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# How Large was the Credit Crunch in the OECD?

Michiel Bijlsma
Andrei Dubovik
Bas Straathof

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Michiel Bijlsma [a,b] Andrei Dubovik [a,c] Bas Straathof [a]

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**Abstract**

Reduced credit supply in the years 2008 and 2009 should have resulted in lower growth in industries that are more dependent on external finance. This effect should have been stronger in countries with a more prominent and/or more leveraged financial system. We focus on the OECD countries and, controlling for omitted variables, find robust empirical support for both hypotheses. We estimate that the credit crunch reduced the industrial growth rate by 5.5 percentage points in 2008 and by 21 percentage points in 2009.

**Key Words:** financial crises, industrial growth, lending channels.

**JEL Classification:** G01, O43.

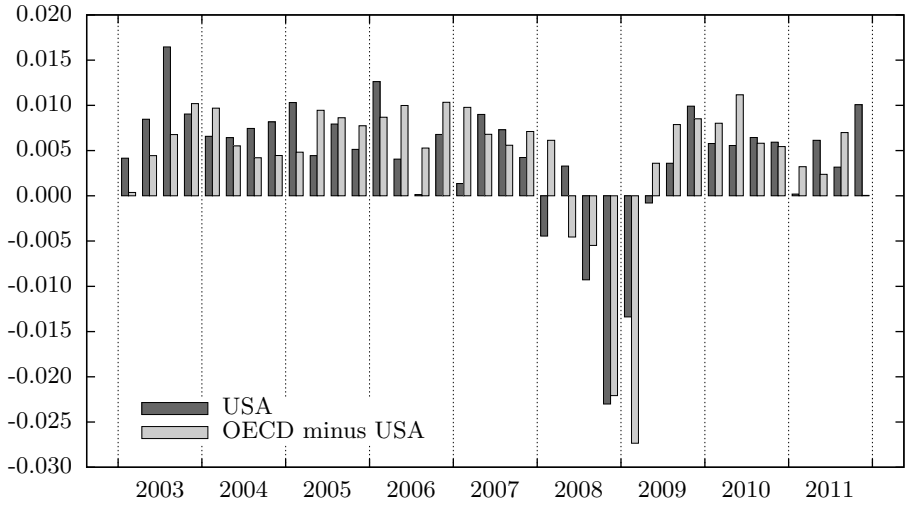
## 1 Introduction

The primary role of the banking sector is efficient transformation of savings into investments. Successful investments build up the capital in the economy and foster future growth. While banks are not the only institutions for financial intermediation, they have come to play a dominant role in the developed world. Consequently, disruptions of the global banking system—like the 2007–2008 financial crisis—bear significant negative impacts on the economy.

The crisis of 2007-2008 started with an increase in foreclosure rates in the US housing market (see, e.g., Brunnermeier, 2009). Higher foreclosure rates raised concerns about banks' health worldwide, because the underlying mortgages had been packaged and sold to international banks (mainly in developed countries). Following the failure of Lehman Brothers, these concerns developed in to a banking panic in which private financiers, e.g. mutual funds, withdrew their funding and the central banks stepped in to substitute for the loss of private liquidity. At the same time the United

[a]CPB Netherlands Bureau for Economic Policy Analysis.
[b]TILEC, Tilburg University.
[c]Corresponding author. Email: a.a.dubovik@cpb.nl.

Figure 1: Quarterly Growth of Real GDP




Source: authors' own calculations based on OECD National Accounts Statistics.

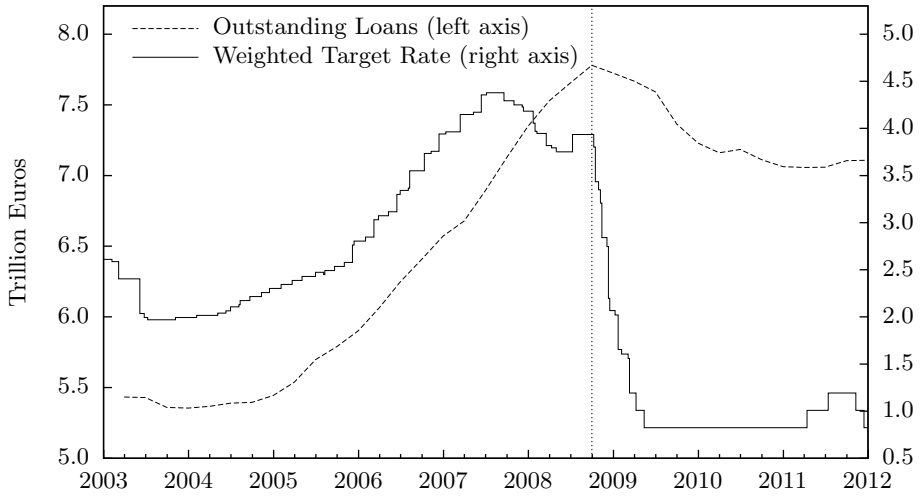
States, closely followed by the rest of the OECD countries, experienced large negative growth rates (Fig. 1).

Banking credit to non-financial sectors also started to contract by the end of 2008. Fig. 2 shows the volume of outstanding loans together with the mean target interest rate of the major central banks. The observed contraction in loans could have taken place either due to banks withholding further credit—a credit supply shock—or due to firms asking for less financing, because the unfolding crisis meant lower expectations for future growth—a credit demand shock. Whether there really was a credit supply shock and, if so, whether it hindered economic growth, are our primary research questions.

A credit supply shock increases the spread between external and internal cost of financing. In turn, a relatively higher cost of external financing implies slower growth for financially dependent firms. By testing whether financially dependent firms grew slower during the crisis, we thus indirectly test for a credit supply shock. One difficulty in applying this logic lies in measuring the dependence on external finance, because most measures are endogenous with firms' performance. In this regard we adopt the measure of Rajan and Zingales (1998).

Rajan and Zingales propose to treat dependence on external finance as being in part technologically determined and, therefore, common for the same industries over time and across countries. Conditional on this assumption, data from the markets with the least financial frictions can be used to construct such a common measure of dependence on external finance. Rajan and Zingales use data on publicly traded U.S. manufacturing companies

Figure 2: Banks' Loans to Non-financial Corporations (OECD)




Source: authors' own calculations based on data from the European Central Bank, the Federal Reserve System, the Bank of England, and OECD National Accounts Statistics. The coverage is partial (but comprises more than 67% in terms of output); included countries are: AT, BE, CZ, DE, DK, ES, FI, FR, GB, HU, IE, IT, LU, NL, PT, SE, US. The target rates (ECB MRO, federal funds, base rate) are weighted by banks' loans.

for the years 1980-1989. By using Rajan and Zingales' measure, we address the issue of reverse causality, because the performance of the OECD firms during the recent crisis does not determine the use of external finance by the US industries two decades earlier.

