On the Direct and Indirect Effects of Credit Supply Shocks

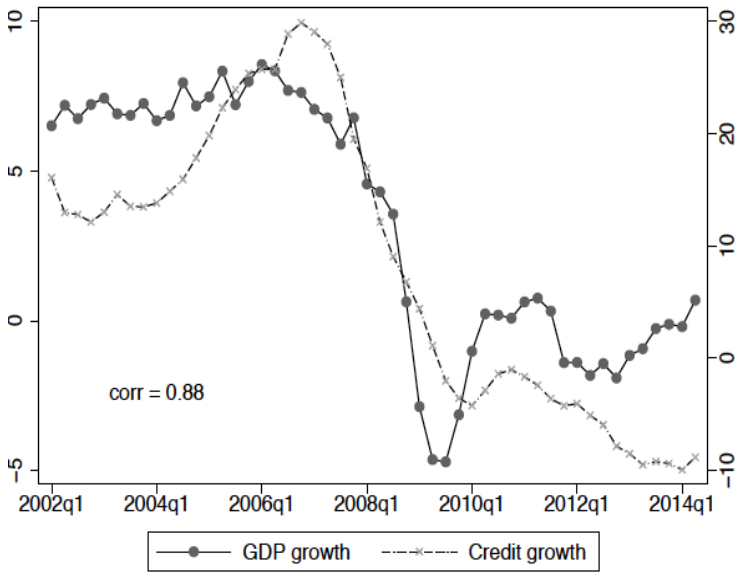
Laura Alfaro
Harvard Business School
& NBER

Manuel García-Santana
UPF, Barcelona GSE,
& CEPR

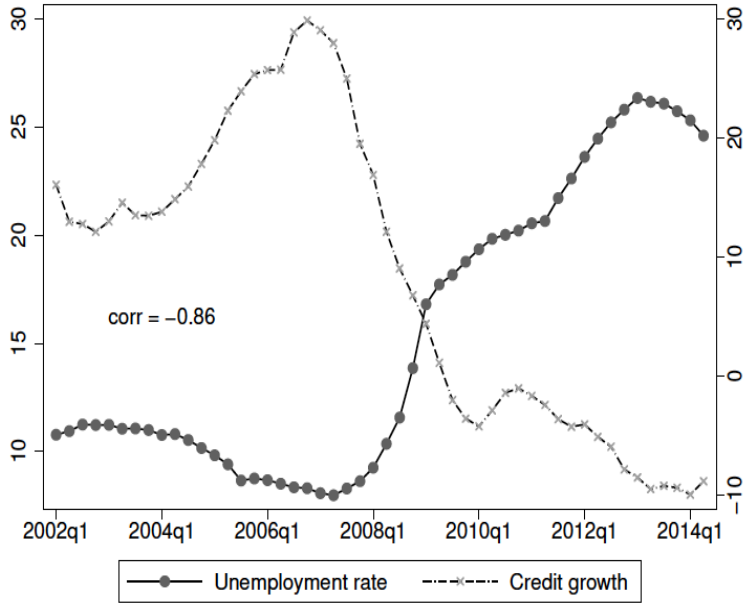
Enrique Moral-Benito
Banco de España

Real Direct and Indirect Effects of Credit Shocks: Bank Lending Channel

Credit and Output Growth: Spain



Credit and Unemployment: Spain



Challenges

- Identifying plausible exogenous shocks.
  - Bank lending-channel (or the bank-specific shock)
  - Firm borrowing-channel (firms' ability, or lack of, to borrow from alternative sources).
- Quantifying aggregate real effects;
  - Expansions/Contractions; Direct/indirect effects.
- Data requirements; methodological requirements large data sets/ small samples.

Methodology and Approach
Spain: Quasi-Census of Firms

- Exploit novel dataset covering Spain's universe of bank-firm credit relations over 2003-2013 + matched administrative data.
  - Micro data replicates to a nearly complete picture of the Spanish economy.
  - Evidence expansion, financial crisis, recessions.

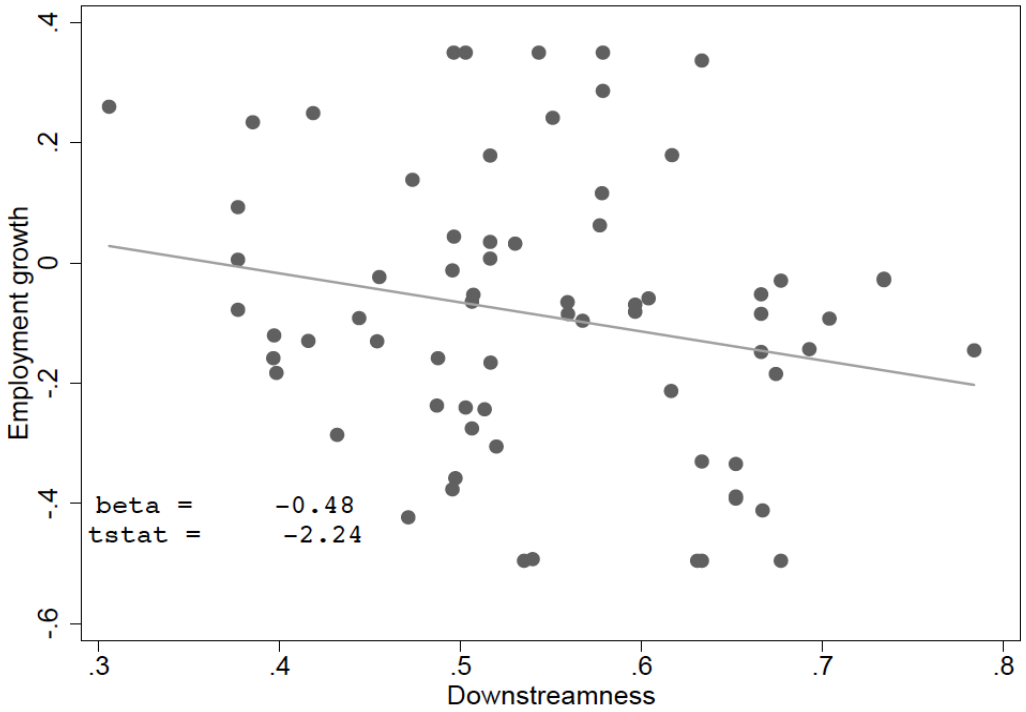
- Exploit firm-loan-bank relations (Amiti and Weinstein) + matched employer-employee (Abowd, Kramarz, and Margolis (1999) to disentangle the bank lending channel from the firm borrowing channel.
  - Large data sets / different episodes.
    - Identify bank-specific credit supply shocks for each year through differences in credit growth between banks lending to the same firm
      - 75% firms borrow from different banks.

Findings

- One std. increase in bank credit supply shock:
  - Loan Level: Sizeable effects on credit growth (5.1 pp): very stable.
  - Firm Level: credit growth (3.2 pp): evidence multibank firms are able to partially offset bank supply shocks. / higher during the crisis.

- Regressing annual employment, output growth and investment rates on the estimated bank supply shocks (controlling for other firm-specific characteristic).
  - Sizeable effects on the real economy: 0.3 pp. employment, 0.1 pp. of output growth, 0.8 pp. investment.

Real Direct and Indirect Effects of Credit Shocks: Bank Lending Channel



Downstreamness: ratio of aggregate final direct use of industry's output to aggregate use of industry's output as an input.

Methodology: Indirect Effects

- Compare direct and indirect propagation effects of bank-lending shocks related to input-output relations.

