{t-1} \times \text{TS}_{t-4} \times \text{Net Foreign Assets}_{t-1}$					0.030*
					(0.017)
$\text{TS}_{t-4} \times \text{Net Foreign Assets}_{t-1}$					-0.370***
					(0.122)
Firm-Year FE	Yes	Yes	Yes	No	No
Firm-Year-Quarter FE	No	No	No	Yes	Yes
Bank-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Obs	573,985	707,742	188,965	387,734	514,985
R^2	0.141	0.145	0.147	0.456	0.430

NOTE. The regressions are based on quarterly bank-firm-relationship level data over the period 2009:Q1-2014:Q4. The dependent variable is the log-difference in loan value of bank i to firm j in quarter-year pair t. The independent variable is the PIGS spread interacted with firms' share of tangible assets. The latter is replaced by its industry mean in Column (2). In Column (3), we inflate the pre-determined 2008 share of firm-level tangible assets with the city-level real commercial real estate price index. Column (1)-(3) include bank-time and firm-year fixed effects. Columns (4) interacts the PIGS spread with firm-level tangible assets and the interbank funding over retail deposits ratio. Column (5) interacts the spread with tangible assets and banks' net foreign assets vs. euro area countries over total assets, respectively. In Column (4) and (5), we replace firm-year with firm-year-quarter fixed effects. The standard errors are clustered at the bank-firm level and shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

The role of two important bank characteristics is explored in Columns (4)-(5). Specifically, following Baskaya et al. (2018), first we examine whether the role of collateral is stronger for banks with higher interbank-to-deposit ratios. As this type of funding is more likely to be exposed to international capital market fluctuations, banks with a high share of non-deposit funding should be most affected by changes in the PIGS spread, which captures also changes in global financial conditions. Second, we also examine the role of individual-bank pre-GFC exposure to the rest of the euro area as captured by the net foreign assets position vs the rest of the euro area as a share of total assets in 2006. If the PIGS spread is capturing bank retrenchment from Southern Europe, we should find that banks with a higher pre-GFC exposure to the rest of the euro area should respond more to the spread change. To this end, we include two triple interaction terms. The first is the interaction between the PIGS spread, the share of tangible assets and the lagged interbank-to-deposit funding ratio (Column 4). The second term interacts the spread with the share of tangible assets and the lagged value of the share of net foreign assets (Column 5).

In these two additional regressions, the granularity of the credit register data permits us to restrict the sample to firms with multiple bank relationships, and hence allowing us to include firm-year-quarter fixed effects ($\alpha_{j,t}$), as opposed to firm-year fixed effects as before. As shown by Khwaja and Mian (2008), this strategy fully absorbs firm-specific loan demand shocks.[105] The estimation results in Column (4) indicate that the sensitivity of the credit supply to real estate collateral is stronger for banks with a higher non-core funding ratio, as can be gauged from the positive and statistically significant coefficient on the triple interaction term. The results in Column (5) suggest that lending might also be affected by the initial euro area exposure, even though this effect is statistically significant only at the 10 % level.

Appendix Table 4.B.3 reports additional robustness checks. The results in Table 4.9 are robust to augmenting the baseline regression with the interaction between the PIGS spread

[105] Recall that we can employ this identification strategy because 92% of the firms in the German credit register borrow from more than one bank. Note here that, in these two specifications, firm-time fixed effects absorb the double interaction term between the PIGS spread and the tangible asset ratio, which therefore cannot be included separately.

with other firm-level controls that are likely to be correlated with the firm share of tangible assets (Columns (1)-(3)). This additional experiment ensures that the baseline results are not driven by a correlation between the share of tangible assets and other firm-level characteristics. The results show that, if anything, adding more firm-level controls interacted with the PIGS spread increases the economic magnitude of the estimated coefficient on the key interaction term between the PIGS spread and tangible assets. In Column (4) of Table 4.B.3, we drop observations during the 2009-2010 period. This might be important because the German government, after the GFC, provided guarantees to certain firms and sectors. To the extent to which these guarantees are correlated with the tangible asset ratio of firms, our baseline results could be biased. The results in Column (4) show that, even excluding 2009-2010, a higher PIGS spread leads to a shift in credit supply towards high-tangible asset firms. Finally, in Column (5), we document that our results are also robust to employing a time-invariant level of TS, measured in 2008, without inflating the initial level with commercial property price changes.

To sum up, Table 4.9 documents an important role of real estate collateral in firm access to credit in response to bank flow shocks. The results suggest that banks allocate more credit to firms with more real estate collateral as measured by a higher share of tangible assets, even after controlling for loan demand. This effect is stronger for riskier banks with higher interbank funding ratios or greater net

4.5.2 Industry-level Credit Allocation

Next, we study the credit allocation by industry showing that credit increases (declines) the fastest (the slowest) in the industries with the highest shares of tangible assets. As we saw earlier, these sectors are those in which land and buildings are used more intensively in the production of their output (Figure 4.8 and Table 4.A.4).