Rajan and Zingales' measure of dependence on external finance is defined as a ratio of capital investments not financed by internal cash flows and captures the long-term dependence on external finance. We complement it by a short-term measure of liquidity needs from Raddatz (2006), which is defined as inventories over sales. We then assess, for a large subsample of the OECD countries, whether the industries that are more dependent on external finance or that have higher short-term liquidity needs were hit harder during the recent crisis.

We obtain correlations that are economically and statistically significant. An increase in dependence on external finance from its $25^{\text{th}}$ percentile to its $75^{\text{th}}$ percentile reduces production growth by an average of 1.9% per year during the crisis. An increase in liquidity needs reduces growth by an average of 3.9% per year.

A negative correlation between financial dependence and output growth during the crisis is consistent with a credit crunch. However, alternative explanations exist. For example, if high-tech industries are more financially dependent and, at the same time, experienced a larger demand shock dur-

ing the crisis due to a more elastic demand, then we would find the same correlation. To increase the power of our assessment against such alternative explanations we exploit cross-country differences in the structure of the financial system. Namely, we focus on the size of the bank and market lending channels and on the fragility of banks in terms of leverage. If there was a credit crunch, then financially dependent industries not only should have been hit harder, but they also should have been hit harder in countries, where the bank and market lending channels were more relied upon and/or were more fragile.

Indeed, we find that the industries that are more dependent on external finance were hit harder in countries where the banking system was more leveraged prior to the crisis. We further find that the industries with higher liquidity needs were hit harder in countries with more developed financial markets (as measured by total value of shares traded relative to GDP). We check if our results are driven by an influential country or an influential industry, and we find this not to be the case. In summary, we find indirect evidence that there was an increase in the wedge between the costs of external and internal financing during the recent financial crisis, i.e. that there was a credit crunch.

Having identified the channels through which the credit crunch impacted the real economy, we turn to assessing its magnitude. We compute what the growth rate would have been, had the more financially dependent industries not experienced lower growth in countries with a more fragile financial system. We estimate this rate to be around 2.4% in the years 2008–2009 (see Fig. 3). Comparing it with the observed growth rates of around $-3.1\%$ and $-18\%$ in the same years, we obtain that the credit crunch caused a 5.5% and a 21% decline respectively.[1]

The paper is organized as follows. The following Section 2 discusses the relevant literature. We outline our econometric methodology in Section 3, followed by the discussion of the data sources in Section 4. Estimation results are presented in Section 5, and robustness checks are collected in Section 6. Section 7 concludes.

## 2 Related Literature

We follow Rajan and Zingales (1998). Rajan and Zingales construct a measure of industries' financial dependence and test whether more financially dependent industries grow slower in countries with less developed financial systems. In comparison, we apply their approach to test whether financially dependent industries were hit harder during the recent financial crisis.

[1] The confidence intervals are 2.9%–8.2% and 11%–31% respectively.

Besides ours, several earlier papers also follow Rajan and Zingales' methodology: Braun and Larrain (2005), Raddatz (2006), Kroszner et al. (2007), Dell'Ariccia et al. (2008), Laeven and Valencia (2011).

Our paper is closest to Kroszner et al. (2007) and Dell'Ariccia et al. (2008), who focus on banking crises that took place between 1980 and 2000. Dell'Ariccia et al. show that banking crises cause lower growth in more financially dependent industries, they provide further evidence that this result is not due to recessions in general, or currency crises. Kroszner et al. confirm this finding and additionally show that the negative impact of banking crises on financially dependent industries is larger (worse) in more financially developed countries. Kroszner et al., as well as Dell'Ariccia et al., find no significant effects for developed countries. In comparison, we focus on the impact of the recent crisis on the OECD countries.

Braun and Larrain (2005) comprise a panel of about hundred countries spanning forty years and ask whether more financially dependent industries were hit harder during recessions. They further investigate whether the effect was aggravated in financially less developed countries, i.e. whether financial development mitigates the effect of recessions. They answer both questions in the affirmative. Their findings can be contrasted with the aforementioned results of Kroszner et al. (2007).

Raddatz (2006) develops a short-term measure of liquidity needs, as opposed to the long-term RZ measure of dependence on external finance. The author then focuses on volatility of growth and shows that the industries with higher short-term liquidity needs experienced higher growth volatilities in financially less developed countries. Raddatz also argues that the increased volatility is primarily due to the increased per-firm volatility rather than the volatility of the number of firms in an industry.

Laeven and Valencia (2011) draw on a cross section of fifty countries to assess the effectiveness of policy interventions that occurred in 2008 and 2009 in response to the financial crisis. Analogously with the aforementioned papers, the authors counteract their policy measures with the industry-wide dependence on external finance. The authors find that bank recapitalization was the only singularly significant policy measure.

# 3 Methodology

We estimate two complementary models to test for the presence of a credit crunch. Model (1) allows us to assess the impact of the crisis on financially dependent industries; model (4) aims to identify specific channels through which the crisis had its impact.

We start with model 1:

$$g_{cit} = \alpha_{ci} + \beta_{ct} + \gamma_1 \, \mathrm{C}_t \cdot \mathrm{DEF}_i + \gamma_2 \, \mathrm{C}_t \cdot \mathrm{LN}_i + \mu \, \mathrm{SIZE}_{ci,t-1} + \varepsilon_{cit}, \qquad (1)$$

where $g_{cit}$ is the growth rate of industry $i$ in country $c$ during year $t$, $g_t$ is defined as $\ln(\text{value added}_t) - \ln(\text{value added}_{t-1})$, $\alpha_{ci}$ and $\beta_{ct}$ are, respectively, country/industry and country/year fixed effects, $\mathrm{C}_t$ is the crisis dummy, $C_t = 0$ for $t \leq 2007$, $C_t = 1/4$ for $t = 2008$ and $C_t = 1$ for $t = 2009$ (such choice of years is motivated by Fig. 1, the crisis began the last quarter of 2008), $\mathrm{DEF}_i$ is the long-term dependence on external finance in industry $i$ (Rajan and Zingales, 1998), $\mathrm{LN}_i$ stands for the short-term liquidity needs in industry $i$ (Raddatz, 2006), and $\mathrm{SIZE}_{cit}$ is a logarithm of the relative size of industry $i$, $\mathrm{SIZE}_{ci} = \ln(\text{value added}_{ci}) - \ln(\sum_j \text{value added}_{cj})$. We allow for general heteroskedasticity and for general autocorrelation of errors, i.e. $\mathbb{E}(\varepsilon_{cit} \cdot \varepsilon_{ci\tau}) = \Sigma_{cit\tau}$ and $\mathbb{E}(\varepsilon_{cit} \cdot \varepsilon_{sj\tau}) = 0$ if $c \neq s$ or $i \neq j$.

