



EUROPEAN CENTRAL BANK

EUROSYSTEM

Working Paper Series

Federico Kochen **Equity financing in a banking crisis:
evidence from private firms**

ECB – Lamfalussy
Fellowship Programme

No 30xx

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Abstract

To what extent can private firms' external equity substitute for debt financing in a banking crisis? To answer this question, I use firm-level data and firm-bank linkages to estimate the causal effect of an imported lending cut from a large German bank on firms' capital structure and real outcomes. The estimates imply that for every 1 euro reduction in debt, private firms in Germany received 0.27 euros of external equity. Firm-owner linkages indicate that outsiders provided equity funds in 40% of the firms that received an equity injection, while existing owners provided the funds in the rest. These findings highlight the importance of multiple sources of financing that can serve as backup facilities when the primary source of intermediation fails. The results also have implications for Macro-Finance heterogeneous firm models that typically overlook the role of equity financing.

Keywords: equity financing, banking crisis, capital and ownership structure.

JEL classifications: G01, G21, G32, E32, E44.

Non-technical Summary

Financial crises have shown the importance of economies maintaining multiple sources of financing that can act as a backup should the primary form of intermediation fail. Of particular relevance for firms' access to finance is whether equity can substitute for debt in a banking crisis. While this question has been studied for public firms participating in the stock market, we know little about the degree of substitution between equity and debt for privately held firms. This issue is especially important in countries with less developed capital markets and where private firms account for a significant share of economic activity.

In this context, this paper asks: to what extent can private firms' external equity substitute for debt financing in a banking crisis? To answer this question, I use firm-level data and firm-bank linkages to estimate the causal effect of an imported lending cut from a large German bank on firms' capital structure and real outcomes. In line with previous studies, I document that firms fully dependent on this bank had 7.9 percent *lower* financial debt in the years after the lending cut. Unlike previous work, I estimate that firms entirely dependent on this bank had 4.1 percent *higher* external equity funds than firms with no linkages to the bank after the credit supply cut. Considering the average firm's capital structure, these estimates imply that for every 1 euro reduction in financial debt, private firms in Germany received 0.27 euros of external equity funds.

To investigate who provides the external equity funds, I use firm-owner linkages to distinguish whether equity injections came primarily from firms' insiders, defined as existing owners, or from outsiders, identified through all the new owners. I find that out of all the firms that received at least one equity injection during the banking crisis, in 40% of them, a new owner joined the firm during the same period. This result implies that the external equity funds came from existing owners in 60% of the firms.

The empirical results presented in this paper show that private firms' external equity can partially substitute for debt financing in a banking crisis. The results highlight the importance of economies having multiple sources of financing that can serve as backup facilities when the main source of intermediation fails. The paper's key findings also have significant implications for Macro-Finance heterogeneous firm models that typically overlook equity financing, resulting in an incomplete picture of firms' access to finance.

1 Introduction

Financial crises have shown the importance of economies maintaining multiple sources of financing that can act as a backup should the primary form of intermediation fail. Of particular relevance for firms' access to finance is whether equity can substitute for debt after a lending cut. Using the analogy of a spare tire, Alan Greenspan, former chairman of the Federal Reserve, argued that a well-functioning stock market could mitigate the negative effect of a banking crisis by allowing firms to issue equity to substitute for the reduction in bank loans (Greenspan, 1999). While the spare tire hypothesis has been assessed for publicly traded firms that participate in the stock market (Levine, Lin, and Xie, 2016), we know little about the degree of substitution between equity and debt financing for privately held firms. This issue is especially important in countries with less developed capital markets and where private firms account for a significant share of economic activity.

This paper fills this gap in the literature by providing the first analysis of private firms' equity financing after a credit supply cut. Specifically, the paper *asks*: to what extent can private firms' external equity substitute for debt financing in a banking crisis? To answer this question, I use firm-level data and firm-bank linkages for Germany. Building on the work of Huber (2018), I study the causal effects of an imported lending cut from a large German bank during the Great Financial Crisis, arguably exogenous to the bank's domestic customers. Considering the average firm's capital structure, the main finding of the paper is that for every 1 euro reduction in firms' debt, private firms in Germany received 0.27 euros of external equity. Thus, private firms' external equity can partially substitute for debt, consistent with the spare tire view.

As a first step in the analysis, I document key facts about private firms' capital structure. I focus on the components of financial capital, which captures all the funds available to the firm and is given by financial debt plus book value equity. Central to the paper is that the data allows me to decompose firms' equity into two according to the source of the funds: *external equity*, which is the external funds of the owner(s), and *internal equity*, which captures all the funds internally generated by the firm due to retained earnings, undistributed profits or losses. Using this data, I measure equity injections through the change in external equity. I show that external equity injections are lumpy events. Hence, while infrequent, they are sizable in terms of the funds injected into the firms.

I characterize the importance of the different components of financial capital using the average ratios. The average leverage, the debt to financial capital ratio, of private firms in Germany is 0.44. The average ratios of external and internal equity to financial capital are 0.24 and 0.32, respectively. Consistent with Kochen (2023), I document that there

is an important life cycle component determining firms' capital structure, with leverage and the external equity ratio being higher for younger firms. In contrast, the internal equity ratio is larger for older firms, in line with the fact that as firms age, they accumulate internal equity while paying back debt and potentially buying back external equity.

The paper's main objective is to study the causal effect of bank lending cuts on private firms' capital structure, emphasizing the response of external equity funds. For this, I follow the identification strategy in Huber (2018), which estimates the effects *Commerzbank's* credit supply cut during the Great Financial Crisis (GFC). The case of Commerzbank constitutes an ideal natural experiment to study the impact of credit supply disruptions, as the lending cut was arguably exogenous to the bank's German customers. This bank suffered significant losses on its international trading book during the GFC, mainly related to its investments in the U.S. subprime mortgage market and its exposure to the collapse of Lehman Brothers. Due to these losses in its international portfolio, the bank cut its loan supply inside Germany. Commerzbank's imported lending cut addresses the reserve causality identification challenge in the empirical literature on financial frictions, where a shock to borrowers can lead to defaults on loans, in turn affecting the bank's equity and might result in a lending cut. Equipped with this credit supply shock, I use firms' heterogeneous dependence on Commerzbank for their debt financing to identify the effect of a lending cut on the components of firms' capital structure and other real outcomes.¹

Before moving into the firm-level analysis, I investigate the dynamics of total debt and external equity during the banking crisis conditional on firms' Commerzbank dependence. In the aggregate, firms with relationships with Commerzbank experienced a sharper decline in total debt after the lending cut triggered by the GFC. The contribution of this paper is the study of private firms' equity financing after a credit supply cut. I document that aggregate external equity increased during the GFC, in contrast to the reduction in total debt. More importantly, the aggregate external equity of Commerzbank-dependent firms increased by more than those with no linkages to the bank.

Motivated by these aggregate dynamics, I estimate firm-level responses to Commerzbank's lending cut using an empirical specification with firm- and time-fixed effects and a battery of controls for the pre-crisis period. The first set of results shows that firms fully dependent on Commerzbank had 0.082 log points *lower* (-7.9 percent) financial debt than no Commerzbank-dependent firms in the years after the lending cut, consistent with the estimates in Huber (2018). The paper's main finding is that firms entirely dependent on Commerzbank had 0.041 log points *higher* (4.1 percent) external equity funds than firms

¹Previous contributions using similar imported lending cuts include Peek and Rosengren (2000), which studies the effect of the Japanese banking crisis on the U.S. credit market.

with no linkages to the bank after the credit supply cut. Considering the average firm's capital structure, these estimates imply that for every 1 euro reduction in financial debt, private firms in Germany received 0.27 euros of external equity funds. Therefore, consistent with the spare-tire hypothesis, these results show that private firms' equity financing can partly substitute for debt in a banking crisis.