Table 4.10 BANK FLOWS AND BANK LENDING BEHAVIOR: BETWEEN-SECTOR DIFFERENCES

Dependent variable: ΔL	
$\text{Spread}_{t-1} \times \text{I}_{\text{Agriculture}}$	2.980^{***}
	(0.97)
$\text{Spread}_{t-1} \times \text{I}_{\text{Energy/Utility}}$	1.053^{***}
	(0.27)
$\text{Spread}_{t-1} \times \text{I}_{\text{Transport/Warehousing}}$	0.628^{**}
	(0.24)
$\text{Spread}_{t-1} \times \text{I}_{\text{Information}}$	-1.635^{**}
	(0.80)
$\text{Spread}_{t-1} \times \text{I}_{\text{Real Estate}}$	0.960^{***}
	(0.33)
Bank-Year-Quarter FE	Yes
Firm-Year FE	Yes
Obs	708,714
R^2	0.133

NOTE. This regression is based on matched quarterly German bank-firm-level data over the period 2009:Q1-2014:Q4. The dependent variable is the log difference in loan value of bank i to firm j in quarter-year pair t. The main regressor is the PIGS spread interacted with a sector dummy that corresponds to the 2-digit NAICS classification as in Figure 4.8. The table reports only sectors behaving in a statistically significant different manner. The regression also includes bank-time and firm-year fixed effects. The standard errors are clustered at the bank-firm level and are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

In order to identify between-industry differences, we estimate the following regression:

$$\Delta \text{L}_{i,j,t} = \alpha_{i,t} + \alpha_{j,year} + \beta * (SPREAD_{t-1} * SECTOR_s) + \varepsilon_{i,j,t} \quad (4.6)$$

where $SECTOR_s$ is a dummy variable for sector s constructed based on the 2-digit NAICS industry classification used in Figure 4.8. In particular, for all sectors except manufacturing, we interact the PIGS spread with a set of industry dummies that are equal to one for industry s and zero otherwise. We use manufacturing as the reference group because this is the industry in which real estate is least likely to dominate total tangible fixed assets.[106] Manufacturing is also the largest industry in the data set by number of firms. Thus, this specification evaluates the difference in credit growth in response to the bank flow shock relative to the allocation of credit in manufacturing. To control for time-varying bank heterogeneity and loan demand, we also control for bank-year-quarter and firm-year fixed effects as discussed above.

[106] Manufacturing is right at the 25th percentile of the tangible asset share distribution with an average value slightly below 30% in Table 4.8 and Table 4.A.4. See also Rochdi (2015).

Table 4.10 reports the estimation results. For ease of presentation, the table displays only sectors whose credit allocation is statistically different than manufacturing. It is evident that a higher PIGS spread has a stronger effect on the credit growth of industries with a higher share of tangible assets, and hence more likely to be exposed to commercial real estate. Specifically, credit growth is highest in Agriculture, Energy and Utility, Transport and Warehousing and Real Estate itself—the industries with the highest average shares of tangible assets in total assets, as can be seen from Figure 4.8 and Table 4.A.4. In contrast, the results show that the information sector, which has one of the lowest shares of tangible fixed assets and whose production function is intensive in intangible assets, receives a significantly lower share of credit in response to bank inflows. For robustness, we also regress credit growth of bank i to firm j on the triple interaction between the PIGS spread, the industry dummies and the different bank characteristics introduced in Table 4.9. The results are not reported to conserve space, but are in line with those reported in Table 4.10.

In summary, the evidence at the sector level confirms the findings at the bank-firm level and suggests that firms with more real estate collateral have easier access to credit in response to bank flow shocks. Or, in other words, banks allocate disproportionately more credit to firms and sectors with more real estate collateral. This evidence is in strong accord with a transmission mechanism of bank flow shocks to output in which real estate collateral plays a critical role, as established in Section 4.4.

4.6 FIRM AND INDUSTRY OUTCOMES

Having established that retrenching banks supplied more credit to firms with more real estate collateral, in this section, we want to evaluate the role of collateral in determining the differential impact a bank flow shock on firm and industry-level outcomes. We focus on employment, investment, total factor productivity (TFP), and borrowing costs. We then also evaluate whether bank flow shocks are associated with capital misallocation.

We measure borrowing cost changes (ΔINTEXP) with the log difference of firm interest expenses as a share of total debt, following Bernile et al. (2017) and Gambacorta and Shin (2018).[107] Employment growth (ΔEMPL) is the rate of growth in the total number of firm employees. Investment (ΔK) is the change in firm total fixed assets as a share of total assets, so as to make sure that the results are not driven by firm size. TFP growth (ΔT FP) is constructed by estimating a production function based on our firm-level data aggregated at the industry level at the second digit of the NAICS code, following Wooldridge (2009). Specifically, TFP is the residual of a regression of firm-level log real value added on log labor input (the log of the real wage bill) and log capital input (the log of the real book value of total fixed assets), where firm value added and the wage bill are deflated with the two-digit industry price deflators from the OECD STAN database. The capital stock is deflated by the price of investment goods. For this TFP regression, all variables are winsorized at the 1% level before taking logs. To evaluate the role of real estate collateral in the transmission of bank flow shocks to firms, we specify the following firm-level reduced-form regression:

$$\Delta Y_{j,t} = \alpha_j + \alpha_t + \gamma * \Delta Y_{j,t-1} + \upsilon * \left(SPREAD_{t-1} * TS_{j,t-1}\right) + \varepsilon_{j,t} \quad (4.7)$$

where Y denotes alternative firm outcomes. As in the credit regression of the previous section, the main independent variable in all specifications is the PIGS spread interacted with the firm-level share of tangible assets. To mitigate endogenity concerns, we continue to rely on the microeconomic nature of the data, including firm and time fixed effects. In order to address concerns that firms may be on different trend paths, all regressions include the lagged dependent variable (LDV).