In line with Rajan and Zingales (1998) and Dell'Ariccia et al. (2008) we include SIZE, because larger industries are expected to grow slower due to convergence, and assume that DEF and LN are exogenous. Indeed, DEF and LN are based on data that predates our sample by more than a decade and that further comes from the US, which is excluded from our sample in accordance with Rajan and Zingales. We also assume exogeneity for C, which is reasonable because the crisis was triggered for reasons other than the growth of manufacturing industries.

If Fig. 2 is correct in hinting at an increased wedge between external and internal cost of financing, i.e. if there has been a credit crunch, then we should find that $\gamma_k < 0$ for $k \in \{1, 2\}$. However, $\gamma_k < 0$ could, in principal, occur for reasons other than a credit crunch. For example, if high-tech industries are more dependent on external finance—consider office machinery or scientific equipment—and if high-tech industries also experience a larger drop in demand during recessions, then $\gamma_k$ will be negative but due to a different cause than a credit crunch. In econometric parlance, if we conclude from a negative $\gamma_k$ that there was a credit crunch, we might be making a type II error.

A more powerful test, i.e. a test with a lower probability of a type II error, can be conducted by interacting the effect the crisis had on financially dependent industries with country-specific bank and market characteristics:

$$\begin{aligned} g_{cit} = \alpha_{ci} + \beta_{ct} + \gamma_1 \, \mathrm{C}_t \cdot \mathrm{DEF}_i + \gamma_2 \, \mathrm{C}_t \cdot \mathrm{LN}_i \\ + (\mathrm{C}_t \cdot \mathrm{DEF}_i \cdot \mathrm{Z}_c) \, \delta_1 + (\mathrm{C}_t \cdot \mathrm{LN}_i \cdot \mathrm{Z}_c) \, \delta_2 + \mu \, \mathrm{SIZE}_{ci,t-1} + \varepsilon_{cit} \end{aligned} \quad (2)$$

with

$$\mathrm{Z}_c = [\, \mathrm{CREDIT}_c \quad \mathrm{VTRAD}_c \quad \mathrm{LEV}_c \quad \mathrm{ZSCORE}_c \,], \quad (3)$$

where $\mathrm{CREDIT}_c$ is private credit relative to GDP in country $c$, $\mathrm{VTRAD}_c$ is value of shares traded relative to GDP, $\mathrm{LEV}_c$ is leverage of depositors' banks, LEV = Total Assets/(Capital + Reserves), and $\mathrm{ZSCORE}_c$ is a distance to default measure (Roy, 1952). We use a precompiled per-country z-score from the Database of Financial Development and Structure (Beck

et al., 2000a). Regressors $Z_c$ are for the year 2007, but in robustness checks we also use 2006. As before, we allow for arbitrary heteroskedasticity and autocorrelation.

The variation in the aforementioned country-specific variables corresponds to a variation in the bank and/or market lending channels. Thus, if $\delta_k$ are significant, then the impact of the crisis on financially dependent industries must have been through either one of those channels, and such a result is a more powerful evidence for a credit crunch.

Private credit relative to GDP (CREDIT), where private credit is the credit extended by financial intermediaries to the private sector, serves as a proxy for the development of financial intermediaries. This is a common measure: see, e.g., Levine et al. (2000) and Beck et al. (2000b).

Value of shares traded relative to GDP (VTRAD) serves as a proxy for the development of financial markets. This measure is used by, e.g., Levine and Zervos (1998), and is a better measure than a more widely used market capitalization relative to GDP ratio, because VTRAD takes market liquidity into account.[2]

Although financial development can help industries during recessions (Braun and Larrain, 2005), when the financial system itself is under stress, e.g. during a banking crisis, financially dependent industries are hit more severely in countries that are more financially developed (Kroszner et al., 2007). We therefore expect to find a negative coefficient in front of CREDIT and/or VTRAD.

Arguably, the single most important risk factor of the banking system during the recent crisis was leverage. High leverage was most easily achieved with short-term wholesale funding, which evaporated during the crisis: consider the Northern Rock episode (Shin, 2009). We expect then, that in countries where the banks were more leveraged, the bank lending channel was hit more severely during the crisis and thus the financially dependent industries experienced a relatively lower growth.

Besides leverage, which was an important risk factor in the recent crisis, we also use a more general indicator of bank riskiness/soundness: z-score, which is a basic distance to default measure widely used in the literature.

Specification (2) is motivated by an observation that DEF (or LN) could be correlated with the drop in the demand during the crisis, and so $C_t \cdot DEF_i$ (or $C_t \cdot LN_i$) would not exclusively capture the effects of the credit crunch. While specification (2), by considering specific financing channels, offers a better test than (1) in this respect, the aforementioned possible correlation still constitutes an omitted variables problem. To address this problem we

[2]For example, Chile has higher market capitalization to GDP ratio than the Netherlands, whereas turnover in Chile is some 9 times lower.

add industry/time fixed effects:

$$g_{cit} = \alpha_{ci} + \beta_{ct} + \gamma_{it} + (\mathrm{C}_t \cdot \mathrm{DEF}_i \cdot \mathrm{Z}_c)\,\delta_1 + (\mathrm{C}_t \cdot \mathrm{LN}_i \cdot \mathrm{Z}_c)\,\delta_2 + \mu\,\mathrm{SIZE}_{ci,t-1} + \varepsilon_{cit}. \quad (4)$$

Specification (4) is our preferred specification.

# 4 Data

The measure of dependence on external finance as well as the measure of liquidity needs comes from Raddatz (2006). In comparison with Rajan and Zingales, Raddatz uses the same data (accounts of US corporate firms for the period 1980–1989) but computes the two measures across a more detailed industry breakdown (4 digit ISIC codes). For convenience, Raddatz's computations are reprinted in Table A.1 (in the appendix). Notably, dependence on external finance and liquidity needs are similar measures: Pearson's correlation coefficient equals 0.36 and the null hypothesis of no correlation can be rejected at a 1% significance level.

The industry data on value-added comes from INDSTAT. We use years 2002–2009, thus we take the period after the Asian financial crisis and just after the dot-com bubble. We restrict our sample to the OECD countries; we further exclude the US so as to address possible endogeneity concerns w.r.t. DEF and LN (following the literature).

The current version of INDSTAT uses ISIC Rev. 3 classification. We follow ISIC Rev. 2 classification, as this is the version for which DEF and LN measures are available. Rev. 3 is more detailed, therefore we make a one-to-many correspondence from Rev. 3 to Rev. 2 and then aggregate INDSTAT data over Rev. 2 industries.[3] We further ensure that in different years the aggregation goes over the same industries (the INDSTAT panel is not fully balanced).

We deflate the nominal value-added on a country basis using a GDP deflator from the World Bank, and then compute the real growth rates. Because we are interested in the *general* impact of the crisis on industrial growth, and because growth rates exhibit outliers,[4] we remove the bottom 2.5% and the top 2.5% of the distribution of the growth rates.