- Spanish Input-Output structure and firm-specific measures of upstream and downstream exposure (di Giovanni et al, 2018; Alfaro, Antràs, Chor and Conconi, forthcoming).
  - whether firms that buy inputs from industries in which firms affected by the shocks operate are indirectly affected (downstream effects).
  - whether firms that sell goods to industries whose firms were affected by the shocks are indirectly affected (upstream effects).

- Quantify magnitude of the real effects over the business cycles.
  - We plug our estimated shocks into a simplified general equilibrium economy with buyer-supplier relations under the presence of financial frictions, as in Bigio and Lao (2016).
  - Counterfactuals

Findings (cont.)

- Propagation through industry linkage sizeable (downstream effects)
  - Effects larger than direct effects
- Central sectors, those used intensively by other sectors, generate the large output losses:
  - Electricity, construction and wholesale sectors, the propagation effects dominated the direct ones.
- Effects differs expansion/financial crisis/recession
  - Significant employment and output effects during financial crisis
  - No significant employment effects before financial crisis. .
  - Investment effects

Related Literature

- Bank lending channel literature
  - Khwaja and Mian (2008), Jimenez et al. (2014), Bentolila et al. (2016), Chodorow-Reich (2014), Cingano et al. (2015), Greenstone et al. (2015), Huber (forthcoming).
  - Amiti and Weinstein (2013)

- Propagation/Networks literature:
  - Acemoglu, Carvalho, Ozdaglar and Tahbaz-Salehi (2012), Acemoglu, Akcigit, Kerr (2015), Barrot and Sauvagnat (2016), Boehm, Flaaen, and Nayar (2016); di Giovanni et al. (2016)
  - Bigio and Lao (2016)

Road Map

- Data.
- The Bank Lending Channel
  - Estimating Bank-Specific Credit Supply Shock
    - Validation
  - Loan-Level Effects
  - Firm-Level Effects
- Real Direct Effects of Credit Shocks
- Indirect Real Effects of Credit Shocks
- From Micro to Macro: Aggregate Effects of Credit Shocks
- Conclusions

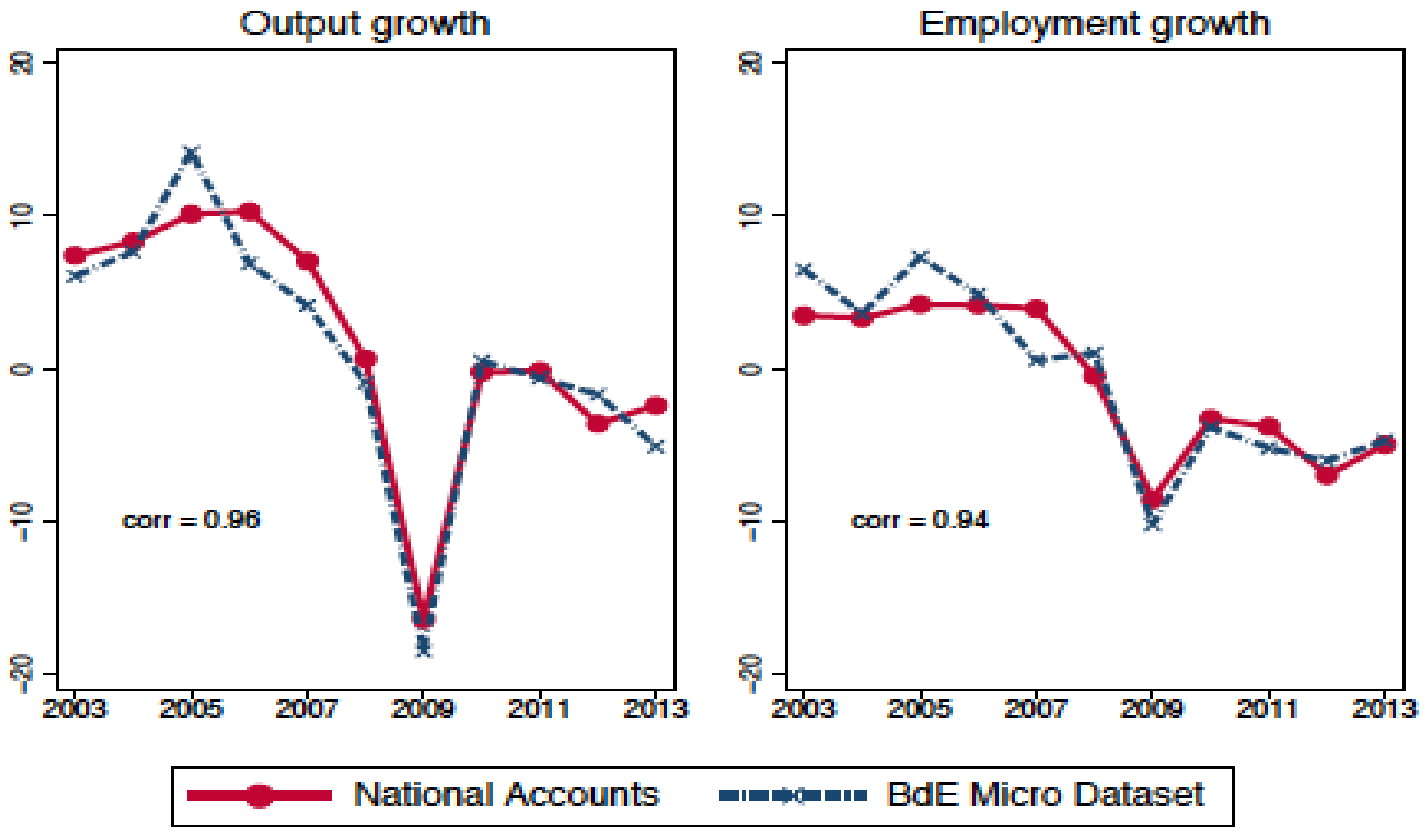
Data I: Credit Registry Data (CIR)

- Central Credit Register (CIR) maintained by the Bank of Spain in its role as primary banking supervisory agency (same as in Jimenez et al, 2012).
  - Detailed monthly information on all outstanding loans over 6,000 euros to non-financial firms granted by all banks operating in Spain.
  - Annual bank-firm credit exposure is computed as the average value of monthly loans between bank i and firm j.
    - Trade-off: more firms per bank/matching.
- Bank-firm-year database covering years from 2002 to 2013
  - 235 banks
  - 1,555,806 firms
  - 18,346,144 bank-firm-year observations (outstanding loans).

Data II: SABI-CBI (Firm-level data)

- Matched to Administrative data on firm-level characteristics taken from the Spanish Commercial Registry (SABI-CBI) and constructed by Almunia, Lopez-Rodriiguez and Moral-Benito (2016).
- Sample: firm-year database for 2002 to 2013:
  - 85-95% of firms and 95% of value added;
  - Multibank firms: 75% bank-firm-year relationships.
- We end up with a firm-year covering years from 2002 to 2013 (1,801,955 firms, average 993,876 firms per year).
- INE Input-Output tables (64 industry level disaggregation)
- Sub-periods: 2003-2007 (expansion); 2008-2009 (Financial crisis); 2010-2013 (recession).

Micro Aggregated Data: Output and Employment Growth



Estimating Bank-Specific Credit Supply Shocks

- Consider the following decomposition of outstanding credit growth between **bank i** and **firm j** in year t :

$$\Delta \ln c_{ijt} = \delta_{it} + \lambda_{jt} + \varepsilon_{ijt} \quad (1)$$

- $\Delta \ln c_{ijt}$: yearly average change of outstanding credit of firm *j* with bank *i* in *t*.
- δ_{it} : bank-lending (supply), captures bank-specific effects identified through differences in credit growth between banks lending to the same firm.
  - Example: Imagine one firm borrowing from banks A and B in t-1
    - Imagine the change in credit between t-1 and t is larger with the bank A than with the bank B
  - We interpret this as the credit supply of bank A having increased more than that of bank B; this is because demand factors are constant.
- λ_{jt} firm-borrowing (demand) channels.

