



THE TWENTY-NINTH DUBROVNIK ECONOMIC CONFERENCE

Organized by the Croatian National Bank

Jurica Zrnc and Martin Pintarić

Loan Supply and Prices

Hotel "Palace"

Dubrovnik

May 25 – 27, 2023

Draft version

Please do not quote



CROATIAN NATIONAL BANK

EUROSYSTEM

Loan Supply and Prices*

Jurica Zrnc¹
(joint with: Martin Pintarić¹)

¹Hrvatska narodna banka

May 26, 2023

*The views and conclusions expressed in this paper are those of the authors and do not necessarily reflect the position of the institution that the authors work for.

How do financial shocks affect inflation?

- ▶ Central banks worldwide are battling high inflation, but at the same time there is a growing threat of financial instability
- ▶ "Standard" view - financial shocks depress output
 - ▶ But what happens to prices? How relevant is the cost channel of financial shocks?
- ▶ Not a theoretical quirk - the greatest financial shock in recent memory featured a "missing disinflation"
- ▶ In this paper, we study the effects of bank loan supply shocks on retail prices using micro data

What we do

- ▶ Merge data on retail prices with firm financial statements and the credit registry
- ▶ Estimate bank shocks using Amiti and Weinstein (2018)
- ▶ Study how bank shocks from firms transmit to retail prices:
 - ▶ Short-term loans and Working capital
 - ▶ Market power
 - ▶ Fire sales of inventories
 - ▶ Interaction with energy shocks

Conceptual framework

1. **Cost channel:** e.g. firms must pay factors of production in advance (e.g. Christiano, Eichenbaum and Trabandt, 2015)
 - ▶ a financial shock raises the production cost for firms
2. **Market power:** firms invest in customer base to increase size
 - ▶ a financial shock induces firms to increase markups and cash flows at the expense of market share (Chevalier and Sharfstein (1996), Gilchrist et al. (2017))
3. **Fire sales:** firms decrease markups to sell more products and gain additional liquidity (Hendel, 1996; Kim , 2021; Lenzu, Rivers and Tielens, 2022)

Data sources

- ▶ Data covering the 2011-2022 period
- ▶ Fina (Business Registry): annual financial statements (balance sheet, profit and loss account and additional information)
- ▶ Monetary statistics of the Croatian National Bank: monthly stock and transactions data on bank claims against firms, including individual firm-bank relationships
- ▶ Detailed monthly data on retail prices in biggest supermarkets in Croatia (private company) - 200,000 individual retail items at monthly level.

Identification problem and empirical approach

Identification problem: how to disentangle loan demand from supply shocks?

Amiti and Weinstein (2018): using multi-bank firms, one can control perfectly for firm \times time shocks:

$$\text{Loan growth}_{ibt} = \alpha_{it} + \beta_{bt} + \epsilon_{ibt},$$

where α_{it} is the firm \times time effect β_{bt} is the bank \times time (the bank lending shock).

AW show that their methodology is valid for all models in which loan growth is a linear combination of bank and firm characteristic and their interactions.

Amiti and Weinstein (2018) Idiosyncratic Bank Shocks

AW do much more as their estimator obeys aggregate resource constraints and allows for new lending relationships. We implement this estimator, which is widely used in the literature.

These bank shocks are then aggregated at the firm level using pre-determined exposures:

$$\text{Bank shock}_{ft} = \sum_b \theta_{f,b,t-1} \hat{\beta}_{b,t}. \quad (1)$$

Bank shock $_{ft}$ is the loan growth for the firm f stemming from bank supply shocks.

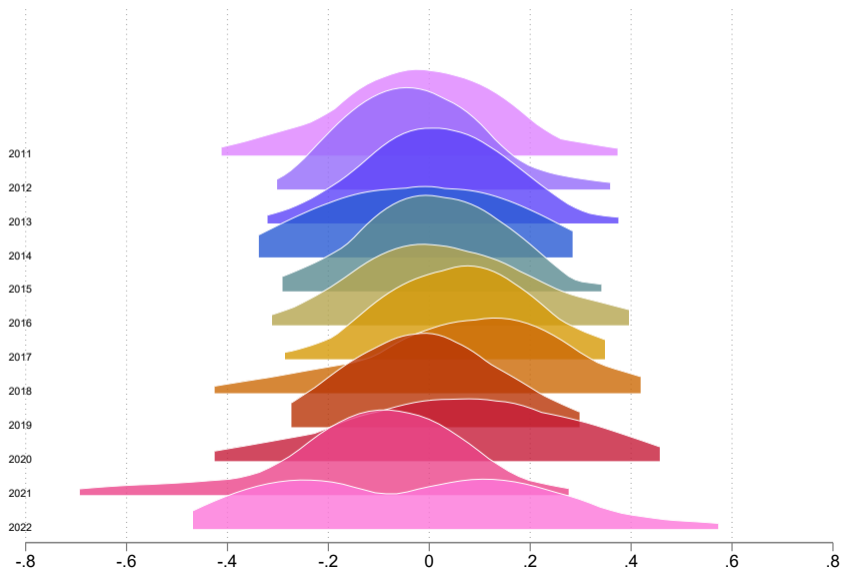
One concern is that the pre-determined weights result from sorting between weak banks and bad firms.

- ▶ we check differences in firm characteristics across quintiles of the bank shock distribution.

▶▶ Table

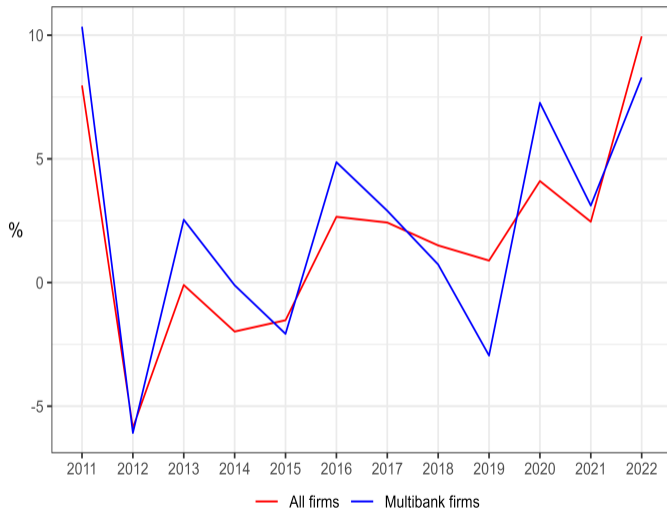
- ▶ we include a rich set of characteristics in the analysis.