[107] This variable is winsorized at the 1% level to mitigate the impact of outliers.

We expect bank flow shocks to reduce the borrowing costs of firms with a higher share of real estate collateral since these firms can obtain more credit on possibly better terms (Benmelech et al., 2005; and Benmelech and Bergman, 2008).[108] Second, for consistency with the results in Section 4.4, one should also find a positive coefficient on employment growth and investment in the transmission of a bank flow shock to output through the commercial real estate sector. In contrast, we do not have a definite prior on the impact of the bank flow shock on TFP.

Table 4.11 FIRM AND INDUSTRY OUTCOMES

	Firm-Level	Firm-Level	Firm-Level	Firm-Level	Industry-Level	Industry-Level
	(1)	(2)	(3)	(4)	(5)	(6)
	ΔINTEXP	ΔEMPL	ΔK	ΔTFP	ΔTFP	SD(TFP)
$\text{Spread}_{t-1} \times \text{TS}_{t-1}$	-0.031***	0.009***	0.144*	-0.002	-	-
	(0.01)	(0.00)	(0.08)	(0.01)		
$\text{Spread}_{t-1} \times \text{TS}_{\text{Industry},t-1}$	-	-	-	-	-0.016	0.005
					(0.02)	(0.03)
TS_{t-1}	1.279***	-0.042	1.225***	0.386***	-	-
	(0.16)	(0.07)	(0.34)	(0.08)		
$\text{TS}_{\text{Industry},t-1}$	-	-	-	-	1.308	0.335
					(0.86)	(1.14)
LDV_{t-1}	-0.369***	-0.484***	0.031	-0.425***	-0.358**	-0.024
	(0.01)	(0.03)	(0.03)	(0.03)	(0.12)	(0.21)
Firm FE	Yes	Yes	Yes	Yes	-	-
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	-	-	-	-	Yes	Yes
Obs	22419	41827	50774	15143	64	64
R^2	0.311	0.364	0.031	0.389	0.340	0.735

NOTE. The regressions in columns (1)-(4) are based on annual firm-level data over the period 2009-2014. The dependent variables are: changes in firm borrowing costs ($\Delta INTEXP$) measured as the log difference of firm interest expenses as a share of total debt in Column (1); employment growth ($\Delta EMPL$) measured as the rate of growth in the total number of firm employees in Column (2); investment (ΔK) measured as the change in firm *total* fixed assets as a share of total assets in Column (3); TFP growth (ΔTFP) constructed by estimating a production function based on our firm-level data aggregated at the industry level at the second digit of the NAICS code, following Wooldridge (2009). The independent variable is the PIGS spread interacted with the firm share of tangible assets. All specifications (1)-(4) include the respective lagged dependent variable (LDV), in addition to firm and time fixed effects. The standard errors are clustered at the industry-year level and are shown in parentheses. Columns (5)-(6) are industry level regressions in which the dependent variables are industry-level average total factor productivity growth, and the industry-level dispersion in total factor productivity. The main regressor here is the PIGS spread interacted with the industry average share of tangible assets. Both specifications include the lagged dependent variable, as well as time and industry fixed effects. Standard errors are clustered at the industry level. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

108 See also the aggregate evidence we reported in Table 4.1 and Baskaya et al. (2018), who explore the effect of capital flows on both the volume and price of credit. Unfortunately, the German credit registry does not include information on the price of credit contracted.

Table 4.11 reports the results. Column (1) shows that bank flow shocks not only increase the credit supply to high-tangible asset firms, as shown before, but also reduce their costs of borrowing. Moreover, Columns (2)-(3) show that bank flow shocks increase employment and investment of high-tangible asset firms, with a statistically significance at the 1% and 10% level, respectively. Column (4) suggests that a higher firm share of tangible assets has a strong positive linear effect on TFP growth, with no differential impact on high-tangible asset firms during the episode of bank retrenchment that we consider. This is evident from the estimated coefficient on the level of lagged firm TS, which is positive and highly significant, and the insignificant coefficient on the interaction term. In other words, Column (4) says that bank flow shocks are not associated with a disproportionate increase or reduction in TFP growth of high-tangible asset firms. This result suggests that we should not expect strong evidence of capital misallocation during the bank repatriation episode that we study.