Methodology

- Regression run by relying on multi-bank firms.
  - Matched employer-employee techniques: Abowd, Kramarz, Margolis(1999);
  - Amiti and Weinstein (forthcoming): consistent estimates
    - Robustness lagged bank-firm idiosyncratic factor: similar results.
    - Most variation across firms for a given bank (maturity): data consistent with assumption (firm's credit demand similar for all lenders).

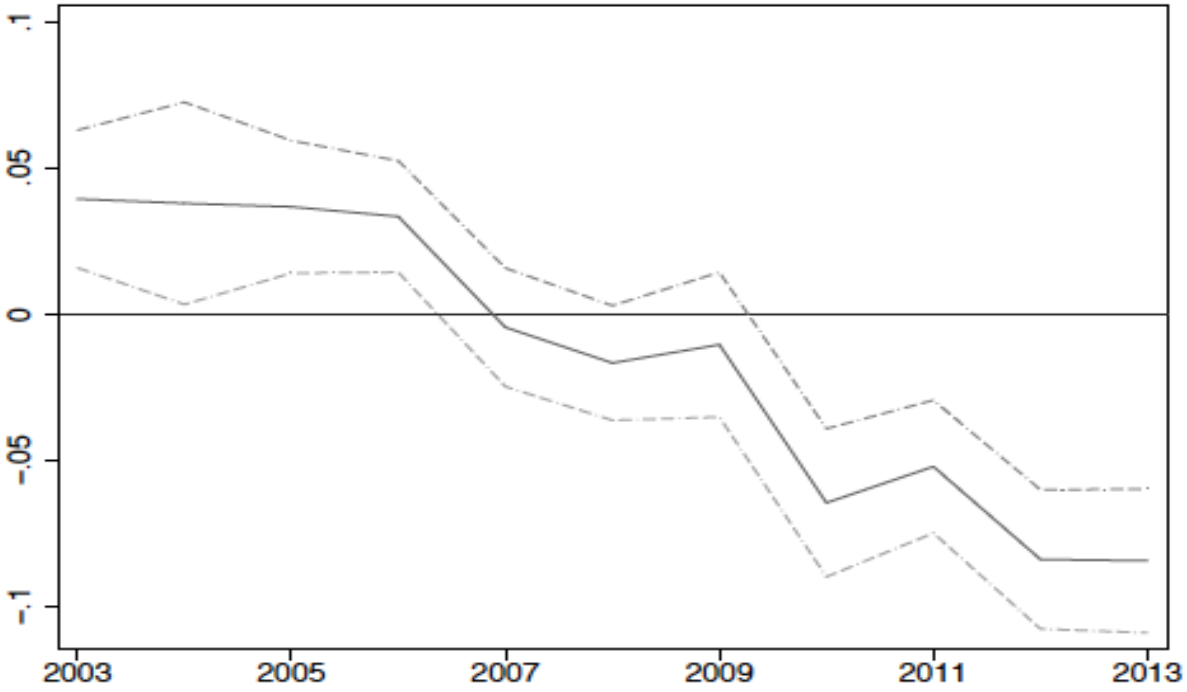
- Bank- and firm-effects identified in relative terms within each group.
  - A group: set of banks and firms connected such that the group contains all firms that have a credit relationship with any of the banks, and all banks that provide credit to at least one firm in the group.
  - A group of banks and firms is not connected to a second group if no bank in the first group provides credit to any firm in the second group, nor any firm in the first group has a credit relationship with a bank, in the second group.
    - 11 groups-calendar year: all firms and banks are connected within a year but there are neither banks nor firms connected across years.

Validating Bank-Specific Credit Supply Shocks Check I

- We divide our sample of 218 banks into "healthy" and "weak", definition by Bentolila et al. (2016)
- A bank is classified as weak if it was bailed out by the Spanish government in 2011-2012
  - 33 banks in total; 32 were savings banks (cajas de ahorros)
- We check whether the dummy "weak" helps in predicting our estimated bank dummies $\hat{\delta}_{it}$

Weak vs Healthy Banks
Check I

Average difference in bank supply shocks (weak - healthy)



Average difference in credit supply shocks between healthy and weak banks: weak banks had higher supply shocks until 2006 and lower afterward.

Validating Bank-Specific Credit Supply Shocks Check II

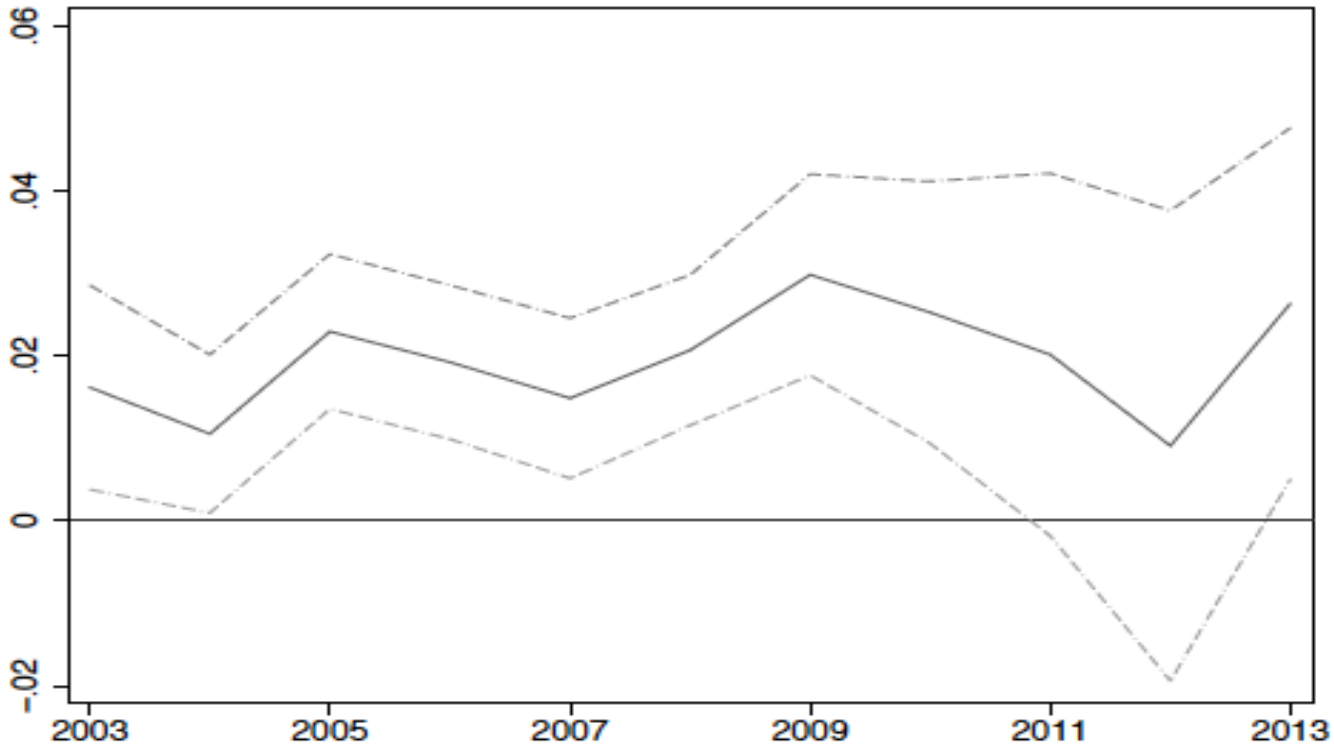
- If a bank-specific credit shock captures supply factors: bank with larger dummy $\hat{\delta}_{it}$ should grant more loans for a given firms.
- Credit registry data: loan applications bank-firm relationships
  - Observe when a firm applies for a loan to a bank; whether firm was not connected before; whether the loan was granted or not.
- For a given year, we run the following regression:

$$Loan\_Granted_{ij} = \widehat{\gamma\delta}_i + \lambda_j + \varepsilon_{ij}$$

- Loan_Granted $_{ij}$ is a dummy that takes value of 1 if the bank i has granted at least one loan to firm j (conditional on the application taking place)
- $\hat{\delta}_i$: estimated bank-supply shock for bank i, from (1).
- γ: effect of estimated supply shocks on the probability of a loan being granted.

