

# The Persistence of a Banking Crisis

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## Abstract

This paper analyses the effects of bank lending on GDP and employment. Following losses on international financial markets in 2008/09, a large German bank cut its lending to the German economy. I exploit variation in dependence on this bank across counties. To address the correlation between county GDP growth and dependence on this bank, I use the distance to the closest of three temporary, historic bank head offices as instrumental variable. The results show that the effects of the lending cut were persistent, and resembled the growth patterns of developed economies during and after the Great Recession. For two years, the lending cut reduced GDP growth. Thereafter, affected counties remained on a lower, parallel trend. The firm results exhibit similar dynamics, and show that the lending cut primarily affected capital expenditures. Overall, the lending cut reduced aggregate German GDP in 2012 by 3.9 percent, and employment by 2.3 percent. This shows that a single bank can persistently shape macroeconomic growth.

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# 1 Introduction

Many economies experienced a severe crisis of their banking sector in 2008/09. The subsequent Great Recession in the United States, the United Kingdom, and other developed economies was characterised by two years of negative growth. The eventual recovery was slow, and output and employment failed to return to their pre-crisis trends. This paper finds that the causal effects of a bank lending cut resemble this growth pattern. A temporary banking crisis can persistently keep output and employment low, even after bank loan supply has normalised.

I analyse a lending cut by Commerzbank, Germany's second-largest bank. During the financial crisis 2008/09, Commerzbank suffered significant losses and write-downs on its international trading portfolio. These translated into huge equity capital losses, raised the bank's cost of external funds, and forced it to reduce its risk exposure. As a result, Commerzbank cut its loan supply to the German economy. Crucially, the trading losses were unrelated to Commerzbank's loan portfolio. Interest income, which includes what Commerzbank earns from lending to German firms and households, remained on an upward trend up to 2009. Firms dependent on Commerzbank reported restrictive bank loan supply in 2009, but by 2011 their bank financing was not affected anymore.<sup>1</sup>

I use variation across counties in dependence on Commerzbank to study the effect of this lending cut. By focusing on an imported banking crisis, I address the key identification challenge that plagues the literature on financial frictions: the correlation between the health of the financial sector and the business cycle. The unfolding of the Great Recession in the United States exemplifies the empirical challenge. The housing market crisis forced banks to reduce their loan supply (Ivashina and Scharfstein (2010)). At the same time, it led to a fall in aggregate demand (Mian and Sufi (2014b)), higher uncertainty (Baker et al. (2013)), and a sovereign debt rating downgrade. Since there was no housing, sovereign debt, or other domestic crisis in Germany leading up to the Great Recession, the lending cut provides a natural experiment to disentangle the causal impact of bank lending.<sup>2</sup>

In a previous recession, counties dependent on Commerzbank grew faster, probably because Commerzbank selectively expanded to economically resilient counties (Klein (1993)). This suggests that during recessions there may be a positive correlation between county Commerzbank depend-

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<sup>1</sup>Commerzbank refers to all branches that were part of the Commerzbank AG in 2009, including Dresdner Bank.

<sup>2</sup>See figure 4 for GDP and figure 5 for house prices.

ence and growth, which would attenuate the OLS estimates. I employ an instrumental variable to overcome this problem. The instrument is based on the enforced break-up of Commerzbank by the Allied occupation forces after World War II. This led Commerzbank to set up three separate, temporary head offices, in Duesseldorf, Frankfurt, and Hamburg. These cities were chosen through a combination of historic accident and power struggles among the Allies, rather than the bank's business considerations.

Banks tend to form relationships with geographically close customers (Guiso et al. (2004); Degryse and Ongena (2005); Mian (2006)). Using historic records, I show that Commerzbank expanded its branch network around its temporary head offices in the post-war period. The association between proximity to a post-war head office and Commerzbank dependence survived until 2006. I can thus use a county's distance to the closest of Commerzbank's post-war head offices as instrument for Commerzbank dependence before the banking crisis. To address concerns that proximity to certain cities biases the results, I control for the linear distances to Duesseldorf, Frankfurt, Hamburg, Berlin, and Dresden, as well as a range of economic, demographic, and geographic factors in the regressions. Controlling for the linear distances does not raise an econometric collinearity problem, because the instrument is a nonlinear function (the minimum) of the linear distances to the three post-war head offices. To my knowledge, this is the first paper to use a nonlinear distance instrument, while simultaneously controlling for linear distances to avoid spurious correlations.

Figure 1 shows how the lending cut affected GDP growth over time. For two years, affected counties grew more slowly. Thereafter, the growth rates were similar, which means affected counties remained on a lower, parallel trend after bank loan supply had been restored. These dynamics resemble the development of the United States economy during and after the Great Recession, and suggest a role for the banking crisis 2008/09 in explaining the sluggish recovery.

Standard growth theory implies the effects of a temporary lending cut should be transitory (Hall (2010); Fernald and Jones (2014)). But if total factor productivity is affected, the losses can be permanent, as in models by Aghion et al. (2010) and Benigno and Fornaro (2015). Back-of-the-envelope growth accounting suggests that the lending cut indeed slowed productivity growth. Overall, the lending cut lowered German GDP in 2012 by 3.9 percent, and employment by 2.3 percent. The instrumental variable estimate is larger than the OLS estimate, but not statistically different.

The instrumental variable exclusion restriction assumes that the minimum distance instrument affects growth from 2009 to 2012 only through the lending cut, conditional on the linear distances to the cities. I present a range of evidence supporting this assumption. First, Commerzbank’s income statements show that the lending cut was entirely due to losses in its trading portfolio. Interest income, which includes what Commerzbank earns from lending to firms and households, continued to increase up to 2009. Second, in a survey, firms dependent on Commerzbank report restrictive bank loan supply in 2009, but not in 2003, 2006, and 2011. There is no difference in their reported product demand in any year. Third, figure 1 shows that there is no association between the instrument and GDP growth before the lending cut. Fourth, the effect is not an artefact of large banks’ customers performing badly during the Great Recession. I carry out a county placebo experiment, for which I construct an analogous minimum distance instrument for Deutsche Bank dependence. I find no effect of Deutsche Bank dependence on growth.

Next, I turn to the effects of the lending cut on firms. Figure 2 shows that the firm dynamics resemble the county effects. The lending cut lowered the employment growth rate at affected firms for two years. In 2011, firms dependent on Commerzbank reported they are not credit constrained anymore. Nevertheless, they remained on a lower, parallel trend for another two years, with no convergence.

A large literature finds that credit frictions reduced firm short-run employment (Chodorow-Reich (2014)) and firm investment (Almeida et al. (2012)) during the 2008/09 financial crisis.<sup>3</sup> I find that the lending cut primarily affected firms through their capital expenditures, and lowered the capital-labour ratio. In line with a model of competitive factor markets, average wages and average labour productivity remained constant, while the average product of capital rose. I do not instrument for firm Commerzbank dependence, because I use county fixed effects, and there is no evidence that, within the same county, firms dependent on Commerzbank grew more quickly in recessions.

A recent literature has documented that, across different episodes of history, banking crises have been correlated with recessions (Reinhart and Rogoff (2009); Schularick and Taylor (2012); Giesecke et al. (2014); Romer and Romer (2015); Krishnamurthy and Muir (2015)). But, as Reinhart and Rogoff (2009) note, there is no “definitive evidence on the causal effects.” The natural experiment

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<sup>3</sup>Gan (2007); Khwaja and Mian (2008); Amiti and Weinstein (2011); Garicano and Steinwender (2013); Bentolila et al. (2015); Paravisini et al. (2015) present further evidence.

literature has provided ambiguous evidence on the effects of banking crises. Rosengren and Peek (2000) and Benmelech et al. (2011) find that the reduction in lending by Japanese banks in the 1990s affected the US construction sector and unemployment. Ashcraft (2005) shows the failure of Texas bank branches reduced county income. Mondragon (2015) argues that shocks to household credit lowered US employment from 2007 to 2010.

On the other hand, Driscoll (2004) and Ashcraft (2006) find that shocks to bank loan supply have zero effect on output across US states. Greenstone et al. (2014) report only modest effects of bank lending on county employment from 2007 to 2009. Mian and Sufi (2014b) similarly argue that business financing was not an important problem during the Great Recession, and find banking crises unexceptional unless accompanied by “elevated levels of debt” (Mian and Sufi (2014a)). Overall, the literature has provided no evidence that bank lending causally and persistently affects GDP.

In addition to the literature on banking crises, this paper contributes to the literature on the importance of a single firm, in this case a bank, in shaping macroeconomic outcomes. Models by Gabaix (2011), Acemoglu et al. (2012), and Baqaee (2015) show that idiosyncratic firm shocks may translate into large aggregate fluctuations, countering the traditional argument by Lucas (1977) that microeconomic shocks average out in the aggregate.

It is a general problem in empirical work that well-identified, partial equilibrium effects may not be informative about the aggregate implications of a given policy or shock (Acemoglu (2010)). The existing firm literature on financial frictions has had to rely on strong assumptions to extrapolate the aggregate effects of credit market imperfections. In the final section of the paper, I take advantage of the fact that I estimate the effects of the lending cut on both firms and counties. I calculate the relative importance of firm-level, partial equilibrium channels to the aggregate economy. The results provide suggestive evidence that simply summing up the firm-level, partial equilibrium effects underestimates the aggregate consequences of bank lending.

This paper proceeds in the following section by describing the source of Commerzbank’s lending cut. Section 3 details the instrumental variable strategy. I describe the data in section 4, including a unique dataset on pre-crisis firm-bank relationships. Section 5 contains the model and the empirical strategy; section 6 performs the county analysis; and section 7 reports the firm analysis. Section 8 calculates the relative importance of the firm-level, partial equilibrium effects. Section 9 concludes.

## 2 The Lending Cut

This paper's empirical challenge lies in identifying a bank lending shock that is exogenous to the real economy. This allows me to estimate the causal effect of a pure banking crisis, as opposed to the correlation between the health of the financial sector and the business cycle. This section argues that the lending cut by Germany's second-largest bank, Commerzbank, during the financial crisis 2008/09 serves as such an exogenous shock.

### 2.1 Bank Evidence

Commerzbank branches were responsible for around 9 percent of total bank lending to German firms and households in 2006. Figure 3 shows that until 2007 Commerzbank's lending moved in parallel with that of other banks. The other banks' lending rose continually until 2010. Commerzbank, on other hand, cut lending sharply after the Lehman Brothers insolvency in September 2008. By 2012, Commerzbank's lending stock was 22 percent lower relative to the other banks.

Why did lending decrease? Commerzbank is a universal bank, which means it earns both interest income, from lending and securities, and non-interest income, from trading and investing in financial markets. During the financial crisis, Commerzbank suffered significant losses and write-downs on its trading and investment portfolios. These translated into huge equity capital losses.

A bank's equity capital is the residual of the balance sheet and indicates the value of assets that a bank can lose without becoming insolvent. Equity capital losses lead to a lending cut through three channels. First, there is a direct effect, as the Basel II regulations required a bank to hold at least 4 percent of its risk-weighted assets in equity. Second, past equity capital losses indicate excessive risk on the balance sheet and predict losses in future periods, requiring a reduction in risk exposure. Third, equity capital losses raise a bank's cost of external funds, in particular during a credit crunch.

Figure 8 shows that the other German banks increased their aggregate equity capital during the crisis. Commerzbank reduced it in every year from 2007 to 2009, losing 68 percent of its equity capital. The German government fund Soffin supported Commerzbank twice, on 3 November 2008 and on 8 January 2009, but was unable to entirely prevent a lending cut. Overall, Soffin provided Commerzbank with 18.2 billion Euros in equity and bought a 25 percent stake in the bank. Only

three other, specialised banks received equity from Soffin, a combined total of 13.3 billion Euros (two real estate banks, Aareal Bank and Hypo Real Estate Group, and former Landesbank Portigon). This shows that Commerzbank was uniquely affected among German banks.

Figure 6 shows that the changes in Commerzbank's equity capital were entirely driven by write-downs on financial instruments and profits. Write-downs on financial instruments include, for example, changes in the valuation of derivatives the bank holds, and are unrelated to the household and firm loan portfolio. This leaves me to confirm that the change in profits is unrelated to firms and households. Figure 7 confirms that trading and investment income are entirely responsible for the huge negative profits in 2008 and 2009. Interest income, on the other hand, which includes the amount Commerzbank earns from lending to firms and households, remains on an upward trend up to 2009.<sup>4</sup>

Anecdotal evidence suggests that Commerzbank had wrongly predicted the developments on financial markets. Commerzbank head Martin Blessing admitted that his bank had pulled the plug on its subprime mortgage investments too late. In comparison, the head of Germany's largest institution Deutsche Bank Josef Ackermann claimed that they avoided greater damage by predicting the persistent drop in the US subprime mortgage market early on (O'Donnell and Nann (2008); Landler (2008)). Research by credit rating agencies confirms that Commerzbank's lending to firms and households was not riskier than other German banks' (Moody's (2008b); Standard & Poor's (2009)). Instead, losses on international financial markets were responsible for the lending cut (Moody's (2008a, 2009a,b)).

