

The Inflationary Effects of Quantitative Easing

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- Unconventional monetary policies have become popular tool to boost private demand and raise prices.
- Although implemented by many central banks, their effects and transmission mechanism still an unsettled question.

Bernanke (2014): “The problem with quantitative easing is that it works in practice, but not in theory.”

- Did QE contribute to the recent surge in inflation?
- Most existing studies use *aggregate data* to trace out the dynamic impact of unconventional monetary policy (with mixed evidence).
Problems: limited time variation, no heterogeneous effects.

What we do

- Estimate **inflationary effects** of quantitative easing using very detailed **micro level data** from Sweden.
- Merging official price data with administrative bank and firm level data.
- Advantages compared to studies at the aggregate level:
 1. Data allow to track the entire chain *Riksbank QE-banks-firms-prices*.
 2. Large cross sectional variation in firms' exposure to QE through bank-firm credit relationships.
 3. Potential heterogeneities can be investigated in great detail.

What we find

- Government bond purchase program led to significant increase in producer prices.

⇒ QE as effective tool to produce inflationary pressure at the ZLB.
- Strong heterogeneities in the price setting behaviour across firms.
- High leverage firms increase prices, low leverage firms do not adjust.
 - High leverage firms: increase in fixed asset investment (loosening of future constraints), interest rate expenses rise (higher marginal costs).
 - Low leverage firms: higher investment in machines and equipment (no significant change in marginal costs).
- Leverage-dependent price response less pronounced for conventional monetary policy interventions.

- **Effect of QE on inflation:** Lewis (2019), Gambacorta et al. (2014), Boeckx et al. (2020), Lenza et al. (2010), Carlstrom et al. (2017),..., mixed evidence (Fabo et al. 2021).
We: Detailed micro data to estimate inflationary effects of QE.
- **Bank lending channel of QE:** Joyce and Spaltro (2014), Butt et al. (2015), Bowman et al. (2015).
We: QE transmits through bank-firm credit relationship.
- **Heterogeneous impact of QE on banks, households, and firms:** Sims and Wu (2021), Cui and Sterk (2021), Grimm et al. (2021).
We: First to document firms' heterogeneous price responses to QE.
- **Financial frictions and price setting:** D'Acounto et al. (2018), Gilchrist et al. (2017).
We: Financial position key to understand how QE transmits to inflation.

Institutional background

- In February 2015, Riksbank introduced the QE program to purchase Swedish government bonds.
- In April 2022, the Riksbank held Swedish government bonds worth SEK 401 billion.
 - More than half of outstanding nominal bonds and around one-fourth of the inflation-linked ones.
- During Corona pandemic, Riksbank extended the purchase to include covered bonds, municipality bonds, and corporate bonds.
- More than 500 auctions of nominal and real Swedish government bonds.
- We utilize proprietary data on bond purchase allocation among participating banks.

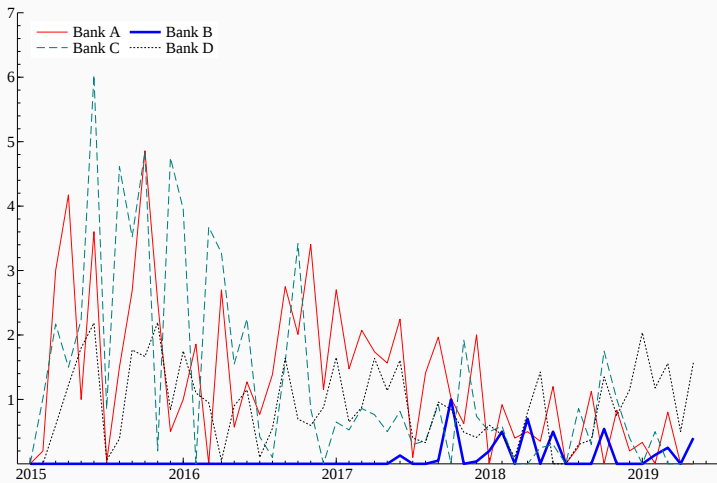
- We focus on producer (not consumer) prices (ending in 2017M12).
- Government bond purchases (not QT).

- Price data (monthly).
 - All micro prices underlying producer and import price index (PPI).
- Firm-level data (annual).
 - Comprehensive dataset covering the universe of Swedish firms.
 - All firm balance sheet items, financial accounting and real variables.
- Bank-level data (daily).
 - Bond purchase auction and sales history in the QE program.
 - Bond sales and price information from each bank.
 - Bank-firm credit relationships.

Riksbank QE–banks–firms–prices

- QE period 2015m2-2017m12: 51,000 price observations (Swedish domestic market), 1,100 firms.

Banks' QE activities



Firms' QE exposure measure

- Firm i 's exposure at month t through bank b , given its ω_{i,b,t_0} fraction of credit from bank b :

$$\text{Expo}_{i,t} = \sum_b \omega_{i,b,t_0} \cdot QE_{b,t}.$$

- Firms that have a credit relationship with banks more active in the QE program are more exposed to the unconventional monetary policy intervention (bank lending channel, Acharya et al. 2019).
- We fix the weight ω_{i,b,t_0} as the credit relationship ratio in January 2015, right before the Riksbanks' QE program started.
→ Variation over time comes from banks' decision only.
- Captures direct effects of QE (does not include more indirect price effects on banks' balance sheets).

