Banking Relationships and Inflation During a Financial Crisis

Tobias Renkin

(Danmarks Nationalbank)

Gabriel Züllig

(Danmarks Nationalbank & Oxford University)

June 8, 2021

Introduction

In this paper, we estimate the effect of credit supply shocks during the Global Financial crisis on firms' output prices.

1. Why did prices not decrease more during the Great Recession?

   - "Missing disinflation" during the recession

2. Can macroprudential policy affect inflation?

   - Macroprudential policy aims at financial stability —
   - but could have unintended effect on inflation through credit supply.

Why would prices depend on credit supply?

The previous literature has introduced several channels through which credit supply directly affects prices (mostly) in theory:

- Working capital channel (negative)

  Christiano and Eichenbaum (1992); Bigio (2015); Christiano et al. (2015)

- Liquidity channel (negative)

  Gilchrist et al. (2017)

- Inventory fire-sale channel (positive)

  Kim (2021)

But existing empirical evidence is still scarce—no clear answer on direction and magnitude of the effects, or the importance of channels

We provide causal evidence on the relationship between credit supply and prices, using

- a rare collection of matched microdata on bank loans and prices
- for a broadly representative sample of Danish manufacturing and wholesale firms
- and an established identification strategy based on bank-level shocks.

  Similar to Chodorow-Reich (2014), Jensen and Johannesen (2017), Kim (2021)

Moreover, we provide some evidence for the relative importance of mechanisms.

Main results

- Large negative credit supply shocks lead to large increases in producer prices
- Exposed firms increase profits in the short run, but lose market share in the longer run

Takeaways

- Higher prices and profits in line with liquidity channel of Gilchrist et al. (2017)
- Counterfactuals suggest loan supply played important role in the "missing disinflation"
- Policies aimed at maintaining financial stability could enhance deflationary tendencies during financial crises

Data, Estimation, Idenfitication

Data

Universe of loans between Danish banks and firms

- Based on banks' annual reports to SKAT
- Includes any type of bank loan, excludes mortgages.
- Loan balance EOY, interest paid over year. Interest rate
  $i_t = \text{interest payments}_t / (0.5 \cdot (\text{Loans}_t + \text{Loans}_{t-1}))$

Producer Price Index survey (Clean data, but small sample)

- Monthly survey of large Danish manufacturing firms
- Firms report prices for a persistent selection of products

Export quantities and sales (Noisy data, but large sample)

- Monthly customs data (non-EU exports) and firm reports (EU exports) at 8-digit CN level
- P = Revenue / Quantity. We calculate annual price indices at the firm 2-digit CN level.

Loan data vs. bank balance sheets   Interest rate benchmark   Prices vs UV benchmark

Sample

Sample construction from population of Danish firms:

- Manufacturing and wholesale firms
- >10 employees and >1 Mio DKK revenue in 2007
- Survive 2005–2010
- >DKK100,000 Loans and >0.01 Loans-to-revenue in 2007

This results in a sample of

- 2960 firms
- 271 matched to PPI prices
- 1989 matched to Export data

Match accounts for 36% (PPI) and 89% (UV) of employment conditional on restrictions

Descriptives

Bank Level Shocks

Exogenous variation in firm-level credit supply from bank-level exposure to GFC, based on Jensen and Johannesen (2017):

- Before 2007, some banks rely on interbank market for funding
- When interbank market freezes up, these banks reduce loan supply relative to deposit-focused banks
- We split banks in exposed and non-exposed group at the median 2007 loans (on asset side) to deposits ratio
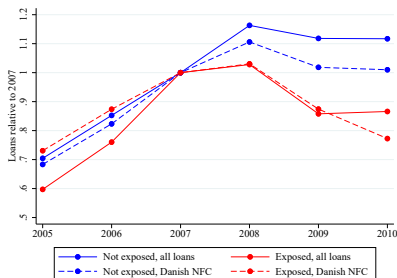
Firm exposure and identification

Firms exposure to loan supply shock is the share of loans with exposed banks in 2007:

$$\text{Exposure}_i = \frac{\sum_{j \in J} \text{Loans}_{i,j,2007} \times 1(LDR_{j,2007} > K)}{\sum_{j \in J} \text{Loans}_{i,j,2007}}$$

Identification assumption: Bank exposure is independent of susceptibility to the recession through other channels.