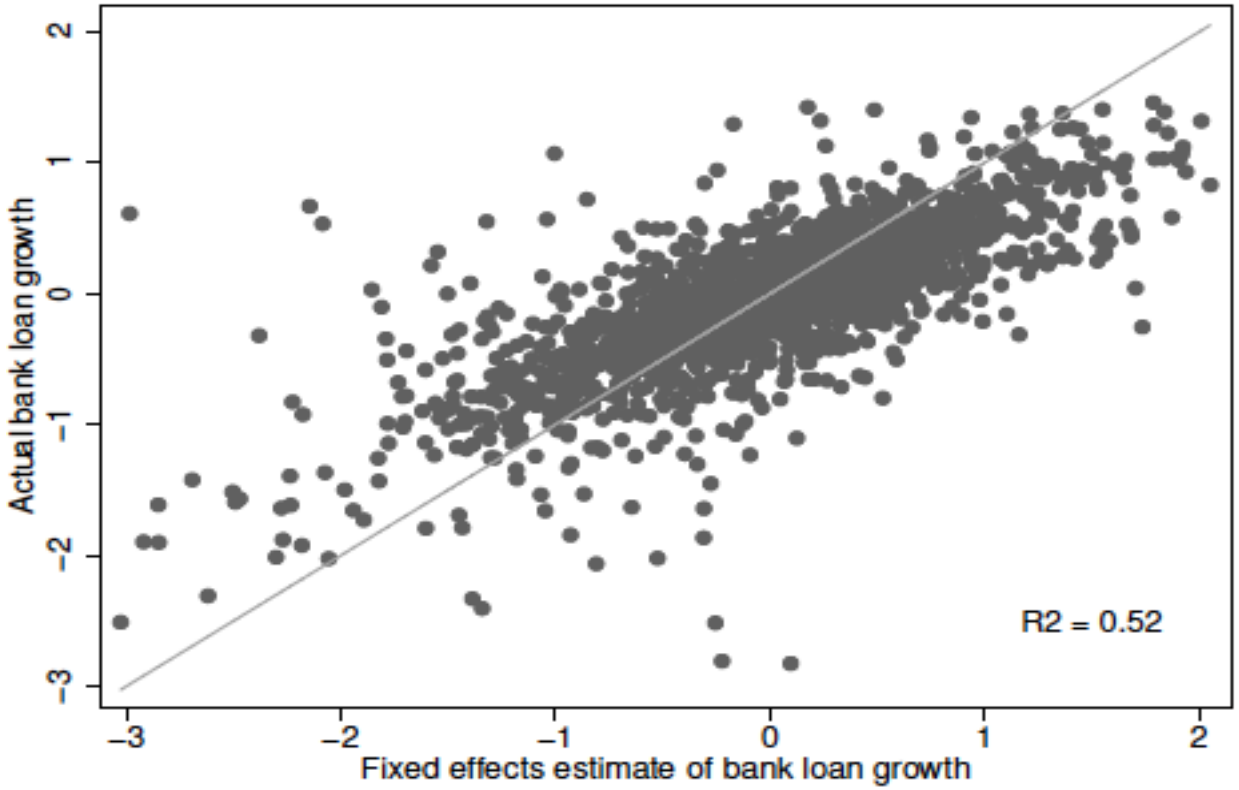
Effect of Bank Shocks on Loan Granting Check II

$$Loan\_granted_{ij} = \gamma \hat{\delta}_i + \lambda_j + \epsilon_{ij}$$



Notes. This plot is based on year-by-year regressions of the loan granted dummy on the bank-level dummies and a set of firm fixed effects. The γ parameter plotted estimates the effect of the bank dummies on the probability of acceptance of a loan request. Standard errors are clustered at the bank level.

Actual Versus Estimated Bank Loan Growth
Check III



Notes. This graph plots the relationship between the banks' actual credit growth ($\Delta \ln c_{it}$) (y-axis) and that predicted by our estimates ($\Delta \hat{\ln} c_{it}$) (x-axis). $\Delta \hat{\ln} c_{it}$ is constructed as a weighted average of the change in credit at the bank-firm (loan) level, where weights are computed as the amount of credit extended to firm j by bank i as a fraction of total credit granted by bank i (computed in $t-1$): $\Delta \hat{\ln} c_{it} = \sum_j \frac{c_{ijt-1}}{\sum_j c_{ijt-1}} \Delta \hat{\ln} c_{ijt}$ where $\Delta \hat{\ln} c_{ijt} = \hat{\delta}_{it} + \hat{\lambda}_{jt}$.

Loan-Level Effects

- For **multibank-firms**, we run:

$$\Delta \ln c_{ijt} = \beta \hat{\delta}_{it} + \eta_{jt} + \nu_{ijt} \qquad (3)$$

- $\Delta \ln c_{ijt}$: yearly average change of outstanding credit of firm *j* with bank *i* in *t*.
- $\hat{\delta}_{it}$ bank-specific supply shock (estimated in 1; standardized to have zero mean and unit variance); β lending channel
- η_{jt} firm-year effects to account for demand side (multi-banks).

- For **all banks**, we run,

$$\Delta \ln c_{ijt} = \beta \hat{\delta}_{it} + \gamma \widehat{\lambda_{jt}} + \nu_{ijt}$$

- $\hat{\lambda}_{it}$ estimated time varying firm-demand effects from (1);
- For single bank firms, firm-specific shocks are recovered subtracting the bank-specific component $\hat{\lambda}_{jt} = \Delta \ln c_{ijt} - \hat{\delta}_{it}$

Estimates of the Bank Lending Channel
Loan-Level

	2003-2013		
	(1)	(2)	(3)
Credit Shock	5.058***	5.218***	5.272***
(s.e.)	(0.088)	(0.037)	(0.025)
# obs	12,216,375	12,216,375	17,954,745
# banks	221	221	221
# firms	700,722	700,722	1,511,767
R2	0.350	0.349	0.522
Fixed effects	firm × year	$\hat{\lambda}_{jt}$	$\hat{\lambda}_{jt}$
Sample firms	Multibank	Multibank	All

Notes. This table reports the estimates of the bank lending channel parameter at the loan level (β). Column (1) is based on equation (3) for a sample of multibank firms. Columns (2) are (3) are based on equation (4) controlling for the firm-year estimated fixed effects. Dependent variable is credit growth between firm j and bank i. Bank_shock refers to the bank-specific credit supply shock ($\hat{\delta}_{it}$) estimated in equation (1) and normalized to have zero mean and unit variance. We denote significance at 10%, 5% and 1% with *, ** and ***, respectively. Standard errors clustered at the bank level are reported in parentheses.

Estimates of the Bank Lending Channel Loan-Level, cont.