Finally, we retain only those country/industry series that cover at least one crisis and one non-crisis year. Table A.2 summarizes our final coverage on a per-country basis.

[3] Our one-to-many correspondence is a simplified version of the official correspondence table, which can be found at `http://unstats.un.org/unsd/cr/registry/regdnld.asp?Lg=1`.

[4] E.g. the shipbuilding industry in Ireland in years 2004–2008 had value-added of, respectively, 14, 13, −330, 19, and 17 million euros.

Data on value traded relative to GDP come from World Bank's WDI and GDF database (namely, stocks traded, total value). Leverage is computed as a ratio of total assets to capital plus reserves, where the accounts are aggregated accounts for depositors' banks. These balance sheet data come from ECB, OECD Bank Profitability Statistics (ECB data is preferred whenever available), and the Central Bank of the Republic of Turkey. Private credit and z-score come from the Database of Financial Development and Structure (Beck et al., 2000a). Leverage and z-score are similar measures (except for the sign), Pearson's correlation coefficient equals $-0.45$ and the null hypothesis of no correlation can be rejected at a 5% significance level. Table A.3 lists private credit to GDP, value traded to GDP, leverage and z-score on a per-country basis.

To ease interpretation of regression coefficients and interaction terms we normalize the following regressors to a unit interval: DEF, LN, CREDIT, VTRAD, LEV, ZSCORE. Tables A.1 and A.3 report pre-normalized values.

# 5 Estimation Results

Table 1 presents estimation results for the first model in which production growth is related to dependence on long-term external finance, liquidity needs, and the size of the industry. The specification of the model is given in (1) and includes fixed effects for country-industry combinations and fixed effects for country-year combinations (not reported). Column (1.1) reports the result for regression of lagged industry size and the Rajan and Zingales measure of dependence on external finance. The results show that the industries with higher dependence on long-term external finance experienced relatively lower growth rates after the onset of the crisis. The coefficient on the lagged size of industries has a negative sign implying that larger industries tend to grow slower.

In column (1.2) we assess the relation between output growth in the crisis and liquidity needs—an indicator of dependence on short-term external finance. In line with the results of (1.1) we find that the industries with higher liquidity needs are associated with a larger reduction in output growth since the start of the crisis in comparison to the industries with smaller liquidity needs. The coefficient on industry size is almost identical to (1.1).

The long-term and short-term indicators for dependence on external finance enter simultaneously in the regression in column (1.3). The coefficients on both indicators are significant. The size of coefficients is smaller than in the previous models, but the difference is small. This suggests that each indicator captures different aspects of financial dependence.

The coefficients in Table 1 are economically sizeable. Consider column (1.3). An increase in DEF from its $25^{\text{th}}$ percentile to its $75^{\text{th}}$ percentile decreases growth by 0.34%–3.5% per annum (95% confidence interval); the

Table 1: Estimation Results for Model (1)

| | (1.1) | (1.2) | (1.3) |
|---|---|---|---|
| $\text{SIZE}_{ci,t-1}$ | $-0.272^{***}$ | $-0.276^{***}$ | $-0.274^{***}$ |
| | (0.0227) | (0.0226) | (0.0226) |
| $\text{C}_t \cdot \text{DEF}_i$ | $-0.164^{***}$ | | $-0.114^{*}$ |
| | (0.0483) | | (0.0479) |
| $\text{C}_t \cdot \text{LN}_i$ | | $-0.179^{***}$ | $-0.155^{***}$ |
| | | (0.0349) | (0.0352) |
| Country-industry f.e. | yes | yes | yes |
| Country-year f.e. | yes | yes | yes |

Notes: The dependent variable is the log difference in value added. The number of observations is 6571. The number of regressors including fixed effects is 1247. Significance at 5%, 1% and 0.1% levels is denoted by $^{*}$, $^{**}$ and $^{***}$ respectively. The reported standard errors are robust to general heteroskedasticity and general autocorrelation. Regressors DEF and LN are normalized to a unit interval.

same increase in LN decreases growth by 2.1%–5.6%. With respect to dependence on external finance, Dell'Ariccia et al. (2008) obtain similar results, albeit their results are driven by developing countries, whereas we focus on OECD. Namely, they find that financially dependent industries grow slower during crises and that an increase in DEF from its $25^{\text{th}}$ percentile to its $75^{\text{th}}$ percentile reduces growth by 1.1%.

The results reported in Table 1 support the hypothesis that there was a credit crunch (i.e. a drop in credit supply) during the crisis period, but these results could also be compatible with mechanisms related to a drop in credit demand. For instance, sectors that were growing at high rates before the crisis could have relied more on external finance than industries with lower growth rates. At the same time, fast-growing industries could have been more vulnerable to a relative drop in the growth of demand. This would introduce a spurious negative correlation between output growth and dependence on external finance.

In order to verify the sensitivity of our results to a correlation between credit demand and dependence on external finance, we assess whether the impact of the crisis on financially dependent industries differed across countries with respect to bank and market lending channels. The results of these regression are reported in Table 2.

Model (2.1) in Table 2 interacts dependence on external finance and liquidity needs with the crisis dummy and one of three channels: private credit as percentage of GDP (CREDIT), the value of shares traded as percentage of GDP (VTRAD), and leverage (LEV). The regression results show that industries more dependent on long-term external finance were impacted more severely by the crisis in countries where the banking system was more

Table 2: Estimation Results for Models (2) and (4)

| | (2.1) | (2.2) | (4) |
|---|---|---|---|
| $\text{SIZE}_{ci,t-1}$ | $-0.275^{***}$ | $-0.274^{***}$ | $-0.315^{***}$ |
| | (0.0224) | (0.0225) | (0.0264) |
| $\text{C}_t \cdot \text{DEF}_i$ | 0.0242 | $-0.181$ | |
| | (0.103) | (0.0957) | |
| $\text{C}_t \cdot \text{DEF}_i \cdot \text{CREDIT}_c$ | 0.294 | $-0.00262$ | 0.204 |
| | (0.236) | (0.230) | (0.209) |
| $\text{C}_t \cdot \text{DEF}_i \cdot \text{VTRAD}_c$ | $-0.159$ | $-0.191$ | $-0.125$ |
| | (0.233) | (0.257) | (0.196) |
| $\text{C}_t \cdot \text{DEF}_i \cdot \text{LEV}_c$ | $-0.504^{**}$ | | $-0.549^{**}$ |
| | (0.190) | | (0.168) |
| $\text{C}_t \cdot \text{DEF}_i \cdot \text{ZSCORE}_c$ | | 0.353 | |
| | | (0.183) | |
| $\text{C}_t \cdot \text{LN}_i$ | $-0.241^{**}$ | $-0.212^{**}$ | |
| | (0.0926) | (0.0782) | |
| $\text{C}_t \cdot \text{LN}_i \cdot \text{CREDIT}_c$ | 0.265 | 0.298 | $0.345^{*}$ |
| | (0.187) | (0.208) | (0.156) |
| $\text{C}_t \cdot \text{LN}_i \cdot \text{VTRAD}_c$ | $-0.287$ | $-0.286$ | $-0.419^{**}$ |
| | (0.166) | (0.166) | (0.150) |
| $\text{C}_t \cdot \text{LN}_i \cdot \text{LEV}_c$ | 0.111 | | 0.0643 |
| | (0.141) | | (0.122) |
| $\text{C}_t \cdot \text{LN}_i \cdot \text{ZSCORE}_c$ | | 0.0132 | |
| | | (0.147) | |
| Country-industry f.e. | yes | yes | yes |
| Country-year f.e. | yes | yes | yes |
| Industry-year f.e. | no | no | yes |