The distribution of estimated bank shocks at the firm level



Multibank firms represent aggregate loan dynamics quite well

Claims growth in Croatia



Source: CNB

Validation

- ▶ check known episodes of bank distress or success
 - ▶▶ Swiss franc conversion
 - ▶▶ Exposure to Russia

- ▶ known correlates of bank distress
 - ▶▶ bankruptcy
 - ▶▶ Bank characteristics and loan supply shocks
 - ▶▶ rebalancing towards consumer loans
 - ▶▶ Bank characteristics and loan supply shocks
 - ▶▶ inflow of deposits
 - ▶▶ Bank characteristics and loan supply shocks
 - ▶▶ CDS spreads
 - ▶▶ CDS and loan supply shocks
 - ▶▶ Figure

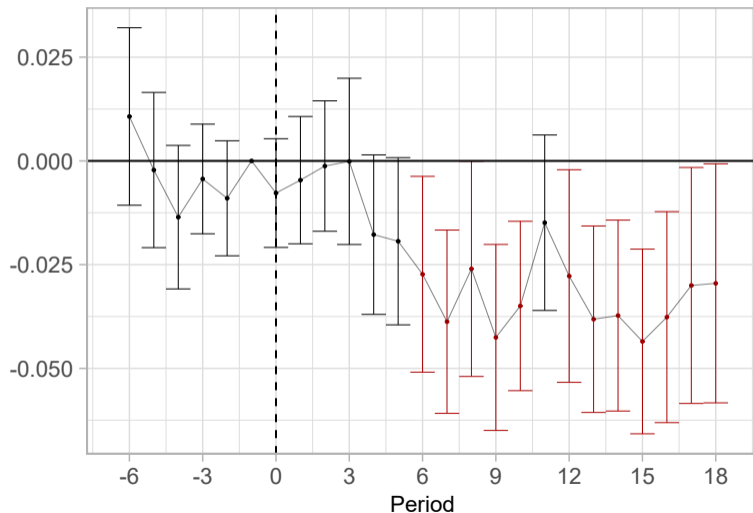
Main estimating equation

We estimate the following model:

$$\ln P_{iprt+h} - \ln P_{iprt-1} = \alpha_p + \alpha_{rt} + \alpha_{gt} + \beta \text{Bank Shock}_{it} + \gamma' X_{it} + \epsilon_{it}, \quad (2)$$

where i denotes the firm, p the product, r the retailer, g is the product group, t time and h the horizon. $\ln P$ is the natural log of prices, Bank Shock_{it} is the bank shock and X_{it} is a vector of controls that contains loan demand shock, leverage, share of short term debt, cash share, inventories share, energy cost share, labor productivity, profit share and firm size. α_p is the firm fixed effect, α_{rt} is the retailer \times time FE, α_{pt} is the product \times time FE.

Positive (negative) financial shocks cause firms to decrease (increase) prices



The figure shows the estimated effect (β) of bank shock on prices h periods ahead. Periods are months.

Robustness and additional results

- ▶ The probability of price increases drives the result, while prices are downward rigid (except for discount prices).
 - ▶▶ Probability of price increases
 - ▶▶ Probability of price decreases
 - ▶▶ Probability of price decreases with discounts
 - ▶▶ Probability of price increases with discounts
- ▶ The result is similar both in periods of expansion and contraction in aggregate lending.
 - ▶▶ Contraction
 - ▶▶ Expansion
- ▶ Producers, not wholesalers, drive the results.
- ▶ Robust to the inclusion of an array of controls.
- ▶ There is no heterogeneity in pass-through across retailers...

There is no heterogeneity in pass-through across retailers...

	(1)	(2)	(3)	(4)
		$\ln P_{iprt+9} - \ln P_{iprt-1}$		
Bank shock _{it}	-0.0419*** (0.0118)	-0.0420*** (0.0120)	-0.0427*** (0.0116)	-0.0393*** (0.0112)
Controls				Yes
Product	Yes	Yes	Yes	Yes
Month-Product group	Yes	Yes	Yes	Yes
Size		Yes	Yes	Yes
Month-Retailer			Yes	Yes
Observations	1,325,489	1,316,614	1,316,614	1,316,614
R ²	0.33342	0.33574	0.34563	0.34620

This table shows the results of estimating the main equation with successively adding fixed effects and controls. Controls are leverage, short term debt over assets, cash over assets, inventories over assets, energy costs over total costs, labor productivity, net income over sales and firm size.

Why do firms increase prices following a financial shock?

- ▶ They face a shortage or higher cost of working capital financing
- ▶ Increase prices by more if they are facing a lower elasticity of demand and higher customer switching costs
- ▶ Decrease prices if they have large inventories.

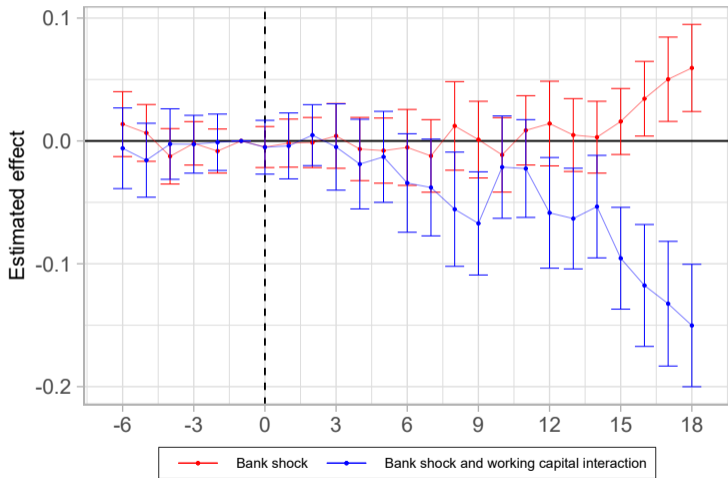
Exploring mechanisms

To explore the drivers of our results, we estimate:

$$\ln P_{iprt+h} - \ln P_{iprt-1} = \alpha_p + \alpha_{rt} + \alpha_{pt} + \beta \text{Bank Shock}_{it} + \beta_2 \text{Bank Shock}_{it} \times H_{it-1} + \delta H_{it-1} + \gamma' X_{it} + \epsilon_{it},$$