	2003-2013			2003-2007	2008-2009	2010-2013
	(1)	(2)	(3)	(4)	(5)	(6)
Credit Shock	5.058***	5.218***	5.272***	5.401***	5.320***	5.181***
(s.e.)	(0.088)	(0.037)	(0.025)	(0.021)	(0.062)	(0.063)
# obs	12,216,375	12,216,375	17,954,745	7,624,590	3,682,414	5,124,886
# banks	221	221	221	209	192	192
# firms	700,722	700,722	1,511,767	1,183,558	1,049,208	1,019,567
R2	0.350	0.349	0.522	0.543	0.503	0.484
Fixed effects	firm × year	$\hat{\lambda}_{jt}$	$\hat{\lambda}_{jt}$	$\hat{\lambda}_{jt}$	$\hat{\lambda}_{jt}$	$\hat{\lambda}_{jt}$
Sample firms	Multibank	Multibank	All	All	All	All

Notes. This table reports the estimates of the bank lending channel parameter at the loan level (β). Column (1) is based on equation (3) for a sample of multibank firms. Columns (2) are (3) are based on equation (4), controlling for the firm-year estimated fixed effects. The dependent variable is credit growth between firm j and bank i. *Credit Shock* refers to the bank-specific credit supply shock ($\hat{\delta}_{it}$) estimated in equation (1), normalized to have zero mean and unit variance. We denote significance at 10%, 5%, and 1% by *, **, and ***, respectively. Standard errors clustered at the bank level are reported in parentheses.

Firm-Level Effects

- We run:

$$\Delta \ln c_{jt} = \beta^F \bar{\delta}_{jt} + \gamma^F \widehat{\lambda}_{jt} + \nu_{jt}$$

- $\Delta \ln c_{ijt}$: yearly average change of outstanding credit of firm *j* with bank *i* in *t*.
- $\bar{\delta}_j$ firm-specific bank credit supply shock (weighted average of supply shocks estimated for all banks in relationship with firm j; weights: share of previous credit of each bank with firm j).

$$\bar{\delta}_{jt} = \sum_i \frac{c_{ij,t-1}}{\sum_i c_{ij,t-1}} \hat{\delta}_{it}$$

- $\widehat{\lambda}_{jt}$ firm-level demand shock estimated in (1)

Estimated Bank Lending Channel
Firm-Level

	2003-2013	
	(1)	(2)
Credit Shock	1.158**	3.207***
(s.e.)	(0.515)	(0.278)
# obs	4,424,519	8,743,459
# banks	220	220
#firms	924,441	1,481,377
R2	0.330	0.501
Sample firms	Multibank	All

Notes. This table reports the estimates of the bank lending channel parameter at the firm level (β^F) estimated from equation (5). Dependent variable is credit growth of firm j in year t. Bank_shock refers to the firm-specific credit supply shock ($\hat{\delta}_{jt}$) estimated in equation (6) and normalized to have zero mean and unit variance. All specification include a set of firm-year effects ($\hat{\lambda}_{jt}$). We denote significance at 10%, 5% and 1% with *, ** and ***, respectively. Standard errors clustered at the main bank level are reported in parentheses.

Estimated Bank Lending Channel
Firm-Level, cont.

	2003-2013		2003-2007	2008-2009	2010-2013
	(1)	(2)	(3)	(4)	(5)
Credit Shock	1.158**	3.207***	3.414***	4.846***	2.162***
(s.e.)	(0.515)	(0.278)	(0.197)	(0.483)	(0.564)
# obs	4,424,519	8,743,459	4,122,017	1,920,723	2,700,719
# banks	220	220	208	191	193
#firms	924,441	1,481,377	1,183,558	1,049,208	1,019,567
R2	0.330	0.501	0.525	0.521	0.412
Sample firms	Multibank	All	All	All	All

Notes. This table reports the estimates of the bank lending channel parameter at the firm level (β^F) estimated from equation (5). The dependent variable is the credit growth of firm j in year t. *Credit Shock* refers to the firm-specific credit supply shock ($\hat{\delta}_{jt}$) estimated in equation (6), normalized to have zero mean and unit variance. All specifications include a set of firm-year effects ($\hat{\lambda}_{jt}$). We denote significance at 10%, 5%, and 1% with *, **, and ***, respectively. Standard errors clustered at the main bank level are reported in parentheses.

Direct Real Effects of Bank Credit Supply Shocks

- We regresses:

$$Y_{jt} = \theta \bar{\delta}_{jt} + \pi X_{jt} + \nu_{jt}$$

- $Y_{jt:}$: for firm j in time t
  - Employment growth (log difference of number of employees);
  - output growth (log difference in Euros)
  - investment (investment as a share of total capital sock in Euros)

- Bank credit supply shock

$$\bar{\delta}_{jt} = \sum_i \frac{c_{ij,t-1}}{\sum_i c_{ij,t-1}} \hat{\delta}_{it}$$

- X_{it} = firm specific characteristics:
  - firm specific credit shock, $\widehat{\lambda_{jt}}$
  - size dummies, lagged loan-to-assets ratio; lagged productivity

- Sector x year dummies.

Real Effects of Credit Shocks
Boom, Financial Crises, Recession
Employment

	Employment		
	(1)	(2)	(3)
	2003-07	2008-09	2010-13
Credit Shock	0.251	0.503***	0.243**
(s.e.)	(0.153)	(0.149)	(0.111)
# obs	1,823,859	810,335	1,430,182
R2	0.042	0.055	0.035

Notes. This table reports the effect of credit supply on employment growth for the 2003-2007 period (column (1), 2008-2009 (column (2)), and 2010-2013 (column (3)) estimated from equation (7). *Credit Shock* refers to the firm-specific credit supply shock estimated in equation (6), normalized to have zero mean and unit variance. All regressions include a set of industry × year fixed effects as well as the following control variables: firm-specific credit demand shocks ($\hat{\lambda}_{jt}$), size dummies, lagged loan-to-assets ratio, and lagged productivity. We denote significance at 10%, 5%, and 1% with *, **, and ***, respectively. Standard errors clustered at the main bank level are reported in parentheses.

Real Effects of Credit Shocks
Boom; Financial Crises; Recession
Employment

	2003-2007		2008-2009		2010-2013	
	(1)	(2)	(3)	(4)	(5)	(6)
Bank_shock	0.251	0.201	0.503***	0.502**	0.243**	0.151
(s.e)	(0.153)	(0.179)	(0.149)	(0.206)	(0.111)	(0.156)
# obs	1,823,859	1,102,347	810,335	482,597	1,430,182	851,233
R2	0.042	0.047	0.055	0.069	0.035	0.045
Sample firms	All	Multibank	All	Multibank	All	Multibank
Fixed effects	sector × year	sector × year	sector × year	sector × year	sector × year	sector × year

Notes. This table reports the effect of credit supply on employment for the 2003-2007 period (columns (1) and (2)), 2008-2009 (columns (3) and (4)), and 2010-2013 (columns (5) and (6)) estimated from equation (7). Dependent variable is employment growth in %. Bank_shock refers to the firm-specific credit supply shock estimated in equation (6) and normalized to have zero mean and unit variance. All regressions include the following control variables: firm-specific credit demand shocks ($\hat{\lambda}_{jt}$), size dummies, lagged loan-to-assets ratio, and lagged productivity. We denote significance at 10%, 5% and 1% with *, ** and ***, respectively. Standard errors clustered at the main bank level are reported in parentheses.