Notes: The dependent variable is the log difference in value added. The number of observations is 6571. The number of regressors including fixed effects is 1253 (1645 in column 4 due to an additional inclusion of industry/time fixed effects). Significance at 5%, 1% and 0.1% levels is denoted by $^{*}$, $^{**}$ and $^{***}$ respectively. The reported standard errors are robust to general heteroskedasticity and general autocorrelation. Regressors DEF, LN, CREDIT, VTRAD, LEV and ZSCORE are normalized to a unit interval.

leveraged. This finding strengthens our previous conclusion that there was a credit crunch, it further shows that excess leverage was an important determinant in how hard the bank lending channel was hit during the crisis.

In model (2.2) leverage is replaced by the distance to default (ZSCORE). Here we do not find any statistically significant results for the banking sector channels. The fact that leverage has a better explanatory power than a classic distance-to-default measure (z-score) is consistent with the recent findings by Beltratti and Stulz (2012), who find that more capitalized banks performed better during the crisis whereas z-score was insignificant.

We have also tested the interaction of the financial dependence indicators with the concentration in the banking sector (C3, source: Beck et al. 2000a, not reported). A higher concentration might have implied a more severe credit crunch via reduced competition among banks. We have found no significant results.

Model (4) adopts a more flexible specification, which includes fixed effects for the combination of industry and year. The coefficient on the interaction with leverage is of comparable size to the estimate of model (2.1). For liquidity needs we now find statistically significant results for the interactions with the size of private credit and the value of shares traded.

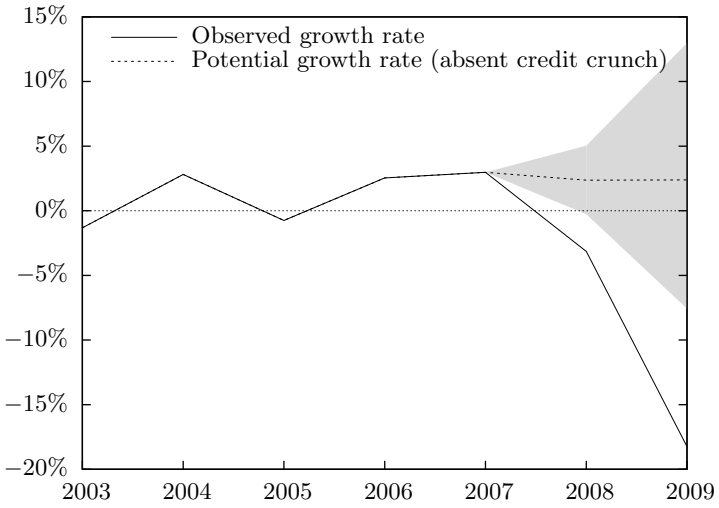
The interaction of liquidity needs with the size of private credit is not robust (see Section 6.1). Regarding the interaction with the value of shares traded, we obtain that the industries with higher short-term liquidity needs experienced a lower growth in countries with larger value of shares traded, i.e. in countries with deeper financial markets. This result gives further evidence for the credit crunch.

So far we have argued that there was a credit crunch in the years 2008–2009. Presently we turn to assessing the size of that credit crunch. First, we discuss the magnitude of the coefficients in Table 2. Then we estimate what the industrial growth would have been, had there been no credit crunch. In both cases we base our assessment on specification (4).

Consider column (4), Table 2. An increase in DEF from its $25^{\text{th}}$ percentile to its $75^{\text{th}}$ percentile decreases growth by 3.7%–15% (95% confidence interval) per annum more in a country with the most leveraged banking system in comparison to a country with the least leveraged banking system. An increase in LN from its $25^{\text{th}}$ percentile to its $75^{\text{th}}$ percentile decreases growth by 3.1%–18% per annum more in a country with the most developed financial market in comparison to a country with the least developed financial market.

Consider eq. (4). Let $\tilde{g}_{cit}$ denote a hypothetical growth rate that would have taken place if there had been no credit crunch; we call $\tilde{g}_{cit}$ a potential growth rate. Earlier we have associated two effects with the credit crunch: financially dependent firms were hit harder in countries with more leveraged banking systems, and firms with higher liquidity needs were hit harder in countries with larger and deeper financial markets. If these two effects were

Figure 3: Growth Absent Credit Crunch




Notation: the grey area denotes a 95% confidence interval.

absent, we would obtain a potential growth rate. So,

$$\tilde{g}_{cit} = g_{cit} - \hat{\delta}_1^{\text{lev}} \, \text{C}_t \cdot \text{DEF}_i \cdot \text{LEV}_c - \hat{\delta}_2^{\text{vtrad}} \, \text{C}_t \cdot \text{LN}_i \cdot \text{VTRAD}_c, \qquad (5)$$

where $\hat{\delta}_i$ are the estimated coefficients from Table 4. Having potential growth rates $\tilde{g}_{cit}$, it is straightforward to compute potential value added, then aggregate and compute potential growth rates $\tilde{g}_c$. Fig. 3 plots these rates along with the observed growth rates $g_c$ (for our sample of industries). If there had been no credit crunch, then the industrial production would have grown at around 2.4% in years 2008–2009. The credit crunch decreased growth by 5.5% in 2008 and by 21% in 2009 (the confidence intervals are 2.9%–8.2% and 11%–31% respectively).

We can not compute coefficients $\delta$ on a per-country or per-industry basis, because our estimation approach utilizes cross-country and cross-industry variation. Nevertheless, the credit crunch would have impacted the countries differently due to the difference in the industrial structure and in the financial system across countries. Similarly, the credit crunch would have impacted the industries differently. Tables A.4 and A.5 show the impact of the credit crunch by country and by industry (at a 2-digit industry level).