## 2.2 Firm Survey Evidence

I present evidence from the Firm Business Expectations Panel of the ifo Institute from the period 2003 to 2011. All the specifications control for county Commerzbank dependence, industry, federal states, firm size, and age. Table 1 examines whether firms dependent on Commerzbank perceived their banks to lend more restrictively. The outcome variable is the answer to the question: "How do you evaluate the current willingness of banks to grant loans to businesses: cooperative, normal or

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<sup>4</sup>Commerzbank's take-over of Dresdner Bank, announced only a fortnight before the unexpected Lehman bankruptcy, was completed on 12 January of 2009. The restructuring expenses only had a modest impact on equity capital. For the purpose of this paper, it is sufficient to note that the aim of the take-over was simply to grow in size, to prevent future take-overs by competitors, and unrelated to the banks' loan portfolios (Schultz (2008)).

restrictive?" The lower its value, the more restrictive the firm perceives bank loan supply to be. The regressor of interest is *Commb dep*, the fraction of bank relationships with Commerzbank branches in the year 2006.<sup>5</sup>

The coefficient on *Commb dep* in column (3) has the interpretation that in 2009 a firm fully dependent on Commerzbank perceived its banks to be 0.39 standard deviations less willing to grant loans, compared to a firm with no Commerzbank relationship. The estimate is statistically significant at the 5% level. The lagged dependent variable from 2006 has coefficient of similar magnitude to *Commb dep*. This suggests that that the effect of Commerzbank dependence is sizeable, because it is qualitatively similar to the role that time-invariant factors play in explaining bank loan supply.

Columns (4) to (6) show there is no significant association between Commerzbank dependence and bank loan supply in 2006 and 2003. In fact, the point estimate is always small and positive, which, if significant, would imply that firms dependent on Commerzbank faced slightly easier access to bank loans. The estimates also imply that Commerzbank's lending was not more cyclical, as in 2006 Germany experienced a boom and in 2003 a recession.

Column (1) reports that in 2011, pre-crisis Commerzbank dependence was no longer associated with differences in bank loan supply. The point estimate is essentially zero. This implies that the lending cut only led to temporary credit constraints. After two years, firms were able to substitute other lenders for Commerzbank.

Table 2 finds that firms dependent on Commerzbank did not face lower product demand than other firms at any point between 2003 and 2011, controlling for county Commerzbank dependence. The coefficient on *Commb dep* is insignificant in all years between 2003 and 2011, and the point estimates are of small magnitude. For example, the (statistically insignificant) estimate in column (3) implies that in 2009, a firm fully dependent on Commerzbank perceived product demand to be 0.09 standard deviations higher than a firm with no Commerzbank relationship. This is evidence against the view that reverse causality from Commerzbank's corporate loan portfolio led to its income losses. Overall, the survey suggests that firms dependent on Commerzbank faced a temporary lending cut in 2009, but that there were no differential demand shocks.

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<sup>5</sup>See section 4 for the construction of the variable *Commb dep*.

### 3 The Instrument for County Exposure to Commerzbank

A standard parallel-trends assumption would argue that counties dependent on Commerzbank would have grown at the same rate as counties with no connection to Commerzbank, had there been no lending cut. This assumption would naturally lead to a differences-in-differences analysis, in which one compares economic growth before after the lending cut to the degree of Commerzbank dependence. But there is evidence that Commerzbank selectively expanded across German counties. For example, Klein (1993) describes that Commerzbank followed a unique branch expansion strategy in the former GDR after the German reunification in 1990. All the other German banks simply took over pre-existing branch networks, while Commerzbank built up its own. If Commerzbank successfully identified counties with greater economic resilience, the differences-in-differences estimates would underestimate the effect of the lending cut.

Table 3 examines whether the pre-lending cut data support the parallel-trends assumption. I regress GDP growth on Commerzbank dependence, as well as Commerzbank dependence interacted with a dummy for the single recessionary year 2003. For the years of positive growth, there is no association between Commerzbank dependence and growth. But in 2003, a county fully dependent on Commerzbank grew by 10 percent more. This suggests that Commerzbank dependence is positively correlated with growth during recessions, even controlling for economic and demographic characteristics. Since Germany experienced a recession from 2009 to 2010, the parallel-trends assumption is likely to be violated after the lending cut.

I instrument for county Commerzbank dependence to overcome the resulting bias. The instrument is the county's distance to the closest of three temporary, post-World War II Commerzbank head offices in Duesseldorf, Frankfurt, and Hamburg. Crucially, since this minimum distance instrument is a non-linear function of the linear distances, I can include the linear distances to these cities in the regressions. This directly controls for any factors associated with linear proximity to each of the cities. Furthermore, I control for a range of economic, demographic, and geographic factors to exclude as far as possible any spurious correlation between the instrument and post-crisis growth.

After World War II, the Americans were convinced that the Nazi government's ability to wage war effectively stemmed from the Third Reich's economic centralisation. From 1948 to 1957, they forced Commerzbank to break up into separate entities in three mandated banking zones, with three

separate head offices in Duesseldorf, Frankfurt, and Hamburg.<sup>6</sup>

These cities were chosen due to a combination of historic accident and power struggles among the Allies, rather than the bank's business considerations. In the first banking zone, North-Rhine Westphalia, the British declared Duesseldorf as the state capital, because it was the only city with a large building that had survived the war (Düwell (2006)). The banks followed the political power and settled there. In the second, Northern zone, the British ordered the surviving and non-imprisoned board members of Commerzbank and Dresdner Bank to set up a central head office in Hamburg. Frankfurt was chosen as head office for the Southern zone because the Americans had placed the new central bank there. At the time, Frankfurt was far from its contemporaneous role as Germany's financial centre, but it was chosen for its central location (Horstmann (1991)).<sup>7</sup>

The literature has established that banks prefer to form relationships with geographically close customers (Guiso et al. (2004); Degryse and Ongena (2005); Mian (2006)). Table 4 analyses the effect of Commerzbank's relocation to Duesseldorf, Frankfurt, and Hamburg on the location of its branches, controlling for demographic and economic factors. Columns (1) and (2) show that from 1948 to 1970 Commerzbank was significantly more likely to establish a new branch in counties close to its new head offices. This finding is confirmed when looking at the number of branches that were newly set up in column (3). Column (4) shows that there is no significant relationship between the establishment of a branch from 1925 to 1948 and the distance to the post-war head office. Column (5) shows that there is also no association between this distance and the likelihood that a county had a Commerzbank branch in 1925. Taken together, this evidence suggests that the move to the post-war head offices prompted Commerzbank to set up branches in counties close by.

As I show in table 8, this association survived until 2006. There is a robust first-stage relationship between the instrument and county Commerzbank dependence in 2006. The map in figure 10 confirms this visually.

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<sup>6</sup>The former capital Berlin was in the Soviet sector, where commercial banking was forbidden. A temporary state-level break-up between 1948 and 1951 was too short-lived to lead to the creation of significant head offices in each state.

<sup>7</sup>Deutsche Bank based its Southern head office in the Bavarian capital Munich - a fact I use for a placebo experiment (Horstmann (1991)).

## 4 Data

### 4.1 Data Construction

This paper uses three datasets: a firm panel, a firm survey, and a county dataset.<sup>8</sup> The firm panel is based on balance sheet and profit-loss account data from Dafne, a commercial database by Bureau van Dijk. I use all firms that have non-missing data throughout the period 2006 to 2012 for the following variables: employment, the wage bill, bank debt, value added, production capital (fixed tangible assets), and capital depreciation. Additionally, I use all firms with non-missing data until they become insolvent. This leaves 2,675 firms in Dafne. Since investment is not directly observable, I calculate it using the capital stock and depreciation. I calculate the average wage as the ratio of the wage bill over employment.

The firm survey I use is the confidential Business Expectations Panel of the ifo Institute, which can only be accessed on-site in Munich. The sample includes all firms that responded to the following two questions in 2009 and 2006: “How do you evaluate the current willingness of banks to grant loans to businesses: cooperative, normal or restrictive?” and “Are your business activities constrained by low demand or too few orders: yes or no?” From both firm datasets, I drop all firms in the financial sector to avoid reverse causality (WZ sector K) and firms that are funded entirely by the government (WZ sector O).

In both firm datasets, I link firms to their pre-crisis banks. The pre-crisis timing of the bank relationships is crucial to avoid endogeneity resulting from weak banks getting matched with weak firms during the financial crisis. I obtain confidential data on the year 2006 bank relationships of 112,344 German firms from the archives of a German credit rating agency. These data include up to seven bank branches the firm has a relationship with. Using a unique firm identification number (Crefonummer), I match the firm-bank relationships with the firm panel and the survey. The match leaves 2,011 firms in the panel and 1,031 firms in the survey.

I construct a variable to measure a firm’s dependence on Commerzbank in 2006, called *Commb dep<sub>f</sub>* for firm  $f$ . It is the fraction of bank relationships with Commerzbank branches out of the firm’s

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<sup>8</sup>Details on the construction of the datasets are in the Data Appendix.

total number of bank relationships, as given in equation 1.<sup>9</sup>

$$Commb\ dep_f = \frac{\text{number of bank relationships to Commerzbank branches}_f}{\text{total number of bank relationships}_f} \quad (1)$$

In addition to the firm datasets, I construct a county panel from 2000 to 2012. It contains data on GDP and employment from the German Statistical Federal Office.<sup>10</sup> I calculate a county's dependence on Commerzbank in 2006 as the average value of  $Commb\ dep_f$  for firms with their head office in the county, using all 112,344 firms in the bank relationships dataset. I call this measure  $\overline{(Commb\ dep)}_c$  for county  $c$ .<sup>11</sup>

The instrument for county Commerzbank dependence is based on the county's distance to the closest of the three Commerzbank post-war head offices in Duesseldorf, Frankfurt, and Hamburg. For each firm with available pre-crisis bank data, I measure the geodesic distance (as the crow flies) between the postcode of the firm and the post-war head offices. I then average this measure across all firms in a county to get the distance between the county and each of the three post-war head offices. This method is preferable to simply using the county's geographical centre because the location of firms approximates the centre of economic activity. The instrument is given by the minimum of the three distances, as in equation 2.

$$Commb\ min\ dist\ instrument_c = \min(Dist\ to\ Duesseldorf_c, Dist\ to\ Frankfurt_c, Dist\ to\ Hamburg_c) \quad (2)$$

## 4.2 Summary Statistics

Table 5 summarises the firm panel dataset, and figure 9 plots a histogram of  $Commb\ dep$ . The data reveal the high bank dependence of German firms in 2007. For the average firm in the panel, bank debt amounts to 49 percent of liabilities, while liabilities account for 66 percent of total assets. This

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<sup>9</sup>Alternatively, one could measure exposure to Commerzbank using a dummy for a relationship to Commerzbank. The results are in line with using  $Commb\ dep_f$ .

<sup>10</sup>Germany has 402 counties, the dataset contains 385. I drop 17 counties, for which the Statistical Federal Office does not provide data for the pre-crisis years. The results remain unchanged, when I include these counties into analyses for the years with data for all counties. The Bundesbank does not provide data on the lending share of individual banks at the county level.

<sup>11</sup>It is not advisable to weight this measure by the number of bank relationships or the size of each firm, since there is no reason to believe that large firms' bank dependence matters more for the county.

is consistent with aggregate statistics on the financial structure of German firms. Schwartz (2014) reports that 36 percent of investment at small and medium firms (with less than 500 million Euro revenue) was financed through bank debt. For firms with less than 50 million Euro in revenue, bank debt is 40 percent of liabilities, while liabilities compose 70 percent of assets (Bundesbank (2015)).

Table 6 analyses whether Commerzbank’s corporate customers systemically differed from other firms before the crisis. I regress firm Commerzbank dependence (Commb dep) on a cross-section of firm observables from 2007. The coefficients have the interpretation of the approximate change in Commb dep following a 100 percent increase in the regressor. Only the coefficient on ln capital has a coefficient that is statistically significantly different from zero. The estimate implies that a 100 percent increase in the capital stock is associated with a 0.014 decrease in Commb dep. Conversely, the estimate on employment implies that a 100 percent increase in the number of workers leads to a 0.008 increase in Commb dep. I therefore conclude that, in the firm panel, there are no economically meaningful differences between firms dependent on Commerzbank and other firms. Table 7 presents summary statistics for the county panel.

## 5 Model and Empirical Implementation

### 5.1 Model

I present a three-period model of a firm that uses bank debt to finance capital investment. Period 1 is analogous to the years 2009/10, during which credit constraints affected firms dependent on Commerzbank. Periods 2 and 3 are the years 2011 and 2012, during which credit constraints had been overcome.

The firm’s concave production function in each period  $t$  is  $z_t f(k_t, n_t)$ , where  $k_t$  is production capital and  $n_t$  is employment.  $z_t$  is a parameter that captures the output price and productivity, both exogenous to the firm. Capital needs to be installed one period before it can be used. Labour gets paid out of contemporaneous profits at wage  $w_t$ .

The firm chooses the amount of bank debt  $e_t$  it takes out in period  $t$ , which needs to be repaid in period  $t+1$  at price  $R(s_t)$ .  $s_t$  is the loan supply of the firm’s relationship banks. A reduction in loan supply raises the firm’s cost of bank debt because information frictions in financial markets make it costly to find new lenders (Sharpe (1990); Chodorow-Reich (2014)). I allow for adjustment costs

to capital, given by the convex function  $\chi(k_t - k_{t-1})$ . These costs stem from adjusting the capital stock from one period to the next, such as from identifying investment opportunities or training the workforce (Lucas (1967)).