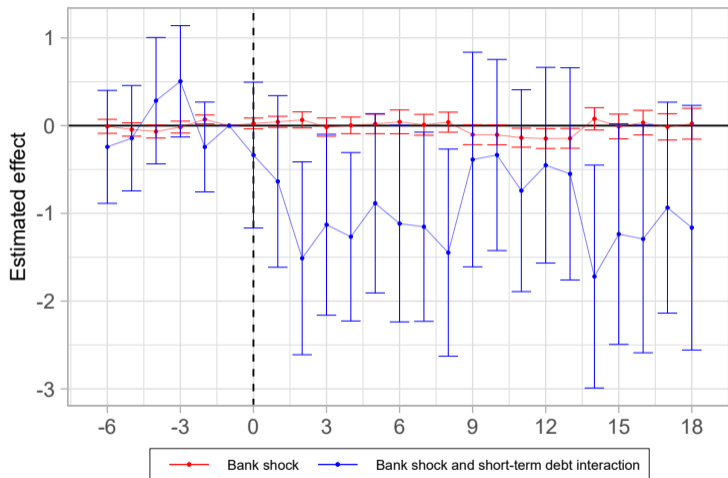
where H_{it-1} denotes as pre-determined characteristics, i denotes the firm, p the product, r the retailer, t time and h the horizon. $\ln P$ is the natural log of prices, Bank Shock_{it} is the bank shock and X_{it} is a vector of controls that contains loan demand shock, leverage, share of short term debt, cash share, inventories share, energy cost share, labor productivity, profit share and firm size. α_p is the firm fixed effect, α_{rt} is the retailer \times time FE, α_{pt} is the product \times time FE.

Firms that have large working capital decrease (increase) prices by more following a positive (negative) shock..



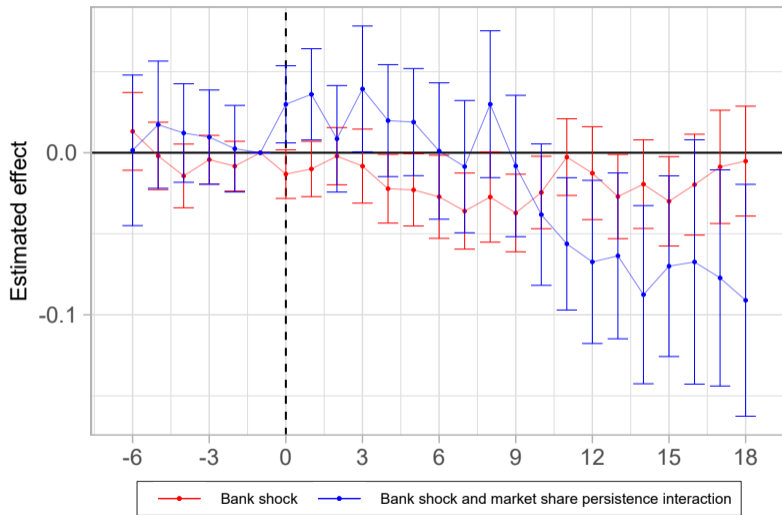
Note: Working capital is defined as in Barth and Ramey (2001) and Renkin and Zullig (2022):
 $\text{inventories} + \text{accounts receivable} - \text{accounts payable}$ divided by a fourth of sales. x - axis denotes months relative to the shock.

Similarly, for firms that have a high ratio of short-term loans to assets...



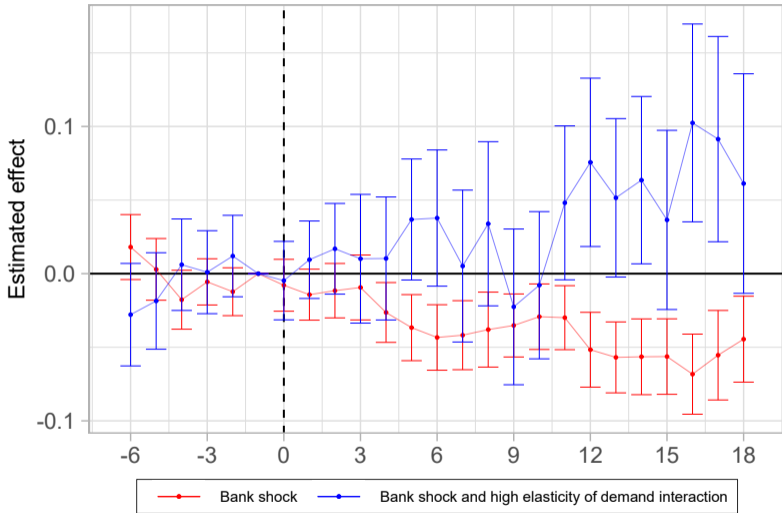
Note: Short-term debt is short-term loans to assets ratio. Short-term loans to asset sample mean is 4% and standard deviation is 6.3%. x - axis denotes months relative to the shock.

Persistence of market shares (Meinen and Soares, 2022)



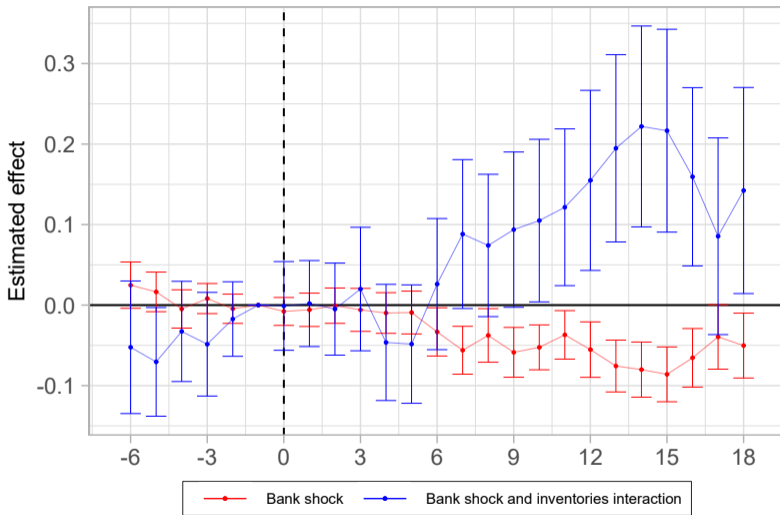
Note: Persistence of market shares is the above median persistence of firm market shares. It is calculated for each NACE 3-digit industry separately. x - axis denotes months relative to the shock.

