

THE EFFECT OF CREDIT OUTPUT ON OUTPUT PRICE DYNAMICS

THE CORPORATE INVENTORY AND LIQUIDITY MANAGEMENT CHANNEL

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The Effect of the Credit Crunch on the Output Price

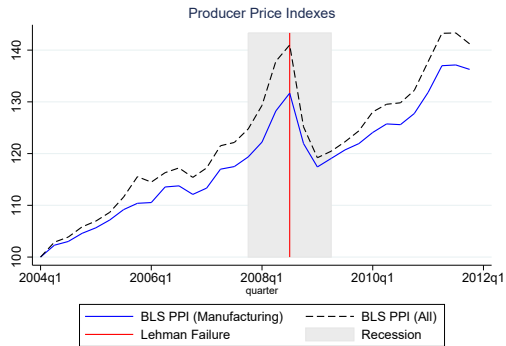
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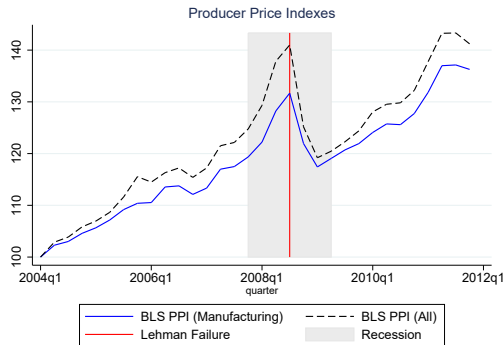
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Intro

A Motivating Fact

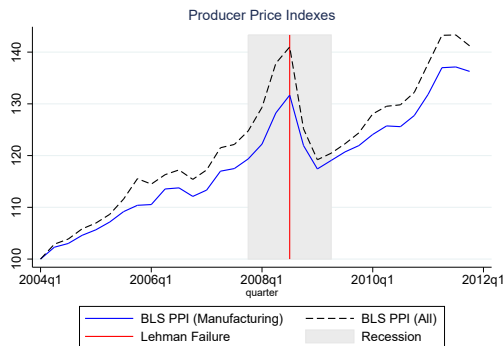


A Motivating Fact



Does a credit supply shock lead firms to **reduce** prices?
If so, why?

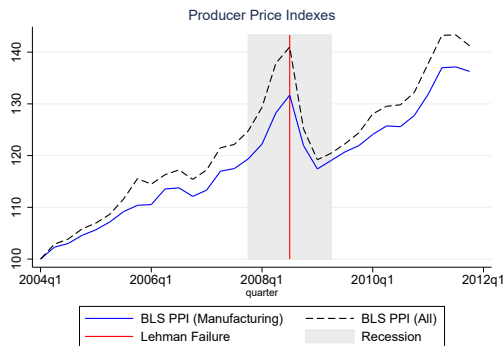
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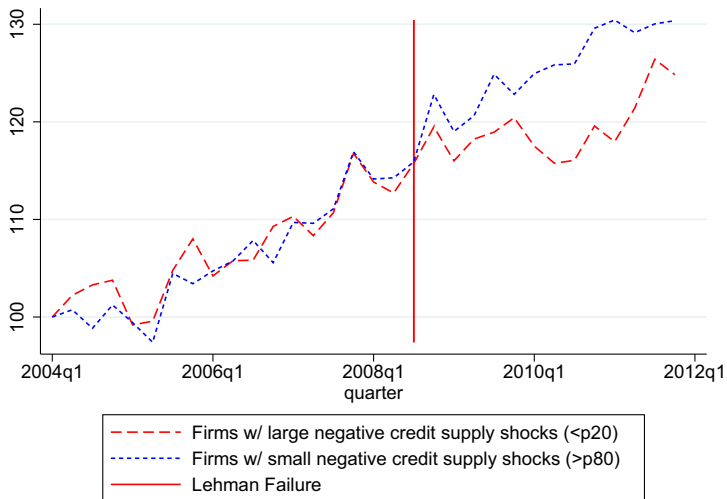
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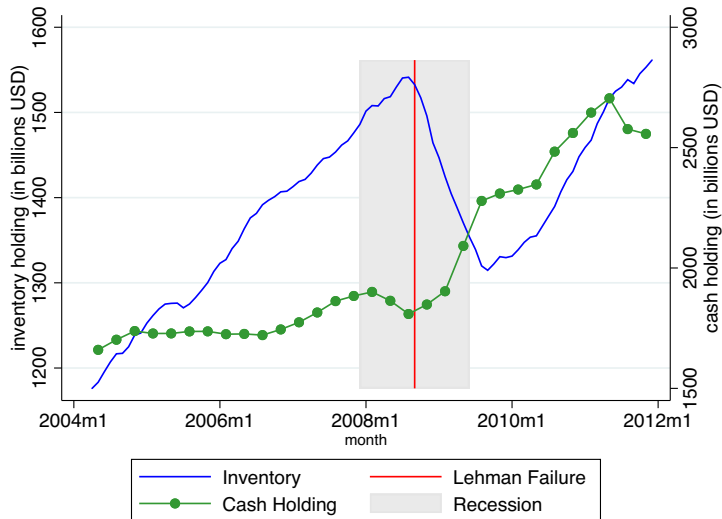
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If so, why?