The firm's objective is to maximise period 3 profits (equation 3), after which the model ends.

$$\pi_3 = z_3 f(k_3, n_3) - w_3 n_3 - R(s_2) e_2 - \chi(k_3 - k_2) \quad (3)$$

For simplicity, I assume full depreciation and that the firm starts period 1 with no capital ( $k_1 = 0$ ). That means all period 2 capital is paid using bank debt ( $k_2 = e_1$ ). To finance period 3 capital, the firm uses both bank debt and period 2 profits (equation 4).

$$k_3 = \pi_2 + e_2 = z_2 f(k_2, n_2) - w_2 n_2 - R(s_1) e_1 - \chi(k_2) + e_2 \quad (4)$$

Optimal employment is given by the standard equality of the wage to the marginal product of labour (equation 5).<sup>12</sup>

$$z_t f^2(k_t, n_t) = w_t \quad (5)$$

Solving backwards, in period 3, the marginal product of capital equals the price of bank debt plus the marginal adjustment cost (equation 6). In period 2, there is an additional term, the ratio of the marginal adjustment cost to the marginal product of capital (equation 7). Using equation 6, we know this is strictly below 1, and greater than or equal to zero. The intuition is that lowering the adjustment costs in period 3 adds an additional benefit to higher period 2 capital.

$$z_3 f^1(k_3, n_3) = R(s_2) + \chi^1(k_3 - k_2) \quad (6)$$

$$z_2 f^1(k_2, n_2) = R(s_1) + \chi^1(k_2) - \frac{\theta}{1 - \theta} \quad (7)$$

First, consider firms that borrow from Commerzbank. A temporary shock to loan supply in period 1 lowers  $s_1$ , but leaves  $s_2$  unaffected. This raises  $R(s_1)$ , the price of period 2 capital. Period 2 capital and labour fall, since they are complements. The marginal product of capital rises with

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<sup>12</sup>A superscript on a function indicates its derivative with respect to the argument whose number is given in the superscript. A subscript indicates the period.

the price of capital. The wage is determined exogenously, so the marginal product of labour remains constant. Since the relative price of capital increases, the capital-employment ratio falls. The capital-employment ratio remains low in period 3 if the marginal adjustment cost of capital is positive

Consider next the general effect of the Commerzbank lending cut on all firms in an economy, not just those dependent to Commerzbank. The general effect is driven by a number of channels, all of which affect the output price or general productivity, i.e.  $z_2$  and  $z_3$ . These channels are that product demand shifts from constrained to unconstrained firms (Chodorow-Reich (2014)); aggregate demand falls due to household credit constraints and employment losses at firms dependent on Commerzbank (Mondragon (2015)); general uncertainty rises when an important bank cuts lending (Baker et al. (2013)); cascade effects, stemming from input-output linkages, amplify the shocks (Acemoglu et al. (2012); Baqaee (2015)); lower investment into research and development reduces total factor productivity and technology spill-overs (Aghion et al. (2010); Bloom et al. (2013); Benigno and Fornaro (2015)). The general channels do not affect the relative price of capital and thus do not change the capital-labour ratio.

## 5.2 Empirical Implementation

The model describes that the lending cut affects a firm through two effects. Equation 8 captures both effects in a firm panel specification, for an outcome  $y_{i,c,t}$  at firm  $i$  in county  $c$  at time  $t$ .

First, there is the firm-level, partial equilibrium effect. This effect is captured by the coefficient  $\beta$ . Firms dependent on Commerzbank experience a shock to their loan supply following the lending cut. Therefore, I identify an exogenous shock to firm loan supply using variation across firms in Commerzbank dependence, interacted with interacted with  $d_t$ , a dummy for the years following the lending cut, 2009 to 2012.

Second, there is an effect of the lending cut on all firms, through the general channels described above. It is captured by the coefficient  $\rho$ . I identify this effect using variation in Commerzbank dependence across counties, where the measure  $\overline{(Commb\ dep)}_c$  is the average Commerzbank dependence of firms in county  $c$ .  $X_{i,c}$  is a vector of time-invariant control variables, again interacted with  $d_t$ .  $\gamma_{i,c}$  is a firm fixed effect,  $\lambda_t$  a year fixed effect.

$$y_{i,c,t} = \alpha + \beta (Commb\ dep)_{i,c} * d_t + \rho \overline{(Commb\ dep)}_c * d_t + \Gamma' X_{i,c} * d_t + \gamma_{i,c} + \lambda_t + \varepsilon_{i,c,t} \quad (8)$$

The county analysis in section 6 estimates the aggregate impact of a lending cut, and therefore the joint impact of  $\beta$  and  $\rho$ . By averaging equation 8 over all firms in a county, one obtains equation 9. This shows the relationship between county outcomes and Commerzbank dependence.

$$\overline{y_{c,t}} = \alpha + (\beta + \rho) \overline{(Comm\,dep)_c} * d_t + \Gamma' \overline{X_c} * d_t + \overline{\gamma_c} + \lambda_t + \overline{\varepsilon_{c,t}} \quad (9)$$

The firm analysis in section 7 is concerned with the firm-level, partial equilibrium effect, and hence estimates  $\beta$ . For the firm specifications, I adapt equation 8 by including county fixed effects, which gives equation 10. This means I only compare firms within the same county, keeping constant any county-specific shocks and the general effect of the lending cut.

$$y_{i,c,t} = \alpha + \beta (Comm\,dep)_{i,c} * d_t + \kappa_c * d_t + \Gamma' X_{i,c} * d_t + \gamma_{i,c} + \lambda_t + \varepsilon_{i,c,t} \quad (10)$$

## 6 Effects on Counties

This section exploits variation in Commerzbank dependence across counties to estimate the impact of a lending cut on county GDP and employment. Figure 1 summarises the findings. It plots the coefficients and 95 percent confidence intervals from a regression of the GDP growth rate on the county minimum distance instrument, interacted with annual dummies. The specification can be interpreted as the instrumental variable reduced-form specification. It includes the full set of controls described below.

The figure shows that only in the years 2009 and 2010 was there a positive association between the instrument and GDP growth. This means that counties further from the historic head offices, with lower Commerzbank dependence, grew faster during the years of the lending cut. In 2011 and 2012, the growth rates were once again similar. Recall that firms dependent on Commerzbank reported restrictive bank loan supply in 2009, but not in 2011. This means that after credit constraints had been overcome, GDP remained on a lower, parallel trend. There is no convergence to the pre-crisis levels and the temporary lending cut has persistently reduced GDP.

## 6.1 County Specification

I estimate equation 9 using county ln GDP and ln employment as outcomes. The following, time-invariant control variables are all interacted with dummy  $d_t$ . There are 17 variables for the industry shares, giving the fraction of firms in each each of the 17 industries in 2006.<sup>13</sup> Population density, ln total population, and ln GDP per capita are from 2000. Debt index is a 2003 measure of county household debt, calculated by credit rating agency Schufa, based on credit data of practically the entire German adult population. The export share is the fraction of exports out of total revenue and the import share is the fraction of imports out of total costs, both averaged across firms in the county. Landesbank in crisis is a dummy for whether the county’s Landesbank received state funding during the financial crisis (Puri et al. (2011)).<sup>14</sup>

I run both OLS and instrumental variable specifications. The use of the instrument is motivated by the findings in table 3 that suggest the parallel-trends assumption fails during recessions. I instrument for  $Commb\ dep_c$  using  $Commb\ min\ dist\ instrument_c$ , the distance to the closest of Commerzbank’s post-war head offices. I control for the linear distances to Duesseldorf, Frankfurt, Hamburg, Berlin, and Dresden, interacted with  $d_t$ , in all instrumental variable specifications. Berlin and Dresden are included because previous head offices of Commerzbank were located there.

Table 8 reports the first stage. It shows that a one standard deviation increase in distance to the historic head offices (0.97) leads to a decrease in Commerzbank dependence by about half a standard deviation (0.03), a sizeable effect. The instrument is strong, with a t-statistic of 5.33 in the specification with all the controls.

To calculate the standard errors, I split the counties into 42 evenly-sized quantile bins for their industrial production share in 2000 (share out of GDP of agriculture, mining, manufacturing, utilities, recycling, construction). Similarly, I split the counties into 42 evenly-sized quantile bins for their population size. The standard errors are two-way clustered at the level of these two bins. This is a more general method than clustering at the level of the county. It simultaneously allows for arbitrary correlations across time for counties with similar industrial structure and similar size.<sup>15</sup>

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<sup>13</sup>The industries are based on the WZ2008 classification: agriculture, mining, manufacturing, utilities, recycling, construction, retail trade and vehicle repairs, transportation and storage, hospitality, information, finance, real estate, business services, other services, public sector, education, health.

<sup>14</sup>The effects could also be estimated using a cross-section in first differences. The results are very similar. The panel is preferable because it uses all the available years of data.

<sup>15</sup>See Angrist and Pischke (2009), page 238, on the choice of 42 bins.

## 6.2 County Results

Table 9 presents the results of the OLS specifications. The coefficient on  $\text{Commb dep}^*d$ , scaled by 100, has the interpretation of the average post-lending cut percentage difference in GDP between a county fully dependent on Commerzbank ( $\text{Commb dep}$  equal to one) and a county with no Commerzbank relationships ( $\text{Comm dep}$  equal to zero).

The coefficient in column (1) estimates that a one standard deviation increase in Commerzbank dependence lowered county GDP by an average of 1.03 percent during the period 2009 to 2012. The 95 percent confidence interval places the estimated GDP drop between 0.43 and 1.63 percent. This is an economically large effect, and suggests the lending cut had strong effects on output growth. The subsequent columns add control variables. The addition of industry shares in column (2) hardly affects the point estimate and raises the standard error only slightly. Controlling for the county's population, population density, GDP per capita, and the household debt index in column (3) lowers the coefficient slightly to -0.141, but does not affect its economic and statistical significance. In column (4), taking into account the health of the state's Landesbank and the export and import share does not change the coefficient at all. This suggests that the previous controls for economic and demographic factors account for the relevant cross-county variation.

Table 10 presents the results of the instrumental variable specifications. The point estimates are larger, but statistically indistinguishable from the OLS estimates. The point estimate in column (1) suggests that a standard deviation increase in Commerzbank dependence lowered county GDP by an average of 2.01 percent. The 95 percent confidence interval is between 0.76 percent and 3.26 percent. Adding the control variables does not significantly affect the instrumental variable point estimates. This strengthens the argument that controlling for the linear distances removes most of the spurious correlation between Commerzbank dependence and the instrument.

I use the county estimates to calculate the output loss to the German economy due to the Commerzbank lending cut.<sup>16</sup> I calculate fitted values for county GDP using the instrumental variable estimates. I also calculate counterfactual values, assuming there is no effect of Commerzbank dependence on GDP growth. Last, I sum the fitted and counterfactual values for the year 2012 over all counties, and subtract the counterfactual sum from the fitted sum. The instrumental variable point

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<sup>16</sup>Section 8 describes the calculation exercise in detail.

estimate suggest that in 2012, German GDP was 3.94 percent lower because of the lending cut.

The employment results in table 11 have a similar flavour to the GDP results. In general, the employment point estimates are lower than the GDP point estimates. This suggests that the lending cut reduced output per worker. The OLS coefficient in column (3) estimates that a one standard deviation increase in Commerzbank dependence lowered county employment by an average of 0.76 percent during the period 2009 to 2012. The instrumental variable point estimate places the effect at 1.15, with a 95 percent confidence interval between 0.07 and 2.23. I use the instrumental variable point estimate to calculate that the total 2012 employment shortfall due to the Commerzbank lending cut was 2.26 percent, using the methodology described for GDP above.<sup>17</sup>

Back-of-the-envelope growth accounting sheds light on the effects of the lending cut on total factor productivity (TFP). Assume aggregate output  $Y = AF(K, L)$ , where A is TFP, F is a concave production function, K is capital, and L is labour. With competitive factor markets, TFP growth ( $g_{TFP}$ ) is a weighted average of the growth of output per worker and the growth of output per unit of capital. The weights are the respective factor shares  $\alpha_L$  and  $\alpha_K$  (equation 11). Karabarounis and Neiman (2014) estimate  $\alpha_L \approx 0.6$  for Germany.

$$g_{TFP} = \alpha_L(g_Y - g_L) + \alpha_K(g_Y - g_K) \tag{11}$$

I need to make two important simplifying assumptions for a meaningful calculation. First, I take the county point estimates at face value. Subtracting the employment point estimate from the GDP point estimate implies that the lending cut reduced aggregate output per worker by 1.68 percent. Second, the capital stock is unobservable at the county level, so I need to make an educated guess on the growth of capital per worker. The firm results show that the partial equilibrium effect of the lending cut reduced the capital-labour ratio at firms by 7.7 percent (table 14). The model predicts that the general effect of the lending cut will not affect the capital-labour ratio. I therefore weight 7.7 percent by the average fraction of bank relationships with Commerzbank, which is 0.16. This calculation suggests that the aggregate capital-labour ratio fell by 1.23 percent, and output per unit of capital fell by 1.02 percent.

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<sup>17</sup>The German government's short-time work scheme does not significantly affect this calculation. Firms could only claim subsidies for a maximum of two years, and the level of short-time workers was back to its pre-crisis value in 2011 (Fujita and Gartner (2014)). Burda and Hunt (2011) show that short-time work had a very small overall impact on the German labour market in the Great Recession.

Plugging these numbers into equation 11, I calculate that the lending cut reduced TFP by 1.42 percent. This drop in productivity would explain why affected counties do not converge after credit constraints have been overcome. While the concavity of the aggregate production function implies that shocks to capital do not lead to persistent output losses, there is no such mechanism that guarantees TFP shortfalls will ever be made up.

### 6.3 Further County Specifications

Table 12 presents the results of additional county specifications. Columns (1) and (2) report the results of a placebo experiment, which estimates the effect of Deutsche Bank dependence on GDP growth. DtB dep and the instrument are defined analogously to Commb dep, as the average fraction of bank relationships with Deutsche Bank branches for firms in the county in 2006. The instrument for DtB dep is the county's distance to the closest historic Deutsche Bank head office, interacted with  $d$ . This distance is equivalent to the minimum out of the distances to Duesseldorf, Munich, and Hamburg for Deutsche Bank. Column (1) shows that there is a strong first stage (t-statistic of 7.0), while column (2) estimates an insignificant and positive coefficient of Deutsche Bank dependence. Therefore, there is no effect of large bank dependence. The Commerzbank estimates are driven by the Commerzbank lending cut.