To assess this hypothesis more formally, we first aggregate our firm-level data at the NAICS2 code industry level as in Doerr (2018). We then regress average industry TFP growth rates on the interaction between the PIGS spread and average industry-level shares of tangible assets, controlling for lagged TFP growth in addition to time and industry fixed effects. Column (5) shows that, as in the firm regression, there is no significant association between the bank flow shock and a disproportionate change in TFP of high-tangible asset industries.

Second, we also regress the industry-level TFP dispersion on the interaction between the PIGS spread and the industry-level average share of tangible assets. Following Hsieh and Klenow (2009), the idea here is that, if credit growth leads to capital misallocation, TFP dispersion across firms in the same industry should increase with the bank flow shock, especially in industries with more real estate collateral that obtained a more than proportional share of the declining credit volumes during the 2009-2014 period. Column (6) shows that the estimated coefficient on this interaction term is positive, but statistically insignificant. Even though this regression is run with very few observation, the finding is consistent with the results of Gopinath et al. (2017), who do not uncover evidence of misallocation in Germany. The result is unchanged if we replace TFP dispersion with the dispersion of the marginal product of capital.[109] In an unreported regression, we also regressed TFP dispersion on the PIGS spread, without interacting the latter with industry-level average tangible asset ratios, finding no association between the PIGS spread and industry-level TFP dispersion.

These results are interesting as they stand in contrast to some other findings in the misallocation literature specifically focused on housing booms. For example, Doerr (2018) and Chakraborty et al. (2018) document that real estate booms tend to distort credit and capital allocation, leading to sizable aggregate TFP losses. In contrast, we show that bank retrenchment, while causing higher property prices with varying intensities across cities, is not associated with lower productivity growth at the firm or industry-level, or increased TFP dispersion. One way to reconcile these seemingly conflicting results is to note that the German residential and commercial real estate price booms did not take place in the context of a credit boom. On the contrary, as noted above, aggregate credit declined in real terms during the period considered (see, for instance, Panel D in Figure 4.1).

To summarize, the results in this section also accord well with our main results in Section 4.4 based on city-level data. The estimated differential impact of a bank flow shock on firm and industry-level outcomes provide additional evidence that real estate collateral plays a significant role. Real estate collateral seems critical not only for the differential access of firms and sectors to the increased credit supply triggered by bank inflows, but is also associated with increased hiring and investment, thus contributing to higher levels of local economic activity, without evidence of capital misallocation.

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109 This is not surprising because, with the constant factor shares and a Cobb-Douglas production function, TFP dispersion and the dispersion of the marginal product of capital are proportional to each other (see Gopinath et al., 2017).

4.7 CONCLUSION

This chapter studies the role of real estate markets in the transmission of bank flow shocks to city business cycles in Germany by using a new and unique matched city-level and bank-firm-level data set. Germany is an interesting laboratory because it experienced sizable bank inflows with a real estate boom, but without a domestic credit boom, during and after the global financial crisis (GFC).

To identify the differential impact of bank flow shocks on output growth across German cities, we exploit the quasi-random geographic variation in a city-level measure of real estate market tightness or exposure. This measure is the product of the gross share of land that cannot be developed, which is determined by geography and land use regulations, and the city-level share of refugees in total refugees, which is determined by longstanding government rules and regulations.

We find that the output growth impact of a bank flow shock, as measured by the sovereign bond spread of Southern European countries (the so-called PIGS spread), is more significant in cities that are more exposed to tightness in local real estate markets. We estimate that, during the 2009-2014 period, for every 100-basis point increase in the PIGS spread, the most exposed German cities grow 15-25 basis points more than the least exposed ones. The differential response of commercial property prices across cities to the bank flow shock accounts for all of this growth differential.

The transmission mechanism that we uncover works through a collateral channel on the firm side in which commercial real estate plays a central role. We document the importance of real estate collateral for firm credit access and bank behavior by showing that German banks repatriated gross foreign assets from the rest of Europe after the GFC and lent disproportionately more to domestic firms and sectors with more tangible fixed assets. We also show that firms with more tangible assets hire and invest more in response to the bank flow shock. Consistent with the extant literature on Germany, but differently from studies of housing booms with credit booms, we do not find evidence of capital misallocation associated with the transmission of bank flow shock across German cities.

This chapter is ultimately silent on the role of the residential real estate sector in the transmission of the bank flow shock that we consider. Macroeconomic data show that the leverage of German households, already low by international standards before the GFC, declined further during the post-GFC period. Exploring drivers on residential house prices in the context of a portfolio re-balancing framework, like in Flavin and Yamashita (2002), and exploring its impact on consumption is an interesting area of future research.