- Standard macro models can explain a decrease in inflation during the GFC **without** relying on credit market conditions;
- Other events may play a **confounding** role;
- **Exploit exogenous variation of bank shock at the time of Lehman failure**

How a credit crunch affects output price dynamics



The Fire Sale of Inventory Hypothesis



- **Financial Frictions and Pricing Decisions:** traditional financial frictions focuses on the cost push channel (e.g. e Barth and Ramey (2002), Del Negro, Giannoni, and Schorfheide (2015)). Supported by the influential work of Gilchrist et al. (2017).

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 - Corroborates industry-level studies showing evidence of price reduction with broad micro-level empirical evidence;
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- **Inventory Dynamics:** builds on previous literature (e.g. Gertler and Gilchrist (1994), Kashayap,Lamont and Stein (1994)) focusing on the inventory dynamics of constrained firms.
 - Emphasizes the importance of the interaction between inventory and liquidity management for output price dynamics during the banking crisis;
 - Shows that bank shocks generate procyclicality of inflation and inventory dynamics.

Data Description

Contribution: novel dataset linking granular product information with firms balance sheet and bank relationships data.

- ACNielsen Homescan Panel (Household Scanner Data);
- GS1 U.S. Data Hub;
- Orbis and Fixed Income Securities Database (FISD);
- Dealscan Database;
- Supplementary Data Sources (e.g. Zillow housing price data, NBER-CES industry-level inventory information etc.).

Merged dataset includes approximately 200 firms accounting for one-fifth of the sales and one-fourth of the total number of purchases in the Nielsen Data.

► [summary statistics](#)

Building Blocks (y, X)

Starting point: nested CES utility function. Utility based price index incorporates variety and quality effect

$$\ln P_{fgt} = \underbrace{\ln \tilde{P}_{fgt}}_{\text{Standard Index}} - \underbrace{\frac{1}{\sigma_g^U - 1} \ln \left[\sum_{u \in \Omega_{fgt}} \frac{S_{ut}(P_{ut}, \phi_{ut}, \sigma_g^U)}{\tilde{S}_{fgt}(\tilde{P}_{ut}^U, \tilde{\phi}_{ut}, \sigma_g^U)} \right]}_{\text{Quality/Variety Correction}}$$

▶ nested CES

Empirically, the second term is negligible. Henceforth, use

$$\ln P_{fgt} = \ln \tilde{P}_{fgt} = \ln \left(\prod_{u \in \Omega_{fgt}} P_{ut} \right)^{\frac{1}{N_{fgt}}}$$

Measurement: changes in firms' access to credit as consequence of change in bank health. Not using firm-level balance sheet variable due to identification issues.

- pre-Lehman: 2005:Q4 to 2006:Q2 and 2006:Q4 to 2007:Q2;
- post-Lehman: 2008Q4 to 2009:Q2.

$$\Delta L_f = \sum_{b \in S_f} \alpha_{fb, \text{last}} \Delta(\text{Bank Health})_{-f, b}$$

where

$$\Delta(\text{Bank Health})_{-f, b} = \frac{\sum_{j \neq f} \alpha_{jb, \text{post}} \times \mathbb{1}(b \text{ lent to } j \text{ post-Lehman})}{\frac{1}{2} \sum_{j \neq f} \alpha_{jb, \text{pre}} \times \mathbb{1}(b \text{ lent to } j \text{ pre-Lehman})}$$

Valid shock, not correlated with pre-Lehman purchasers' characteristics.