Elasticity of demand (Broda and Weinstein, 2006)



Note: High elasticity of demand is above median elasticity of demand, estimated by Broda and Weinstein (2006). x - axis denotes months relative to the shock.

Inventories and financial shocks (Kim, 2021)



Note: Inventories - inventories to sales ratio. Inventories to sales ratio mean is 11% and standard deviation is 16%. x - axis denotes months relative to the shock.

Financial statements - other margins of adjustment to a financial shock

The equation we estimate:

$$y_{it} = \alpha + \beta \text{Bank Shock}_{it} + \gamma' X_{it} + \phi_i + \omega_{st} + \epsilon_{it}, \quad (3)$$

where y_{it} is the outcome of interest Bank Shock_{it} is the bank shock and X_{it} is a vector of controls that contains loan demand shock, leverage, the share of short term debt, cash share, inventories, energy cost share, labor productivity, profit share and firm size. ϕ_i is the firm fixed effect, ω_{st} is the sector \times time FE.

Firms decrease other costs and decrease (increase) measures of profits after a positive (negative) shock

	(1) lnWL	(2) lnL	(3) Investment	(4) Inventories	(5) Operating profits	(6) Profit share
Bank shock	0.0380** (0.0166)	0.0299** (0.0145)	0.0520** (0.0212)	-0.0016 (0.0075)	-0.0564** (0.0283)	-0.0060* (0.0094)
Controls	✓	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Observations	44,237	44,237	44,237	44,237	44,237	44,237
R-squared	0.9483	0.9340	0.4246	0.8043	0.9276	0.5647

Note: lnWL - log labor cor, lnL - log labor, Investment - change in fixed assets + amortization divided by lagged fixed assets, Inventories - inventories divided by sales, Operating profits - log sales minus log intermediates minus log labor cost, Profit share - net income over sales. Controls are leverage, short term debt over assets, cash over assets, inventories over assets, energy costs over total costs, labor productivity, net income over sales and firm size.

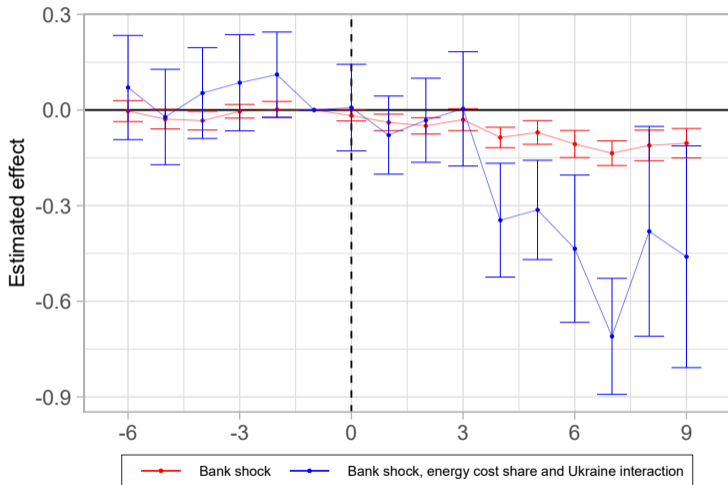
Financial shocks and rising energy costs - triple interaction

To explore whether financial shocks interact with rising energy costs we estimate :

$$\begin{aligned} \ln P_{iprt+h} - \ln P_{iprt-1} = & \alpha_p + \alpha_{rt} + \alpha_{pt} + \beta \text{Bank Shock}_{it} + \gamma' X_{it} + \\ & \beta_2 \text{Ukraine}_{it} \times \text{Energy}_{it} \times \text{Bank Shock}_{it} + \beta_3 \text{Bank Shock}_{it} \times \text{Ukraine}_{it} + \\ & + \beta_4 \text{Bank Shock}_{it} \times \text{Energy}_{it} + \beta_5 \text{Ukraine}_{it} \times \text{Energy}_{it} + \epsilon_{it}, \end{aligned}$$

where Energy denotes pre-determined energy cost share, Ukraine is a dummy equal to one after February 2022, i denotes the firm, p the product, r the retailer, t time and h the horizon. $\ln P$ is the natural log of prices, Bank Shock_{it} is the bank shock and X_{it} is a vector of controls that contains loan demand shock, leverage, share of short term debt, cash share, existing stock of goods share, energy cost share, labor productivity, profit share and firm size. α_p is the firm fixed effect, α_{rt} is the retailer \times time FE, α_{pt} is the product \times time FE.

An increase in energy costs is curbed (exacerbated) by positive (negative) bank shocks



Note: Blue - the effect of bank shock interacted with the above median energy share indicator and Ukraine war indicator (β_2).

A simpler sample split illustration of the estimate

	$\ln P_{iprt+6} - \ln P_{iprt-1}$			
	(1)	(2)	(3)	(4)
	Baseline	Energy	Energy & Ukraine	Full model
Bank shock	-0.0274**	-0.0088	-0.1837***	-0.1099***
	(0.0125)	(0.0176)	(0.0608)	(0.0216)
Bank shock \times Energy share \times Ukraine				-0.4627***
				(0.1187)
Energy share \times Ukraine				0.0242***
				(0.0059)
Bank shock \times Ukraine				0.3433***
				(0.1137)
Bank shock \times Energy share				0.1067***
				(0.0224)
R ²	0.28019	0.28536	0.68292	0.28019
Observations	1,267,219	866,982	50,256	1,267,219

The table shows the results of four regressions that all contain the full set of controls and fixed effects as in the main estimation strategy. In column (1) we show the baseline model results. Column (2) shows the same model but estimated for energy intensive firms before the war in Ukraine. Column (3) shows the estimated parameter for energy intensive firms during the war in Ukraine. Column (4) shows the full estimated triple interaction model.