I also document the effect of Commerzbank's lending cut on firms' overall capital structure. I estimate that the internal equity of firms entirely dependent on Commerzbank was 0.077 log points lower (-7.4 percent) than non-dependent firms. This reduction reflects the decline in cash holdings and firms' lower earnings after the lending cut. The opposite sign estimates for external and internal equity response to a lending cut highlight the importance of differentiating between the components of firms' equity. Consequently, interpreting the dynamics of total firms' book value equity as those of external equity would lead to incorrect conclusions on the role of equity financing in a banking crisis.² Having established the effects on the three components of firms' total funds (debt, external, and internal equity), I find that firms with entire dependence on Commerzbank had 0.031 log points lower (-3.1 percent) financial capital in the years after the lending cut. The more significant equity injections received by Commerzbank-dependent firms explain the lower reduction in financial capital despite the sizable decline in firms' financial debt and internal equity in the years following the credit supply cut.

After estimating the effects of the lending cut on firms' capital structure, I study the real effects on firms' tangible capital, employment, and output. The results indicate that firms' tangible capital was 0.059 log points lower (-5.7 percent) for firms entirely dependent on Commerzbank in the years after the lending cut. For the case of employment, Commerzbank-dependent firms had a level of employment 0.018 log points lower (-1.8 percent) than non-dependent firms. It is worth noting that these heterogeneous effects on firms' inputs are consistent with financial frictions primarily affecting firms' capital investment decisions, with limited implications for labor.³ Lastly, firms' output, measured by value added using a comprehensive measure of costs, was 0.036 log points lower (-3.5 percent) for firms entirely dependent on Commerzbank than those with no linkages. Overall, the results in this paper present a comprehensive picture of the implications of an exogenous lending cut on firms' capital structure and real side variables.

²Begenau and Salomao (2019) also discusses this issue when comparing that paper's findings on the business cycle properties of public firms' external equity relative to those in Covas and Haan (2011).

³Consistent with these findings, Guntin and Kochen (2024) documents that after a trade of firms that relaxes financial constraints, firms' average revue product of capital (ARPK) significantly declines, with no changes in the average revenue product of labor (ARPL). Bau and Matray (2023) find similar evidence in the context of a financial liberalization episode.

In the last part of the paper, I present additional evidence to unpack the nature of private firms' equity injections and answer the following questions. How frequent and how large are firms' external equity injections in a banking crisis? Who provides the external equity funds? Are firms' insiders or outsiders? I document that while 12% of the firms received an equity injection, the amount of funds is sizable, with each injection increasing, on average, firms' financial capital by 15%. Further consistent with the previously described findings, firms dependent on Commerzbank saw more frequent and larger equity injections than non-Commerzbank-dependent firms in the years after the lending cut.

To analyze who provides the external equity funds, I use the firm-owner linkages in Orbis to distinguish whether firms that received equity injections also changed their ownership structure in the years after the lending cut. In particular, I analyze whether the external equity funds are primarily from firms' insiders, defined as existing owners, or from outsiders, identified through all the new owners. I find that out of all the firms that received at least one equity injection during the banking crisis, in 40% of them, a new owner joined the firm during the same time period. This result implies that the external equity funds came from existing owners for 60% of the firms. Firms' outsiders were more likely to provide the external equity funds in Commerzbank-dependent firms, with 43.5% of the firms receiving equity injections also having a new owner, relative to firms with no dependence on the bank for which this number is 39.1%.

Overall, the empirical results presented in this paper show that private firms' external equity can partially substitute for debt financing in a banking crisis. The results highlight the importance of economies having multiple sources of financing that can serve as backup facilities when the main source of intermediation, in this case, bank financing, fails. The paper's key findings also have significant implications for Macro-Finance heterogeneous firm models that typically overlook equity financing and assume a strict non-negative constraint on dividends. This assumption results in an incomplete picture of firms' access to financing, especially when modeling private firms, and can lead to overestimating the role of debt and the aggregate effects of a credit crunch in quantitative models.⁴

Related Literature This paper contributes to different strands of literature within corporate finance, financial economics, and macroeconomics.

This paper primarily contributes to the literature that studies firms' alternative sources of financing during a banking crisis. Earlier work has studied the role of non-bank debt as a substitute for bank loans. Using an unexpected credit supply cut in Portugal, Iyer et al.

⁴Exceptions include Cooley and Quadrini (2001), Midrigan and Xu (2014), Peter (2021), and Kochen (2023). The structural corporate finance literature modeling public firms do incorporate equity financing, e.g., Hennessy and Whited (2007), Gomes and Schmid (2010), and Begenau and Salomao (2019).

(2014) documents stronger effects for smaller firms that cannot compensate with other sources of debt. In this line, Fernández, González, and Suárez (2018) shows that non-bank credit partially substitutes bank loans in bank-dependent firms after the GFC, with the degree of substitution varying by countries' creditor rights and information sharing.

Closer to my work is the role of equity financing after a lending cut. Using data from publicly traded firms in multiple countries, Levine, Lin, and Xie (2016) presents the first systematic analysis of Greenspan's spare tire hypothesis on whether equity raised through the stock market can substitute for debt financing. The paper shows that the adverse consequences of banking crises are smaller in countries with stronger shareholder protection laws. My work also relates to Covas and Haan (2011) and Begenau and Salomao (2019), which study the business cycle properties of firms' debt and equity financing. It is worth emphasizing that previous work has focused on public firms. The main contribution of my paper is to study the spare tire hypothesis in the context of privately held firms.

This paper is also related to the literature on the intersection of corporate finance and macroeconomics that studies the real effects of identified credit supply shocks using firm-level data and firm-bank linkages (Chodorow-Reich, 2014; Iyer et al., 2014; Huber, 2018; Bentolila, Jansen, and Jiménez, 2018; Amiti and Weinstein, 2018; Biermann and Huber, 2024). Building on the work of Huber (2018), which documents the direct and indirect effects of a banking crisis, I contribute to this literature by analyzing the response of firms' equity financing after a lending cut of a large German bank during the GFC. I complement existing work by presenting novel evidence on the implications of this lending cut for firms' overall capital structure composition and real outcomes such as output, capital, and employment for a large sample of German private firms.

Outline The rest of the paper is organized as follows: [Section 2](#) describes the firm-level data and firm-bank linkages and explains the sample selection; [Section 3](#) offers a primer on private firms' capital structure; [Section 4](#) presents the case of Commerzbank and documents firms' dependence to this bank; [Section 5](#) reports the main results of the paper on the effects of a lending cut on private firms' capital structure and real outcomes; [Section 6](#) unpacks equity injections and classify them according to who provides the funds; and finally, [Section 7](#) concludes.

2 Data

This section describes the data used in the paper and discusses the sample selection. It also provides the definitions of the main variables used in the analysis.

2.1 Orbis Historical

The data used in the paper is Orbis Historical, a comprehensive dataset containing information on millions of companies worldwide. This data is compiled by Moody's Bureau van Dijk (BvD), which collects data from various sources, such as national business registries, and standardizes it into an internationally comparable format. The dataset provides balance sheets and income statements on an annual basis from 1996 to 2020 for both private and publicly traded companies. Orbis Historical also reports information on firms' inputs, industry identifiers, and the year they were established. Furthermore, the dataset includes firm-bank linkages and ownership data for a subset of countries, information that will play a key role in my analysis.

Firm-Bank Linkages Orbis Historical includes information about firm-bank linkages for a subset of countries. The data reports the date when the link was active. For most observations, bank links correspond to the most recent years of the data, from 2016 onward. Unfortunately, the data does not provide longitudinal information on when relationships began or potentially ended. Furthermore, the dataset does not include any intensive margin information. Hence, for the firms borrowing from multiple banks, I cannot assign the exact shares of their total financial debt across the banks with which they have linkages.

Some comments about the limitations of these firm-bank linkages are appropriate. First, measurement error could arise from the relationships formed after the GFC, when the lending cut occurred. Yet, the nature of relationship lending between firms and banks, further discussed in [Section 5](#) below, results in long-lasting and sticky linkages. Indeed, Elsas and Krahen (1998) reports that the average firm-bank relationship in Germany varies between 19.9 to 35.9 years as a function of firm size. Hence, it is highly probable that if the link existed in 2016, it existed by 2007. A second limitation of the analysis is that it focuses on a selected sample of firms that survived the crisis periods and were active by 2016 onward, when I can observe their bank linkages. Thus, the analysis misses firms that exit in or after the banking crisis.