Column (3) adds a dummy for the Ruhr region, interacted with  $d$ , to the specification. The Ruhr is an area of fifteen counties that has traditionally been dominated by heavy industry. It is located about 50 kilometres north of Duesseldorf and therefore has relatively high Commerzbank dependence. One may worry that this leads to spurious correlation between the instrument and economic growth. The point estimate implies a slightly larger effect, but it remains well within the confidence intervals of the previous estimates.

Inspecting figure 10, one may worry that the effect of Commerzbank is driven solely by the fact that Commerzbank dependence is lower in the Southern states Bavaria and Baden-Wuerttemberg. Alternatively, one may worry that Commerzbank dependence in North Rhine-Westphalia drives the effect, which is the largest and most densely populated state. Columns (4) to (6) subsequently add dummies to control for differential developments in these states following the crisis. The point estimates remain significant and of similar magnitude.

## 7 Effects on Firms

This section uses firms' Commerzbank dependence to identify exogenous variation in firm bank loan supply. The main findings of this section are well summarised by figure 2. Employment at firms with a Commerzbank relationship develops in parallel to other firms before the crisis. Following the lending cut, they experience lower employment growth for two years. From 2011 onwards, firms dependent on Commerzbank report that their bank loan supply has returned to normal. Standard theory predicts that firms should return to the employment and capital levels of unaffected firms. Nevertheless, they remain on a lower, parallel trend.

### 7.1 Firm Specification

The firm analysis in this section estimates equation 10. As outcome variables  $y_{i,c,t}$ , I use the ln of bank debt, employment, capital, the investment rate, value added and the average wage.

By including county fixed effects, I isolate the firm-level, partial equilibrium effect of a lending cut,  $\beta$ , from the general effect,  $\rho$ . The county fixed effects also circumvent the need for an instrument, because there is no evidence that, within the same county, firms dependent on Commerzbank grew faster during recessions. In the firm survey (tables 1 and 2), there is no association between Commerzbank dependence and firm constraints in either recession or growth years before the lending cut. Furthermore, Commerzbank dependence is not significantly correlated with firm observables before the lending cut (Table 6).

The identifying assumption in this section is a parallel-trends assumption. I argue that, between 2009 and 2012, firms dependent on Commerzbank would have developed in parallel to firms with no Commerzbank relationship, had there been no lending cut. I control for a range of observables, all interacted with  $d$ . I include industry fixed effects for 85 industries, at the three-digit level of the German industrial classification scheme WZ. I add four firm size bins, based on the firm's number of employees in 2006. The bins are for 1-49, 50-249, 250-999, and over 1000 employees. Further controls are the export share out of total revenues, the import share out of total inputs, the ln of the firm's age, and county fixed effects.

The standard errors in all firm specifications are two-way clustered at the level of the county and the industry. This is a more general method than clustering at the level of the firm, because it

allows for arbitrary correlations across time for firms in the same county and the same industry.

## 7.2 Firm Results

Column 1 of table 13 reports the results of a simple panel regression that includes year fixed effects, firm fixed effects, and the regressor  $\text{Commb dep}^*d$ . The point estimate implies that, following the lending cut, employment at a firm fully dependent on Commerzbank was 4.4 percent lower than at a firm with no Commerzbank relationship. Adding the set of control variables, interacted with  $d$ , increases the point estimates only slightly, to 5.3 percent. This strengthens the assumption that there were no structural differences correlated with Commerzbank dependence. The addition of county fixed effects lowers the standard error by around a third, which suggests that county-specific shocks and the general effect of the lending cut make it more difficult to identify the effects precisely. Export and import dependence do not affect the results much, probably because industry and size already account for much of the variation. The 95 percent confidence of the employment effect ranges from 2.5 percent to 8.8 percent.

Table 14 reports the results for the other outcomes. It shows that a firm fully dependent on Commerzbank held on average 20.5 percent less bank debt over the period 2009 to 2012. This suggests that firms dependent on Commerzbank were not able to substitute other lenders for Commerzbank. The average investment rate was 4.3 points lower over the four years, while the capital stock fell by an average of 13 percent. As predicted by the model, the capital-labour ratio fell significantly by 7.7 percent.

The model also predicts that the marginal product of capital should increase following a lending cut, while the marginal product of labour stays constant. This differentiates a lending cut from the effects of a demand or productivity shock, where both marginal products should fall. To identify the direction of change in the marginal products, I use value added per unit of capital and labour, i.e. average capital and labour productivity. Table 15 shows that the capital productivity indeed increased, while labour productivity remained unchanged.

The lending cut did not affect the average wage. This is consistent with the model, which takes the wage as exogenously determined by market forces. There are other theories of the labour market that could explain the fact that wages are unaffected, for example sticky nominal wages or changes in the composition of the labour force. In the United States, the median wage actually

rose during the Great Recession, because mainly low-wage employees were laid off. Further research is needed on whether a lending cut affects wages and the composition of employment differently, compared to aggregate demand or productivity shocks.

To gauge the importance of bank debt, it is useful to set up an instrumental variable strategy. Ln bank debt is the endogenous regressor, and Commb dep\*d the instrument. The first stage is the reduced-form regression of ln bank debt on Commerzbank dependence in table 14. The t-statistic of the first stage regression is only 2.56, but this is not a serious problem, because I am estimating a single causal effect using a single instrument (Angrist and Pischke (2009)).

Table 16 shows the instrumental variable results. A one percent drop in bank debt leads to a 0.26 percent fall in employment and to a 0.64 fall in capital. The 95 percent confidence intervals are from 0.10 to 0.42 for employment and from 0.16 to 1.11 for capital. These results are large and confirm the importance of bank debt to German firms.

### 7.3 Further Firm Specifications

Table 17 adds the variable Commb dep\*d(2011/2012) to the regression, which interacts Commb dep with a dummy for the years 2011 and 2012. The coefficient on this variable tests whether Commerzbank dependence has a differential effect in the years 2011 and 2012. If there is no persistence, the coefficient should be of the same magnitude and the opposite sign to the coefficient on Commb dep\*d. For both capital and labour, the coefficients on Commb dep\*d(2011/2012) are small, negative, and statistically insignificant. The 95 percent confidence intervals reject the hypothesis that the firms recovered to the capital and employment levels of unaffected firms within two years after the lending cut. The capital-labour ratio remained persistently depressed, which suggests that there were significant adjustment costs to capital.

Column (3) reports that there is no effect of Deutsche Bank dependence on firm outcomes during the Great Recession. The coefficient is insignificant and slightly positive. This shows that the estimated effect on Commerzbank is not simply the result of being attached to a large bank, but is driven by the Commerzbank lending cut.

One would expect that firms that rely heavily on banks for external financing will be more affected by a bank lending cut. I calculate two evenly-sized bins, based on the 2006 fraction of bank debt out of liabilities. Firms with low bank debt dependence have up to 50 percent of their liabilities

with banks; for firms with high bank debt dependence it is over 50 percent. Only for firms with high bank debt dependence is there a statistically significant effect of Commerzbank dependence. The coefficient for firms with high bank debt dependence is still negative, but half the size and statistically insignificant, suggesting these firms are less affected.

The effects of Commerzbank dependence are non-linear. For firms with low Commerzbank dependence ( $0 < \text{Commb dep} \leq 0.25$ ), there was no effect of the lending cut on employment. These firms found it relatively easy to substitute for Commerzbank financing, because they already had over 75 percent of their bank relationships with other banks. On the other extreme, firms with high Commerzbank dependence ( $\text{Commb dep} > 0.5$ ) found it significantly more difficult, and their employment fell by an average of 6.5 percent after the lending cut. Firms with medium Commerzbank dependence ( $0.25 < \text{Commb dep} \leq 0.5$ ) were affected, but lost only 1.7 percent of their employment after the lending cut.

The literature on the United States has found that large firms are less sensitive to credit shocks (Gertler and Gilchrist (1994); Chodorow-Reich (2014)). I find a small, negative, and statistically insignificant coefficient when I test whether Commerzbank dependence affects large firms (over 1,500 employees) differentially following the lending cut. This suggests there were no heterogeneous effects by firm size, in line with the conventional wisdom that German firms of all sizes depend on bank debt (Bundesbank (2015)).

## 8 Importance of Partial Equilibrium Effects

It is a general problem in empirical work that well-identified, partial equilibrium effects may not be informative about the aggregate implications of a given policy or shock (Acemoglu (2010)). The existing firm-level literature on financial frictions has had to rely on strong assumptions about the nature of general equilibrium and demand effects to extrapolate the aggregate effects of credit market imperfections. In this section, I present suggestive evidence that summing up the firm-level, partial equilibrium effects underestimates the aggregate effect of a lending cut.

The exercise exploits the fact that I estimate both firm and county effects. First, I calculate what the change in aggregate employment would have been, had there been only firm-level, partial equilibrium effects of the lending cut. Second, I use the county estimates to calculate what the

change in aggregate employment would have been, had there been no effects of the lending cut on counties. Third, I compare the two numbers and conclude on the relative importance of the partial equilibrium effects.

## 8.1 The Partial Equilibrium Implications for Aggregate Employment

The first step of the exercise is to calculate the aggregate employment shortfall that results from adding up the firm-level, partial equilibrium effects. Using ln employment ( $\ln(n_{i,c,t})$ ) as the outcome variable and taking the expectation of equation 10 gives me equation 12.

$$E[\ln(n_{i,c,t})] = \alpha + \beta (\text{Commb dep})_{i,c} * d_t + \kappa_c * d_t + \Gamma' X_{i,c} * d_t + \gamma_{i,c} + \lambda_t + \delta_t \quad (12)$$

Equation 13 calculates the fitted value  $\ln(\widehat{n}_{i,c,t})$ , using the firm estimate  $\hat{\beta} = -0.053$ .  $\ln(\widetilde{n}_{i,c,t})$  is the counterfactual value, had there been no Commerzbank lending cut. It is calculated in equation 14, setting  $\hat{\beta} = 0$ .

$$\ln(\widehat{n}_{i,c,t}) = \hat{\alpha} + \hat{\beta} (\text{Commb dep})_{i,c} * d_t + \hat{\kappa}_c * d_t + \hat{\gamma}' Z_i * d_t + \hat{\zeta}_i + \hat{\delta}_t \quad (13)$$

$$\ln(\widetilde{n}_{i,c,t}) = \hat{\alpha} + \hat{\kappa}_c * d_t + \hat{\gamma}' Z_i * d_t + \hat{\zeta}_i + \hat{\delta}_t \quad (14)$$

Converting the values from lns to levels, taking the difference between the fitted and the counterfactual values, and summing over all firms gives me an estimate of the aggregate employment change due to the partial equilibrium effect of the Commerzbank lending cut (equation 15). I call this estimate  $\Delta(\text{partial, point estimate})$ .

$$\Delta(\text{partial, point estimate}) = \sum_i [\widehat{n}_{i,c,t} - \widetilde{n}_{i,c,t}] \quad (15)$$

The first argument of  $\Delta(\text{partial, point estimate})$ , “partial”, refers to the fact that this estimate of the change is based on partial equilibrium estimates. The second argument “point estimate” refers to the fact that the estimate  $\hat{\beta}$  used in the calculations is the actual OLS point estimate. To check the precision of the calculation, I also construct two other measures that use the upper and lower bound of the 95 percent confidence interval of the distribution of  $\hat{\beta}$ . These are called  $\Delta(\text{partial, lower})$

and  $\Delta$  (*partial, upper*).

## 8.2 The County Implications for Aggregate Employment

The second step of the exercise is to calculate what the county estimates imply about the effect of the Commerzbank lending cut on aggregate employment in Germany. The procedure is the county analogue to the previous section.  $\ln(\widehat{n}_{c,t})$  is the fitted value and  $\ln(\widetilde{n}_{c,t})$  is the counterfactual value, had there had been no Commerzbank lending cut. The estimate of the aggregate employment change due to the Commerzbank lending is  $\Delta$  (*county, point estimate*) (equation 16).

$$\Delta(\text{county, point estimate}) = \sum_c [\widehat{n}_{c,t} - \widetilde{n}_{c,t}] \quad (16)$$

## 8.3 Relative Importance

Table 18 reports the loss to 2012 aggregate employment in Germany that the different estimates imply. Consider first the column that uses the point estimates. Row 1 adds up the firm-level, partial equilibrium effects, and finds that employment fell by 0.82 percent. Row 2 uses the county OLS point estimate to calculate that the lending cut reduced employment by 1.49 percent. In row 3, the calculation based on the instrumental variable point estimate reports an even larger loss of 2.26 percent.

Taking the point estimates at face value, these numbers imply that the general channels played a significant role in exacerbating the effects of the lending cut. The firm-level, partial equilibrium effects account for only 38 percent of the aggregate effect that the instrumental variable county estimate implies. This is a natural conclusion if the lending cut reduced aggregate TFP and aggregate demand, because in that case even firms that did not borrow from Commerzbank would have been affected.

An important caveat of this conclusion is that the standard errors do not statistically reject the hypothesis that the firm-level, partial equilibrium effects account for most of the aggregate employment shortfall. This can be seen by examining the range of employment effects implied by the 95 percent confidence intervals of the respective estimates. Overall, the data are suggestive on the quantitative importance of general channels, but they cannot deliver the decisive statistical punch.

## 9 Conclusion

The persistence of the Great Recession poses a challenge for growth theory. A standard model predicts that the economy should converge to its pre-crisis trend as soon as financial frictions are overcome. Alas, there has been little convergence in developed economies following the financial crisis 2008/09, even though the banking sector has stabilised. What is to blame? Summers (2014) and Gordon (2014) point to structural changes in the economy, while Fernald (2014) and Antolin-Diaz et al. (2014) find that the growth rate had slowed even before the financial crisis.