Real Effects of Credit Shocks: Subperiods Boom; Financial Crises; Recession

Output

	2003-2007		2008-2009		2010-2013	
	(1)	(2)	(3)	(4)	(5)	(6)
Bank_shock	0.060**	0.085***	0.152***	0.201***	0.109***	0.150***
(s.e)	(0.028)	(0.025)	(0.032)	(0.038)	(0.024)	(0.029)
# obs	1,765,665	1,074,736	764,699	459,036	1,342,639	805,684
R2	0.040	0.041	0.075	0.079	0.042	0.046
Sample firms	All	Multibank	All	Multibank	All	Multibank
Fixed effects	sector × year	sector × year	sector × year	sector × year	sector × year	sector × year

Notes. This table reports the effect of credit supply on employment for the 2003-2007 period (columns (1) and (2)), 2008-2009 (columns (3) and (4)), and 2010-2013 (columns (5) and (6)) estimated from equation (7). Dependent variable is employment growth in %. Bank_shock refers to the firm-specific credit supply shock estimated in equation (6) and normalized to have zero mean and unit variance. All regressions include the following control variables: firm-specific credit demand shocks ($\hat{\lambda}_{jt}$), size dummies, lagged loan-to-assets ratio, and lagged productivity. We denote significance at 10%, 5% and 1% with *, ** and ***, respectively. Standard errors clustered at the main bank level are reported in parentheses.

Real Effects of Credit Shocks: Subperiods Boom; Financial Crises; Recession

Investment

	2003-2007		2008-2009		2010-2013	
	(1)	(2)	(3)	(4)	(5)	(6)
Bank_shock	0.821***	1.065***	0.625***	0.678***	0.711***	0.931***
(s.e)	(0.173)	(0.294)	(0.087)	(0.187)	(0.080)	(0.169)
# obs	1,763,184	1079532	783,316	473,468	1,391,738	837,583
R2	0.034	0.033	0.016	0.016	0.011	0.012
Sample firms	All	Multibank	All	Multibank	All	Multibank
Fixed effects	sector × year	sector × year	sector × year	sector × year	sector × year	sector × year

Notes. This table reports the effect of credit supply on employment for the 2003-2007 period (columns (1) and (2)), 2008-2009 (columns (3) and (4)), and 2010-2013 (columns (5) and (6)) estimated from equation (7). Dependent variable is employment growth in %. Bank_shock refers to the firm-specific credit supply shock estimated in equation (6) and normalized to have zero mean and unit variance. All regressions include the following control variables: firm-specific credit demand shocks ($\hat{\lambda}_{jt}$), size dummies, lagged loan-to-assets ratio, and lagged productivity. We denote significance at 10%, 5% and 1% with *, ** and ***, respectively. Standard errors clustered at the main bank level are reported in parentheses.

Indirect Effects: Propagation

- Firms not directly hit by a credit shock may also be affected through buyer-supplier relations.
- Indirect effects: if a supplier of firm j is hit by a negative credit supply shock, the reaction of this supplier may also affect production of firm j (purchases/sales of intermediate inputs; changes in factor and goods prices in general equilibrium, see Acemoglu et. (2012).
- We exploit firm level information combined with input-output linkages to study the propagation effects of our identified bank-credit supply shocks (Alfaro, Antràs, Chor, and Conconi; forthcoming).
- We include two additional regressors in our empirical specification (Giovanni et al. (2017),
  - Downstream propagation (i.e. shocks from suppliers).
  - Upstream propagation (i.e. shocks from customers).

Indirect Effects: Estimation

- We regress

$$Y_{jt} = \theta \bar{\delta}_{jt} + \theta_D DOWN_{ij} + \theta_U UP_{ij} + \pi X_{jt} + \nu_{jt}$$

$$DOWN_{jt,s} = \omega_{jt}^{IN} \sum_p IO_{ps} \Delta_{jt,p}$$

$$UP_{jt,s} = \omega_{jt}^{DO} \sum_p IO_{ps} \Delta_{jt,p}$$

- $DOWN_{jt,s}$ measures the indirect shock received by firm j operating in sector s from its suppliers (downstream propagation).
- $UP_{jt,s}$ measures the indirect shock received by firm j operating in sector s from its customers (upstream propagation).
- $\Delta_{jt,p}$ is the credit supply shock hitting sector p (weighted average firm-specific shocks, using credit exposure as weights).
- IO_{ps} is the share of spending by sector s on sector p inputs.
- ω^{IN} total input usage intensity of firm j in year t (material inputs spending/material inputs + wage bill); ω^{DO} domestic sales intensity.

Propagation Effects of Supply Shocks
Employment

	(1) 2003-2013	(2) 2003-2007	(3) 2008-2009	(4) 2010-2013
Credit Shock	0.284***	0.218	0.482***	0.255**
(s.e.)	(0.098)	(0.151)	(0.156)	(0.111)
DOWN	0.301**	-0.077	0.697***	0.129
(s.e.)	(0.119)	(0.076)	(0.258)	(0.392)
UP	0.061	0.062	-0.187	-0.233*
(s.e.)	(0.120)	(0.078)	(0.291)	(0.123)
# obs	3827042	1727803	759170	1340069
R2	0.053	0.040	0.059	0.036
Fixed effects	sector × year	sector × year	sector × year	sector × year

Notes. This table reports the effects of credit supply on employment over the 2003-2013 period, and the 2003-07, 2008-09, and 2010-13 sub-periods estimated from equation . Bank_shock refers to the firm-specific credit supply shock estimated in equation (6) and normalized to have zero mean and unit variance. DOWN and UP have been constructed according to equation and respectively. All regressions include the following control variables: firm-specific credit demand shocks ($\tilde{\lambda}_{jt}$), lagged loan-to-assets ratio, and lagged productivity. We denote significance at 10%, 5% and 1% with *, ** and ***, respectively. Standard errors clustered at the main bank level are reported in parentheses.

Propagation Effects of Supply Shocks
Output

	(1) 2003-2013	(2) 2003-2007	(3) 2008-2009	(4) 2010-2013
Bank_shock	0.107***	0.069**	0.155***	0.108***
	(0.029)	(0.027)	(0.031)	(0.020)
DOWN	0.354***	0.204*	0.646***	0.184
	(0.069)	(0.106)	(0.166)	(0.251)
UP	0.209***	0.086	0.459***	-0.014
	(0.077)	(0.086)	(0.141)	(0.125)
# obs	3744353	1704934	739238	1300181
R2	0.067	0.051	0.086	0.049
Sample firms	All	All	All	All
Fixed effects	sector × year	sector × year	sector × year	sector × year