# 6 Robustness Checks

## 6.1 Influential Countries and Industries

We check whether our results are driven by an influential country or industry. For each country and for each industry we rerun regressions (1) and (4),

Table 3: Robustness to Influential Countries and Industries (Model 1)

| | Full Sample | Min | Max | Max p-value |
|---|---|---|---|---|
| $\text{SIZE}_{ci,t-1}$ | $-0.274^{***}$ | $-0.287^{***}$ | $-0.267^{***}$ | $-0.270^{***}$ |
| | (0.0226) | (0.0213) | (0.0228) | (0.0244) |
| $\text{C}_t \cdot \text{DEF}_i$ | $-0.114^{*}$ | $-0.185^{***}$ | $-0.0711$ | $-0.0711$ |
| | (0.0479) | (0.0557) | (0.0475) | (0.0475) |
| $\text{C}_t \cdot \text{LN}_i$ | $-0.155^{***}$ | $-0.185^{***}$ | $-0.130^{***}$ | $-0.130^{***}$ |
| | (0.0352) | (0.0355) | (0.0382) | (0.0382) |

For every country and for every industry the regression is run without it, producing a set of estimates. For a given regressor the table gives the minimum, the maximum, and the highest p-value estimates out of this resulting set. $*$, $**$ and $***$ denote significance at a 5%, 1% and 0.1% levels respectively. The reported errors are robust to general heteroskedasticity and general autocorrelation.

Table 4: Robustness to Influential Countries and Industries (Model 4)

| | Full Sample | Min | Max | Max p-value |
|---|---|---|---|---|
| $\text{SIZE}_{ci,t-1}$ | $-0.315^{***}$ | $-0.333^{***}$ | $-0.304^{***}$ | $-0.312^{***}$ |
| | (0.0264) | (0.0250) | (0.0265) | (0.0277) |
| $\text{C}_t \cdot \text{DEF}_i \cdot \text{CREDIT}_c$ | 0.204 | 0.0163 | 0.289 | 0.0163 |
| | (0.209) | (0.239) | (0.210) | (0.239) |
| $\text{C}_t \cdot \text{DEF}_i \cdot \text{VTRAD}_c$ | $-0.125$ | $-0.217$ | $-0.0676$ | $-0.0676$ |
| | (0.196) | (0.198) | (0.198) | (0.198) |
| $\text{C}_t \cdot \text{DEF}_i \cdot \text{LEV}_c$ | $-0.549^{**}$ | $-0.645^{***}$ | $-0.438^{*}$ | $-0.438^{*}$ |
| | (0.168) | (0.171) | (0.174) | (0.174) |
| $\text{C}_t \cdot \text{LN}_i \cdot \text{CREDIT}_c$ | $0.345^{*}$ | 0.227 | $0.403^{*}$ | 0.278 |
| | (0.156) | (0.157) | (0.183) | (0.192) |
| $\text{C}_t \cdot \text{LN}_i \cdot \text{VTRAD}_c$ | $-0.419^{**}$ | $-0.500^{*}$ | $-0.328^{*}$ | $-0.362^{*}$ |
| | (0.150) | (0.220) | (0.153) | (0.176) |
| $\text{C}_t \cdot \text{LN}_i \cdot \text{LEV}_c$ | 0.0643 | $-0.0457$ | 0.146 | $-0.00371$ |
| | (0.122) | (0.170) | (0.115) | (0.137) |

For every country and for every industry the regression is run without it, producing a set of estimates. For a given regressor the table gives the minimum, the maximum, and the highest p-value estimates out of this resulting set. $*$, $**$ and $***$ denote significance at a 5%, 1% and 0.1% levels respectively. The reported errors are robust to general heteroskedasticity and general autocorrelation.

excluding the country or industry in question. The results are presented in tables 3 and 4. We find that dependence on external finance (DEF) is not robust in Regression (1), however the interaction between dependence on external finance and leverage is robust in Regression (4). Further, liquidity needs (LN) are robust in Regression (1), and their interaction with value traded is robust in Regression (4). Thus, our primary results are robust to exclusion of individual countries and industries, in particular they are not driven by any special industry like a pharmaceutical industry. Lastly, the interaction of liquidity needs with private credit is not robust.

### 6.2 Exogeneity of Country-specific Regressors

We take country-specific regressors, namely CREDIT, VTRAD, LEV, and ZSCORE, from the year 2007. While the impact of the financial crisis on the real economy was not clearly visible before the year 2008 (see Fig. 1), the financial crisis itself was already ongoing in 2007. The US housing market was experiencing increasing foreclosure rates; on the $7^{\text{th}}$ of August BNP Paribas suspended withdrawals from three funds citing "the complete evaporation of liquidity in certain market segments"; on the $13^{\text{th}}$ of September Northern Rock sought Bank of England's support. Therefore our country-specific regressors might not be exogenous if taken from the year 2007. We therefore estimate models (2) and (4) using the data from the year 2006. We find qualitatively exactly the same results (not reported).

## 7 Concluding Remarks

There is a large body of economic evidence that better financial institutions cause growth. The recent financial crisis provides rich data for testing whether the opposite is true—whether impaired financial institutions, even in otherwise financially developed countries, cause relatively slower growth. We approached this question using a widely-adopted methodology of Rajan and Zingales, and using the most recent INDSTAT database from UNIDO, comprising 26 developed countries and 68 industries. We found that industries that are more dependent on long-term external finance or that have higher short term liquidity needs experienced relatively lower growth during the years 2007–2009. Furthermore, we found that the former effect was larger for countries with more leveraged banking systems, and the latter effect was larger for countries with more developed financial markets. Thus, we found indirect but strong evidence that there was a credit crunch in OECD countries during these years.

# Appendix

Table A.1 lists the manufacturing industries along with their dependence on external finance (DEF) and liquidity need (LN). Table A.2 summarizes the data coverage. Table A.3 lists OECD countries along with the leading characteristics of their banks and markets.