4.8 APPENDIX A: DATA

Table 4.A.1 DEFINITIONS AND SOURCES OF ALL VARIABLES USED IN THE EMPIRICAL ANALYSIS

Variable	Definition	Unit	Source
$\Delta RREP$	City c's residential real estate price index, log-change and deflated by state-level CPI	%	Bulwiengesa
$\Delta CREP$	City c's commercial real estate price index, log-change and deflated by state-level CPI	%	Bulwiengesa
RREP	City c's residential real estate price index, deflated by state-level CPI	2007=100	Bulwiengesa
CREP	City c's commercial real estate price index, deflated by state-level CPI	2007=100	Bulwiengesa
Non-Developable Area	City c's gross share of land that cannot be developed relative to total area	%	INKAR
Refugees	Share of refugees allocated by the government to city *c* relative to all refugees in the same year	%	Fed. Stat. Off.
Exposure	City c's product of the share of refugees and the share of non-developable area	%	own calculation
ΔGDP	City c's growth in GDP per capita, deflated by state-level CPI	%	INKAR
Population Density	City c's number of inhabitants per square kilometer	-	INKAR
Refugees in 2009	2009 share of refugees allocated by the government to city *c* relative to all refugees in 2009	%	Fed. Stat. Off.
Building Permits	City c's inverse of the change in building permits from the 2000-2008 period to 2009-2014	-	INKAR
PIGS spread	The average of the 10-year government bond spread of Portugal, Italy, Greece and Spain relative to Germany	%	FRED
Net Bank Inflows Outside Eurozone	Change in net foreign liabilities outside the Eurozone of German BIS reporting banks	% of GDP	BIS
Net Bank Inflows Inside Eurozone	Change in net foreign liabilities inside the Eurozone of German BIS reporting banks	% of GDP	BIS
Gross Bank Inflows Inside Eurozone	Change in gross foreign liabilities inside the Eurozone of German BIS reporting banks	% of GDP	BIS
Gross Bank Outflows Inside Eurozone	Change in gross foreign assets inside the Eurozone of German BIS reporting banks	% of GDP	BIS
Lending-Deposit Spread	Lending rate is the interest rate charged by banks on short- and medium-term loans to the private sector. Deposit interest rate is the interest rate offered by commercial banks on three-month deposits (Line 60P - Line 60L).	%	IMF IFS
TS	Firm j's tangible fixed assets (Bureau van Dijk code TFAS) as a share of total assets (TOAS)	%	Amadeus
$TS_{Industry}$	The arithmetic mean of TS by 2-digit NAICS code	%	Amadeus
$TS_{2008} * CREP$	Firm j's 2008 tangible assets as a share of total assets inflated by the city-level real commercial real estate price index	%	Amadeus, Bulwiengesa
EQ	Firm j's capital-to-asset ratio (CAPI/TOAS)	%	Amadeus
ROA	Firm j's return on assets (EBIT/TOAS)	%	Amadeus
TA	Firm j's logarithm of total assets (TOAS)	ln(euro)	Amadeus
$\Delta INTEXP$	Change in firm j's logarithm of interest expenses over total debt (INTE/LOAN)	%	Amadeus
$\Delta EMPL$	Change in firm j's logarithm of the number of employees (EMPL)	%	Amadeus
ΔK	Change in firm j's total fixed assets (FIAS) scaled by total assets (TOAS)	%	Amadeus
ΔTFP	Change in firm j's logarithm of TFP computed by following Wooldridge (2009)	%	Amadeus
$\Delta L_{i,j,t}$	Log-difference of the stock of loans of bank i to firm j in quarter-year t	%	Credit Register
Bank Share of Gross Foreign Assets	Bank i's gross foreign assets over total assets	%	Bundesbank
Net Foreign Assets	Bank i's net foreign assets vis-à-vis the euro area over total assets	[0,1]	Bundesbank
Interbank	Bank i's interbank funding-to-deposits ratio	[0,1]	Bundesbank
Capital Ratio	Bank i's regulatory capital-to-asset ratio	%	Bundesbank
Size	Bank i's logarithm of total assets	ln(euro)	Bundesbank
Liquidity	Bank i's liquid assets over total assets	%	Bundesbank
ROA	Bank i's return on risk-weighted assets	%	Bundesbank
NPL	Bank i's non-performing over total loans	%	Bundesbank
Loans	Bank i's loans over total assets	%	Bundesbank