- Important firm characteristics similar between exposed and non-exposed firms
- No differences in price or loan dynamics up to 2007
- Results are not sensitive to numerous robustness checks that control for firm characteristics

⊳ Treatment Distribution   ⊳ Firm characteristics

Estimation

Baseline OLS for loans and PPI prices:

$$Y_{i,t} = \Lambda_i + \Gamma_{s(i),t} + \sum_{\substack{k=2005 \\ k \neq 2007}}^{2010} 1(t=k) \times (\beta_k \text{Exposure}_i + \gamma_k X_i)$$

- β_k estimates diff-in-diff relative to base period
- Identification comes from within-sector variation
- We control for dynamic effect of some firm characteristics
  2007 interest rate, loans to revenue, deposits to revenue, short-term loans share
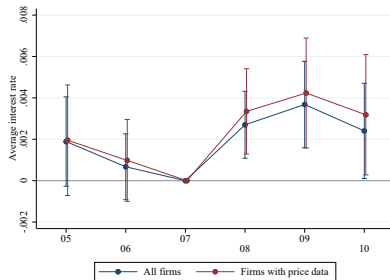
FGLS procedure for unit values:

- Some UV series are noisier than others (misreporting, within-CN8 composition changes, ...)
- Our approach: estimate OLS, calculate residual variance for each series, weight by inverse in 2nd step

Main results
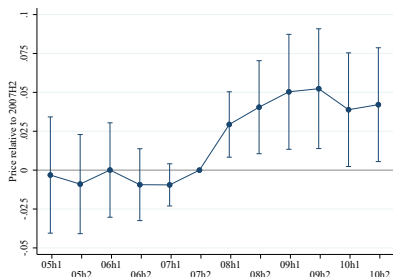
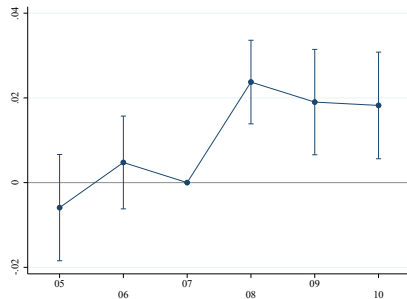# The credit supply shock at the firm level
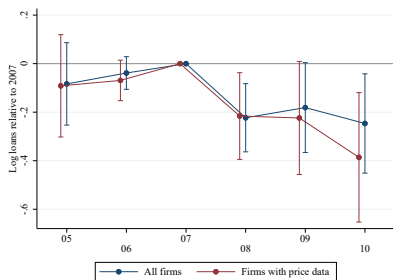
(a) Loans

(b) Interest rate

Effects of firm exposure:

- Loans of fully exposed firms drop by ∼20% relative to non-exposed firms
- Interest rate increases by ∼0.4pp or 8%

⇥ Additional results on loans   ⇥ Robustness

Reduced form effect on prices and unit values

(a) PPI prices

(b) Export unit values

- Domestic prices in the PPI increase by ∼5%
- Export unit values increase by ∼2%
- Effect appears in 2008 and remains significant until end of sample period in 2010

IV estimates of loan supply elasticity of prices

|	PPI prices			Export unit values		
	(1) 2007–2008	(2) 2007–2009	(3) 2007–2010	(4) 2007–2008	(5) 2007–2009	(6) 2007–2010
log Loans	-0.066**	-0.065**	-0.037*	-0.037**	-0.015**	-0.008
	(0.029)	(0.033)	(0.020)	(0.017)	(0.008)	(0.005)
Firm-product	Yes	Yes	Yes	Yes	Yes	Yes
time-4d NACE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5919	5926	5779	29242	29132	28964
Firms	224.00	224.00	224.00	1742.00	1739.00	1724.00
1st stage F stat.	4.53	5.83	6.35	5.81	7.46	9.80

- Instrument loans with Exposure $\times$ post period dummy
- Elasticity of prices to loan supply of -0.06 for domestic PPI prices and -0.03 for export unit values
- We can't distinguish delayed response to shock from variation in the shock over time

- Effect is smaller for firms with more cash reserves and larger for firms with more loans

  ↣ Firm heterogeneity

- Effect is smaller for firms/products with more elastic demand

  ↣ Product heterogeneity I

- Effect is smaller for firms/products that respond more to variation in competitors' prices (strategic complementarity)

  ↣ Product heterogeneity II

# Channels: cost pass-through or higher markups?
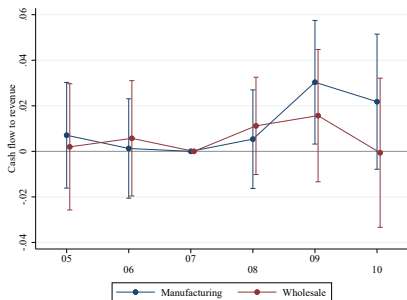
(a) Cash flow to revenue
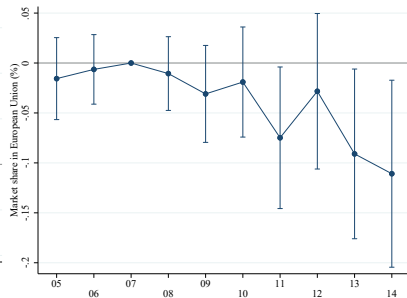
(b) Long run market share (Mfg. only)