Table A.1: Industry Measures

| ISIC | Description | DEF | LN |
|---|---|---|---|
| 3111 | Slaughtering and preserv. meat | −0.02 | 0.08 |
| 3112 | Dairy products | 0.41 | 0.05 |
| 3113 | Fruits and veg. canning | 0.08 | 0.20 |
| 3115 | Vegetable and animal oils | 0.01 | 0.14 |
| 3116 | Grain mill products | 0.04 | 0.11 |
| 3117 | Bakery products | −0.05 | 0.06 |
| 3118 | Sugar factories and ref. | −0.21 | 0.16 |
| 3119 | Chocolate and sugar confect. | −0.32 | 0.14 |
| 3121 | Food products n.e.c. | −0.53 | 0.11 |
| 3131 | Distilling spirits | 0.70 | 0.19 |
| 3133 | Malt liquors and malt | −0.20 | 0.07 |
| 3134 | Soft drinks | −0.47 | 0.06 |
| 3140 | Tobacco manufactures | −0.27 | 0.24 |
| 3211 | Textiles spinning and weaving | 0.00 | 0.16 |
| 3212 | Textile goods exc. apparel | 0.01 | 0.19 |
| 3214 | Carpets and rugs | 0.59 | 0.15 |
| 3219 | Textiles n.e.c. | 0.05 | 0.18 |
| 3220 | Wearing apparel exc. footwear | 0.09 | 0.20 |
| 3233 | Leather products | −0.14 | 0.29 |
| 3240 | Footwear | −0.22 | 0.22 |
| 3311 | Sawmills and other wood mills | 0.20 | 0.14 |
| 3320 | Furniture and fixtures | 0.19 | 0.16 |
| 3411 | Pulp, paper and paperboard | 0.12 | 0.11 |
| 3412 | Boxes of paper and paperboard | −0.07 | 0.13 |
| 3419 | Pulp, paper and paperboard n.e.c. | 0.06 | 0.13 |
| 3420 | Printing, publishing and allied | 0.20 | 0.08 |
| 3511 | Basic industrial chemicals | 0.35 | 0.14 |
| 3512 | Fertilizers and pesticides | 0.10 | 0.14 |
| 3513 | Synthetic resins and plastic | 0.21 | 0.11 |
| 3521 | Paints, varnishes and lacquers | 0.13 | 0.15 |
| 3522 | Drugs and medicines | 1.47 | 0.16 |
| 3523 | Soap and cleaning prep. | −0.02 | 0.15 |
| 3529 | Other chemical products | 0.02 | 0.13 |
| 3530 | Petroleum refineries | 0.03 | 0.06 |
| 3540 | Misc. prod. of petroleum | 0.12 | 0.15 |
| 3551 | Tyre and tube industries | −0.11 | 0.13 |
| 3559 | Rubber products n.e.c. | −0.03 | 0.15 |
| 3560 | Plastic products n.e.c. | 0.31 | 0.14 |
| 3610 | Pottery, china and earthenware | −0.21 | 0.17 |

Table A.1: Industry Measures

| ISIC | Description | DEF | LN |
|---|---|---|---|
| 3620 | Glass and glass prod. | 0.26 | 0.16 |
| 3691 | Structural clay prods | 0.22 | 0.19 |
| 3692 | Cement, lime and plaster | 0.27 | 0.15 |
| 3699 | Non-metallic mineral prod. n.e.c. | −0.09 | 0.12 |
| 3710 | Iron and steel basic ind. | 0.00 | 0.16 |
| 3720 | Non-ferrous metal basic ind. | 0.02 | 0.15 |
| 3811 | Cutlery and hand tools | −0.09 | 0.20 |
| 3813 | Structural metal products | 0.45 | 0.15 |
| 3819 | Fabricated metalprods. | 0.30 | 0.18 |
| 3821 | Engines and turbines | 0.23 | 0.19 |
| 3822 | Agric. mach. and equip. | 0.33 | 0.20 |
| 3823 | Metal and wood wkg. mach. | 0.17 | 0.23 |
| 3824 | Special indus. mach. and eqp. | 0.37 | 0.25 |
| 3825 | Office and computing mach. | 1.07 | 0.20 |
| 3829 | Machinery and eqp. n.e.c. | 0.30 | 0.21 |
| 3831 | Elect. ind. machinery | 0.27 | 0.20 |
| 3832 | Radio, TV. and comm. eqp. | 0.93 | 0.21 |
| 3833 | Electrical appliances | 0.29 | 0.18 |
| 3839 | Elect. app. and supp. n.e.c. | 0.42 | 0.21 |
| 3841 | Ship building and repair | 0.46 | 0.17 |
| 3842 | Railroad equipment | 0.18 | 0.15 |
| 3843 | Motor vehicles | 0.72 | 0.11 |
| 3845 | Aircraft | 0.28 | 0.22 |
| 3851 | Scientific equipment | 1.05 | 0.21 |
| 3852 | Photo. and optical goods | 0.72 | 0.25 |
| 3853 | Watches and clocks | 0.79 | 0.26 |
| 3901 | Jewelry | 0.79 | 0.30 |
| 3902 | Musical instruments | 0.59 | 0.28 |
| 3903 | Sport and athletic goods | 0.16 | 0.21 |

Source: Raddatz (2006), except for the dependence on external finance for ISIC 3233 "Leather products". The latter number comes from Rajan and Zingales (1998), because the number from Raddatz, −1.53, is a clear outlier.

Table A.2: Coverage

The table shows how many observations are available for a given country for a given time span. All OECD countries are listed, with the exception of the US.

| Country | 2003–2007 | 2008 | 2009 | Total |
|---|---|---|---|---|
| Australia | 0 | 0 | 0 | 0 |
| Austria | 214 | 43 | 40 | 297 |
| Belgium | 201 | 52 | 39 | 292 |
| Canada | 261 | 54 | 0 | 315 |
| Chile | 81 | 17 | 0 | 98 |
| Czech Republic | 0 | 0 | 0 | 0 |
| Denmark | 160 | 35 | 0 | 195 |
| Estonia | 104 | 23 | 21 | 148 |
| Finland | 222 | 45 | 21 | 288 |
| France | 280 | 58 | 54 | 392 |
| Germany | 300 | 60 | 51 | 411 |
| Greece | 0 | 0 | 0 | 0 |
| Hungary | 279 | 57 | 48 | 384 |
| Iceland | 0 | 0 | 0 | 0 |
| Ireland | 96 | 27 | 11 | 134 |
| Israel | 30 | 6 | 0 | 36 |
| Italy | 301 | 60 | 51 | 412 |
| Japan | 0 | 0 | 0 | 0 |
| Korea, Rep. | 300 | 62 | 0 | 362 |
| Luxembourg | 29 | 6 | 3 | 38 |
| Mexico | 0 | 0 | 0 | 0 |
| Netherlands | 161 | 40 | 0 | 201 |
| New Zealand | 4 | 1 | 0 | 5 |
| Norway | 214 | 49 | 0 | 263 |
| Poland | 278 | 59 | 48 | 385 |
| Portugal | 142 | 23 | 38 | 203 |
| Slovak Republic | 148 | 34 | 23 | 205 |
| Slovenia | 180 | 41 | 39 | 260 |
| Spain | 309 | 61 | 52 | 422 |
| Sweden | 215 | 45 | 33 | 293 |
| Switzerland | 0 | 0 | 0 | 0 |
| Turkey | 150 | 40 | 0 | 190 |
| United Kingdom | 249 | 51 | 42 | 342 |
| Total | 4908 | 1049 | 614 | 6571 |