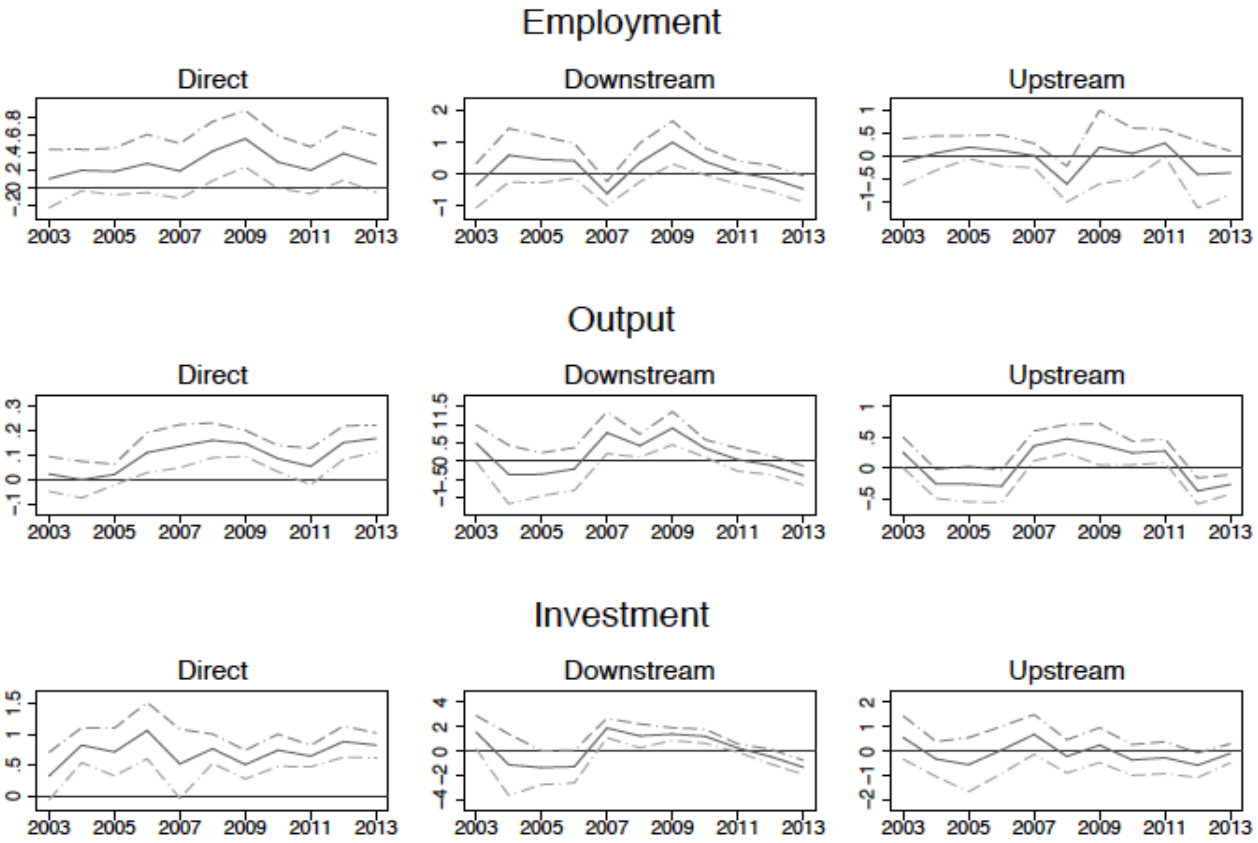
Notes. This table reports the effects of credit supply on output over the 2003-2013 period, and the 2003-07, 2008-09, and 2010-13 sub-periods estimated from equation . Bank_shock refers to the firm-specific credit supply shock estimated in equation (6) and normalized to have zero mean and unit variance. DOWN and UP have been constructed according to equation and respectively. All regressions include the following control variables: firm-specific credit demand shocks ($\tilde{\lambda}_{jt}$), lagged loan-to-assets ratio, and lagged productivity. We denote significance at 10%, 5% and 1% with *, ** and ***, respectively. Standard errors clustered at the main bank level are reported in parentheses.

Propagation Effects of Supply Shocks
Investment

	(1) 2003-2013	(2) 2003-2007	(3) 2008-2009	(4) 2010-2013
Bank_shock	0.798***	0.845***	0.576***	0.708***
	(0.075)	(0.177)	(0.101)	(0.085)
DOWN	0.690***	0.266	1.263***	0.110
	(0.174)	(0.281)	(0.320)	(0.552)
UP	0.174	0.403**	0.085	-0.402
	(0.209)	(0.172)	(0.352)	(0.401)
# obs	3737540	1687930	739729	1309881
R2	0.030	0.036	0.018	0.012
Sample firms	All	All	All	All
Fixed effects	sector × year	sector × year	sector × year	sector × year

Notes. This table reports the effects of credit supply on investment over the 2003-2013 period, and the 2003-07, 2008-09, and 2010-13 sub-periods estimated from equation . Bank_shock refers to the firm-specific credit supply shock estimated in equation (6) and normalized to have zero mean and unit variance. DOWN and UP have been constructed according to equation and respectively. All regressions include the following control variables: firm-specific credit demand shocks ($\tilde{\lambda}_{jt}$), lagged loan-to-assets ratio, and lagged productivity. We denote significance at 10%, 5% and 1% with *, ** and ***, respectively. Standard errors clustered at the main bank level are reported in parentheses.

Aggregate Direct and Indirect Effect: Employment, Output and Investment



Notes. This figure plots the estimated direct and indirect effects of credit supply shocks from year-by-year regressions. Specifically the figure plots the effect of a one standard deviation increase in the credit supply shock on annual employment and output growth as well as investment in percentage points. The estimation samples includes, on average, 347,913, 340,396 and 339,776 firms in each year. Standard errors used to construct the confidence bands are multi-clustered at the main bank and industry level.

Additional Robusntess

- Different Subsamples for Shock Identification and Real Effects Estimation
- Subsample firms with at least 5 banks
- Lagged exposure bank i firm j

Real Effects of Credit Shocks (2008-2009)
Firm Size

	employment			output			investment		
	(1) 0-10	(2) 10-500	(3) +500	(4) 0-10	(5) 10-500	(6) +500	(7) 0-10	(8) 10-500	(9) +500
Credit Shock	0.447***	0.638*	1.063	0.065***	0.305***	0.268	0.460***	0.438***	3.106
(s.e)	(0.133)	(0.319)	(0.894)	(0.013)	(0.049)	(1.247)	(0.098)	(0.148)	(2.807)
DOWN	1.016***	0.480	-1.028	0.515***	2.183***	4.407	1.497***	0.925**	0.061
(s.e)	(0.336)	(0.663)	(1.309)	(0.170)	(0.343)	(1.598)	(0.266)	(0.407)	(1.917)
UP	0.312	-0.219	1.455	0.328**	0.246	1.834	0.242	0.134	-0.212
(s.e)	(0.392)	(0.609)	(0.838)	(0.153)	(0.224)	(1.218)	(0.348)	(0.402)	(1.215)
# obs	289,327	98,522	1,036	279,098	97,389	1,015	280,285	97,939	1,050
R2	0.042	0.051	0.058	0.116	0.096	0.10	0.012	0.015	0.013
Sample firms	All	All	All	All	All	All	All	All	All
Fixed effects	sector × year	sector × year	sector × year	sector × year	sector × year	sector × year	sector × year	sector × year	sector × year

From Micro to Macro: Aggregate Effects of Credit Shocks

- Quantify the aggregate effects of bank credit supply shocks on output and employment (Biggio and La'O).
- IV strategy to identify the elasticity between credit and employment at the firm level;
- We aggregate to the industry level the employment effects of credit shocks estimated at the firm level.
- We use these direct effects estimated from the data in the calibration of a general equilibrium model with input-output linkages that allows us to quantify the aggregate effects (both direct and indirect) of credit shocks.