- Cash flow (or profit) measures increase in the short run
- Longer run market share decreases
- Consistent with liquidity channel—firms increase markups to raise liquidity internally

Aggregate implications

PE counterfactual: How would aggregate PPI evolve if exposed banks' loan supply evolved like non-exposed banks'?
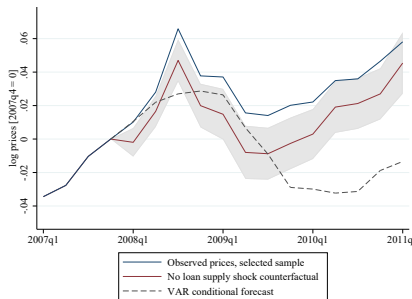

- PPI up to 2.5% lower during 2008–2010
- Price developments closer to conditional VAR forecast
- Partial equilibrium should understate aggregate response (i.e. no strategic complementarity, loan market spillovers)

Conclusion

- Negative loan supply shock has positive impact on prices

- Elasticities between -0.06 and -0.03

- Results on profits suggest this is driven by liquidity needs rather than cost of working capital

- Counterfactual calculations suggest financial frictions had large impact on aggregate prices during the Great Recession
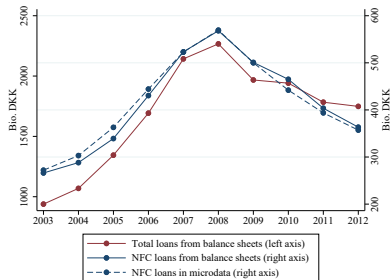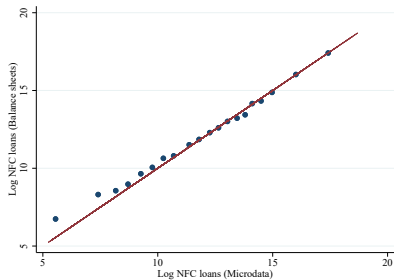
Appendix slides

Prices vs unit values benchmark
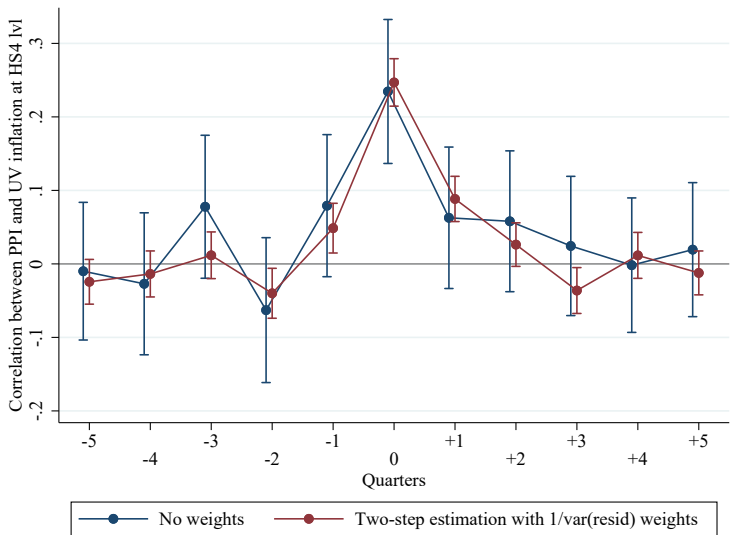
Interest rate benchmark
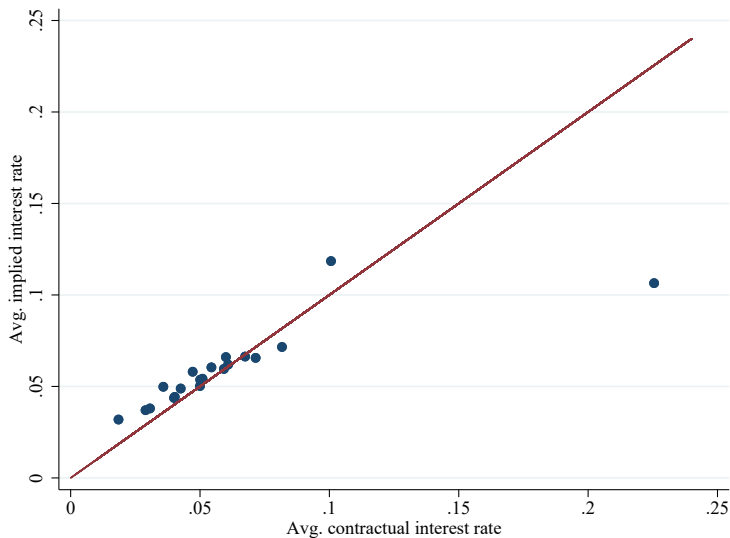
Bank balance sheets vs. Microdata