Firm-Owner Linkages From 2007 onward, Orbis Historical includes annual ownership records with the name and equity shares of firms' owners. The data also specifies whether the owner is an individual, another company, a financial institution, or a government. To account for firms' sometimes complex ownership structures, I follow Peter (2021) and identify firms' ultimate owners by sequentially matching the ownership files. The main objective of this iterative procedure is to account for the cases where other companies own firms by assigning the respective ownership shares of the parent company. Indeed, for the sample of German firms described in detail below, 14.7% of the direct owners are

other companies. Hence, for example, if 100% of company A is owned by company B, the procedure assigns the ownership information of B to A. If $x\%$ of company A is owned by company B, only $x\%$ of the ownership of B will be transferred to A. For the analysis, I focus on the ultimate owner after three rounds of matching the ownership files. The results on the sources of external equity funds described below are robust to using direct or higher round ownership links.

2.2 Sample Selection

Given the paper’s objectives, I focus on Germany for three reasons. First, Orbis has the best coverage for European countries. Kalemli-Özcan et al. (2024) show that Orbis Historical covers a significant share of the gross national output of Western European countries and captures well the firm-size distribution documented in official sources. Second, for Germany in particular, Orbis Historical has firm-bank and firm-owner linkages starting in 2007 for a large sample of firms. Firm-bank linkages are required for the analysis of the effects of bank lending cuts, and the ownership information allows me to differentiate whether new or existing firm owners provide external equity funds. Lastly, the heterogeneous exposure of German banks to the GFC represents an ideal setup for studying the firm-level responses after identified credit supply shocks (Huber, 2018).

For the empirical analysis, I focus on privately held firms in the non-financial sector, defined as partnerships, private limited companies, and sole proprietorship firms, which account for nearly 70% of total output in Germany.⁵ Private firms are more likely to be affected by banks’ lending cuts, and their use of equity financing has been relatively understudied compared to publicly traded firms. Hence, I concentrate on a sample of firms that satisfy the following criteria: 1) they have available balance sheet data for financial debt and external equity (formally defined below); 2) they report firm-bank linkages; and 3) they have available ownership files. For the main analysis on the effects of a lending cut, I also focus on 4) a balanced sample of firms continuously observed between 2007 and 2013 and 5) those with positive financial debt in at least one year.

2.3 Variable Definitions

Throughout the analysis, firms’ debt, b , is the sum of short- and long-term financial debt (acronyms `loan` and `ltdb`, in Orbis), which for private European firms mostly reflects loans with banks. For publicly traded firms, long-term debt might also include corporate bonds. Firms’ equity, n , is total assets minus total liabilities (`toas - culi - ncli`). As

⁵To focus on the firms in the non-financial private sector, I exclude the firms in the following NACE classifications: (K) Financial and insurance activities; (O) Public administration and defense; compulsory social security; (T) Activities of households as employers, undifferentiated goods and services; and (U) Activities of extraterritorial organizations and bodies.

explained in further detail in the next section, firms' equity in Orbis can also be obtained as the sum of external (`capi`) and internal equity (`osfd`), with the former playing a crucial part in the analysis. While most of the analysis will focus on firms' capital structure and the degree of substitution between debt and equity, I also analyze some firms' real outcomes, such as tangible capital (`tfas`), employment (`empl`), and output measured as value added using a comprehensive definition of costs (`ebta + staf`).⁶ Table A.1 and Table A.2, in the Appendix, presents the list of Orbis variables used in the analysis and summarizes the key variable definitions, respectively.

3 The Capital Structure of Private Firms

This section discusses the measurement of key variables characterizing firms' capital structure and their measurement in the data. Further, it describes the role of debt and equity financing in private firms' capital structure in the cross-section and by firm age.

3.1 Measurement

Central to my analysis is the role of firms' debt and equity financing in firms' financial capital, which captures all the funds available to the firm. Financial capital, k_{it} , is defined as the sum of financial debt b_{it} and book value equity n_{it} ,

$$\begin{aligned} k_{it} &= b_{it} + n_{it} \\ &= \underbrace{(\text{loan}_{it} + \text{ltdb}_{it})}_{\text{Debt}} + \underbrace{\text{capi}_{it}}_{\text{Ext. Equity}} + \underbrace{\text{osfd}_{it}}_{\text{Int. Equity}} \end{aligned} \quad (1)$$

where i denotes the firm and t the year.⁷ Throughout the paper, I follow the timing of the balance sheet data where stock variables are measured at the end of year t .

External and Internal Equity Equation (1) shows that firms' equity can be decomposed into two components given by the source of the funds: $n_{it} = \text{capi}_{it} + \text{osfd}_{it}$. *External equity* (variable `capi` in Orbis) are firm owners' external funds that were *not* generated inside the firm. *Internal equity* (variable `osfd` in Orbis) captures all the funds internally generated by the firm due to retained earnings or undistributed profits or losses.⁸ It is

⁶In detail, I define output as valued added net of non-capital and non-labor related costs. By substituting Orbis variable definitions, it follows that output defined as `ebta + staf` equals `opre - (cost - staf - depr) - oope` where `opre` is operating revenue, `cost` is cost of goods sold, `staf` are labor costs, `depr` is capital depreciation, and `oope` are all other operating expenses.

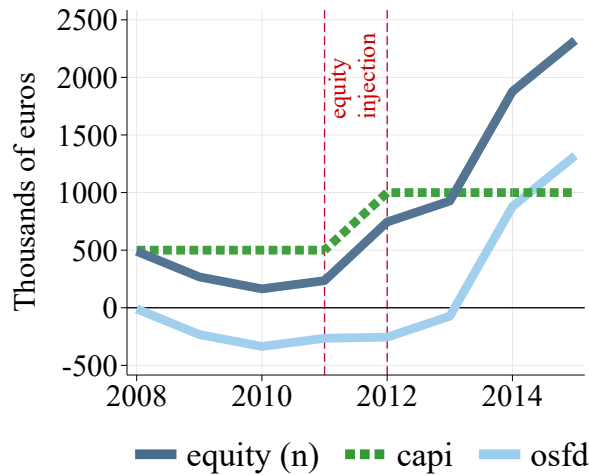
⁷Another approach is to use net financial debt (financial debt minus cash), when defining financial capital (Welch, 2011). Given the paper's interest in the effect of credit supply cuts on debt financing, I focus on financial debt without subtracting cash to avoid confounding debt and cash availability.

⁸I perform several checks on the data to guarantee that these variables are correctly reported and that they capture firms' external and internal equity. For example, I drop some observations where `osfd` equals zero for all years, and hence `capi` captures all book value equity fluctuations. I also exclude a few observations with $\Delta \text{capi} = \Delta \text{osfd}$, despite total equity being unchanged.

important to note that these definitions do not distinguish the identity of the owner who provides the external equity funds. In [Section 6](#), I use the ownership files together with the balance sheet data to further unpack the nature of external equity funds and differentiate whether they come from firms’ insiders (existing owners) or outsiders (new owners).

Equity Injections Given the previous definitions, an *equity injection* into firm i at year t occurs when there is a positive change in the firm’s external equity, $\frac{\Delta \text{capi}_{it}}{\text{capi}_{it-1}} > 0.01$.⁹ In recent work, Kochen ([2023](#)) reports that equity injection episodes are infrequent but are sizable in the amount of funds injected into firms. That paper also documents facts about equity financing over the life cycle of firms. It shows that younger firms are more likely to receive equity injections from their owners and receive more funds as a share of their existing financial capital than older firms. Relative to Kochen ([2023](#)), the contribution of this paper is to investigate the business cycle properties of private firms’ equity injections and whether they can substitute for debt financing during a banking crisis.

Figure 1: Equity Injections in the Data, An Example



Notes: Example trajectory of a firm founded in 2008. All variables are in nominal thousands of euros. Firms’ total equity (n) is the sum of internal ($osfd$) and external equity ($capi$). Equity injections are increases in $capi$, as the vertical dashed lines indicate.