The results in this paper imply an additional narrative. I show that a bank lending cut can cause an extended hangover, depressing output and employment even after bank loan supply has normalised. If a banking crisis persistently lowers total factor productivity, as the results in this paper imply, the persistence of the Great Recession is not surprising. The law of motion for productivity in standard models implies no convergence, and so the economy can be permanently worse off following a productivity shock.

Further research should identify the mechanisms that lead from banking crises to persistent losses. Likely candidates include the shortfalls in all types of tangible and intangible investment, such as in production capital, research and development, and relationships to firms and customers. In addition, the role of general channels in amplifying partial equilibrium shocks merits further evidence and analysis.

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## Figures

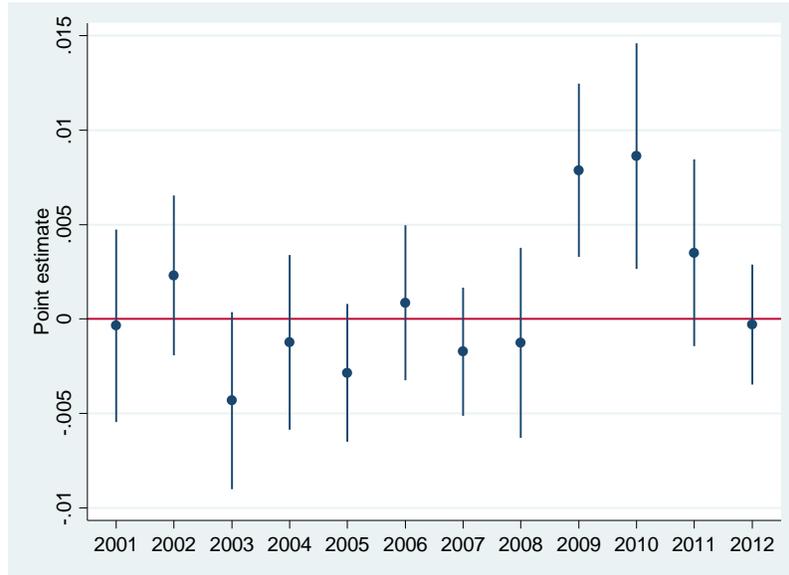


Figure 1: Reduced-form impact of the instrument on GDP growth

Notes: This figure illustrates the reduced-form relationship between county GDP growth and the Commerzbank minimum distance instrument. It is based on a single regression, in which the dependent variable is the county's annual GDP growth rate. The plotted point estimates are the coefficients on dummy variables for each year, interacted with the instrument. This instrument is the county's distance to the closest historic Commerzbank head office, equivalent to the minimum out of the distances to Duesseldorf, Frankfurt, and Hamburg. The vertical lines are 95 percent confidence intervals. Standard errors are two-way clustered at the level of the county's industrial production share (share out of GDP of agriculture, mining, manufacturing, utilities, recycling, construction) and its population size, each split into 42 quantile bins. The regression includes year fixed effects and the following, time-invariant control variables interacted with  $d$ , a dummy for the years following the lending cut, 2009 to 2012: 17 variables for industry shares, giving the fraction of firms for each of the 17 industries in 2006 (agriculture, mining, manufacturing, utilities, recycling, construction, retail trade and vehicle repairs, transportation and storage, hospitality, information, finance, real estate, business services, other services, public sector, education, health); population density, total population (in  $\ln$ ) and GDP per capita (in  $\ln$ ) from 2000; a 2003 measure of county household debt, calculated by credit rating agency Schufa; the fraction of exports out of total revenue and the fraction of imports out of total costs, both averaged across firms in the county for 2006; a dummy for whether the county's Landesbank received public funding during the financial crisis; a dummy for the 15 counties of the Ruhr; a dummy for the former GDR; and the linear distances to Duesseldorf, Frankfurt, Hamburg, Berlin, and Dresden.

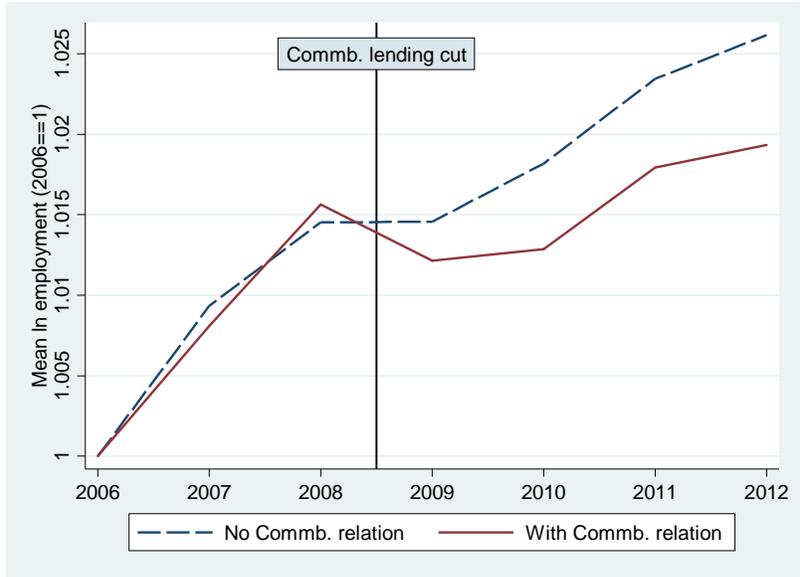


Figure 2: Firm Employment Effects

Notes: This figure plots the raw time series for the mean ln employment of firms with and without a bank relationship to Commerzbank, using data from the firm panel. Both time series are indexed at their respective year 2006 value.

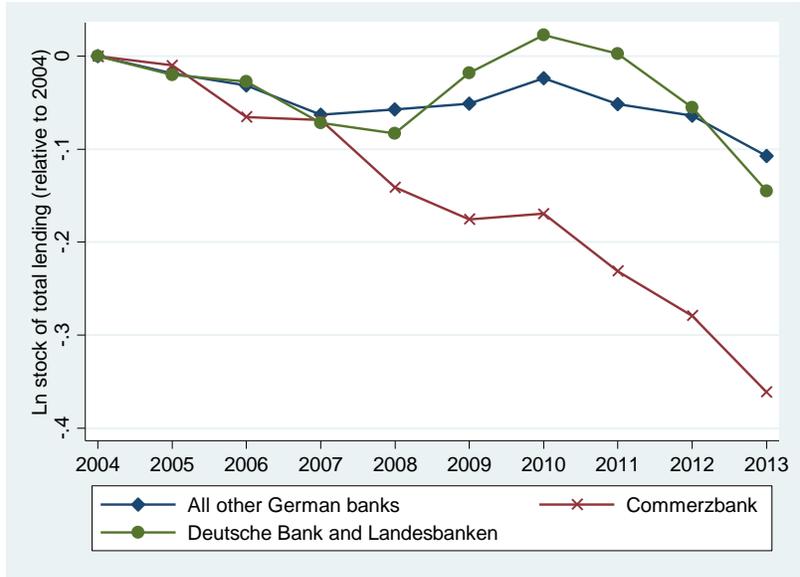


Figure 3: Lending stock to German firms and households

Notes: The figure plots the ln stock of total lending relative to 2004, which means the value for 2004 is subtracted from the annual value. The stock of total lending is measured as the book value of total lending, which includes overdraft facilities, collateral loans, bonded loans, consumer credit, and loans to municipal governments. The values are in ln year 2010 billion Euros. The data are from the annual reports of Commerzbank, Eurohypo, Dresdner Bank, and the Bundesbank. I aggregate the positions of Commerzbank and Dresdner Bank for the years before the 2009 take-over. The figures for Commerzbank do not include real estate bank Eurohypo, a Commerzbank acquisition from 2005.

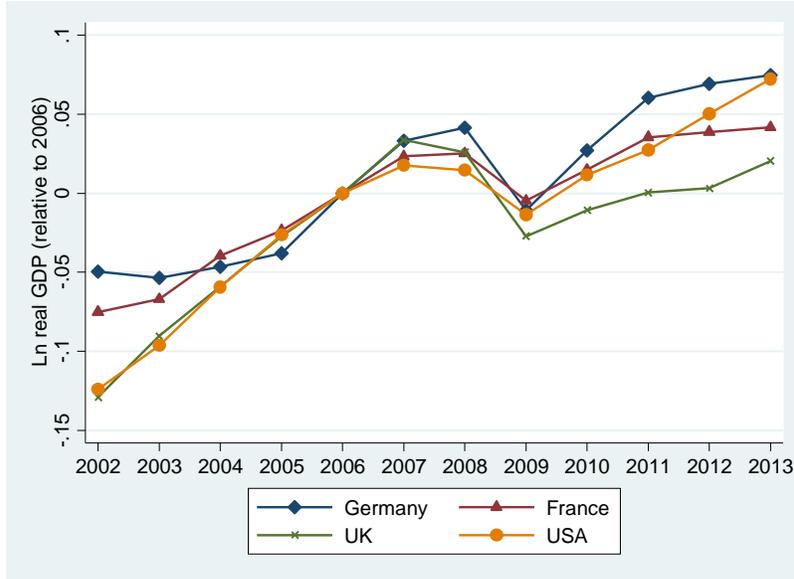


Figure 4: Real GDP

Notes: The figure plots the ln real GDP relative to 2006, which means the value for 2006 is subtracted from the annual value. The data are from the IMF.

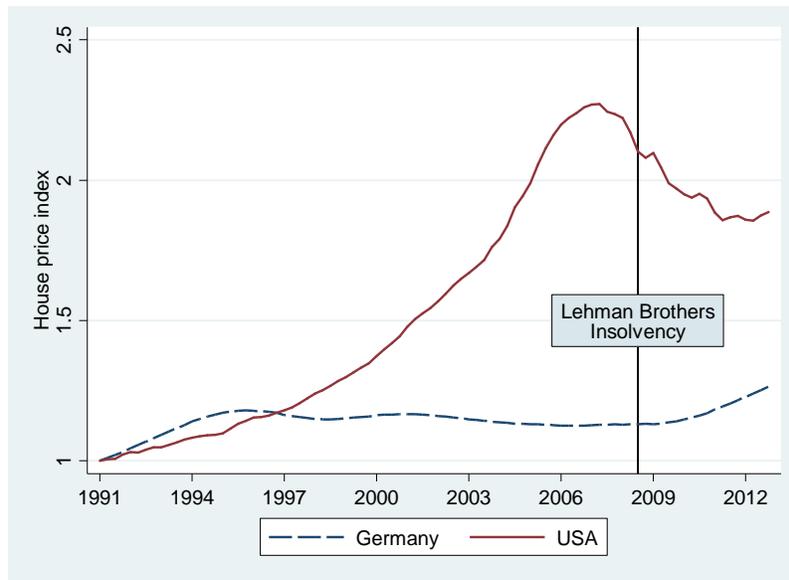


Figure 5: House prices

Notes: The data are from the Federal Reserve Bank of Dallas International House Price Database, which harmonises quarterly statistics on domestic house prices collected by the US Federal Housing Finance Agency and the German Bundesbank.

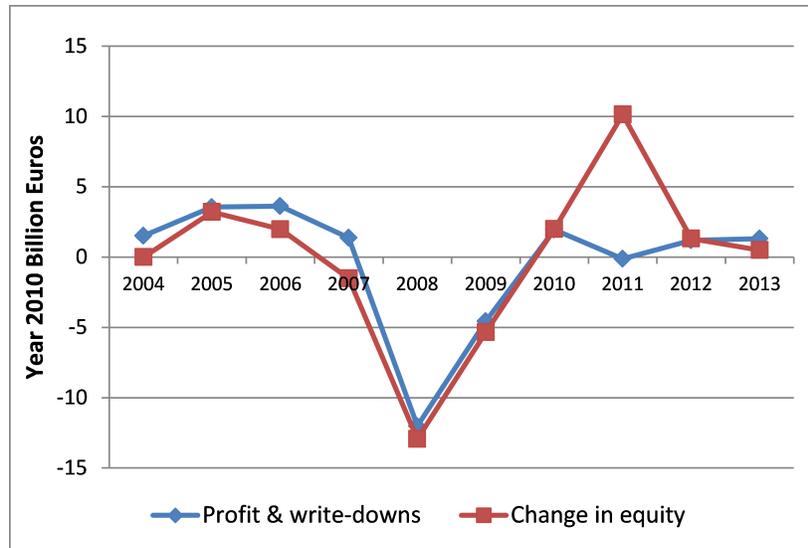


Figure 6: Commerzbank's profits, write-downs and equity

Notes: The data are from the annual reports of Commerzbank, Eurohypo, Dresdner Bank, and the Bundesbank. I aggregate the positions of Commerzbank and Dresdner Bank for the years before the 2009 take-over. Profit is the after-tax profit. Write-downs include changes in revaluation reserve, changes arising from cash flow hedges and changes in currency reserve. The monetary values are in year 2010 billion Euros.