(a) Aggregate lending over time

(b) Bank level correlation

Accounting debt vs. bank loans
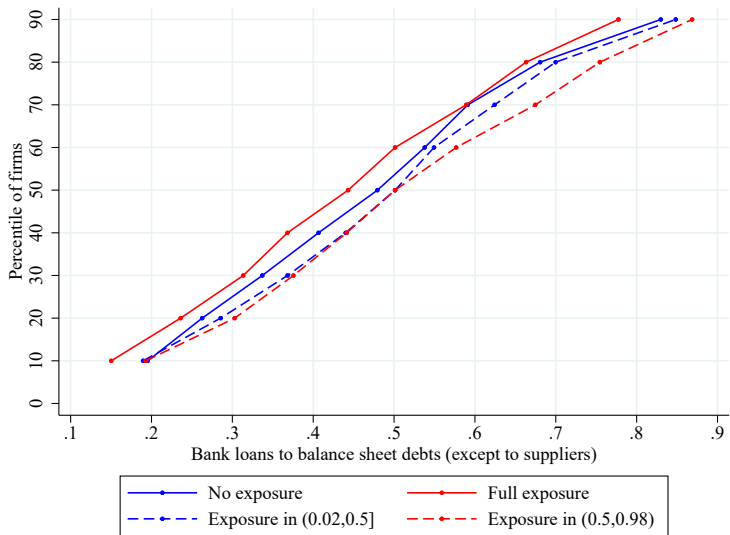
Sample construction

Median in:	Baseline sample	Matched with PPI	Matched with UV
Employment	32.0	135.0	41.0
Manufacturing share	0.64	0.96	0.63
Profit to revenue	0.05	0.05	0.05
Bank deposits to revenue	0.00	0.01	0.00
Bank loans to revenue	0.13	0.15	0.13
Bank loans to BS debt	0.46	0.44	0.47
Inventories to revenues	0.14	0.15	0.15
Avg. interest rate	0.06	0.05	0.05
Bank lending connections	2.0	3.0	2.0
Share of primary bank in loans	0.99	0.95	0.99
Products reported in PPI		3.0	
Exported 2-digit CN categories			5.0
Observations	2960	271	1989

↪ Back

Sample construction

Restriction	All firms		In PPI			In exports		
	Firms	Emp. share	Firms	Emp. share	Match share	Firms	Emp. share	Match share
Manufacturing and wholesale firms in 2007	15044	1	551	.28	.28	5967	.78	.78
At least 10 employees and 1 Mio DKK revenue in 2007	6215	.9	530	.28	.31	3917	.75	.83
Banking relationship in 2007	6134	.89	527	.28	.31	3888	.75	.84
Active 2005–2010	4950	.77	472	.26	.34	3268	.67	.87
100,000 DKK outstanding loans in 2006 and 2007 and loans-to-revenue ratio in 2007> 0.01	2960	.45	271	.16	.36	1989	.39	.87
Reports prices every year 2007–2010	1767	.37	268	.16	.43	1760	.37	1

▸ Back

Distribution of treatment
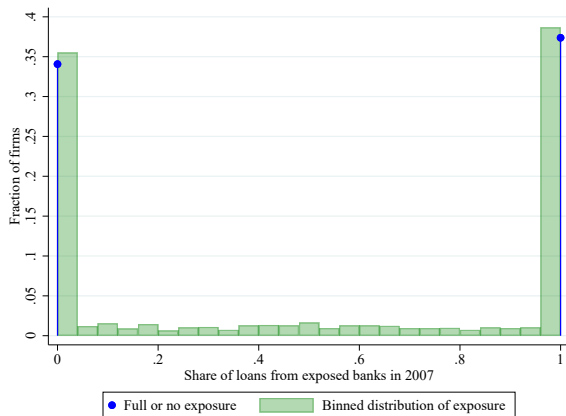
Exposure commonly either 0 or 1, but because some firms have multiple banks it is a continous variable. ⟪ ↦ Back ⟫

Characteristics of exposed and non-exposed firms

Figure: Size (Employment)

Characteristics of exposed and non-exposed firms

Figure: Profits to revenue

Characteristics of exposed and non-exposed firms

Figure: Equity share

Characteristics of exposed and non-exposed firms
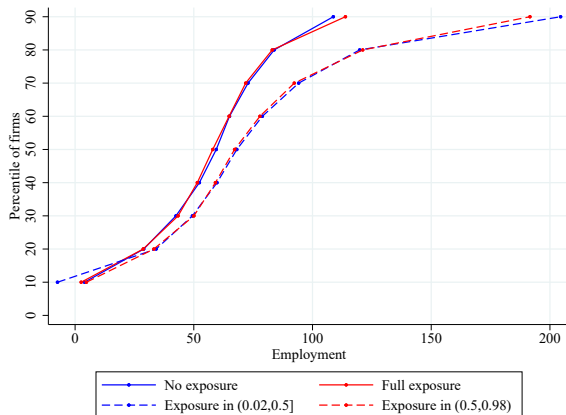