To exemplify the dynamics of the components of private firms’ equity, [Figure 1](#) presents the trajectory of a firm in the data established in Germany in the year 2008. At age 0, when the firm is founded, the firm’s total equity n_{it} is equal to 500,000 euros and is entirely composed of external equity, $capi_{it}$. During the first three years of operation, the firm incurred losses, as the negative values of $osfd_{it}$ indicate. It is important to note that any changes in firms’ book value equity directly associated with the operations of the firm coming from undistributed profits or losses will be captured by firms’ internal equity,

⁹Gonzalez-Urbe and Paravisini ([2019](#)) also measures equity issuances using the change of this variable in Orbis to estimate the sensitivity of young firms’ investment to the cost of outside equity in the UK.

as the fluctuations in osfd_{it} shows. Between ages 0 and 3, the external equity of this firm remained constant at 500,000 euros. In the year 2012, the firm received an equity injection which doubled the value of capi_{it} to 1 million euros, as the vertical dashed lines in [Figure 1](#) indicate. The trajectory of this firm exemplifies the lumpy nature of equity injections, which, while infrequent, might represent sizable injections of funds into firms.

3.2 The Role of Debt and Equity in Firms' Capital Structure

Having defined and discussed the measurement of the main variables of interest, this subsection provides cross-sectional moments characterizing the role of debt and equity financing in firms' capital structure. These moments will be useful to interpret the empirical results about the effects of a lending cut presented in [Section 5](#).

[Table 1](#) presents the contribution of the key elements of financial capital, defined in (1), measured by each variable x to k ratio. The columns report the simple average, 25th, 50th, and 75th percentile of each ratio, considering all the firm-year observations between 2007-2019. The first row summarizes the role of debt financing, adding short- and long-term debt. The table shows that, on average, private firms in Germany have a leverage ratio (debt to financial capital, b/k) of 0.44. There is significant heterogeneity across firms, with the 25th percentile close to 0 and a 75th percentile of 0.72. The second and third rows report the ratios of external and internal equity to financial capital. On the one hand, the average external equity ratio (capi/k), which captures the role of equity financing in firms' capital structure, is 0.24, while the median across firms is 0.09. On the other hand, the average internal equity ratio (osdf/k) is 0.32, with a median value of 0.40.

Table 1: Firms' Capital Structure

	Mean	p25	p50	p75
Leverage, debt/ k	0.44	0.01	0.33	0.72
Ext. Equity Ratio, capi/k	0.24	0.03	0.09	0.26
Int. Equity Ratio, osdf/k	0.32	0.07	0.40	0.75

Notes: Private firms' capital structure considering all the firm-year observations between 2007-2019. All the ratios are relative to financial capital, k , excluding ratios above 5 in absolute value. The variable osdf denotes internal equity, capi is external equity, and debt is total financial debt. Mean and percentiles are simple moments across all observations.

The trajectory in [Figure 1](#) suggests an important life cycle component determining the role of equity financing in firms' capital structure. In this line, [Table 2](#) presents the average ratio of the different components in financial capital conditional on firms' age. The first column shows the importance of external financing early in firms' life cycle, with

debt and external equity playing a more prevalent role in the capital structure of the youngest firms (0 to 5 years old), with an average leverage ratio of 0.51 and an external equity ratio of 0.33. In contrast, these ratios are 0.41 and 0.21 for the oldest group of firms (21 years old and above), respectively. These numbers show that as firms age, they accumulate internal equity while paying back debt and potentially buying back external equity. Indeed, the average internal equity to financial capital ratio ($osfd/k$) is 0.16 for the youngest firms and monotonically increases with a value of 0.38 for the oldest group.¹⁰

Table 2: Firms' Capital Structure by Firms' Age

	Age			
	0-5	6-10	11-20	21+
Leverage, $debt/k$	0.51	0.46	0.42	0.41
Ext. Equity Ratio, $capi/k$	0.33	0.26	0.23	0.21
Int. Equity Ratio, $osfd/k$	0.16	0.28	0.34	0.38

Notes: Private firms' capital structure by firms' age considering all the firm-year observations between 2007-2018. See notes in [Table 1](#) for description of variables.

To sum up, this section presented the definitions and measurement of the variables that characterize firms' capital structure and documented the role of debt, external, and internal equity in the cross-section of German private firms. Before presenting the paper's main results, the following section describes the case of Commerzbank's lending cut during the GFC, which is the credit supply shock studied in the paper.

4 The Case of Commerzbank

This paper aims to study the causal effect of bank lending cuts on private firms' capital structure, emphasizing the response of external equity financing. I follow the identification strategy in Huber (2018), which estimates the effect of an exogenous lending cut by a large German bank during the GFC. This section describes the origins of this lending cut and reports the degree of dependence on this bank for the firms included in my sample.

4.1 Commerzbank's Lending Cut

To study firms' responses to a credit supply cut, I focus on the case of Commerzbank, one of Germany's largest banks, during the 2008-2009 financial crisis. Commerzbank's lending cut constitutes an ideal setup to study the effects of credit supply disruptions as

¹⁰See Kochen (2023) for a more detailed analysis of finance over the life cycle of firms using an empirical specification that properly captures firm age effects.

it was a shock arguably exogenous to the bank’s German customers.

As Huber (2018) documents, Commerzbank suffered significant losses on its international trading book, reducing its equity capital by 68% between 2007 and 2009. Notably, the fall in equity did not originate in the bank’s operation within Germany. Instead, the bank’s investments in the U.S. subprime mortgage market and its exposure to the insolvencies of Lehman Brothers and some Icelandic banks almost entirely explain this decline. Due to these losses in the bank’s international portfolio, Commerzbank was forced to cut its loan supply inside Germany for two reasons. First, Basel II establishes specific rules between banks’ equity and risk-weighted assets. When equity falls, banks have to reduce assets, including firm loans, and start raising new equity. Second, the equity losses raised Commerzbank’s cost of external funds, so it had to lower its risk exposure to access funding markets. The evidence in Huber (2018) convincingly shows that reverse causality, from firms to banks, is not a concern when analyzing the effects of Commerzbank’s lending cut as its origins were unrelated to the bank’s borrowers inside Germany.

4.2 Firms’ Commerzbank Dependence

Using the firm-bank linkages reported in the data, I construct a firm-level measure of dependence on Commerzbank. In detail, for each firm i , I define:

$$cb_i = \frac{\sum_{b \in B_i} \mathbb{1}\{b = \text{Commerzbank}\}}{\#B_i} \quad (2)$$

where B_i is the set of banks with which firm i has linkages. Thus, this measure aims to capture the degree of firms’ debt financing dependence on Commerzbank, given their total number of bank linkages.¹¹

Table 3: Firms’ Dependence on Commerzbank

	$cb_i = 0$	$0 < cb_i < 0.5$	$cb_i = 0.5$	$cb_i = 1$
Percentage	81.4%	7.1%	6.7%	4.8%
Number of Firms	149,572	13,128	12,265	8,887

Notes: Distribution of firms’ dependence on Commerzbank cb_i defined in (2).

The degree of dependence on Commerzbank for my sample of firms is summarized in Table 3. The average value of cb_i across all firms equals 0.103. This number, however, hides significant heterogeneity. Table 3 reports that out of the 183,852 firms in the sample,

¹¹This variable captures the exposure to Commerzbank at the extensive margin. An intensive margin measure requires loan-level data, which is not available in Orbis Historical. The measure in (2) is coarser than the one used in Huber (2018), which constructs Commerzbank dependence at the branch level.

81.4% of them have no linkages with Commerzbank.¹² From the firms that have linkages with Commerzbank, 7.1% of them have a low degree of dependence as $0 < \text{cb}_i < 0.5$. This implies that while those firms report a linkage with Commerzbank, they also have linkages with at least two other banks ($\#\text{B}_i \geq 3$). For 6.7% of firms, $\text{cb}_i = 0.5$, meaning that the firm has two bank linkages in total ($\#\text{B}_i = 2$), one of them with Commerzbank. Finally, the table shows that 4.8% of the firms have $\text{cb}_i = 1$, as Commerzbank is the only bank with which they have a banking relationship.