Table 4.A.2 SUMMARY STATISTICS FOR ALL VARIABLES USED IN THE EMPIRICAL ANALYSIS

Variable	Observations	Mean	Median	SD	25th	75th
$\Delta RREP$	466	2.22	2.15	3.48	-0.43	4.49
$\Delta CREP$	466	1.22	1.27	3.19	-0.97	3.10
RREP	466	102.69	99.92	10.58	95.55	108.14
CREP	466	102.42	102.25	10.72	95.74	108.69
Non-Developable Area	466	54.74	54.80	13.60	45.10	66.50
Refugees	466	1.23	0.63	1.83	0.32	1.26
Exposure	466	54.43	35.69	61.85	17.85	65.73
ΔGDP	466	1.01	0.96	4.48	-1.48	2.77
Population Density	466	1530.40	1354.00	773.34	1004.00	2027.00
Refugees in 2009	466	1.25	0.62	1.87	0.35	1.26
Building Permits	466	-5.06	0.39	31.48	-2.42	1.46
PIGS spread	60	2.04	0.46	2.84	0.19	3.22
Net Bank Inflows Outside Eurozone	60	-2.08	-4.28	12.31	-8.52	1.96
Net Bank Inflows Inside Eurozone	60	-2.32	-1.17	6.05	-5.33	1.06
Gross Bank Inflows Inside Eurozone	60	0.13	0.78	4.65	-1.96	2.64
Gross Bank Outflows Inside Eurozone	60	2.46	2.03	6.69	-1.39	4.97
Lending-Deposit Spread	48	2.15	2.05	0.70	1.61	2.50
TS	72,290	38.04	29.63	32.03	8.74	65.52
$TS_{Industry}$	90,483	36.41	27.09	18.53	22.35	54.36
$TS_{2008} * CREP$	19,972	33.98	21.41	33.40	5.19	59.41
EQ	73,948	26.36	23.85	27.77	8.56	42.76
ROA	42,275	5.48	4.51	12.29	0.75	10.30
TA	75,076	21.09	23.06	4.68	15.62	24.02
$\Delta INTEXP$	29,722	2.62	-0.45	83.42	-33.68	35.72
$\Delta EMPL$	65,776	4.31	0.00	54.85	-0.80	6.24
ΔK	62,043	33.44	0.04	476.42	-0.24	0.65
ΔTFP	28,813	-0.52	0.04	35.51	-9.15	9.49
$\Delta L_{i,j,t}$	723,296	-2.84	-0.83	63.54	-7.34	2.04
Bank Share of Gross Foreign Assets	89,651	58.07	59.82	15.74	50.23	67.78
Net Foreign Assets	29,606	0.0009	-0.00006	0.07	-0.001	0.002
Interbank	27,338	0.0003	0.00	0.009	0.00	0.00
Capital Ratio	28,769	18.90	17.03	14.40	14.59	20.48
Size	29,615	20.76	20.59	1.32	19.87	21.41
Liquidity	29,615	20.91	17.06	15.33	12.62	23.32
ROA	28,583	2.12	1.99	3.46	1.56	2.49
NPL	27,344	3.90	3.30	3.85	2.05	4.89
Loans	29,610	58.52	60.23	15.80	51.01	68.17

Table 4.A.3 List of Cities, Average Refugee Allocation, and Exposure Measure

Aschaffenburg (0.4, 24.4)	Cottbus (0.3, 18.0)	Fürth (0.4, 20.8)	Kassel (1.4, 54.2)	Mannheim (1.3, 52.3)	Rosenheim (0.2, 9.3)
Augsburg (1.4, 78.2)	Darmstadt (2.3, 152.1)	Gelsenkirchen (1.2, 29.4)	Kempten (0.1, 6.8)	Mönchengladbach (0.8, 42.8)	Rostock (0.6, 38.9)
Bamberg (0.2, 9.5)	Dessau-Roßlau (0.2, 14.6)	Gera (0.1, 9.5)	Kiel (0.9, 43.6)	**München** (9.1, 237.6)	Salzgitter (0.4, 26.2)
Bayreuth (0.4, 20.9)	Dortmund (3.0, 116.4)	Hagen (0.8, 53.8)	Koblenz (0.6, 38.9)	Münster (0.9, 60.6)	Schweinfurt (0.3, 13.1)
Berlin (12.2, 362.3)	Dresden (1.0, 56.6)	**Hamburg** (11.0, 444.7)	Krefeld (0.6, 27.4)	Neumünster (0.4, 18.7)	Solingen (0.4, 21.8)
Bielefeld (1.6, 92.2)	Duisburg (1.9, 73.3)	Hamm (0.5, 31.9)	Köln (4.1, 158.4)	Nürnberg (2.9, 110.9)	Stuttgart (3.0, 147.3)
Bochum (1.3, 38.4)	Düsseldorf (2.6, 102.7)	Heidelberg (0.5, 36.4)	Landshut (0.2, 13.3)	Offenbach (0.9, 44.7)	Suhl (0.1, 7.1)
Bonn (1.6, 81.4)	Eisenach (0.1, 6.5)	Heilbronn (1.0, 62.8)	Leipzig (1.4, 65.7)	Osnabrück (0.5, 26.0)	Trier (0.4, 29.3)
Bottrop (0.3, 17.2)	Erfurt (0.7, 48.4)	Herne (0.5, 11.9)	Leverkusen (0.6, 23.4)	Passau (0.1, 7.2)	Ulm (0.6, 43.0)
Braunschweig (2.6, 30.1)	Erlangen (0.3, 18.6)	Ingolstadt (0.3, 17.3)	Ludwigshafen (0.9, 33.1)	Pforzheim (0.9, 59.6)	Wiesbaden (1.2, 70.2)
Bremen (2.6, 107.4)	Essen (3.2, 104.2)	Jena (0.2, 16.3)	Lübeck (0.6, 39.6)	Potsdam (0.5, 36.0)	Wilhelmshaven (0.2, 13.4)
Bremerhaven (0.4, 20.4)	Flensburg (0.2, 9.2)	Kaiserslautern (0.2, 15.1)	Magdeburg (0.7, 40.6)	Regensburg (0.4, 19.2)	Wolfsburg (0.4, 28.8)
Chemnitz (0.7, 41.3)	Frankfurt (3.7, 156.0)	Karlsruhe (1.3, 67.1)	Mainz (1.0, 47.5)	Remscheid (0.3, 15.6)	Wuppertal (2.2, 111.5)
					Würzburg (0.7, 36.6)

Note. The table lists the 79 urban areas defined as cities both in the national accounts and by Bulwiengesa. The numbers in parentheses are the 2009-2014 average value of the share of refugees in total refugees and the value of our exposure measure, defined as the product of the share of refugees and the gross share of non-developable area, respectively. Berlin, Bremen and Hamburg, which are underlined, are city states. Berlin, Hamburg and Munich, in bold font, are the largest German cities and have the three highest average shares of refugees in total refugees over the period 2009-2014.