Figure: Loans to revenue

Characteristics of exposed and non-exposed firms
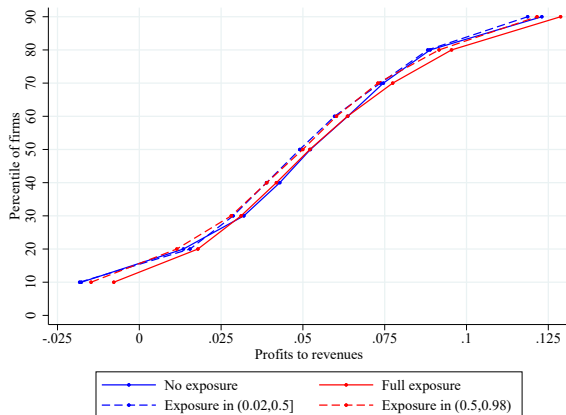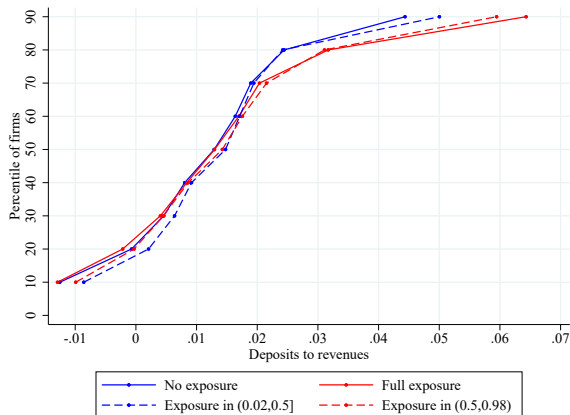

Figure: Deposits to revenue

Characteristics of exposed and non-exposed firms

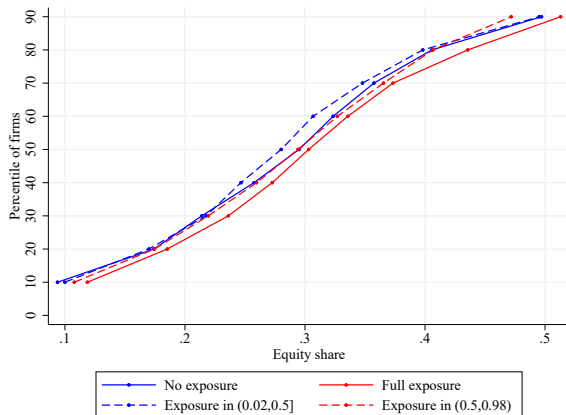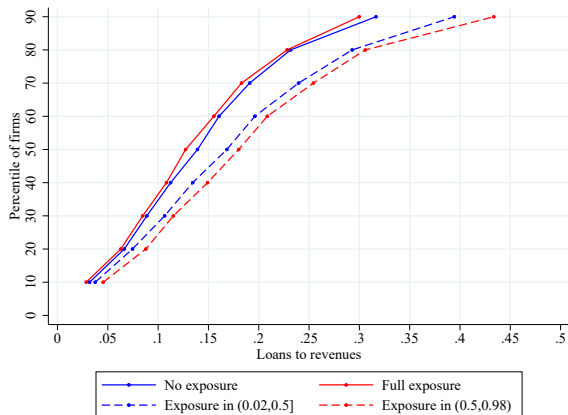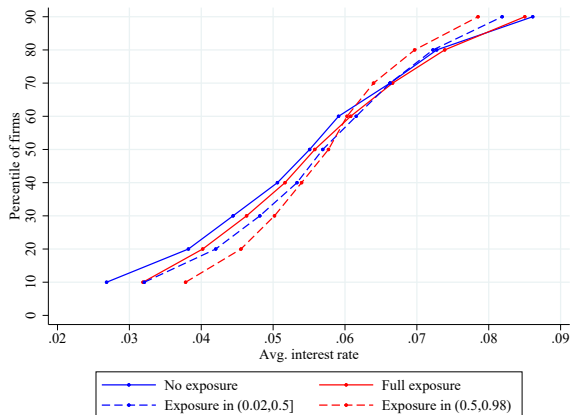Figure: Interest rate