Table 4: Pre-Crisis Descriptive Statistics by Commerzbank Dependence

	$\text{cb}_i = 0$		$0 < \text{cb}_i < 0.5$		$\text{cb}_i \in \{0.5, 1\}$	
	Mean	SD	Mean	SD	Mean	SD
Age	19.51	21.57	29.22	29.85	17.20	18.20
Owners	2.37	3.74	2.80	4.17	2.69	4.81
Bank linkages (B)	1.63	0.82	3.57	0.89	1.58	0.49
ln Fin. Capital (k)	12.90	1.70	14.18	1.81	13.22	1.89
ln Debt (b)	10.10	4.94	11.59	4.87	9.85	5.34
ln Ext. Equity (capi)	10.64	1.57	11.68	2.01	10.91	1.82
ln Int. Equity (osfd)	11.79	2.31	12.95	2.62	12.21	2.44
Leverage, b/k	0.51	0.45	0.48	0.39	0.46	0.45
Ext. Equity Ratio, capi/k	0.24	0.34	0.19	0.27	0.25	0.35
Int. Equity Ratio, osfd/k	0.25	0.53	0.33	0.42	0.29	0.53
Manufacturing	0.19		0.37		0.22	
Services	0.60		0.49		0.66	
Other	0.21		0.14		0.13	
Number of Firms	149,572		13,128		21,152	

Notes: Descriptive statistics for the year 2007 conditional on firms' Commerzbank dependence cb_i defined in (2). Variables in logs are $\ln(x + 1)$, where the monetary values are in 2007 euros. Industry variables are the share of firms in each of the respective sectors.

Table 4 presents pre-crisis descriptive statistics conditional on firms' dependence on Commerzbank. These moments are for 2007, the first year I have the balance sheet and ownership data, and hence serves as the benchmark year before the credit supply cut. For that table, I classify firms in three groups: no Commerzbank dependence ($\text{cb}_i = 0$), moderate dependence ($0 < \text{cb}_i < 0.5$), and high dependence ($\text{cb}_i \in \{0.5, 1\}$).

¹²It is worth noting that the total number of firms in my sample, 183,852 firms, is 91 times larger than the 2,011 firms studied in Huber (2018).

The table shows that firms with moderate Commerzbank dependence ($0 < \text{cb}_i < 0.5$), besides having a higher number of bank linkages by construction, are older and larger. This result was expected, as larger firms tend to have more banking relationships (Kosekova et al., 2023). The firms in this group are also more likely to be in manufacturing and less so in services. In contrast, high Commerzbank dependence firms ($\text{cb}_i \in \{0.5, 1\}$) are much more similar to the firms with no dependence on Commerzbank ($\text{cb}_i = 0$). Importantly, they are closer in age, size, number of owners, bank linkages, and industry composition.¹³ Yet, it is relevant to note that the key ratios characterizing firms' capital structure composition are relatively similar across these three groups of firms.

Taking stock, the previous results document significant heterogeneity in firms' dependence on Commerzbank. This heterogeneity and the foreign origins of Commerzbank's lending cut make this episode an ideal setup to study the effects of a credit supply cut on firms' equity financing and real outcomes, such as capital investments. The descriptive statistics in Table 4 show that firms in the sample have similar capital structure ratios before the crisis. Yet, firms with low dependence on Commerzbank tend to be older and larger. This fact highlights the importance of controlling for detailed firm characteristics, as in the empirical specification presented in the next section.

5 The Effects of a Lending Cut on Private Firms' Capital Structure and Real Outcomes

This section presents the main results of the paper regarding firm responses to a lending cut during a banking crisis. First, I present some motivating evidence using aggregate variables. Second, I discuss the identification strategy and describe the empirical specification. Then, I present the results for debt and equity financing, firms' financial capital, and real variables, such as tangible capital, employment, and output.

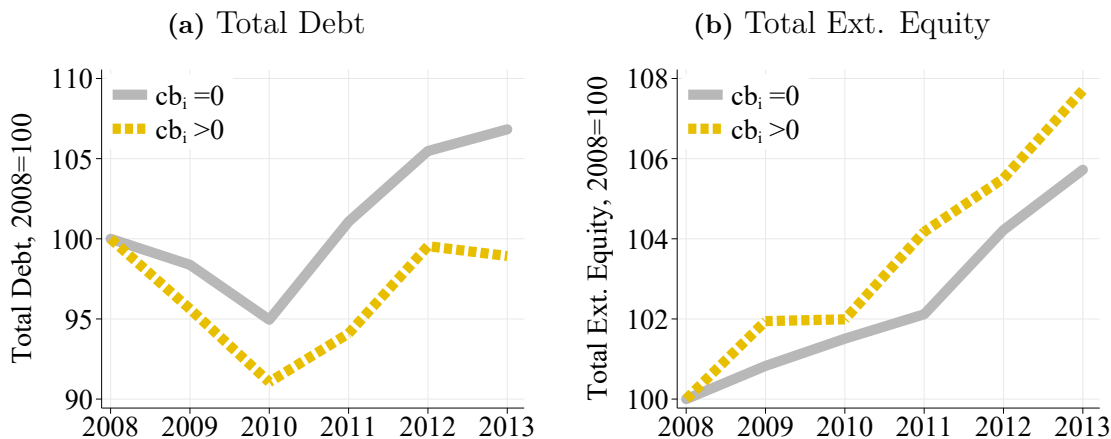
5.1 Aggregate Dynamics

Before moving into the econometric analysis, I investigate the dynamics of total debt and external equity during the GFC conditional on firms' Commerzbank dependence. Panel (a) of Figure 2 reports that, in the aggregate, firms with relationships with Commerzbank experienced a sharper decline in total debt after the lending cut triggered by the GFC. Furthermore, the total debt of Commerzbank-dependent firms stayed well below the rest of the firms even by 2013. The contribution of this paper is to document the evolution of private firms' equity financing after a credit supply cut. Panel (b) of Figure 2 shows

¹³The number of bank relationships per firm in Orbis Historical is consistent with the evidence in Kosekova et al. (2023). Using data from the Eurosystem credit registry (AnaCredit), that paper documents that German firms have 1.59 bank relationships on average.

that aggregate external equity increased during the GFC, in contrast to the reduction in total debt. More importantly, the aggregate external equity of Commerzbank-dependent firms increased by more than those with no linkages. Motivated by these aggregate dynamics, the empirical specification described below properly quantifies the average effect of Commerzbank’s dependence on firms’ debt and equity financing.

Figure 2: Aggregate Dynamics by Commerzbank Dependence



Notes: Firms’ total financial debt and external equity conditional on Commerzbank dependence. A firm is classified as Commerzbank dependent if it has at least one link with the bank ($cb_i > 0$). To capture the evolution of aggregate variables, excluding changes in entry and entry, these series are computed using symmetric one-year growth rates $(x_{it} - x_{it-1}) / (0.5x_{it} + 0.5x_{it-1})$ weighted by the average value $0.5x_{it} + 0.5x_{it-1}$ between the years used to compute the growth rate.

5.2 Identification Strategy and Empirical Specification

The main challenge in the empirical literature within macroeconomics and corporate finance that aims to quantify firm-level causal responses to credit cuts is that the debt observed by the econometrician is the result of both firms’ demand and lenders’ supply for credit. This leads to two well-known identification challenges. The first one is reserve causality, where shocks to firms themselves might lead to loan delinquency affecting banks’ health which could then lead to cuts in credit supply. The second, is omitted variable bias that might simultaneously affect firms’ demand and lenders’ supply of credit.

To circumvent this identification challenge, I follow previous work that exploits banks’ heterogeneous exposures to the GFC (Chodorow-Reich, 2014; Iyer et al., 2014; Huber, 2018; Bentolila, Jansen, and Jiménez, 2018; Amiti and Weinstein, 2018; Biermann and Huber, 2024), which was arguably a shock to banks’ equity that was unrelated to the health of the specific firms borrowing from each bank. Using this exogenous source of variation, I can quantify the differential response of the more exposed firms relative to

those less affected by the lending cut.