Other bank health measures borrowing from Chodorow-Reich (2014)

- **Banks' exposure to Lehman:** fraction of its syndication portfolio in which Lehman Brothers had a lead role;
- **Banks' exposure to asset-backed securities (ABX):** correlation between its daily stock return and the return on the ABX AAA 2006-H1 index;
- **Bank statements items:** net trading revenue plus bank deposit divided by its assets before LB failure.

Empirical Evidence

Estimate the following specification

$$\Delta \ln \tilde{P}_{fg} = \lambda_g + \beta(-\Delta L_f) + \theta X_f + \varepsilon_{fg}$$

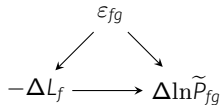
► controls

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Identification assumptions:

- **EXCLUSION RESTRICTION**: weak under not-stable demand. Empirically, variation originates from bank sector (**supply**), not from corporate sector (**demand**)

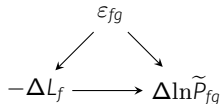


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- **LONG-TERM RELATIONSHIP/SWITCHING COSTS**: need stable firm-bank relationship to avoid quick substitution patterns to hedge against the shock.

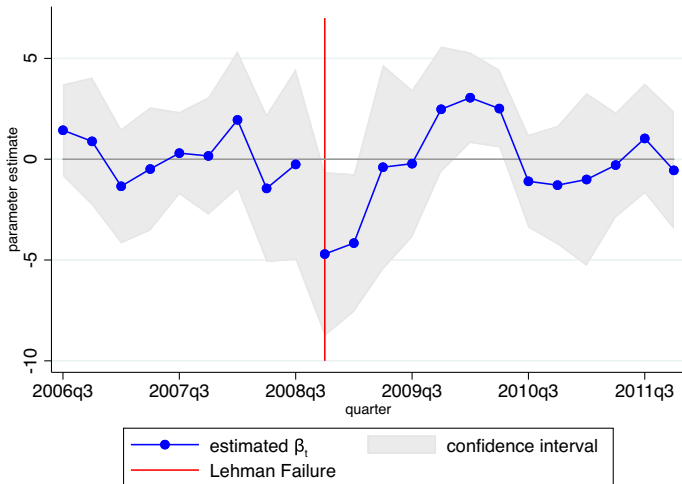
$$\Delta \ln \tilde{P}_{fg} = \lambda_g + \beta(-\Delta L_f) + \theta X_f + \varepsilon_{fg}$$

	$\Delta \ln \tilde{P}_{fg}$: 2006q4–2007q2 to 2008q4–2009q2					
	OLS		$(-\Delta L_f)$ instrumented using			
	(1)	(2)	Lehman (3)	ABX (4)	BankItem (5)	All (6)
$(-\Delta L_f)$	-2.31*** (0.52)	-8.31*** (1.85)	-7.13** (3.13)	-7.36** (3.03)	-7.31** (3.42)	-7.25*** (1.97)
Firm-level controls	No	Yes	Yes	Yes	Yes	Yes
Product group FE	No	Yes	Yes	Yes	Yes	Yes
Four-digit NAICS FE	No	Yes	Yes	Yes	Yes	Yes
First-stage F -statistic			16.70	7.90	15.20	11.90
J -statistic p -value						1.00
$E[\Delta \ln \tilde{P}]$	11.4	11.4	11.4	11.4	11.4	11.4
$E[\Delta \ln \tilde{P} : \Delta L_{p90} \cdot \Delta L_{p10}]$	-5	-18.1	-15.6	-16.1	-15.9	-15.8
Observations	1,658	1,658	1,658	1,658	1,658	1,658

Notes. * $p < .10$, ** $p < .05$, *** $p < .01$; standard errors are clustered by firm and product group; the regression is weighted by initial sales; and firm-level controls are the firm's listed status, age, bond rating, number of loans, amount of loans, loan type, loan-year fixed effects, multi-lead fixed effects, number of loans due in the post-Lehman period fixed effects, loan spread, loan maturity, and lagged $\Delta \ln P_{fg}$.