Table 4.A.4 INDUSTRY CLASSIFICATION

NAICS Code	Industry Name	Average TS (in %)
11	Agriculture	56.2
21	Mining	47.6
22	Energy/Utility	65.2
23	Construction	23.9
31-33	Manufacturing	28.9
42	Wholesale Trade	19.4
44-45	Retail Trade	20.7
48-49	Transport/Warehousing	70.8
51	Information	21.8
52	Finance	37.9
53	Real Estate	56.0
54-56	Technical Services	30.8
61	Education Services	46.1
62	Health Care	63.7
71	Recreation	55.4
72	Accommodation	54.0
81	Other Services	39.2

NOTE. Firms' 2-digit NAICS codes are provided in the Amadeus data set. Average TS is the simple average of the firm-level ratios of tangible assets over total assets by industry.

Macroeconomic Data: Variables Definition and Data Sources

The macroeconomic variables used in the chapter are at quarterly or annual frequency, over the period 2001:Q1-2014:Q4, subject to availability, and are defined as follows.[110]

National Property Price and Rent Indexes. The national price index is a regionally weighted average of transaction-based prices for town houses, owner-occupied apartments, and single-family detached homes. The national rent index is a regionally weighted average of transaction-based rents for owner-occupied apartments. The national commercial price index is an average of the commercial property price indexes for office and retail properties in 127 towns and cities. The national commercial rent index is an average of the Bulwiengesa AG indexes for rental of office and retail core properties. Indexes are normalized to 100 in 2009. The price-to-rent ratios are the simple ratio of the price and rent indexes. Source: Deutsche Bundesbank based on Bulwiengesa AG data.

[110] For Bundesbank data see https://www.bundesbank.de/Navigation/EN/Statistics/Enterprises_and_households/System_of_indicators/system_of_indicators.html.

Total Domestic Credit (% of GDP) is "bank lending to domestic non-banks." Credit provided by foreign banks includes the lending provided by both the branches and the subsidiaries of foreign banks. Bank lending provided by domestic banks is the difference between lending provided by all banks and foreign banks. Data originally at monthly frequency converted to quarterly frequency by taking simple averages. Source: Deutsche Bundesbank.

Credit by Borrowers (% of Total) is loans (including bills of exchange) to domestic households, firms, and foreigners, respectively, by all types of banks as a percentage of the total. Source: Deutsche Bundesbank.

Current Account Balance (% of GDP) is the current account balance of Germany vis-a-vis the rest of world as a share of GDP. Euro area current account is the balance vis-a-vis the rest of the euro area. Outside the euro area current account is the difference between the total balance and the euro area balance. Source: Deutsche Bundesbank.

Real GDP (Index, 2009:Q1=100) is the real GDP index for Germany, Portugal, Italy, Greece and Spain, normalized to 100 in 2009:Q1. Source: FRED.

Immigration is the number of immigrants into Germany. **Emigration** is the number of emigrants. **Net immigration** is the difference. Source: Statistisches Bundesamt. See https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Wanderungen/Tabellen/wanderungen-alle.html.

Nominal Bond Yield is the 10-year government bond yield (percent per annum). The VIX index is the CBOE Volatility Index. Source: FRED.

Capital Flows and Real Estate: Procyclicality and Asset Class Size

Uribe and Schmitt-Grohe´ (2017) estimate that the the correlation between net capital flows, as measured by the current account balance, and output is more than 0.6 in the United States and about 0.3 on average for all countries over the period 1965-2010, with no group of countries (rich or poor, small or large) displaying negative correlations. Davis and Van Nieuwerburgh (2015) report that the correlation of residential investment and house prices with output is also about 0.6 for the United States. Cesa-Bianchi, Cespedes and Rebucci (2015) estimate that the correlation between residential house price changes and GDP growth is about 0.3 in both advanced and emerging economies. In Germany, the correlation between real GDP growth and commercial real property price changes is 0.46 during the longest period for which the data are available (2005-2016) and 0.66 during the 2009-2014 period considered in this chapter. The correlation between real GDP growth and residential real property price changes is 0.2 over the 2005-2016 period and 0.54 over the 2009-2014 period. As Davis and Van Nieuwerburgh (2015) observe, for the United States, “the value of the real estate asset class is enormous”. In the case of Germany, buildings, structures and land represent slightly less than 70 percent of households’ net worth according to official data, while residential and non-residential fixed capital is more than 80 percent of the total capital stock according to the World Penn Tables. Germany, however, has one of the lowest home ownership rates in the world at about 50 percent, and household leverage is low and it declined during the post-GFC period, with household credit to GDP on a downward trend since 2000.