An implicit assumption in this identification strategy is the concept of relationship lending. Due to asymmetric information, learning through repeated interactions, or costly state verification, borrowers and lenders might form long-lasting relationships, making it difficult to switch lenders. Under this assumption, we would expect differential outcomes of firms borrowing from banks that were more severely affected after the GFC, as it would be challenging for firms to find credit elsewhere. Previous work has shown that, indeed, relationship lending is an important feature of the data, with banks gradually expanding their credit supply as they develop a closer relationship with their borrowers (Petersen and Rajan, 1994; Bharath et al., 2011; Chodorow-Reich, 2014).

Empirical Specification I study firm-level responses to Commerzbank’s lending cut by estimating a specification in the spirit of Huber (2018):

$$\ln(x_{it} + 1) = \beta \text{cb}_i \times d_t + \Gamma' X_i \times d_t + \alpha_i + \lambda_t + \varepsilon_{it} \quad (3)$$

where x_{it} is firm i at year t outcome variable of interest; cb_i is Commerzbank’s dependence defined in (2); d_t is a dummy variable equal to one for the post lending cut years, going from 2009 to 2013; X_i includes several time-invariant controls calculated for 2007, such as 8 firm age bins (0-2, 3-4, 5-6, 7-8, 9-10, 11-15, 16-20, 21+), 4 bins for the number of owners (1, 2, 3-4, 5+), and 746 NACE 4-digit industries; α_i are firm fixed effects, accounting for time-invariant and firm-specific differences; and λ_t are year fixed effects that control for changes in the outcome that are common to all the firms, such as business cycle fluctuations. The coefficient of interest, β , captures the log difference between firms entirely dependent on weak banks ($\text{cb}_i = 1$) relative to firms with no bank linkages ($\text{cb}_i = 0$) in the subsequent years after the lending cut. For all the estimation results presented in this section, I consider clustered standard errors at the firm level.¹⁴

5.3 Debt Financing

I now quantify the average effect of Commerzbank’s lending cut on firms’ debt. Table 5 presents the results from estimating (3) with financial debt ($\text{loan} + \text{ltdeb}$) as dependent variable. The columns sequentially introduce different time-invariant fixed effects for 2007 interacted with the post-lending cut indicator d_t . The first column presents the results with firm and year-fixed effects. The second column adds the age and number of owner

¹⁴I consider a log-like transformation in (3) to include a significant number of firms that experienced changes in debt financing falling to 0 during the GFC. Chen and Roth (2024) shows the limitations of this transformation, which captures both the average treatment effect at the intensive and extensive margin. The main findings of the paper are qualitatively consistent when solely focusing on the intensive margin of adjustment (using $\log(x_{it})$ in (3)).

bins. The last column also incorporates detailed NACE 4-digit industry fixed effects.

Table 5: Firms' Debt After Commerzbank's Lending Cut

	(1)	(2)	(3)
$cb_i \times d_t$	-0.100** (0.041)	-0.094** (0.041)	-0.082** (0.041)
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Age bin fixed effects $\times d_t$	No	Yes	Yes
Owners bin fixed effects $\times d_t$	No	Yes	Yes
Industry fixed effects $\times d_t$	No	No	Yes
Adjusted R^2	0.499	0.499	0.500
Observations	1,286,964	1,286,964	1,286,964

Notes: Results from OLS panel regressions in (3) using firms' financial debt (`loan + ltdb`) as dependent variable. The regression consider a balanced sample of firms between 2007 to 2013. d_t is a dummy variable for the post lending cut years, from 2009 to 2013. The following time-invariant control variables are calculated for 2007 and interacted with d_t : fixed effects for 8 firm age bins (0-2, 3-4, 5-6, 7-8, 9-10, 11-15, 16-20, 21+); 4 bins for the number of owners (1, 2, 3-4, 5+); 746 NACE 4-digit industries. Firm-level clustered standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

The point estimate in regression (1) indicates that firms entirely dependent on Commerzbank had 0.1 log points less (-9.5 percent) financial debt than firms with no linkages with the bank in the years after the lending cut. This coefficient is statistically different from zero at the 5 percent level, considering clustered standard errors at the firm level. Column (2) shows that introducing additional controls for firm age and number of owners has small implications for the point estimates. Column (3), which presents the most conservative and preferred specification, shows that, after the lending cut, Commerzbank-dependent firms had 0.082 log points *lower* (-7.9 percent) debt than no Commerzbank-dependent firms. This estimate is also statistically significant at the 5 percent level.

Discussion Relative to Huber (2018) The results in Table 5 are broadly consistent with Huber (2018), which estimates that firms entirely dependent on Commerzbank had between 0.101 to 0.205 log points less debt than non-dependent firms in the years following the lending cut (see Table 4 of that paper). Two main reasons likely explain the exact differences in the estimates. First, my measure of Commerzbank dependence is somewhat coarser than the one in Huber (2018), computed at the branch, not the bank level. Second, and more importantly, are differences in the sample of firms used in the analysis. While Dafne, the dataset used in that paper, is also compiled by Moody's BvD, Orbis Historical

has more extensive coverage. This fact and different sample selection requirements lead to significant differences in sample sizes. For my estimates, I consider a balanced sample of 183,852 firms, 91 times larger than the 2,011 firms in Huber (2018). The sample of firms included in that paper tends to be older and larger and have more banking relationships than the firms in my sample. Overall, the results in Table 5 show that the findings in Huber (2018) regarding the effect of Commerzbank’s lending cut on firms’ debt are robust to considering a much larger and more representative sample of firms.

5.4 Equity Financing

This paper’s main contribution is to quantify to what extent equity financing can substitute for debt after a credit supply cut. Towards this goal, this subsection asks: did firms with higher dependence on Commerzbank, which saw more significant reductions in their financial debt, receive larger equity injections from their owners during the GFC? The aggregate dynamics of debt and equity financing in Figure 2 indicate that the answer to this question is affirmative. The following results formally quantify average firms’ equity injections after Commerzbank’s lending cut.

Table 6 presents the results from estimating (3) with firms’ external equity (`capi`) as dependent variable. As before, the different columns in the table sequentially introduce additional controls. For the case of external equity, adding additional controls has little effect on the estimates. The main takeaway from this table is that contrary to the results for debt, firms dependent on Commerzbank received more significant equity injections after the lending cut. Column (3), which is the paper’s preferred specification, implies that a firm fully dependent on Commerzbank had 0.041 log points *higher* (4.1 percent) external equity funds than firms with no linkages in the years following the lending cut.

The previous results establish that firms entirely dependent on Commerzbank had 0.082 log points *lower* debt and 0.041 log points *higher* external equity funds than firms with no linkages with Commerzbank in the years following the lending cut. Using these estimates and firms’ capital structure composition, documented in Section 3, I can compute the average equity injection relative to the reduction in debt financing. In detail, given average leverage, b/k , and external equity to financial capital ratio, capi/k , reported in Table 1, the previous estimates imply that for every 1 euro reduction in debt financing, firms received equity injections of $0.27 = (0.24 \times 0.041)/(0.44 \times 0.082)$ euros.¹⁵ This number, which captures the degree of substitution between debt and equity financing, is the paper’s

¹⁵This computation follows from using the estimated effects of Commerzbank dependence on debt and external equity, $\frac{\partial b}{\Delta \text{cb}}$ and $\frac{\partial \text{capi}}{\Delta \text{cb}}$ and firms’ average capital structure ratios $\frac{b}{k}$ and $\frac{\text{capi}}{k}$. Hence the ratio: $\frac{\frac{\text{capi}}{k} \frac{\partial \text{capi}}{\Delta \text{cb}}}{\frac{b}{k} \frac{\partial b}{\Delta \text{cb}}} = \frac{\partial \text{capi}}{k} / \frac{\partial b}{k}$ provides an interpretation of the estimated effects in the same units.