Characteristics of exposed and non-exposed firms
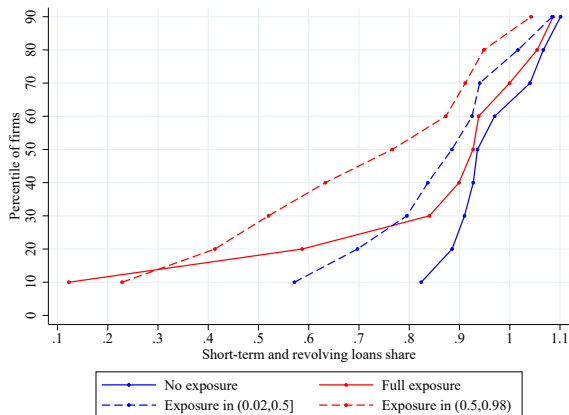
Figure: Short-term and revolving loans share

Characteristics of exposed and non-exposed firms
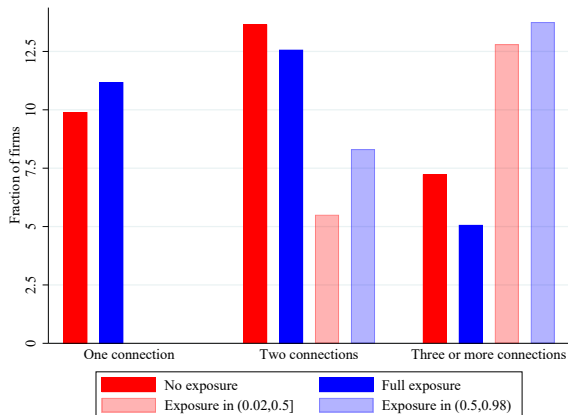
Figure: Bank connections
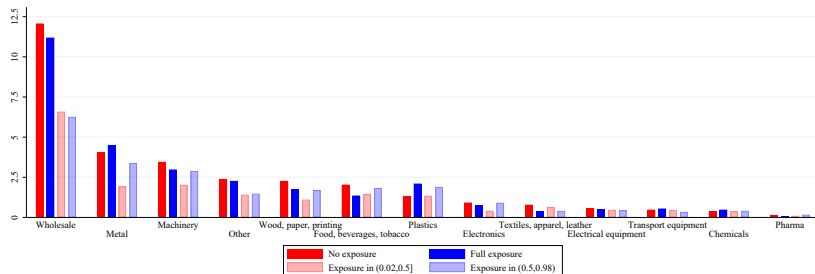
Figure: Sectors

⊳ Back

Alternative treatment of zeros in loan data

	All firms			Firms in price data		
	(1) Log	(2) IHS	(3) GR OLS	(4) Log	(5) IHS	(6) GR OLS
2008	-0.17***	-0.22***	-0.10***	-0.17**	-0.22**	-0.10***
	(0.06)	(0.07)	(0.03)	(0.09)	(0.09)	(0.04)
2009	-0.23***	-0.18*	-0.08***	-0.26**	-0.22*	-0.10***
	(0.08)	(0.09)	(0.03)	(0.11)	(0.12)	(0.04)
2010	-0.26***	-0.25**	-0.08**	-0.36***	-0.39***	-0.11**
	(0.09)	(0.10)	(0.04)	(0.12)	(0.14)	(0.05)
Firm	Yes	Yes	Yes	Yes	Yes	Yes
time-4d NACE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17314	17580	17580	11600	11754	11754
Firms	2930	2930	2930	1959	1959	1959

▸ Back

Robustness checks for loan outcome

	All firms			Firms in price data		
	(1) Trend	(2) No ctrl	(3) PDSLASSO	(4) Trend	(5) No ctrl	(6) PDSLASSO
2008	-0.27***	-0.14**	-0.22***	-0.25*	-0.11	-0.21**
	(0.10)	(0.07)	(0.07)	(0.13)	(0.09)	(0.09)
2009	-0.27*	-0.08	-0.17*	-0.31	-0.10	-0.22*
	(0.15)	(0.09)	(0.09)	(0.19)	(0.12)	(0.12)
2010	-0.37*	-0.17*	-0.24**	-0.52**	-0.28**	-0.37***
	(0.20)	(0.10)	(0.10)	(0.25)	(0.13)	(0.14)
Firm	Yes	Yes	No	Yes	Yes	No
time-4d NACE	Yes	Yes	Yes	Yes	Yes	Yes
Firm trend	Yes	No	No	Yes	No	No
Observations	17580	17580	17580	11754	11754	11754
Firms	2930	2930	2930	1959	1959	1959

↦ Back

Robustness checks for interest rates

	All firms				Firms in price data			
	(1) Base	(2) Trend	(3) No controls	(4) PDS LASSO	(5) Base	(6) Trend	(7) No controls	(8) PDS LASSO
2008	0.003***	0.004***	0.002***	0.003***	0.003***	0.004***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
2009	0.004***	0.006***	0.003**	0.004***	0.004***	0.006**	0.003**	0.004***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
2010	0.002**	0.005**	0.001	0.002**	0.003**	0.006*	0.001	0.003**
	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)	(0.001)
Firm	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
time-4d NACE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm trend	No	Yes	No	No	No	Yes	No	No
Observations	17580	17580	17580	17580	11754	11754	11754	11754
Firms	2930	2930	2930	2930	1959	1959	1959	1959