Conclusion

- ▶ We find that bank shocks are passed to prices through a cost and market power channel
- ▶ Rising energy costs amplify the pass-through
- ▶ Analogously, positive financial shocks decrease the inflationary effect of rising energy costs
- ▶ How important are these effects in the aggregate?
- ▶ We arguably isolate only the effect of firm supply, so the effects on aggregate demand might completely offset them.

Thank you!!

Appendix

What we find

Using micro data, we show that negative financial shocks to producers increase retail prices for firms:

- ▶ exposed to high working capital needs and short-term loans
- ▶ facing inelastic demand schedules and high customer switching costs

Firms with relatively large inventories *decrease* prices after a financial shock.

Negative financial shocks interact with energy costs

- ▶ exploit the unexpected war in Ukraine to identify the effect of financial shocks on firms exposed to increasing energy costs
- ▶ the effect of rising energy costs is curbed (exacerbated) by positive (negative) financial shocks

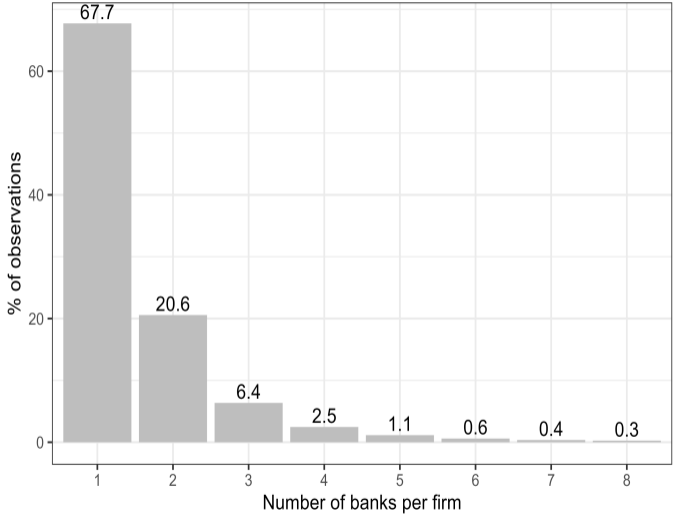
Literature

- ▶ Microeconomic evidence: Chevalier and Sharfstein (1996), Gilchrist et al. (2017), Renking and Zullig (2022), Kim (2021), Lenzu, Rivers and Tielens (2022), Meinen and Soares (2022)
- ▶ Macroeconomic evidence: Gilchrist and Zakrajšek (2012), Basset et al (2014), Altavilla, Darracq Nicolleti, Paries (2019); Abbate, Eickmeier and Prieto (2021)
- ▶ Literature studying the effects of bank shocks on firm outcomes (e.g. Amiti and Weinstein, 2018; Cingano, Manaresi, and Sette, 2016; Chodorow-Reich, 2014; Bentolila, Jansen, and Jiménez, 2018)
- ▶ Cost channel of monetary policy (see e.g. Barth and Ramey, 2001)

Contribution and literature

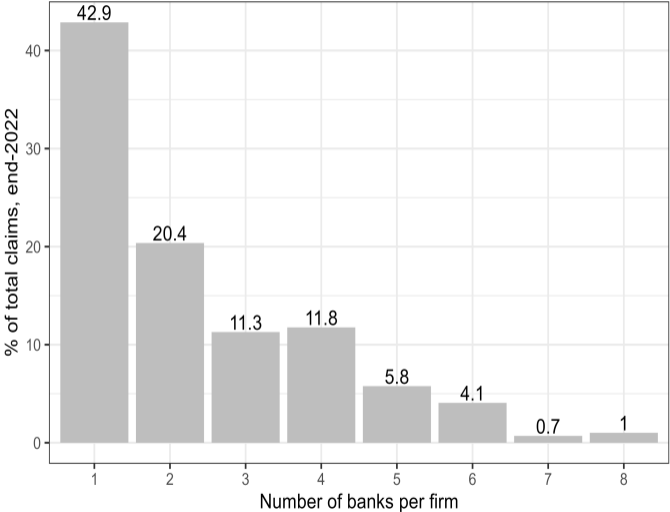
- ▶ We show the cost and market power channel of the financial shock pass-through to retail prices
 - ▶ Kim (2021) - fire sales channel
 - ▶ Gilchrist et al. (2017) and Renking and Zullig (2022) - market power and cost channel on PPI data
- ▶ We show that positive (negative) financial shocks decrease (increase) the pass-through of energy prices to retail prices.
- ▶ In contrast to the bank shock literature, we study a period of no systemic bank distress.

Most firms financed by single bank



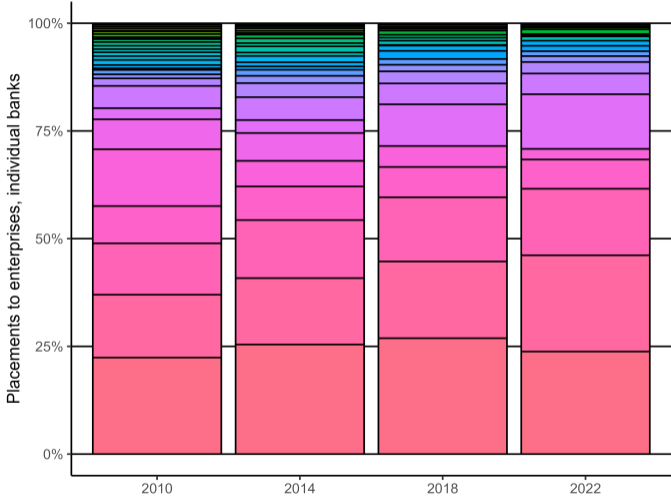
Source: CNB

Distribution of total claims at end-2022



Source: CNB

Concentration of the banking system high and increasing



Source: CNB

Credit activity substantially stronger with multi-bank firms

Table 1: *

Summary statistics of single-bank firms

Statistic	N	Mean	Median	Pctl(25)	Pctl(75)
Stocks	3.239.266	1.557.068	126.667	27.758	572.844
Transactions	3.239.266	1.642	-135	-7.492	62

Note: Monetary values in kuna. Source is the Croatian National Bank.