Table 6: External Equity After Commerzbank's Lending Cut

	(1)	(2)	(3)
$cb_i \times d_t$	0.040*** (0.009)	0.040*** (0.009)	0.041*** (0.009)
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Age bin fixed effects $\times d_t$	No	Yes	Yes
Owners bin fixed effects $\times d_t$	No	Yes	Yes
Industry fixed effects $\times d_t$	No	No	Yes
Adjusted R^2	0.787	0.787	0.787
Observations	1,286,964	1,286,964	1,286,964

Notes: Results from OLS panel regressions in (3) using firms' external equity (*capi*) as dependent variable. See Table 5 for the description of control variables, the standard error calculations, and the years covered by the sample.

main contribution as it has not been estimated for a large sample of privately held firms.

5.5 Firms' Capital Structure and Financial Capital

Having established that firms dependent on Commerzbank saw larger reductions in their debt but received more external equity funds, I now analyze the implications for firms' financial capital, which captures all the funds available to firms. Table 7 reports the results of estimating (3) for financial capital and each of its components, defined in (1): debt, external equity equity, and internal equity. In what follows, I focus on the estimation results with all the fixed effects as controls. The first two columns report the previously described results with debt and external equity as dependent variables.

The third column in (1) reports the results for firms' internal equity (*osfd*). The estimation implies that firms fully dependent on Commerzbank had 0.077 log points lower (-7.4 percent) internal equity funds than non-dependent firms. The reduction in internal equity reflects the decline in cash holdings and firms' lower earnings after the lending cut. It is worth noting that the estimation in column (3) has fewer observations, reflecting the fact that around 20% of the observations had negative internal equity values, which drop out in the estimation with logs. Thus, the overall decline in internal equity might be larger due to the omitted negative values. The opposite signs in (1) for the response of external and internal equity to a lending cut highlight the importance of differentiating between the components of firms' total equity. Indeed, interpreting the dynamics of total firms' book value equity (*capi* + *osfd*) as those of external equity would lead to incorrect conclusions. This issue is discussed in detail by Begenau and Salomao (2019) when

Table 7: Firms' Capital Structure After Commerzbank's Lending Cut

	Debt (1)	Ext. Equity (2)	Int. Equity (3)	Fin. Capital (4)
$cb_i \times d_t$	-0.082** (0.041)	0.041*** (0.009)	-0.077*** (0.013)	-0.031*** (0.008)
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Age bin fixed effects $\times d_t$	Yes	Yes	Yes	Yes
Owners bin fixed effects $\times d_t$	Yes	Yes	Yes	Yes
Industry fixed effects $\times d_t$	Yes	Yes	Yes	Yes
Adjusted R^2	0.500	0.787	0.811	0.880
Observations	1,286,964	1,286,964	1,019,452	1,244,349

Notes: Results from OLS panel regressions in (3) for firms' financial debt (`loan + ltdb`), external equity (`capi`), internal equity (`osfd`), and financial capital (`loan + ltdb + capi + osfd`). See Table 5 for the description of control variables, the standard error calculations, and the years covered by the sample.

comparing that paper's findings on the business cycle properties of public firms' external equity relative to the evidence in Covas and Haan (2011).

The results considering firms' financial capital as the dependent variable are reported in the last column of Table 7. The point estimate implies that firms with entire dependence on Commerzbank had 0.031 log points lower (-3.1 percent) financial capital in the years after the lending cut. This estimate is statistically different from zero at the 1 percent level. As in column (3), this estimation has slightly fewer observations due to some observations taking negative values. The overall takeaway from this table is that after a credit supply cut that significantly reduced firms' debt and internal equity, financial capital, which captures the total amount of funds available to firms, fell by much less due to additional external equity funds that firms received. The differences in the overall effect are economically meaningful, as the average reduction in financial capital (-0.031) was half as small as the debt (-0.082) and internal equity fund (-0.077) declines.

5.6 Real Effects

While the paper's primary focus is on firms' sources of financing after a credit supply cut, this subsection presents additional results for three relevant real-side outcomes: firms' tangible capital, employment, and output. Before describing the results, it is worth mentioning that the balance sheet data for Germany in Orbis Historical is much more populated than firms' income statements. Hence, the results for employment and output are estimated with less than 1/6 of the observations used in the baseline analysis focusing

on debt and external equity financing.

The first column in [Table 8](#) shows that firms' tangible capital (**tfas**) was 0.059 log points lower (-5.7 percent) for firms entirely dependent on Commerzbank in the years after the lending cut. This estimate is statistically significant at the 1 percent level. The second column in this table reports the results for firms' labor inputs (**empl**). The estimate indicates that firms fully dependent on Commerzbank had a level of employment 0.018 log points lower (-1.8 percent) than non-dependent firms. This effect is estimated somewhat less precisely but is statistically different from zero at the 5 percent level. It is worth noting that these heterogeneous effects on firms' inputs are consistent with financial frictions primarily affecting firms' capital investment decisions, with limited implications for labor. Lastly, the last column of [Table 8](#) shows that firms' output, measured by value-added using a comprehensive measure of costs (**ebta+staf**), was 0.036 log points lower (-3.5 percent) for firms entirely dependent on Commerzbank after the lending cut.

Table 8: Real Effects After Commerzbank's Lending Cut

	Tan. Capital (1)	Employment (2)	Output (3)
$\mathbf{cb}_i \times d_t$	-0.059*** (0.014)	-0.018** (0.008)	-0.036*** (0.012)
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Age bin fixed effects $\times d_t$	Yes	Yes	Yes
Owners bin fixed effects $\times d_t$	Yes	Yes	Yes
Industry fixed effects $\times d_t$	Yes	Yes	Yes
Adjusted R^2	0.893	0.977	0.955
Observations	1,237,585	228,560	221,909

Notes: Results from OLS panel regressions in (3) for firms' tangible capital (**tfas**), employment (**empl**), and output. See [Table 5](#) for the description of control variables, the standard error calculations, and the years covered by the sample.

To summarize, this section shows that firms entirely dependent on Commerzbank had significant reductions in debt financing in the years after the lending cut relative to firms with no linkages to this bank. Furthermore, this section estimates the implications of this lending cut for firms' capital structure and real side variables, such as capital, employment, and output. The key contribution of this paper is to document that this same group of Commerzbank-dependent firms also received more significant external equity funds in the years after the lending cut. Using firms' average capital structure, my estimates imply

that for every 1 euro reduction in debt financing, Commerzbank-dependent firms received 0.27 cents of external equity funds. But where do these funds come from? Are they coming from new investors, or are existing owners injecting funds into the firms? The next section aims to shed light on these questions.

6 Unpacking Equity Injections

Given the previous findings on the dynamics of firms' debt and equity after a banking crisis, this section asks: How frequent and how large are firms' external equity injections in a banking crisis? Who provides the external equity funds? Are firms' insiders or outsiders? How do these patterns vary with firms' Commerzbank dependence?

6.1 Frequency and Size of External Equity Injections

This subsection documents the frequency and size of external equity injections in the years after Commerzbank's lending cut, from 2009 to 2013. I define an equity injection episode as the years where external equity funds increased in more than 1%, $\frac{\Delta \text{capi}_{it}}{\text{capi}_{it-1}} > 0.01$. [Table 9](#) reports the results for firms' frequency and size of equity injections, considering all the firms in the sample and conditional on Commerzbank dependence. For this table, I present the results for firms without and with at least one linkage with Commerzbank: $\text{cb}_i = 0$ and $\text{cb}_i > 0$. The first row reports that, on average, only 3% of firms receive an external equity injection, with Commerzbank-dependent firms having a higher frequency of 4%. The second row shows that considering all the years in the crisis period, 12% of the firms received at least one equity injection. Distinguishing by firms' exposure to the lending cut, the table shows that 14% of the firms with dependence on Commerzbank received at least one equity injection. This number is lower and equal to 11% for non-Commerzbank-dependent firms.