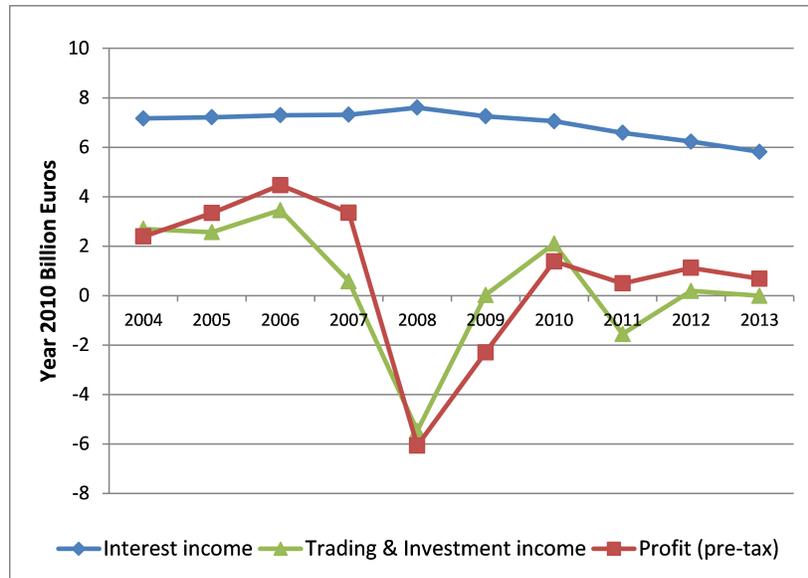


Figure 7: Components of Commerzbank's income

Notes: The data are from the annual reports of Commerzbank, Eurohypo, Dresdner Bank, and the Bundesbank. I aggregate the positions of Commerzbank and Dresdner Bank for the years before the 2009 take-over. Interest income is the profit-loss item "net interest income" (interest received from lending and securities minus interest paid on deposits). Trading & investment income is the sum of the items "net trading income and net income on hedge accounting" and "net investment income". Profit (pre-tax) is interest income plus trading & investment income minus costs. The monetary values are in year 2010 billion Euros.

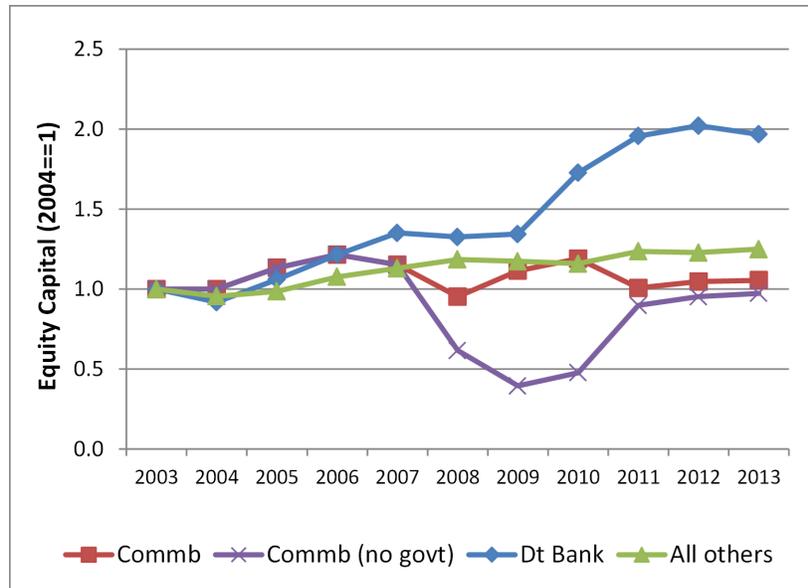


Figure 8: Equity capital for Commerzbank and other German banks

Notes: This figure plots total equity capital for Commerzbank (Commb), Commerzbank minus the capital provided by the government (Commb (no govt)), Deutsche Bank (Dt Bank), and the aggregate for all other banks. The German government's Special Financial Market Stabilization Funds Soffin supported Commerzbank twice, on 3 November 2008 and on 8 January 2009. Overall, Soffin provided Commerzbank with 18.2 billion Euros in equity and bought a 25 percent stake in the bank. The data are from the annual reports of Commerzbank, Dresdner Bank, Deutsche Bank, and the Bundesbank. I aggregate the positions of Commerzbank and Dresdner Bank for the years before the 2009 take-over.

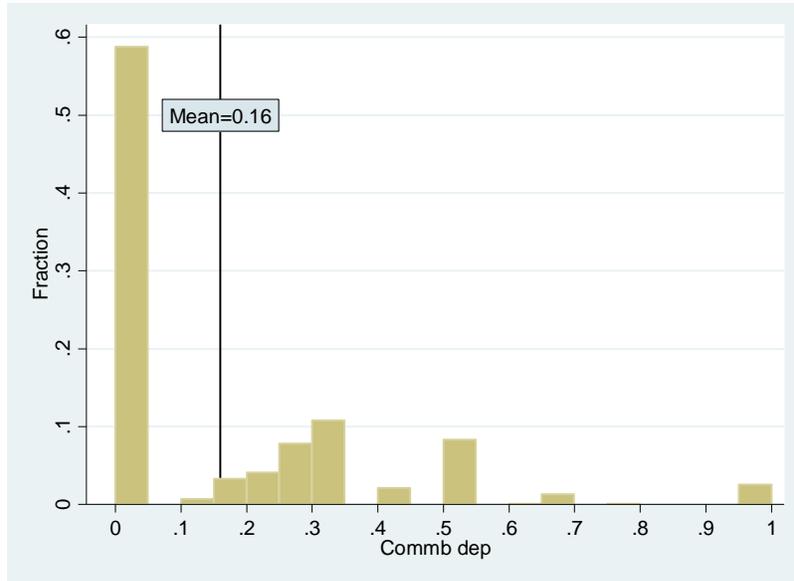


Figure 9: Commerzbank dependence in firm panel

Notes: Commb dep is the fraction of bank relationships with Commerzbank branches in the year 2006. This figure shows a histogram of Commb dep for the 2,011 firms in the firm panel.

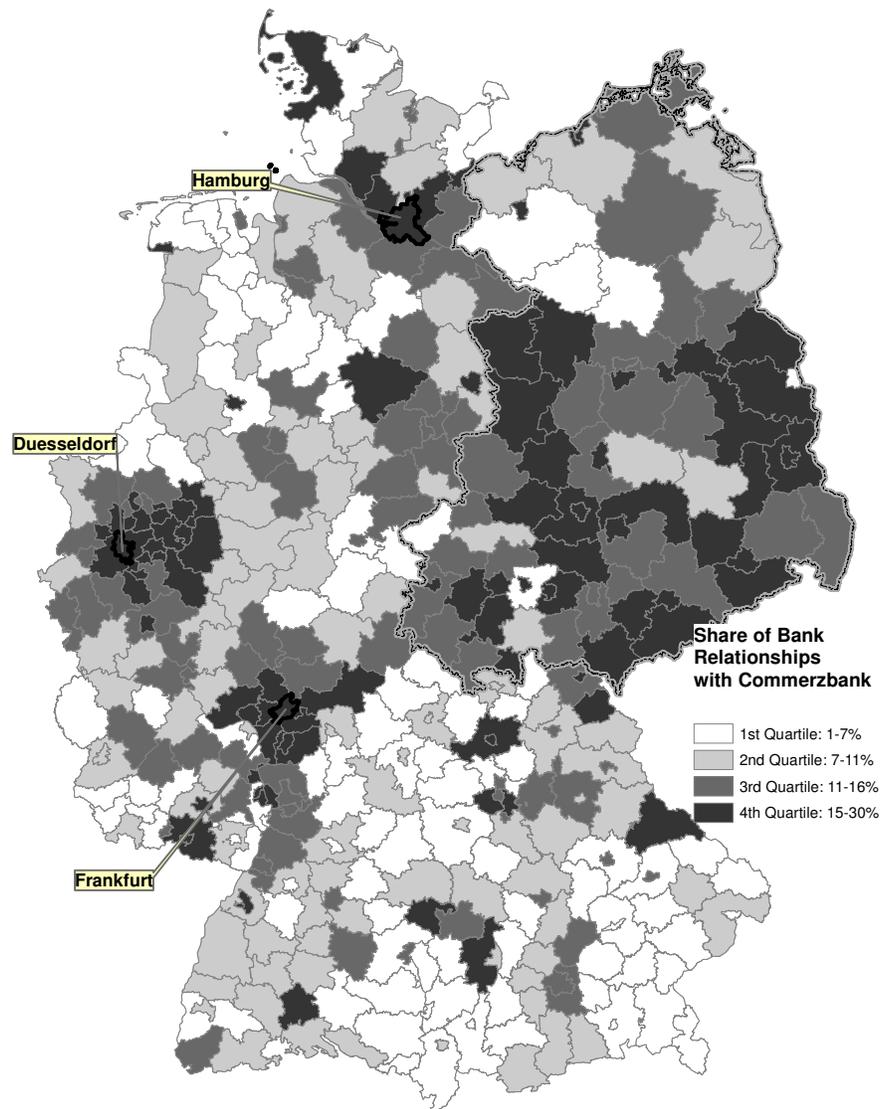


Figure 10: Commerzbank dependence across German counties in 2006

Notes: This map illustrates the Commerzbank dependence of German counties in the year 2006. I measure a county's Commerzbank dependence using a dataset of the year 2006 bank relationships of 112,344 German firms. I calculate firm Commerzbank dependence as the fraction of bank relationships with Commerzbank branches out of the firm's total number of bank relationships. Subsequently, I measure a county's Commerzbank dependence as the average of the Commerzbank dependence for firms with their head office in the county. The former GDR counties are on average more dependent on Commerzbank, because after the German reunification they were specifically targeted by Commerzbank (Klein (1993)).

## Tables

	(1)	(2)	(3)	(4)	(5)	(6)
YEAR	2011	2009	2009	2006	2006	2003
Commb dep	0.004 (0.192)	-0.324 (0.180)	-0.398 (0.192)	0.230 (0.185)	0.125 (0.217)	0.207 (0.238)
County Commb dep	-0.220 (0.963)		-0.009 (0.890)	-0.794 (0.818)	-0.603 (1.083)	-0.086 (1.383)
Lagged dep var	0.338 (0.055)	0.351 (0.045)	0.370 (0.049)		0.138 (0.061)	
Observations	856	1,031	1,031	1,031	641	641
Industry FE	Yes	No	Yes	Yes	Yes	Yes
State FE	Yes	No	Yes	Yes	Yes	Yes
Size Bin FE	Yes	No	Yes	Yes	Yes	Yes
ln age	Yes	No	Yes	Yes	Yes	Yes

Table 1: Firm survey on banks' willingness to grant loans

Notes: This table reports estimates from OLS cross-sectional firm regressions for different years, using data from the confidential ifo Business Expectations Panel. Commb dep is the fraction of bank relationships with Commerzbank branches in 2006. County Commb dep is the average of Commb dep over all firms in the county. The outcome variable is the answer to the question: "How do you evaluate the current willingness of banks to grant loans to businesses: cooperative, normal or restrictive?" It is standardised to have zero mean and unit variance. The coefficients are interpreted as the standard deviation increase in banks' willingness to grant loans from increasing the regressor by one. The control variables include fixed effects for 36 industries, 16 federal states, 4 size bins (1-49, 50-249, 250-999, and over 1000 employees in the year 2006), and the ln of the firm's age. Standard errors are clustered at the level of the county.

	(1)	(2)	(3)	(4)	(5)	(6)
YEAR	2011	2009	2009	2006	2006	2003
Commb dep	0.237 (0.179)	0.018 (0.140)	-0.089 (0.144)	0.082 (0.192)	0.180 (0.188)	-0.190 (0.237)
County Commb dep	-1.022 (0.895)		-0.500 (0.660)	1.664 (0.958)	1.590 (0.840)	1.570 (1.068)
Lagged dep var	0.531 (0.049)	0.405 (0.030)	0.388 (0.034)		0.475 (0.047)	
Observations	856	1,031	1,031	1,031	755	755
Industry FE	Yes	No	Yes	Yes	Yes	Yes
State FE	Yes	No	Yes	Yes	Yes	Yes
Size Bin FE	Yes	No	Yes	Yes	Yes	Yes
ln age	Yes	No	Yes	Yes	Yes	Yes

Table 2: Firm survey on demand constraints

Notes: This table reports estimates from OLS cross-sectional firm regressions for different years, using data from the confidential ifo Business Expectations Panel. Commb dep is the fraction of bank relationships with Commerzbank branches in 2006. County Commb dep is the average of Commb dep over all firms in the county. The outcome variable is the answer to the question: “Are your business activities constrained by low demand or too few orders: yes (1) or no(0)?” It is standardised to have zero mean and unit variance. The coefficients are interpreted as the standard deviation increase in demand constraints from increasing the regressor by one. The control variables include fixed effects for 36 industries, 16 federal states, 4 size bins (1-49, 50-249, 250-999, and over 1000 employees in the year 2006), and the ln of the firm’s age. Standard errors are clustered at the level of the county.

VARIABLES	(1)	(2)	(3)
Commb dep*d(2003)	0.101 (0.038)	0.101 (0.045)	0.099 (0.041)
Commb dep	-0.011 (0.014)	-0.012 (0.014)	
Observations	3,080	3,080	3,080
County FE	No	No	Yes
Year FE	Yes	Yes	Yes
Former GDR FE*d(2003)	Yes	Yes	Yes
Industry Shares*d(2003)	Yes	Yes	Yes
Population*d(2003)	No	Yes	Yes
Pop density*d(2003)	No	Yes	Yes
GDP per capita*d(2003)	No	Yes	Yes
Debt Index*d(2003)	No	Yes	Yes
Former GDR FE*d(2004-2008)	Yes	Yes	Yes
Industry Shares*d(2004-2008)	Yes	Yes	Yes
Population*d(2004-2008)	No	Yes	Yes
Pop density*d(2004-2008)	No	Yes	Yes
GDP per capita*d(2004-2008)	No	Yes	Yes
Debt Index*d(2004-2008)	No	Yes	Yes
Estimator	OLS	OLS	OLS
Number of counties	385	385	385

Table 3: County GDP growth rate and Commerzbank dependence (2000-2008)

Notes: This table uses data from 2000 to 2008 to test whether Commerzbank dependence was associated with differences in county GDP growth rates before the Commerzbank lending cut. The table reports estimates from county panel OLS regressions of the ln GDP growth rate on two regressors of interest. The first is Commerzbank dependence (Commb dep). The second is Commb dep interacted with d(2003), a dummy for the recession year 2003. Commb dep is the average fraction of bank relationships with Commerzbank branches for firms in the county in 2006. d(2004-2008) is a dummy for the years 2004-2008. The following time-invariant controls are separately interacted with d(2003) and d(2004-2008). The industry shares are 17 variables, giving the fraction of firms for each of the 17 industries in 2006 (agriculture, mining, manufacturing, utilities, recycling, construction, retail trade and vehicle repairs, transportation and storage, hospitality, information, finance, real estate, business services, other services, public sector, education, health). Population density, total population (in ln) and GDP per capita (in ln) are from 2000. Debt index is a 2003 measure of county household debt, calculated by credit rating agency Schufa. The regressions are weighted by year 2000 population. Standard errors are two-way clustered at the level of the county's industrial production share (share out of GDP of agriculture, mining, manufacturing, utilities, recycling, construction), and its population size, each split into 42 quantile bins.