Table A.3: Bank and Market Lending Channels (for the year 2007)

| Country | CREDIT | VTRAD | LEV | ZSCORE |
|---|---|---|---|---|
| Austria | 1.12 | 0.32 | 11.7 | 20.5 |
| Belgium | 0.84 | 0.56 | 19.9 | 6.8 |
| Canada | 1.57 | 1.16 | 18.4 | 17.9 |
| Chile | 0.80 | 0.26 | 12.0 | 28.9 |
| Denmark | 1.91 | 0.78 | 15.9 | 17.9 |
| Estonia | 0.81 | 0.10 | 11.6 | 5.9 |
| Finland | 0.78 | 2.21 | 13.8 | 28.0 |
| France | 0.99 | 1.32 | 18.1 | 12.4 |
| Germany | 1.05 | 1.01 | 21.6 | 10.9 |
| Hungary | 0.58 | 0.35 | 12.6 | 16.1 |
| Ireland | 1.85 | 0.53 | 22.3 | 4.3 |
| Israel | 0.89 | 0.68 | 16.1 | 27.5 |
| Italy | 0.95 | 1.09 | 12.9 | 28.5 |
| Korea, Rep. | 0.93 | 1.88 | 16.7 | 14.6 |
| Luxembourg | 1.62 | 0.00 | 23.2 | 17.3 |
| Netherlands | 1.75 | 2.30 | 19.3 | 10.3 |
| New Zealand | 1.30 | 0.16 | 15.4 | 19.1 |
| Norway | 0.88 | 1.20 | 19.4 | 23.8 |
| Poland | 0.35 | 0.20 | 8.2 | 27.0 |
| Portugal | 1.53 | 0.62 | 12.4 | 35.6 |
| Slovak Republic | 0.39 | 0.00 | 11.6 | 12.5 |
| Slovenia | 0.59 | 0.06 | 11.8 | 16.2 |
| Spain | 1.71 | 2.05 | 14.6 | 53.6 |
| Sweden | 1.13 | 2.09 | 19.5 | 16.4 |
| Turkey | 0.26 | 0.47 | 7.9 | 33.4 |
| United Kingdom | 1.73 | 3.67 | 14.9 | 21.8 |

CREDIT is private credit to GDP, VTRAD is value of shares traded to GDP, LEV is leverage (totals assets over capital plus reserves), and ZSCORE is a distance to default measure. Source: World Bank, OECD, ECB, Central Bank of the Republic of Turkey, Beck et al. (2000a).

Table A.4: Credit Crunch by Country (in percentage points)

| Country | 2008 (s.d.) | 2009 (s.d.) |
|---|---|---|
| Austria | −1.97 (0.51) | −7.7 (1.99) |
| Belgium | −5.59 (1.57) | −23.5 (6.74) |
| Canada | −4.93 (1.23) | |
| Chile | −1.72 (0.46) | |
| Denmark | −4.38 (1.13) | |
| Estonia | −1.33 (0.38) | −5.2 (1.49) |
| Finland | −5.63 (1.36) | −19.4 (4.78) |
| France | −5.73 (1.42) | −21.8 (5.47) |
| Germany | −6.97 (1.83) | −27.1 (7.30) |
| Hungary | −2.29 (0.61) | −9.4 (2.57) |
| Ireland | −8.53 (2.46) | −29.7 (8.72) |
| Israel | −3.86 (1.01) | |
| Italy | −3.26 (0.77) | −13.0 (3.10) |
| Korea, Rep. | −6.25 (1.49) | |
| Luxembourg | −5.28 (1.61) | −19.8 (6.10) |
| Netherlands | −6.50 (1.55) | |
| New Zealand | −2.85 (0.82) | |
| Norway | −5.53 (1.40) | |
| Poland | −0.35 (0.09) | −1.4 (0.36) |
| Portugal | −2.47 (0.61) | −8.1 (1.94) |
| Slovak Republic | −1.38 (0.42) | −4.6 (1.40) |
| Slovenia | −1.42 (0.42) | −7.2 (2.15) |
| Spain | −4.79 (1.15) | −19.0 (4.58) |
| Sweden | −7.44 (1.81) | −23.3 (5.56) |
| Turkey | −0.56 (0.20) | |
| United Kingdom | −7.30 (1.84) | −28.8 (7.38) |

Table A.5: Credit Crunch by Industry (in percentage points)

| ISIC | Description | 2008 (s.d.) | 2009 (s.d.) |
|---|---|---|---|
| 31 | Food, Beverages and Tobacco | −2.61 (0.63) | −10.3 (2.53) |
| 32 | Textile and Leather | −4.13 (1.02) | −15.3 (3.86) |
| 33 | Wood and Wood Products | −4.29 (1.02) | −16.3 (3.93) |
| 34 | Paper, Printing and Publishing | −3.55 (0.86) | −14.0 (3.38) |
| 35 | Petroleum Products and Coal | −5.91 (1.49) | −25.1 (6.57) |
| 36 | Non-Metallic Mineral Products | −4.15 (0.99) | −16.6 (4.00) |
| 37 | Basic Metals | −4.01 (0.95) | −17.1 (4.15) |
| 38 | Fabricated Metals and Machinery | −6.81 (1.64) | −24.5 (6.04) |
| 39 | Other Manufacturing | −7.21 (1.71) | −27.9 (6.76) |

## Bibliography


Beck, T., Demirgüç-Kunt, A., and Levine, R. (2000a). A new database on financial development and structure. *World Bank Economic Review*, 14:597–605.

Beck, T., Levine, R., and Loayza, N. (2000b). Finance and the sources of growth. *Journal of Financial Economics*, 58(1-2):261–300.

Beltratti, A. and Stulz, R. M. (2012). The credit crisis around the globe: Why did some banks perform better? *Journal of Financial Economics*, 105(1):1–17.

Braun, M. and Larrain, B. (2005). Finance and the business cycle: International, inter-industry evidence. *The Journal of Finance*, 60(3):1097–1128.

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

Dell'Ariccia, G., Detragiache, E., and Rajan, R. (2008). The real effect of banking crises. *Journal of Financial Intermediation*, 17(1):89–112.

Kroszner, R. S., Laeven, L., and Klingebiel, D. (2007). Banking crises, financial dependence, and growth. *Journal of Financial Economics*, 84(1):187–228.

Laeven, L. and Valencia, F. (2011). The real effects of financial sector interventions during crises. IMF Working Paper.

Levine, R., Loayza, N., and Beck, T. (2000). Financial intermediation and growth: Causality and causes. *Journal of Monetary Economics*, 46:31–77.

Levine, R. and Zervos, S. (1998). Stock markets, banks, and economic growth. *The American Economic Review*, 88(3):537–558.

Raddatz, C. (2006). Liquidity needs and vulnerability to financial underdevelopment. *Journal of Financial Economics*, 80:677–722.

Rajan, R. G. and Zingales, L. (1998). Financial dependence and growth. *The American Economic Review*, 88(3):559–586.

Roy, A. (1952). Safety first and the holding of assets. *Econometrica*, 20(3):431–449.

Shin, H. S. (2009). Reflections on northern rock: The bank run that heralded the global financial crisis. *The Journal of Economic Perspectives*, 23(1):101–120.

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