Table 2: *

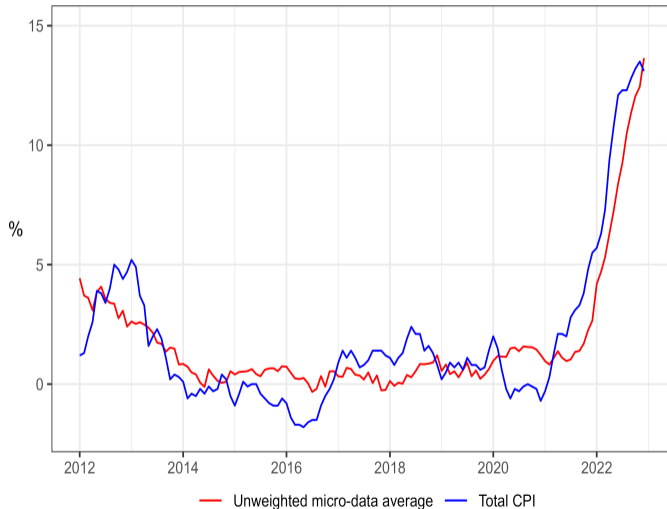
Summary statistics of multi-bank firms

Statistic	N	Mean	Median	Pctl(25)	Pctl(75)
Stocks	1.543.304	4.944.545	442.204	95.136	2.228.445
Transactions	1.543.304	9.082	-178	-18.800	156

Note: Monetary values in kuna. Source is the Croatian National Bank.

Micro-data on prices reflect aggregate developments

YoY price change



Source: PCA

Summary statistics of multi-bank firms

Statistic	Mean	Std	p10	Median	p90	N
Employment	55	246	2	11	97	49.236
Assets	63	449	0,83	6	87	49.236
Cash/Assets	0,05	0,08	0,00	0,02	0,13	49.236
Liabilities/Assets	0,74	0,45	0,35	0,71	1,03	49.236
Energy cost share	0,03	0,05	0,00	0,02	0,08	49.231
Labor productivity	2,61	2,14	1,13	2,03	4,62	49.236
Profits/Sales	-0,02	0,35	-0,10	0,02	0,14	49.141
Inventories/Sales	0,23	0,40	0,00	0,10	0,55	49.141
Loans/Assets	0,24	0,20	0,04	0,20	0,50	47.717

The table reports descriptive statistics for private sector firms. Assets are denoted in million HRK, which was the currency in Croatia until the end of 2022 (1 EUR is equal to 7,53 HRK). The period is from 2010 to 2021.

Profits are net income after taxes, Labor productivity is value added/employment. Source is Fina (Croatian Business Registry).

Summary statistics of multi-bank firm that are joined with price data

Statistic	Mean	Std	p10	Median	p90
Employment	334	721	11	94	748
Assets	354	678	9	69	1.040
Cash/Assets	0,03	0,05	0,00	0,01	0,08
Liabilities/Assets	0,62	0,23	0,32	0,62	0,88
Energy cost share	0,03	0,02	0,00	0,02	0,06
Labor productivity	2,43	1,48	1,32	2,11	3,86
Profits/Sales	0,01	0,17	-0,07	0,02	0,11
Inventories/Sales	0,28	0,32	0,05	0,17	0,59
Loans/Assets	0,24	0,16	0,05	0,21	0,46

The table reports descriptive statistics for private sector firms. Approximately 200 firms in retail price data are multi-bank firms. Assets are denoted in million HRK, the currency in Croatia until the end of 2022 (1 EUR equals 7,53 HRK). The period is from 2010 to 2021. Profits are net income after taxes, Labor productivity is value added/employment. The source is Fina (Croatian Business Registry).

Summary statistics of retail product price data - full dataset

Statistic	Mean	Std	p10	p25	Median	p75	p90
Products per firm	35,77	359,01	1	2	4	12	36
Retailers per firm	3,32	3,29	1	1	2	4	8
YoY product inflation	1,88	9,99	-5,84	-0,25	0	4,04	11,83

Retail product price data cover about 215 thousand individual retail items manufactured by around 6000 firms. Items are sold in 22 retail firms. Monthly data for the 2010-2022 period.

Summary statistics of retail product price data - regression sample

Statistic	Mean	Std	p10	p25	Median	p75	p90
Products per firm	92,02	216,72	2	6	18	78	247
Retailers per firm	3,95	2,05	1	2	4	5	7
YoY product inflation	2,04	9,36	-5,57	-0,99	0	4,55	11,83

Retail product price data cover about 20 thousand individual retail items manufactured by around 220 firms. We select 8 biggest retailers and their stores in Zagreb, the capital of Croatia. Monthly data for the 2010-2022 period.

Firm characteristics across the bank shock distribution

▶ Back

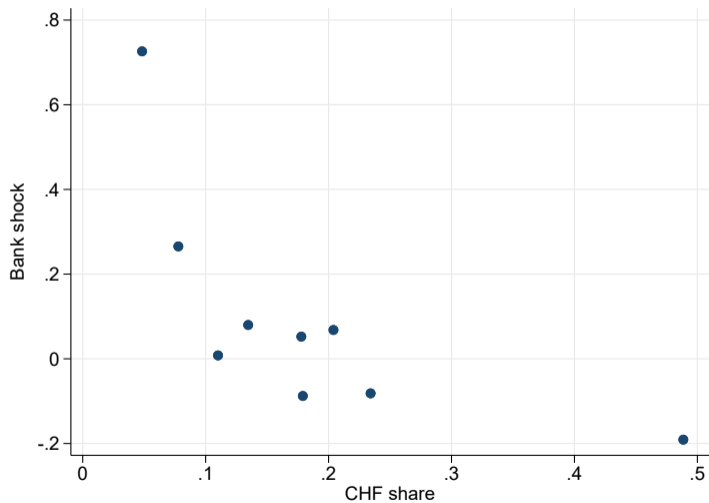
	Quintile of the bank shock distribution				
	(1) 1st	(2) 2nd	(3) 3rd	(4) 4th	(5) 5th
50 < L ≤ 250,	-0.0358** (0.0149)	-0.0158 (0.0144)	0.0201 (0.0148)	0.0248* (0.0147)	0.0067 (0.0139)
L > 250,	-0.0097 (0.0285)	-0.0000 (0.0301)	-0.0284 (0.0287)	0.0158 (0.0302)	0.0223 (0.0256)
Leverage	-0.0126 (0.0123)	0.0016 (0.0130)	0.0315** (0.0136)	-0.0076 (0.0129)	-0.0130 (0.0120)
Profit share,	0.0074 (0.0109)	-0.0004 (0.0114)	0.0061 (0.0109)	-0.0066 (0.0105)	-0.0065 (0.0104)
Cash	0.1324*** (0.0409)	-0.0736* (0.0394)	-0.0115 (0.0421)	-0.0044 (0.0410)	-0.0429 (0.0414)
Labor productivity	-0.0017 (0.0017)	0.0015 (0.0017)	0.0032* (0.0017)	-0.0011 (0.0018)	-0.0020 (0.0017)
Inventories	-0.0006 (0.0289)	0.0140 (0.0293)	-0.0420 (0.0283)	0.0254 (0.0278)	0.0031 (0.0296)
Short term debt share	-0.0001 (0.0145)	0.0088 (0.0144)	0.0061 (0.0145)	-0.0061 (0.0146)	-0.0087 (0.0146)
Energy share	-0.1456 (0.0983)	0.0250 (0.0962)	0.1656* (0.0956)	0.0799 (0.0981)	-0.1250 (0.0997)
Loans over assets	-0.0264 (0.0207)	0.0327 (0.0210)	0.0003 (0.0202)	0.0154 (0.0212)	-0.0220 (0.0211)
Firm FE	✓	✓	✓	✓	✓
Sector-time FE	✓	✓	✓	✓	✓
Observations	44,161	44,161	44,161	44,161	44,161
R-squared	0.3742	0.3029	0.2608	0.2904	0.3219