▸ Back

Mechanics of loan decreases
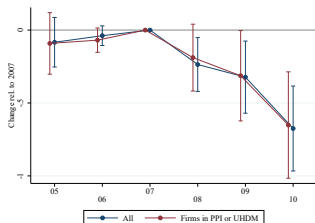
(a) Balance of pre-2007 loans drops strongly
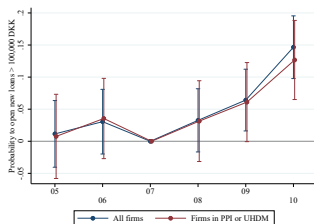
(b) New loans increase (propensity)

(c) New loans increase (share)

(d) Share of 2007 primary bank decreases

PPI Results, different specifications & samples

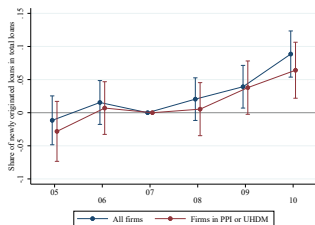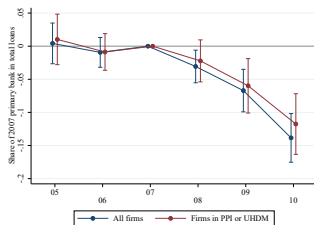|	(1) Baseline	(2) Firm trend	(3) CN FE	(4) No controls	(5) PDSLASSO
2008	0.038*** (0.012)	0.036** (0.014)	0.030** (0.012)	0.033*** (0.012)	0.040*** (0.012)
2009	0.055*** (0.018)	0.053** (0.025)	0.047** (0.018)	0.051*** (0.018)	0.056*** (0.019)
2010	0.045*** (0.017)	0.041 (0.027)	0.036** (0.017)	0.048*** (0.017)	0.045*** (0.017)
Firm-product	Yes	Yes	Yes	Yes	Yes
time-4d NACE	Yes	Yes	Yes	Yes	Yes
time-2d CN	No	No	Yes	No	No
Firm trend	No	Yes	No	No	No
Observations	17071	17071	17071	17071	17071
Firms	223	223	223	223	223

	(1) Full/No Exposure	(2) Manufacturing only	(3) Include entry/exit	(4) Include exports	(5) Include low loans	(6) No sample restrictions
2008	0.023* (0.014)	0.038*** (0.012)	0.033*** (0.011)	0.027** (0.010)	0.035*** (0.010)	0.015** (0.007)
2009	0.051** (0.020)	0.055*** (0.018)	0.050*** (0.018)	0.036** (0.016)	0.034** (0.016)	0.018 (0.013)
2010	0.037** (0.018)	0.045*** (0.017)	0.043*** (0.017)	0.029* (0.017)	0.017 (0.020)	0.015 (0.016)
Firm-product	Yes	Yes	Yes	Yes	Yes	Yes
time-4d NACE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9839	16781	20188	28296	26490	50423
Firms	133	219	272	290	362	558

◄ Back

UV Results, different specifications & samples

	(1) Baseline	(2) Trend	(3) CN	(4) No ctrl	(5) Lasso
2008 × Exposure	0.024***	0.016**	0.025***	0.024***	0.024***
	(0.005)	(0.007)	(0.005)	(0.005)	(0.005)
2009 × Exposure	0.019***	0.010	0.021***	0.014**	0.019***
	(0.006)	(0.010)	(0.006)	(0.006)	(0.006)
2010 × Exposure	0.018***	0.001	0.021***	0.013**	0.018***
	(0.006)	(0.013)	(0.006)	(0.006)	(0.006)
Firm-product	Yes	Yes	Yes	Yes	Yes
time-4d NACE	Yes	Yes	Yes	Yes	Yes
time-2d CN	No	No	Yes	No	No
Firm trend	No	Yes	No	No	No
cvrnr	No	Yes	No	No	No
Observations	35424	35424	35424	35424	35424
Firms	1880	1880	1880	1880	1880

	(1) Full/No Exposure	(2) Mfg.	(3) Wholesale	(4) Incl. entry/exit	(5) Incl. low loans	(6) No restrictions
2008 × Exposure	0.023***	0.024***	0.024***	0.020***	0.018***	0.015***
	(0.006)	(0.007)	(0.008)	(0.005)	(0.005)	(0.004)
2009 × Exposure	0.017**	0.031***	0.009	0.015**	0.012**	-0.000
	(0.007)	(0.008)	(0.010)	(0.006)	(0.006)	(0.005)
2010 × Exposure	0.011	0.031***	0.006	0.013**	0.006	0.001
	(0.007)	(0.009)	(0.009)	(0.006)	(0.006)	(0.005)
Firm-product	Yes	Yes	Yes	Yes	Yes	Yes
time-4d NACE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23928	18180	17244	42054	39936	80843
Firms	1329	1167	713	2002	2044	2588