Output Price Dynamics (2)

$$\ln \tilde{P}_{fg,t} - \ln \tilde{P}_{fg,t-4} = \lambda_{g,t} + \beta_t(-\Delta L_f) + \theta X_{f,t} + \varepsilon_{fg,t}$$



$$\Delta Y_{fg} = \lambda_g + \gamma(-\Delta L_f) + \theta X_f + \varepsilon_{fg}$$

Y_{fg}	Inventory _f (1)	Market Share _{fg} (2)	Cash Holding _f (3)	Employment _f (4)
$(-\Delta L_f)$ instrumented	-30.1**	2.4**	5.6***	-23.5**
using Lehman	(13.4)	(1.2)	(1.8)	(10.9)
Firm-level controls	Yes	Yes	Yes	Yes
Product group FE	No	Yes	No	No
First-stage F -statistic	32.7	17.8	67.1	26.5
$E[\Delta \ln Y: (-\Delta L_{p90}) - (-\Delta L_{p10})]$	-51.8	5.25	11.3	-38.2
Observations	992	1,658	1,286	1,453

Notes. * $p < .10$, ** $p < .05$, *** $p < .01$. For the firm-level regressions in columns (1), (3), and (4), the standard errors are clustered by the three-digit NAICS, the regression is weighted by initial Y_f , and the firm-level controls are a firm's listed status, two-digit NAICS fixed effects, number of loans, multi-lead fixed effects, loan spread, number of loans due in the post-Lehman period fixed effects, and bond rating. For the firm-group-level regression in column (2), the cluster groups of standard errors, regression weights, and control variables are identical to the specification used in [Table IV](#).

$$\Delta \tilde{P}_{fg} = \lambda_g + \beta_1(-\Delta L_f) \times Z_{fg} + \beta_2(-\Delta L_f) + \beta_3 Z_{fg} + \theta X_f + \varepsilon_{fg}$$

- **INVENTORY AND LIQUIDITY**
 - Firms with larger inventories/in urgent need of cash drop prices more aggressively;
- **ALTERNATIVE FINANCING AND SIZE**
 - Smaller effect for firms which diversity financing sources;
 - Bigger effect for small firms;
- **DEMAND ELASTICITY**
 - Larger effect for firms that face high demand elasticity (homogeneous across product groups).

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Estimate their specification

$$\Delta \ln P_{fg} = \beta_0 + \eta_1 \text{LIQ}_f + \eta_2 X_f + \varepsilon_{fg}$$

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	$\Delta \ln P_{fg}$: 2006q4–2007q2 to 2008q4–2009q2			
	Including X_f related to			
	Gilchrist et al. (2017)		Bates, Kahle, and Stulz (2009)	
	(1)	(2)	(3)	(4)
2006 LIQ_f	−2.84** (1.40)	−2.17* (1.21)	0.43 (2.14)	0.04 (2.16)
(− ΔL_f)		−1.99** (0.94)		−3.37** (1.40)
2006 CF volatility			−2.20** (0.93)	−2.15*** (0.79)
Observations	947	947	947	947

The Problem of Liquidity in Gilchrist et al. (2017)

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High liquidity firms happen to be the financially constrained ones!

- Use novel micro-data and change in bank health at the time of the Lehman Brothers failure as an exogenous variation of companies' credit condition to **study output price dynamics**;

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- Propose the **fire sale inventory hypothesis** to rationalize the findings: firm decrease the price by quickly selling off inventories to generate extra cash.
- **Reinterpret** the findings in Gilchrist et al. (2017) in a reconciliative fashion.


Appendix

Summary Statistics

Variable	<i>N</i>	Mean	Std. dev.	p10	p50	p90
Panel A: Firm-group variables						
\hat{P}_{fg}	2,055	3.90	5.92	1.21	2.47	6.80
Sales (millions \$)	2,055	28.51	110.34	0.04	1.36	56.08
Market share (%)	2,055	4.84	12.59	0.01	0.37	14.40
Average # of UPCs per quarter	2,055	31.43	76.01	1	10	72.33
Average # of buyers per quarter (millions)	2,055	2.33	9.11	0.00	0.12	4.76
Panel B: Firm variables						
ΔL_f	200	0.47	0.18	0.26	0.45	0.69
Lehman exposure	198	0.84	0.36	0.50	0.74	1.28
ABX exposure	198	1.06	0.28	0.81	1.01	1.34
Bank items	198	44.90	12.99	28.17	46.63	58.46
Bond issuance (binary)	200	0.28	0.45	0	0	1
Listed status (binary)	200	0.36	0.48	0	0	1
Firm age	198	47.82	35.87	13	35	97
Median spread (bp)	187	150.77	106.34	25	150	300
Average maturity (month)	197	53.65	15.21	32.5	60.0	61.0
Number of groups	200	10.28	19.28	1	3	26
Panel C: Group variables						
Demand elasticities across UPCs	100	8.13	4.25	5.02	6.93	14.06
Demand elasticities across firms	100	4.45	2.04	2.62	3.92	7.33
Number of firms	100	20.55	7.74	10.5	20.5	31.0