External equity injections are lumpy events (Kochen, 2023). Hence, while they are infrequent, they are sizable in terms of the amount of funds injected into the firms. [Table 9](#) reports the size of equity injections relative to firms' financial capital conditional on an injection episode, $\Delta \text{capi}_{it}/k_{it}$ if $\frac{\Delta \text{capi}_{it}}{\text{capi}_{it-1}} > 0.01$. The third row of that table reports an average size of 0.15. Hence, on average, equity injections increase available funds by 15% of firms' financial capital. This number is significant, especially considering that the average external equity to financial capital ratio capi/k is 0.24 (see [Table 1](#)). The simple average could mask ample heterogeneity. To better understand the aggregate amount of external equity funds, the last row of [Table 9](#) reports the average size of equity injections weighted by financial capital.¹⁶ The weighted average equity injection of firms dependent on Commerzbank was 0.11. In contrast, for firms with no linkages with Commerzbank,

¹⁶The average weighted by the denominator is equal to the ratio of the aggregate amounts, which we

Table 9: Frequency and Size of Equity Injections After Commerzbank’s Lending Cut

	All	$cb_i = 0$	$cb_i > 0$
Frequency of Equity Injections			
Per Year	0.03	0.03	0.04
Crisis Period	0.12	0.11	0.14
Size of Equity Injections, $\Delta capi/k$			
Average	0.15	0.15	0.15
Average, k -weighted	0.09	0.07	0.11

Notes: Results for the post-lending cut years from 2009 to 2013. Frequency of external equity injections are years with $\frac{\Delta capi}{capi} > 0.01$. Crisis Period reports the share of firms that received at least one equity injection between 2009 and 2013. Size of equity injections is the change in external equity funds over financial capital $\Delta capi/k$, conditional on an equity injection. Average takes the simple mean across all injection episodes, while Average k -weighted uses financial capital, the denominator, as weights.

this number was 0.07. Overall, consistent with the findings in the previous section, [Table 9](#) shows that firms dependent on Commerzbank saw more frequent and larger equity injections than non-Commerzbank-dependent firms in the years after the lending cut.

6.2 Who Provides the External Equity Funds?

This final subsection investigates the source of the funds behind private firms’ equity injections. Are the funds primarily from firms’ *insiders*, defined as existing owners? Or from *outsiders*, identified through all new owners? Leveraging the ownership data in Orbis Historical, I can distinguish whether firms that received equity injections also changed their ownership structure in the years after the lending cut.¹⁷

Toward this goal, I use the firm-owner linkages in Orbis Historical to identify the set of ultimate owners for all the firms in the sample by sequentially matching the ownership files. As in Peter (2021), I focus on the ultimate owner after three matching rounds. With this procedure, I obtain the set of ultimate owners O_{it} at year $t \geq 2007$ for each firm i . Using the longitudinal data on firms’ owners, I construct two variables capturing changes in firms’ ownership structure. The first variable identifies the years $t \geq 2008$ when there is a change in the set of ultimate owners: $O_{it} = O_{it-1}$. The second variable indicates whether a new owner j joins firm i : $j \in O_{it}$ and $j \notin O_{it-1}$, and t is not firm i ’s year of foundation nor the first year of the ownership data. The following results focus on the firms that had at least one equity injection episode in the years after the lend-

can interpret as the ratio for the representative firm: $\sum_i \frac{k_{it}}{K_t} \frac{\Delta capi_{it}}{k_{it}} = \frac{\sum_i \Delta capi_{it}}{K_t}$, where $K_t = \sum_i k_{it}$.

¹⁷In my analysis, I classify all new owners as firms’ outsiders. Previous work, such as Robb and Robinson (2014), classifies equity from owners’ family members as insiders’ equity. I cannot directly make this distinction on whether firms’ owners are from the same family in my data.

ing cut, 2009 to 2013, and distinguish whether they changed their ownership structure, according to the previously defined variables, during the same period. This strategy accounts for potential mismatches in the exact equity injection and ownership change year.¹⁸

The first row of [Table 10](#) reports that 50.3% of the firms that received an equity injection after the lending cut also had an ownership change between 2009 and 2013. This number is higher for firms dependent on Commerzbank than those with no linkages with the bank, 54.1% and 49.3%, respectively. The previous result includes all ownership changes, including potential reductions in the total number of ultimate owners.¹⁹

Table 10: Ownership Changes in Firms Receiving External Equity

	All	$cb_i = 0$	$cb_i > 0$
Ownership Change	50.3%	49.3%	54.1%
New Owner	40.0%	39.1%	43.5%

Notes: Results for firms that received at least one external equity injection after the lending cut. Ownership Change reports the percentage of firms with at least one change in the set of ultimate owners, $O_{it} = O_{it-1}$, between 2009 and 2013. New Owner is the percentage of firms with at least one new owner joining the firm between 2009 and 2013.

Perhaps more important when analyzing equity injections are the cases of new owners. I classify all equity injections that coincide with a new owner joining the firm as external equity from outsiders. It is worth mentioning that these new owner events can include cases such as a new owner acquiring a minority stake in a firm or a new majority owner buying a business in the market for firms as studied in Guntin and Kochen (2024). The second row of [Table 10](#) documents that 40% of the firms that received an equity injection during the banking crisis also reported having a new owner. This result implies that for 60% of the firms, the external equity funds came from insiders. Furthermore, the table reports that 43.5% of the Commerzbank-dependent firms that received an equity injection after the lending cut also had a new owner. This number is higher than the 39.1% reported for firms with no Commerzbank dependence.

To sum up, the previous results show that for the group of firms that received an equity injection after the 2009 to 2013 lending cut, 40% of them at least partly received funds from outsiders (new owners), while for 60% of firms, insiders (existing owners) provided the external equity funds. Outsiders were moderately more likely to finance external

¹⁸To minimize measurement error due to temporary attrition in the ownership data, I construct these variables using the first and the last year each owner j is observed in the set of firm i 's ultimate owners.

¹⁹Potential reasons for a decline in the number of owners include one of the owners buying out the rest or changes due to mergers and acquisitions, with the acquiring firm having fewer owners than the target.

equity injections in Commerzbank-dependent firms (43.5%) than for non-dependent firms (39.1%). Altogether, these results indicate that while insiders provided external equity funds for most of the firms during the banking crisis, it was not uncommon for firms to raise external equity from outsiders.

7 Conclusions

To what extent can private firms' external equity substitute for debt financing in a banking crisis? I answer this question using firm-level data and firm-bank linkages for Germany. To estimate the causal effect of a credit supply cut on firms' capital structure and real side variables, I focus on an imported lending cut from a large German bank during the Great Financial Crisis, which was arguably exogenous to the bank's domestic customers. Considering the average firm's capital structure, the paper's main finding is that for every 1 euro reduction in firms' debt, private firms in Germany received 0.27 euros of external equity. Thus, private firms' external equity can partially substitute for debt, consistent with the spare tire view. Using firm-owner linkages, I show that outsiders provided external equity funds in 40% of the firms that received an equity injection while existing owners provided the funds in the rest.

The results presented in this paper highlight the importance of economies having multiple sources of financing that can serve as backup facilities when the primary source of intermediation fails. The paper's key findings also have significant implications for Macro-Finance models that typically overlook firms' equity financing, leading quantitative models to overestimate the role of debt and the aggregate effects of a credit crunch.

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Appendix

A Data Appendix

Table A.1: Orbis Variables Used in the Analysis

Acronym	Description
toas	Total assets
culi	Current liabilities
ncli	Long term liabilities
loan	Short term financial debt (payable within the year)
ltdb	Long term financial debt
capi	Issued share capital
osfd	All shareholders funds not linked with the issued capital
tfas	All tangible assets(buildings, machinery, etc.)
empl	Total number of employees
staf	Cost of employees
ebta	EBITDA = Operating profit + Depreciation

Table A.2: Variable Definitions

Variable	Construction in Orbis
Equity (n)	$toas - culi - ncli = capi + osfd$
Debt (b)	$loan + lt db$
External equity	$capi$
Internal equity	$osfd$
Financial capital (k)	$loan + lt db + capi + osfd$
Output	$ebta + staf$
Tangible Capital	$tfas$
Employment	$empl$

Acknowledgements

I am grateful to Dominik Thaler, Javier Suarez, and an anonymous reviewer for valuable comments and suggestions. I thank Andrea Guccione and Manuel Ruiz for excellent research assistance. I gratefully acknowledge financial support from the ECB Lamfalussy Research Fellowship

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ISBN 978-92-xxx-xxxx-x

ISSN 1725-2806

doi:10.2866/xxxxxx

QB-AR-2x-xxx-EN-N