VARIABLES	(1) 1948-1970	(2) 1948-1970	(3) 1948-1970	(4) 1925-1948	(5) Pre-1925
Commb min dist instrument	-0.094 (0.031)	-0.090 (0.032)	-0.077 (0.033)	-0.021 (0.020)	-0.010 (0.017)
Observations	324	324	324	324	324
Zonal FE	Yes	Yes	Yes	Yes	Yes
Urban FE	No	Yes	Yes	Yes	Yes
Ln population	No	No	Yes	Yes	Yes
Population density	No	No	Yes	Yes	Yes
Estimator	OLS	OLS	OLS	OLS	OLS

Table 4: Establishment of Commerzbank branches in West Germany

Notes: This table reports estimates from regressions using a cross-section of West German counties. The data are hand-collected from the historic annual reports of Commerzbank. The outcome variable is a dummy for whether Commerzbank established a branch in the county during the respective period given in the column title. The regressor of interest is Commb min dist instrument, which is the county's kilometre distance to the closest historic Commerzbank head office, scaled by 100 kilometres. Commb min dist instrument is equivalent to the minimum of the distances to Duesseldorf, Frankfurt, and Hamburg. The zonal fixed effects are dummies for the three historic banking zones of North Rhine-Westphalia, Northern and Southern Germany. The urban fixed effect is a dummy for counties with a year 2000 population density greater than 1,000 inhabitants per square kilometre. The ln population and population density are continuous variables from the year 2000. Standard errors are robust.

	mean	sd	p5	p50	p95
Commb dep	0.16	0.23	0.00	0.00	0.50
DtB dep	0.10	0.18	0.00	0.00	0.50
Employment	915.90	10351.53	20.00	137.00	2156.00
Capital	28753.91	50494.57	248.31	5874.58	195033.05
Investment rate	0.27	0.36	-0.01	0.14	1.05
Wage	30.57	11.66	15.82	29.63	46.55
Export share	11.02	21.31	0.00	0.00	64.00
Import share	5.24	16.73	0.00	0.00	40.00
Age	47.60	45.90	13.00	31.00	126.00
No of bank relationships	3.00	1.54	1.00	3.00	6.00
Depreciation rate	0.18	0.12	0.03	0.14	0.46
Bank debt/liabilities	0.49	0.25	0.05	0.50	0.89
Liabilities/assets	0.66	0.20	0.26	0.68	0.98
Percent going insolvent 2006-2012	0.80	8.89	0.00	0.00	0.00
Observations	2011				

Table 5: Summary statistics for the firm panel dataset

Notes: Monetary values are in year 2000 thousands of Euros. The data are from the balance sheet database Dafne and a confidential record of firm-bank relationships. Commb dep is the fraction of the firm's bank relationships that are with Commerzbank branches in 2006, and DtB the fraction that are with Deutsche Bank. I average the balance sheet variables for the year 2007 across firms. Capital is the book value of fixed tangible assets. The investment rate is total capital expenditure divided by the capital stock at the end of the previous year. (The data start in 2006. Hence the lagged capital stock is unavailable for 2006 and the table uses values from 2007). The wage is the total wage bill divided by the number of employees. The export share is the percentage of exports out of total revenue, and the import share is the percentage of imports out of total costs. The depreciation rate is the book value of total depreciation of fixed tangible assets divided by the capital stock at the end of the previous year. Insolvency is recorded as a dummy variable for whether the firm went insolvent during the period 2006 to 2012.

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VARIABLES	
Ln age	-0.013 (0.009)
Ln value added	0.025 (0.016)
Ln capital	-0.014 (0.007)
Inv rate	0.012 (0.014)
Ln employment	0.008 (0.013)
Ln bank debt	0.005 (0.005)
Observations	2,011
Industry FE	Yes
County FE	Yes
Estimator	OLS

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Table 6: Commerzbank dependence and firm outcome levels in 2007

Notes: This table reports estimates from a cross-sectional firm regression of *Commdb dep* on firm variables from the year 2007. *Commdb dep* is the fraction of the firm's bank relationships that are with Commerzbank branches in 2006. Capital is the book value of fixed tangible assets. The investment rate is total capital expenditure divided by the capital stock at the end of the previous year. (The data start in 2006. Hence the lagged capital stock is unavailable for 2006 and the regressions uses values from 2007.) The regression includes fixed effects for 70 industries and 357 counties. Standard errors are two-way clustered at the level of the county and the industry.

	mean	sd	p5	p50	p95
Commb dep	0.12	0.06	0.04	0.11	0.23
DtB dep	0.08	0.05	0.01	0.07	0.17
2000 GDP (in year 2010 bn Euro)	6.01	9.12	1.46	3.63	14.31
2000 Population (in 1000s)	203.28	229.39	52.68	147.12	487.13
2000 Employment (in 1000s)	98.27	126.49	29.90	64.50	220.40
Former GDR	0.16	0.37	0	0	1
Ruhr region	0.04	0.19	0	0	0
Landesbank in crisis	0.67	0.47	0	1	1
Commb min dist instrument	1.63	0.97	0.28	1.51	3.43
GDP Growth 2008-2012 (in percent)	2.66	6.18	-7.25	2.73	11.76
Population Growth 2008-2012 (in percent)	-1.99	2.51	-6.16	-1.84	2.48
Employment Growth 2008-2012 (in percent)	2.79	3.22	-1.98	2.77	7.21
Observations	385				

Table 7: Summary statistics for the county dataset

Notes: The data are from the Federal Statistical Office of Germany and a confidential record of firm-bank relationships. Commb (DtB) dep is the average fraction of bank relationships with Commerzbank (Deutsche Bank) branches for firms in the county in 2006. Commb min dist instrument is the county's kilometre distance to the closest historic Commerzbank head office, scaled by 100 kilometres. Commb min dist instrument is equivalent to the minimum of the distances to Duesseldorf, Frankfurt, and Hamburg. Landesbank in crisis is a dummy for whether the county's Landesbank received public funding during the financial crisis. Ruhr region is a dummy for the 15 counties of the Ruhr.

VARIABLES	(1)	(2)	(3)
Commb min dist instrument	-0.020 (0.003)	-0.047 (0.008)	-0.032 (0.006)
Observations	385	385	385
Former GDR FE	Yes	Yes	Yes
Linear distances	No	Yes	Yes
Industry Shares	No	No	Yes
Population	No	No	Yes
Pop density	No	No	Yes
GDP per capita	No	No	Yes
Debt Index	No	No	Yes
Export and Import Shares	No	No	Yes
Landesbank in crisis	No	No	Yes
Estimator	OLS	OLS	OLS

Table 8: Commerzbank dependence and the minimum distance instrument

Notes: This table reports estimates from cross-county OLS regressions of Commerzbank dependence (Commb dep) on the minimum distance instrument. Commb dep is the average fraction of bank relationships with Commerzbank branches for firms in the county in 2006. The instrument is the county's distance to the closest historic Commerzbank head office, which is equivalent to the minimum out of the kilometre distances to Duesseldorf, Frankfurt, and Hamburg, scaled by 100 kilometres. This regressions is equivalent to the first-stage of the IV estimation. The second stage is estimated using a panel and therefore interacts Commerzbank dependence and the instrument with a dummy for the years 2009-2012. The industry shares are 17 variables, giving the fraction of firms for each of the 17 industries in 2006 (agriculture, mining, manufacturing, utilities, recycling, construction, retail trade and vehicle repairs, transportation and storage, hospitality, information, finance, real estate, business services, other services, public sector, education, health). Population density, total population (in ln) and GDP per capita (in ln) are from 2000. Debt index is a 2003 measure of county household debt, calculated by credit rating agency Schufa. The export share is the fraction of exports out of total revenue and the import share is the fraction of imports out of total costs, both averaged across firms in the county for 2006. Landesbank in crisis is a dummy for whether the county's Landesbank received public funding during the financial crisis. The linear distances include the county's distances to Duesseldorf, Frankfurt, Hamburg, Berlin, and Dresden. The regressions are weighted by year 2000 population. Standard errors are two-way clustered at the level of the county's industrial production share (share out of GDP of agriculture, mining, manufacturing, utilities, recycling, construction) and its population size, each split into 42 quantile bins.

VARIABLES	(1)	(2)	(3)	(4)
Commb dep*d	-0.171 (0.051)	-0.167 (0.065)	-0.141 (0.070)	-0.141 (0.064)
Observations	5,005	5,005	5,005	5,005
Number of counties	385	385	385	385
County FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Former GDR FE*d	Yes	Yes	Yes	Yes
Industry Shares*d	No	Yes	Yes	Yes
Population*d	No	No	Yes	Yes
Pop density*d	No	No	Yes	Yes
GDP per capita*d	No	No	Yes	Yes
Debt Index*d	No	No	Yes	Yes
Export and Import Shares*d	No	No	No	Yes
Landesbank in crisis*d	No	No	No	Yes
Estimator	OLS	OLS	OLS	OLS

Table 9: County ln GDP and Commerzbank dependence (OLS)

Notes: This table reports estimates from county panel OLS regressions of ln GDP on Commerzbank dependence (Commb dep) interacted with d, a dummy for the years following the lending cut, 2009 to 2012. Commb dep is the average fraction of bank relationships with Commerzbank branches for firms in the county in 2006. The time-invariant controls are also interacted with d. The industry shares are 17 variables, giving the fraction of firms for each of the 17 industries in 2006 (agriculture, mining, manufacturing, utilities, recycling, construction, retail trade and vehicle repairs, transportation and storage, hospitality, information, finance, real estate, business services, other services, public sector, education, health). Population density, total population (in ln) and GDP per capita (in ln) are from 2000. Debt index is a 2003 measure of county household debt, calculated by credit rating agency Schufa. The export share is the fraction of exports out of total revenue and the import share is the fraction of imports out of total costs, both averaged across firms in the county for 2006. Landesbank in crisis is a dummy for whether the county's Landesbank received public funding during the financial crisis. The regressions are weighted by year 2000 population. Standard errors are two-way clustered at the level of the county's industrial production share (share out of GDP of agriculture, mining, manufacturing, utilities, recycling, construction) and its population size, each split into 42 quantile bins.

VARIABLES	(1)	(2)	(3)	(4)
Commb dep*d	-0.335 (0.106)	-0.378 (0.178)	-0.355 (0.178)	-0.345 (0.179)
Observations	5,005	5,005	5,005	5,005
Number of counties	385	385	385	385
County FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Former GDR FE*d	Yes	Yes	Yes	Yes
Linear Distances*d	Yes	Yes	Yes	Yes
Industry Shares*d	No	Yes	Yes	Yes
Population*d	No	No	Yes	Yes
Pop density*d	No	No	Yes	Yes
GDP per capita*d	No	No	Yes	Yes
Debt Index*d	No	No	Yes	Yes
Export and Import Shares*d	No	No	No	Yes
Landesbank in crisis*d	No	No	No	Yes
Estimator	IV	IV	IV	IV

Table 10: County ln GDP and Commerzbank dependence (IV)

Notes: This table reports estimates from county panel IV regressions of ln GDP on Commerzbank dependence (Commb dep) interacted with d, a dummy for the years following the lending cut, 2009 to 2012. Commb dep is the average fraction of bank relationships with Commerzbank branches for firms in the county in 2006. The instrument for Commb dep is the county's distance to the closest historic Commerzbank head office, interacted with d. This distance is equivalent to the minimum out of the distances to Duesseldorf, Frankfurt, and Hamburg. The time-invariant controls are also interacted with d. The industry shares are 17 variables, giving the fraction of firms for each of the 17 industries in 2006 (agriculture, mining, manufacturing, utilities, recycling, construction, retail trade and vehicle repairs, transportation and storage, hospitality, information, finance, real estate, business services, other services, public sector, education, health). Population density, total population (in ln) and GDP per capita (in ln) are from 2000. Debt index is a 2003 measure of county household debt, calculated by credit rating agency Schufa. The export share is the fraction of exports out of total revenue and the import share is the fraction of imports out of total costs, both averaged across firms in the county for 2006. Landesbank in crisis is a dummy for whether the county's Landesbank received public funding during the financial crisis. The linear distances include the county's distances to Duesseldorf, Frankfurt, Hamburg, Berlin, and Dresden. The regressions are weighted by year 2000 population. Standard errors are two-way clustered at the level of the county's industrial production share (share out of GDP of agriculture, mining, manufacturing, utilities, recycling, construction) and its population size, each split into 42 quantile bins.