When consumers visit a store, they choose in order

1. Product group (e.g. jams, jellies, or spreads)
2. Brand or firm's product (e.g. Smucker's product)
3. Specific UPC (e.g. Smucker's sugar-free strawberry-flavor fruit spread)

Elasticities govern output price sensitivity, and perceived quality parameters govern how purchasing behaviour is affected by factors other than output prices (e.g. product quality) 

Controls

- Firms' pre-Lehman bond rating and bond issuance (control liquidity substitution)
- 4-digits NAICS industry FE, listed status and firm size (within comparison)
- # loans received pre-Lehman and # loans matured post-Lehman (control differential loan market access)
- Firm age, type of last loan (term v. revolver/line), year of last loan issuance, indicator of multiple lead banks, last loan's interest spread and maturity (reliable comparison across firms)
- Purchaser demographic information from Nielsen
- ZIP code level house price data from Zillow, county level homeownership from census data.

Heterogeneous Treatment Effects

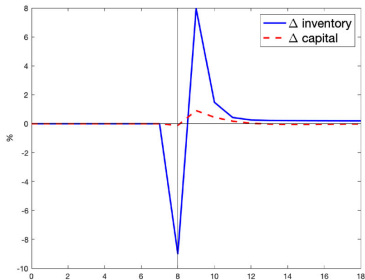
$\Delta \ln \hat{P}_{fg}$: 2006q4–2007q2 to 2008q4–2009q2				
	(1)	(2)	(3)	(4)
Panel A: Inventory and liquidity				
Z_f	Inventory	Ind. inventory	RZ index	Loan due
$(-\Delta L_f) \times Z_f$	-5.26*** (0.90)	-16.98*** (5.17)	-7.50*** (2.29)	-11.38** (5.69)
$(-\Delta L_f)$	-0.67 (11.91)	10.10 (53.86)	-11.89*** (4.08)	-5.67*** (2.12)
Firm-level controls	Yes	Yes	Yes	Yes
Product group FE	Yes	Yes	Yes	Yes
Observations	808	496	496	1,797
Panel B: Alternative financing and size				
Z_f	Bond access	# of lead lenders	Total assets	Employment
$(-\Delta L_f) \times Z_f$	5.83** (2.73)	1.98** (0.99)	9.00*** (1.46)	6.52*** (0.92)
$(-\Delta L_f)$	-5.91*** (2.23)	-10.63** (4.33)	-137.33*** (22.69)	-63.02*** (10.22)
Firm-level controls	Yes	Yes	Yes	Yes
Product group FE	Yes	Yes	Yes	Yes
Observations	1,800	1,800	834	834
Panel C: Demand elasticity				
Z_{fg}	Elasticity w/ Bertrand	Elasticity w/ Cournot		
$(-\Delta L_f) \times Z_{fg}$	-1.62** (0.69)	-1.64** (0.74)	-2.08*** (0.77)	-2.24** (0.86)
$(-\Delta L_f)$	1.46 (2.26)		2.17 (2.36)	
Firm-level controls	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes
Product group FE	Yes	Yes	Yes	Yes
Observations	1,800	1,764	1,800	1,764

- LIQ_f is contemporaneous (2008) or lagged (2006) liquidity;
- X_f : lagged log change in sales, lagged log change in cost of good sold, initial inventory-to-sales ratio, lagged dependent variable;
- Only listed firms (robust with both listed and unlisted).

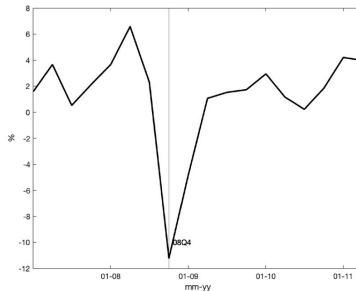
Aggregate Implications

SETUP: canonical monetary business cycle model of Iacoviello (2005) + two representative entrepreneurs facing different degrees of credit supply shocks. To match micro-level evidence, feature

- Product stock-out motive of inventory holding;
- Exogenous borrowing capability.



(A) Model



(B) Data