◄ Back

ing

Figure: Unit value effects and weighting
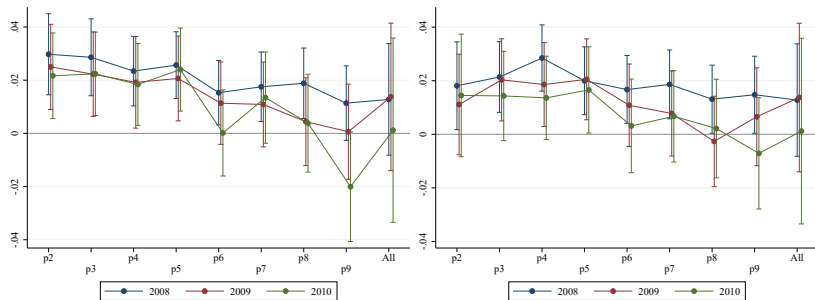
(a) Unweighted effect by SD of
first-step FGLS residuals

(b) Unweighted effect by SD of log
unit value series

▸ Back

Propensity Score Matching

	PPI prices		Export unit values	
	(1)	(2)	(3)	(4)
	Linear	Probit	Linear	Probit
2008	0.046***	0.057***	0.017***	0.030***
	(0.015)	(0.016)	(0.006)	(0.006)
2009	0.063***	0.071***	0.013*	0.033***
	(0.017)	(0.017)	(0.007)	(0.006)
2010	0.056***	0.080***	0.019***	0.037***
	(0.016)	(0.018)	(0.007)	(0.007)
Firm-product	Yes	Yes	Yes	Yes
time-4d NACE	Yes	Yes	Yes	Yes
time-match group	Yes	Yes	Yes	Yes
Observations	14336	13627	22440	22596
Matches	150	149	903	902
Firms	187	177	1333	1339

▸ Back

Other firm outcomes

	(1) Labor cost	(2) Revenue	(3) Revenue per worker	(4) Profit to revenue	(5) Cash flow to revenue	(6) Inventory (IHS)
			Manufacturing			
2008	-0.045***	-0.009	0.036**	0.006	0.004	-0.031
	(0.012)	(0.016)	(0.015)	(0.007)	(0.011)	(0.059)
2009	-0.061***	0.015	0.076***	0.022**	0.030**	0.070
	(0.022)	(0.029)	(0.022)	(0.010)	(0.014)	(0.118)
2010	-0.050*	-0.004	0.046*	0.004	0.022	0.063
	(0.029)	(0.035)	(0.025)	(0.009)	(0.015)	(0.129)
Observations	7338	7338	7338	7338	7338	2535
Firms	1223	1223	1223	1223	1223	428
			Wholesale			
2008	-0.012	0.006	0.018	-0.002	0.011	-0.071
	(0.016)	(0.017)	(0.018)	(0.007)	(0.011)	(0.071)
2009	0.021	0.060*	0.038	-0.001	0.016	-0.011
	(0.025)	(0.032)	(0.030)	(0.010)	(0.015)	(0.118)
2010	-0.008	0.004	0.012	-0.005	-0.001	-0.058
	(0.032)	(0.046)	(0.039)	(0.008)	(0.017)	(0.140)
Observations	4410	4410	4410	4410	4410	920
Firms	735	735	735	735	735	156
Firm	Yes	Yes	Yes	Yes	Yes	Yes
time-4d NACE	Yes	Yes	Yes	Yes	Yes	Yes

Saki Bigio. Endogenous Liquidity and the Business Cycle. *American Economic Review*, 105(6):1883–1927, June 2015. ISSN 0002-8282. doi: 10.1257/aer.20110035. URL https://www.aeaweb.org/articles?id=10.1257/aer.20110035.

Gabriel Chodorow-Reich. The Employment Effects of Credit Market Disruptions: Firm-level Evidence from the 2008–9 Financial Crisis *. *The Quarterly Journal of Economics*, 129 (1):1–59, February 2014. ISSN 0033-5533. doi: 10.1093/qje/qjt031. URL https://doi.org/10.1093/qje/qjt031.

Lawrence J. Christiano and Martin Eichenbaum. Liquidity Effects and the Monetary Transmission Mechanism. *The American Economic Review*, 82(2):346–353, 1992. ISSN 0002-8282. URL https://www.jstor.org/stable/2117426. Publisher: American Economic Association.

Lawrence J. Christiano, Martin S. Eichenbaum, and Mathias Trabandt. Understanding the Great Recession. *American Economic Journal: Macroeconomics*, 7(1):110–167, January