VARIABLES	(1)	(2)	(3)	(4)
Commb dep*d	-0.136 (0.041)	-0.125 (0.047)	-0.127 (0.043)	-0.192 (0.092)
Observations	5,005	5,005	5,005	5,005
Number of counties	385	385	385	385
County FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Former GDR FE*d	Yes	Yes	Yes	Yes
Linear distances*d	No	No	No	Yes
Industry Shares*d	Yes	Yes	Yes	Yes
Population*d	No	Yes	Yes	No
Pop density*d	No	Yes	Yes	No
GDP per capita*d	No	Yes	Yes	No
Debt Index*d	No	Yes	Yes	No
Export and Import Shares*d	No	No	Yes	No
Landesbank in crisis*d	No	No	Yes	No
Estimator	OLS	OLS	OLS	IV

Table 11: County ln employment and Commerzbank dependence (OLS & IV)

Notes: This table reports estimates from county panel regressions of ln employment on Commb dep interacted with d, a dummy for the years following the lending cut, 2009 to 2012. Commb dep is the average fraction of bank relationships with Commerzbank branches for firms in the county in 2006. For the IV regressions, the instrument for Commb dep is the county's distance to the closest historic Commerzbank head office, interacted with d. This distance is equivalent to the minimum out of the distances to Duesseldorf, Frankfurt, and Hamburg. The time-invariant controls are also interacted with d. The industry shares are 17 variables, giving the fraction of firms for each of the 17 industries in 2006 (agriculture, mining, manufacturing, utilities, recycling, construction, retail trade and vehicle repairs, transportation and storage, hospitality, information, finance, real estate, business services, other services, public sector, education, health). Population density, total population (in ln) and GDP per capita (in ln) are from 2000. Debt index is a 2003 measure of county household debt, calculated by credit rating agency Schufa. The export share is the fraction of exports out of total revenue and the import share is the fraction of imports out of total costs, both averaged across firms in the county for 2006. Landesbank in crisis is a dummy for whether the county's Landesbank received public funding during the financial crisis. The linear distances include the county's distances to Duesseldorf, Frankfurt, Hamburg, Berlin, and Dresden. Standard errors are two-way clustered at the level of the county's industrial production share (share out of GDP of agriculture, mining, manufacturing, utilities, recycling, construction) and its population size, each split into 42 quantile bins.

VARIABLES	(1) DtB First Stage	(2) DtB IV	(3) Ruhr Dummy	(4) Bav Dummy	(5) BW Dummy	(6) NRW Dummy
DtB instrument*d	-0.014 (0.002)					
DtB dep*d		0.302 (0.374)				
Commb dep*d			-0.375 (0.179)	-0.345 (0.181)	-0.358 (0.176)	-0.460 (0.204)
Observations	5,005	5,005	5,005	5,005	5,005	5,005
Number of counties	385	385	385	385	385	385
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls*d	Yes	Yes	Yes	Yes	Yes	Yes
Linear distances*d	Yes	Yes	Yes	Yes	Yes	Yes
Ruhr region*d	Yes	Yes	Yes	No	No	No
Bavaria*d	No	No	No	Yes	No	No
BW*d	No	No	No	No	Yes	No
NRW*d	No	No	No	No	No	Yes
Estimator	OLS	IV	IV	IV	IV	IV

Table 12: Further specifications for county ln GDP

Notes: Commb (DtB) dep is the average fraction of bank relationships with Commerzbank (Deutsche Bank) branches for firms in the county in 2006. The instrument for Commb dep (DtB dep) is the county's distance to the closest historic Commerzbank (Deutsche Bank) head office, interacted with d, a dummy for the years following the lending cut, 2009 to 2012. This distance is equivalent to the minimum out of the distances to Duesseldorf, Frankfurt, and Hamburg for Commerzbank (Duesseldorf, Munich, and Hamburg for Deutsche Bank). All regressions include the full set of control variables. Columns (1) and (2) report the results of a placebo experiment, which estimates the effect of DtB dep on ln GDP. The first stage is reported in column (1), the second stage in column (2). The linear distances in column (1) and (2) include the county's distances to Duesseldorf, Munich, Hamburg, Berlin, and Dresden. Columns (3) to (6) estimate the effect of Commerzbank dependence, interacted with d, on ln GDP. Columns (3) to (6) include dummies, interacted with d, for the Ruhr region, Bavaria, Baden-Wuerttemberg, and North Rhine-Westphalia, respectively. The linear distances in column (3) to (6) include the county's distances to Duesseldorf, Frankfurt, Hamburg, Berlin, and Dresden. The regressions are weighted by year 2000 population. Standard errors are two-way clustered at the level of the county's industrial production share (share out of GDP of agriculture, mining, manufacturing, utilities, recycling, construction) and its population size, each split into 42 quantile bins.

VARIABLES	(1)	(2)	(3)	(4)
Commb dep*d	-0.044 (0.021)	-0.049 (0.021)	-0.052 (0.015)	-0.053 (0.015)
Observations	12,066	12,066	12,066	12,066
Number of firms	2,011	2,011	2,011	2,011
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Ln age*d	No	Yes	Yes	Yes
Size Bin FE*d	No	Yes	Yes	Yes
Industry FE*d	No	No	Yes	Yes
County FE*d	No	No	Yes	Yes
Import and Export Share*d	No	No	No	Yes
Estimator	OLS	OLS	OLS	OLS

Table 13: Firm employment

Notes: This table reports estimates from firm panel regressions. All regressions include firm and year fixed effects. The outcome in all columns is firm ln employment. Commb dep\*d is the fraction of bank relationships with Commerzbank branches in 2006, interacted with d, a dummy for the years following the lending cut, 2009 to 2012. The following time-invariant control variables are calculated for the year 2006 and interacted with d: fixed effects for 70 industries, 357 counties, and 4 firm size bins (1-49, 50-249, 250-999, and over 1000 employees); the ln of the firm's age; the export share is the fraction of exports out of total revenue; and the import share is the fraction of imports out of total costs. Standard errors are two-way clustered at the level of the county and the industry.

VARIABLES	(1)	(2)	(3)	(4)
	ln bank debt	inv rate	ln capital	ln capital/emp
Commb dep*d	-0.205 (0.078)	-0.043 (0.029)	-0.130 (0.038)	-0.077 (0.032)
Observations	12,066	12,066	12,066	12,066
Number of firms	2,011	2,011	2,011	2,011
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Ln age*d	Yes	Yes	Yes	Yes
Size Bin FE*d	Yes	Yes	Yes	Yes
Industry FE*d	Yes	Yes	Yes	Yes
County FE*d	Yes	Yes	Yes	Yes
Import and Export Share*d	Yes	Yes	Yes	Yes
Estimator	OLS	OLS	OLS	OLS

Table 14: Firm bank debt and capital

Notes: This table reports estimates from firm panel regressions. All regressions include firm and year fixed effects. The respective outcome variable is given in the column title. Except for the investment rate (inv rate), outcomes are in ln. Bank debt is liabilities owed to credit institutions. Capital is the book value of fixed tangible assets. The investment rate is total capital expenditure divided by the capital stock at the end of the previous year. Capital/emp is the capital-labour ratio. Commb dep\*d is the fraction of bank relationships with Commerzbank branches in 2006, interacted with d, a dummy for the years following the lending cut, 2009 to 2012. The following time-invariant control variables are calculated for the year 2006 and interacted with d: fixed effects for 70 industries, 357 counties, and 4 firm size bins (1-49, 50-249, 250-999, and over 1000 employees); the ln of the firm's age; the export share is the fraction of exports out of total revenue; and the import share is the fraction of imports out of total costs. Standard errors are two-way clustered at the level of the county and the industry.

VARIABLES	(1) ln val add	(2) ln val add/capital	(3) ln val add/emp	(4) ln wage
Commb dep*d	-0.061 (0.028)	0.069 (0.038)	-0.008 (0.024)	0.001 (0.011)
Observations	12,066	12,066	12,066	12,066
Number of firms	2,011	2,011	2,011	2,011
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Ln age*d	Yes	Yes	Yes	Yes
Size Bin FE*d	Yes	Yes	Yes	Yes
Industry FE*d	Yes	Yes	Yes	Yes
County FE*d	Yes	Yes	Yes	Yes
Import and Export Share*d	Yes	Yes	Yes	Yes
Estimator	OLS	OLS	OLS	OLS

Table 15: Firm value added

Notes: This table reports estimates from firm panel regressions. All regressions include firm and year fixed effects. The ln outcomes are given in the column title. Value added (val add) is revenue minus expenditure on intermediates. Value added per worker (val add/emp) and per unit of capital (val add/cap) can be interpreted as labour and capital productivity. The wage is the total wage bill divided by the number of employees. Commb dep\*d is the fraction of bank relationships with Commerzbank branches in 2006, interacted with d, a dummy for the years following the lending cut, 2009 to 2012. The following time-invariant control variables are calculated for the year 2006 and interacted with d: fixed effects for 70 industries, 357 counties, and 4 firm size bins (1-49, 50-249, 250-999, and over 1000 employees); the ln of the firm's age; the export share is the fraction of exports out of total revenue; and the import share is the fraction of imports out of total costs. Standard errors are two-way clustered at the level of the county and the industry.

VARIABLES	(1) ln emp	(2) ln capital
ln bank debt	0.260 (0.083)	0.635 (0.244)
Observations	12,066	12,066
Number of firms	2,011	2,011
Firm FE	Yes	Yes
Year FE	Yes	Yes
Ln age*d	Yes	Yes
Size Bin FE*d	Yes	Yes
Industry FE*d	Yes	Yes
County FE*d	Yes	Yes
Import and Export Share*d	Yes	Yes
Estimator	IV	IV

Table 16: Firm IV

Notes: This table reports estimates from firm panel IV regressions. All regressions include firm and year fixed effects. The outcome variables are the firm's ln employment and ln capital. Capital is the book value of fixed tangible assets. The endogenous regressor is the firm's ln bank debt. The instrument is  $\text{Commb dep}^*d$ , i.e. the fraction of the firm's bank relationships that are with Commerzbank branches in 2006, interacted with  $d$ , a dummy for the years following the lending cut, 2009 to 2012. The following time-invariant control variables are calculated for the year 2006 and interacted with  $d$ : fixed effects for 70 industries, 357 counties, and 4 firm size bins (1-49, 50-249, 250-999, and over 1000 employees); the ln of the firm's age; the export share is the fraction of exports out of total revenue; and the import share is the fraction of imports out of total costs. Standard errors are two-way clustered at the level of the county and the industry.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	ln capital	ln emp				
Commb dep*d	-0.110	-0.048	-0.051			-0.052
	(0.039)	(0.014)	(0.015)			(0.013)
Commb dep*d(2011/12)	-0.041	-0.010				
	(0.032)	(0.019)				
DtB dep*d			0.023			
			(0.031)			
Low bank debt dep*Commb dep*d				-0.035		
				(0.032)		
High bank debt dep*Commb dep*d				-0.071		
				(0.020)		
Low Commb dep*d					0.007	
					(0.016)	
Medium Commb dep*d					-0.017	
					(0.008)	
High Commb dep*d					-0.065	
					(0.018)	
Large firm*Commb dep*d						-0.014
						(0.092)
Observations	12,066	12,066	12,066	12,066	12,066	12,066
Number of firms	2,011	2,011	2,011	2,011	2,011	2,011
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Ln age*d	Yes	Yes	Yes	Yes	Yes	Yes
Size Bin FE*d	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE*d	Yes	Yes	Yes	Yes	Yes	Yes
County FE*d	Yes	Yes	Yes	Yes	Yes	Yes
Import and Export Share*d	Yes	Yes	Yes	Yes	Yes	Yes
Estimator	OLS	OLS	OLS	OLS	OLS	OLS

Table 17: Further firm specifications

Notes: This table reports estimates from firm panel regressions. All regressions include firm and year fixed effects. The ln outcomes are given in the column title. Capital is the book value of fixed tangible assets, emp is employment. Commb dep\*d is the fraction of bank relationships with Commerzbank branches in 2006, interacted with d, a dummy for the years following the lending cut, 2009 to 2012. Commb dep\*d(2011/12) interacts Comm dep with a dummy for the years 2011 and 2012. This tests for a differential effect of Commerzbank dependence in the years 2011 and 2012. DtB dep is the fraction of bank relationships with Deutsche Bank branches in 2006. Firms with “low bank debt dep” have up to 50 percent of their liabilities in bank debt; for firms with “high bank debt dep” it is over 50 percent. Firms with “low Commb dep” have 1-25 percent of their bank relationships with Commerzbank; “medium Commb dep” is 26-50 percent; “high Commb dep” is over 50 percent. Large firms have over 1500 employees. The following time-invariant control variables are calculated for the year 2006 and interacted with d: fixed effects for 70 industries, 357 counties, and 4 firm size bins (1-49, 50-249, 250-999, and over 1000 employees); the ln of the firm’s age; the export share is the fraction of exports out of total revenue; and the import share is the fraction of imports out of total costs. Standard errors are two-way clustered at the level of the county and the industry.

Row	Estimate Used	$\Delta(\cdot, \textit{point estimate})$	$\Delta(\cdot, \textit{lower})$	$\Delta(\cdot, \textit{upper})$
1	Partial Equilibrium	-0.82 percent	-0.36 percent	-1.29 percent
2	County OLS	-1.49 percent	-0.52 percent	-2.47 percent
3	County IV	-2.26 percent	-0.14 percent	-4.39 percent

Table 18: The effect of the lending cut on 2012 aggregate employment

Notes: This table reports calculations on the effect of the Commerzbank lending cut on aggregate employment in Germany in 2012. Section 8 describes the calculation exercise in detail. Row 1 assumes that only the partial equilibrium effects of a lending cut, based on the firm estimates, affect aggregate employment. Rows 2 and 3 calculate the aggregate employment effect using the county estimates. The column  $\Delta(\cdot, \textit{point estimate})$  uses the respective point estimate for the calculations, while the columns  $\Delta(\cdot, \textit{lower})$  and  $\Delta(\cdot, \textit{upper})$  use the lower and upper bounds of the 95 percent confidence intervals of the estimate.