4.9 APPENDIX B: ROBUSTNESS ANALYSIS

Table 4.B.1 THE PIGS SPREAD AND BANK FLOWS: ROBUSTNESS

	Country-Level	Country-Level	Country-Level	Country-Level	Country-Level	Bank-Level
	(1)	(2)	(3)	(4)	(5)	(6)
	Net Bank Inflows Outside Eurozone	Net Bank Inflows Inside Eurozone	Gross Bank Inflows Inside Eurozone	Gross Bank Outflows Inside Eurozone	Lending-Deposit Spread	Bank Share of Foreign Assets
$Spread_t$	0.485	0.976***	-0.026	-1.002**	-0.133***	-0.246***
	(1.086)	(0.330)	(0.339)	(0.404)	(0.041)	(0.030)
Bank Controls	-	-	-	-	-	Yes
Macro Controls	-	-	-	-	-	Yes
Bank FE	-	-	-	-	-	Yes
Obs	32	32	32	32	32	86,129
R^2	0.010	0.206	0.000	0.186	0.260	0.864

NOTE. The regressions in this table are the same as in Table 4.1 in the paper. However, they are based on quarterly data from 2007:Q1 to 2014:Q4. The regression in column (6) is based on the full sample period of 2000:Q1 to 2014:Q4, but includes the following bank and macroeconomic control variables: bank size (log of total assets), the capital-to-asset ratio, liquid assets relative to total assets, the return on assets, the loan-to-asset ratio and the share of non-performing loans to total loans, as well as real GDP growth, the inflation rate (log change in the CPI consumer index). All variables are defined as in the Data Appendix. Heteroskedasticity-robust standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 4.B.2 BANK FLOWS, REAL ESTATE EXPOSURE, AND CITY BUSINESS CYCLES: ALTERNATIVE INSTRUMENTS IN THE EXPOSURE MEASURE

	Population Density	Refugees in 2009	Building Permits
	(1)	(2)	(3)
	ΔGDP	ΔGDP	ΔGDP
$Spread_{t-1} \times Exposure_{t-1}$	0.004*	0.001*	0.001**
	(0.002)	(0.001)	(0.001)
$Exposure_{t-1}$	-0.194	-	-0.109**
	(0.131)		(0.052)
Time FE	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Obs	466	466	466
R^2	0.462	0.460	0.459

NOTE. The regressions are based on annual city-level data over the period 2009-2014. The dependent variable is GDP growth. The main regressors are the city-level exposure measure, and its interaction with the PIGS spread. The exposure in column (1) is the product of the gross share of non-developable area and population density; in column (2) it is the product of the share of refugees measured time-invariantly in 2009 and the gross share of non-developable area; and in column (3) it is the product of the share of refugees and the inverse of the change in building permits during the boom period (2009-2014) relative to the non-boom period (2000-2008). All of the regressions add both city and time fixed effects. Heteroskedasticity-robust standard errors clustered at the city level are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 4.B.3 BANK FLOWS, REAL ESTATE COLLATERAL, FIRM CREDIT ACCESS: ROBUSTNESS

	(1) ΔL	(2) ΔL	(3) ΔL	(4) ΔL	(5) ΔL
$\text{Spread}_{t-1} \times \text{TS}_{t-4}$	0.013^{***}	0.015^{***}	0.016^{***}	0.014^{***}	0.014^{***}
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$\text{Spread}_{t-1} \times \text{EQ}_{t-4}$	-0.008^{*}	-0.004	-0.009		
	(0.003)	(0.003)	(0.003)		
$\text{Spread}_{t-1} \times \text{ROA}_{t-4}$		-0.047^{***}	-0.045^{***}		
		(0.003)	(0.003)		
$\text{Spread}_{t-1} \times \text{TA}_{t-4}$			0.128^{***}		
			(0.003)		
Firm-Year FE	Yes	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	Yes	Yes	Yes	Yes
Obs	568,128	410,649	410,649	387,734	512,985
R^2	0.145	0.145	0.145	0.136	0.141

NOTE. These regressions are based on quarterly data from 2009:Q1 to 2014:Q4. The dependent variable is the log difference in loan volumes of bank i to firm j in quarter-year t, as in Table 9. In Column (1)-(3), in addition to main regressor as in Table 9, the specification includes also the interactions between the PIGS spread and the firm-level capital-to-asset ratio (Column 1), between the PIGS spread and the firm-level return on assets (Column 2), and between the PIGS spread and firm size (measured with the log of total assets in Column 3). Column (4) drops 2009 and 2010 observations during the period of government intervention with guarantees. Column (5) measures TS_{t-4} with the 2008 firm-level of tangible asset ratios TS_{2008} as in Table 9, but without inflating it with commercial property prices. All regressions include bank-time and firm-year fixed effects. The standard errors are clustered at the bank-firm level and shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

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