The table shows the results of five regressions of firm characteristics on an indicator variable corresponding to the quintiles of the bank shock distribution at the firm level. L - employment, leverage - debt over assets, Short term debt short-term debt over liabilities, cash share - cash over assets, inventories share - inventories over assets, energy cost share - energy cost over total cost, labor productivity - value added over labor cost, profit share - net income over sales. All regressions include firm fixed effects, 2-digit sector, and time-fixed effects.

Errors are clustered at the firm level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

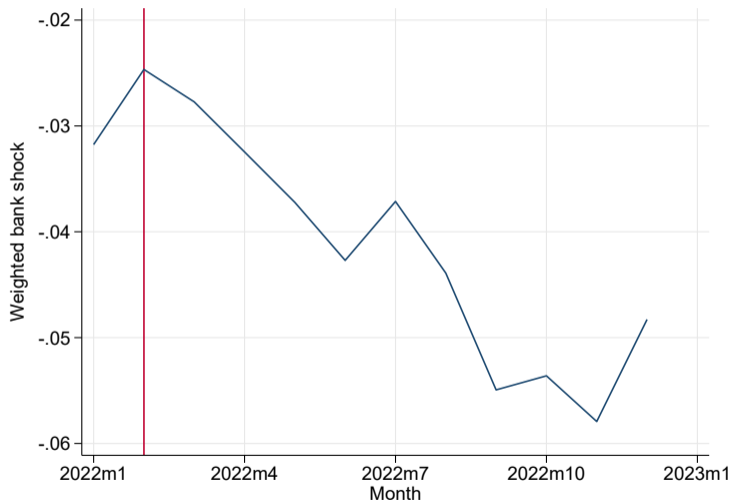
CHF conversion to EUR

▶ Back



Russian invasion and exposed banks

▶ Back



Other relevant bank characteristics

▶ Back

	(1)	(2)	(3)	(4)
		Bank shock _{bt}		
Bankruptcy _{bt}	-0.2325*** (0.0840)			
Household to NFC lending ratio _{bt}		-0.2053** (0.0883)		
Change in deposits, % liabilities			1.1575** (0.5314)	
Negative ROE				-0.0630 (0.0489)
Bank FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	299	294	294	299
R-squared	0.1745	0.1839	0.2072	0.1726

Note: NFC - non-financial corporations, ROE - return on equity.

CDS

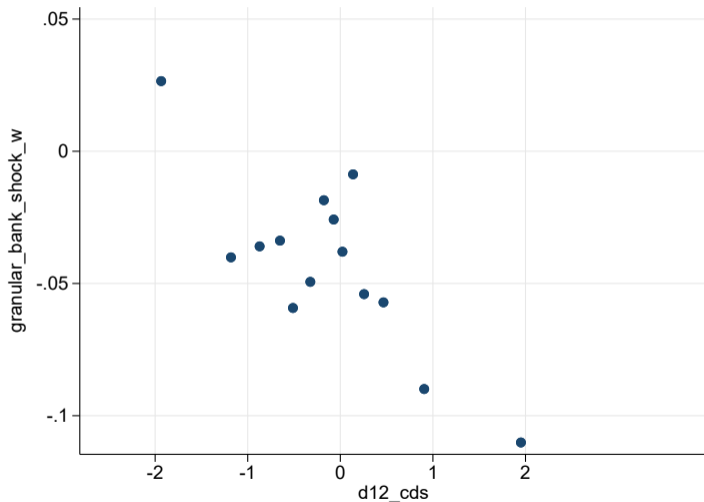
▶ Back

	(1)	(2)	(3)	(4)
	Bank shock _{bt}	Bank shock _{bt+1}	Bank shock _{bt+2}	Bank shock _{bt+3}
CDS yearly difference	-0.0277*** (0.0072)	-0.0294*** (0.0071)	-0.0328*** (0.0071)	-0.0333*** (0.0071)
Bank FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓
Observations	608	603	598	593
R-squared	0.5219	0.5235	0.5277	0.5298

Note: CDS - credit default swap spread. The model is estimated at monthly level. Bank shocks show yearly growth rates in loan supply due to loan supply shocks. CDS yearly difference is the difference in the level of CDS spread relative to last year.