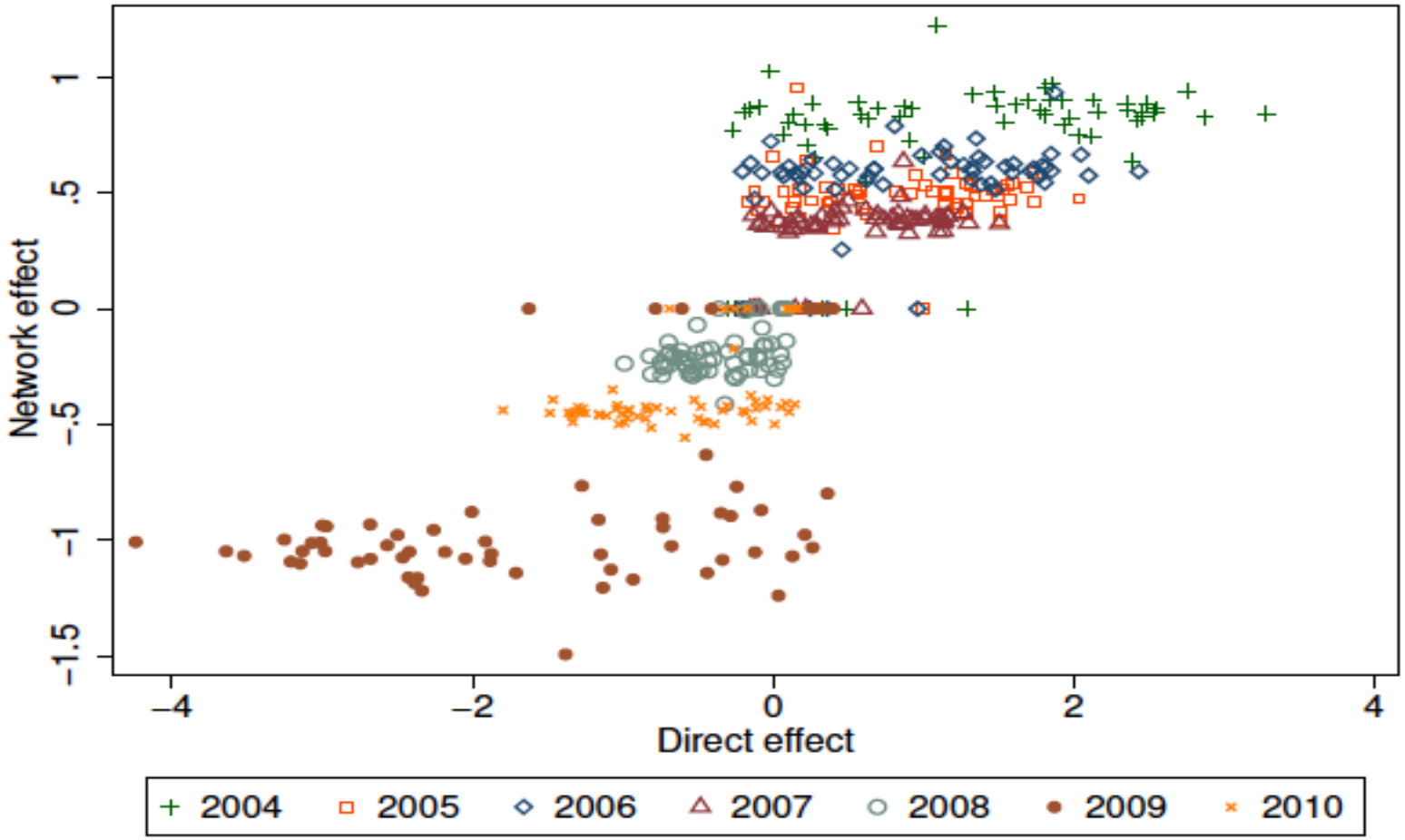
Model: Description

- Production: *n* industries operate in the economy.
  - Firms: decreasing returns to scale Cobb-Douglas production, labor and intermediate goods are used as inputs: $$y_i = \left[l_i^{\alpha_i} \left(\prod_{j=1}^{n} x_{ij}^{w_{ij}} \right)^{1-\alpha_i} \right]^{\eta_i}$$
  - Intensity use of inputs: by the input-output structure of the economy.
- Financial frictions: We assume the existence of working capital: firms must pay wages and the cost of intermediate goods before production takes place and borrow for this purpose.
  - Financial markets are subject to imperfection: firms can borrow up to a fraction of their revenue. A firm operating in industry i maximizes its profits subject to: $$l_i + \sum_{j=1}^{n} p_j X_{ij} \leq \chi_i p_i y_i$$
- Households: maximizes utility depending on consumption and labor
- Equilibrium: i. firms and the representative household solves their maximization problem; ii. Market clears

Calibration

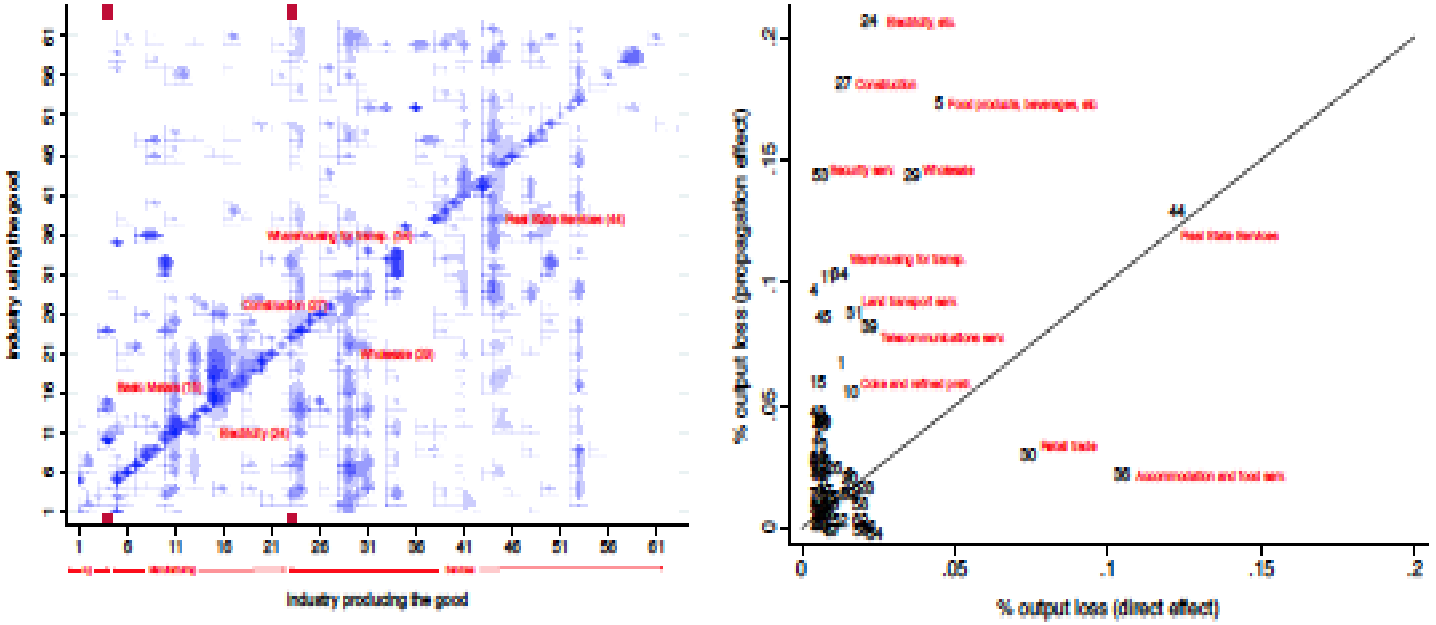
- Solve model for the year 2003 and subsequently match our estimated direct effects year-by-year in the horizontal economy.
- We use full model with IO linkages to recover the propagation effects.
- (i) Parameters from literature: decreasing returns to scale in every industry; household labor supply;
- (ii) Spanish economy in 2003:
  - Expenditure on each intermediate good as a fraction of total expenditure on intermediate goods (I-O).
  - The labor share in each industry: industries' expenditures in labor as a fraction of total expenses in inputs.
  - Industries shares in the household's utility function: final consumption expenditures industry shares
- Financial shocks: matching (with a model in which propagation is absent) the direct effect of employment predicted by estimates

Direct and Indirect Effects



Industry Specific Shocks and their Propagation

Figure 6: IO structure (left panel) and output losses of isolated industry specific shocks (right panel)



Concluding Remarks

- We consider the real effects of the bank lending channel and how bank-lending shocks permeate through the economy using input-output linkages.
- We combine a matched bank-firm-loan dataset with information on the universe of corporate loans in Spain over the period 2002-2013.
- We construct firm-specific credit supply shocks and estimate their effects on firm credit, employment and output.
- Credit supply shocks matter for real economic activity, especially during financial crises.
- Indirect effects are sizeable: the propagation through buyer-seller interactions substantially amplifies the aggregate impact of credit shocks on real activity.