CDS and bank shocks - binned data after removing FE

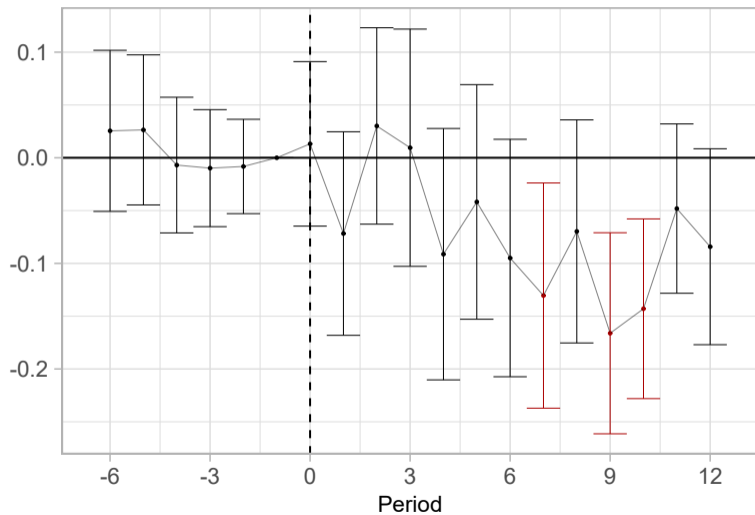
▶ Back



Note: binned data after removing month and bank fixed effects.

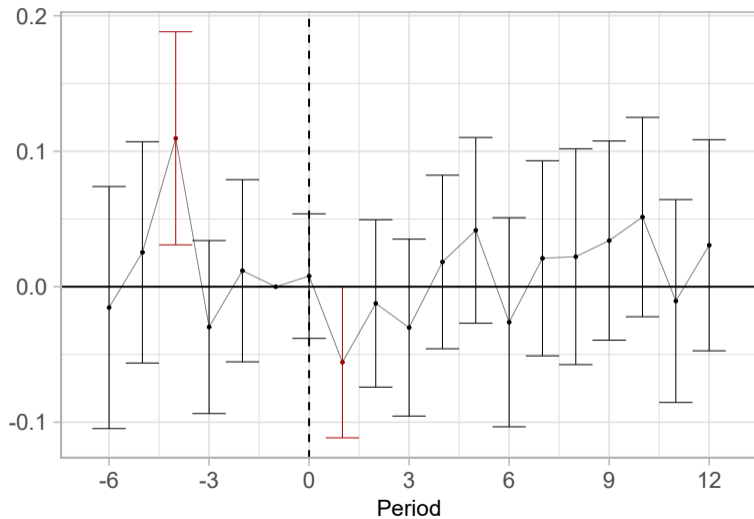
The effect of the bank shock on the probability of price increases

▶ Back



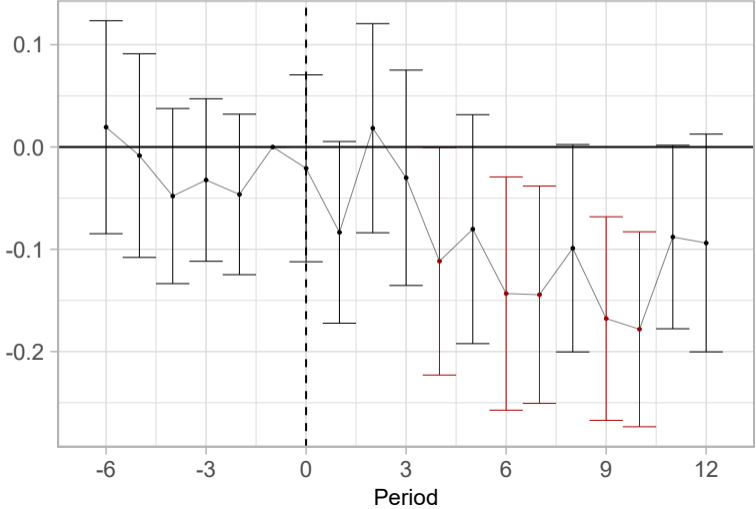
The effect of the bank shock on the probability of price decreases

▶ Back



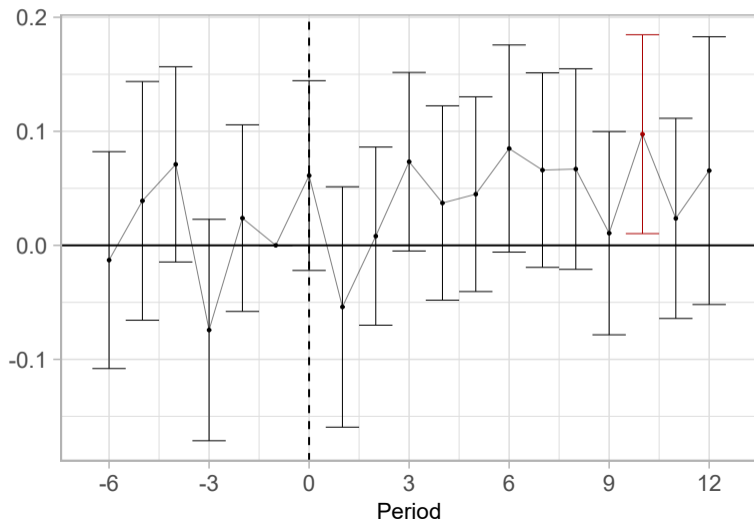
The effect of the bank shock on the probability of price increases, including discounts

▶ Back



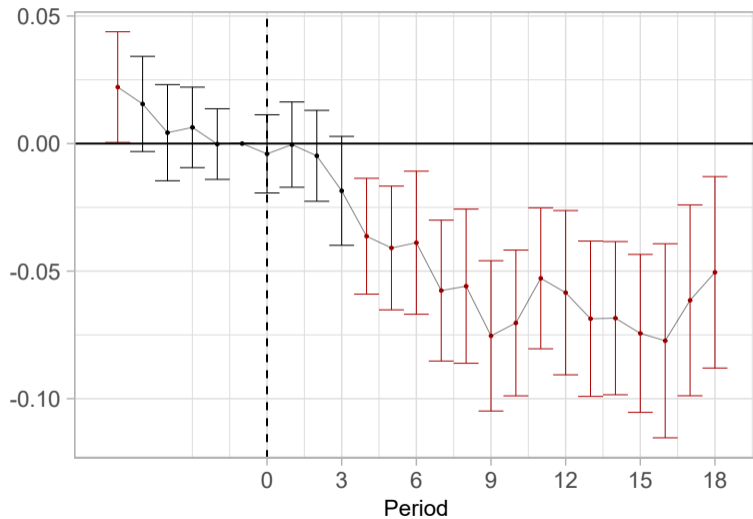
The effect of the bank shock on the probability of price decreases, including discounts

» Back



The effect of the bank shock during periods of credit contraction

▶ Back



The effect of the bank shock during periods of credit expansion

▶ Back