Estimate inflationary effects

- Local projections at the product-level (2015m2–2017m12).
- **Linear specification**, firm i , product j :

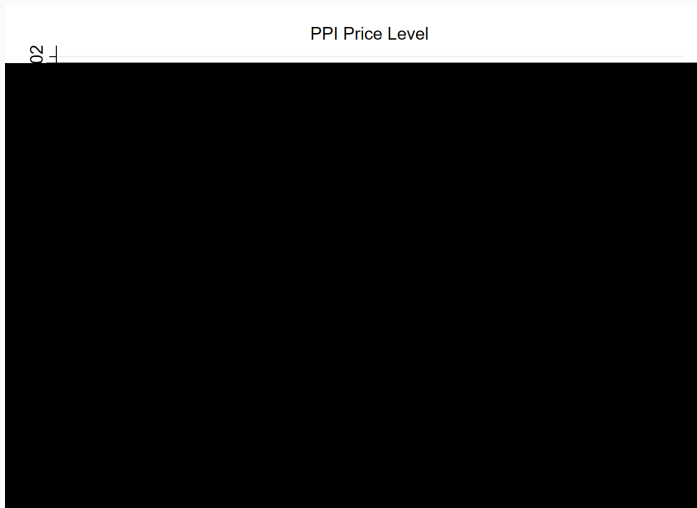
$$\log(y_{i,j,t+h}) - \log(y_{i,j,t-1}) = \beta_h \text{Expo}_{i,t} + \gamma_h X_{i,t} + \alpha_{g,h} + \alpha_{m,h} + u_{i,j,t+h}.$$

- **Non-linear specification:**

$$\begin{aligned} \log(y_{i,j,t+h}) - \log(y_{i,j,t-1}) = & l_{i,t-1} [\beta_h^A \text{Expo}_{i,t} + \gamma_h^A X_{i,t}] \\ & + (1 - l_{i,t-1}) [\beta_h^B \text{Expo}_{i,t} + \gamma_h^B X_{i,t}] \\ & + \alpha_{g,h} + \alpha_{m,h} + u_{i,j,t+h}. \end{aligned}$$

- $l_{i,t}$: specific firm characteristic (leverage).

Producer prices and QE exposure

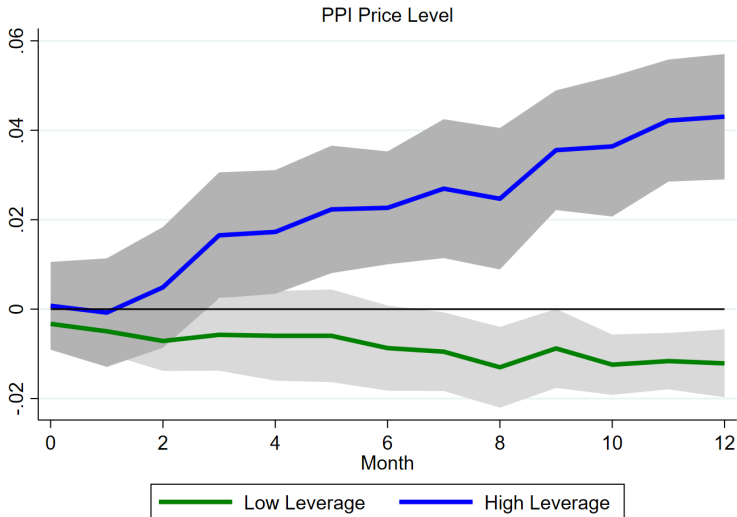


- Back-of-the-envelope calculation: QE of 1% of GDP increases prices by $\sim 0.8\%$.

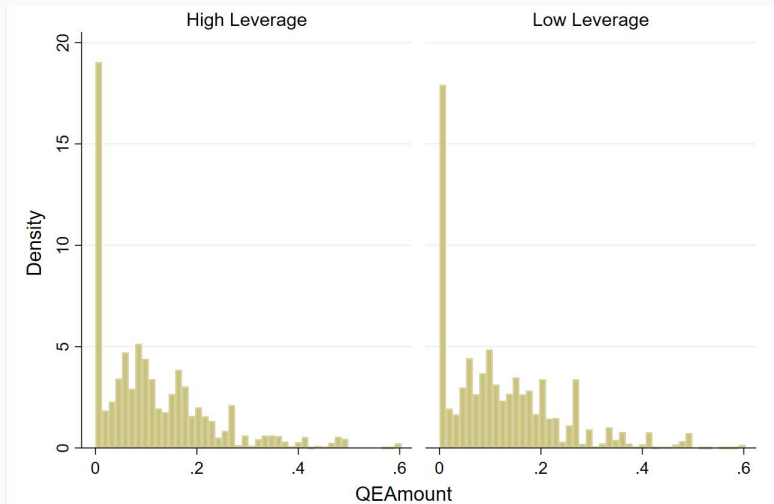
Decomposition

Producer prices, QE exposure, and firm leverage

Decomposition



QE exposure distribution



- **IV**

- Banks' QE participation might be endogenous to lending plan.
- Sell bonds on behalf of their clients (e.g, pension funds, insurance companies) exogenous to lending.
- Deposits created by other financial institutions as instrument (Butt et al. 2015).

- **Placebo tests**

- Two alternative QE exposure measures (bank participation + firm-credit relationship):
 1. Actual bank participation but random weights on firm-credit relationship.
 2. Random bank participation but actual firm-credit relationship.
- Do not reproduce our baseline results.

- **Including firm-fixed effects or (and) industry-fixed effects.**

- **Results not there for young vs. old and small vs. large firms.**

Understanding leverage-dependent price responses

- Additional firm level regressions to explain leverage-dependent price response.
- Balance-sheet data at the annual level.

$$y_{i,yr} = \alpha_i + \alpha_{ind,yr} + \delta \sum_{yr} \text{Expo}_{i,t} + \gamma X_{i,yr-1} + \epsilon_{i,yr}.$$

- $y_{i,y}$: specific variable of interest (debt holdings, debt interest rate expenses, investment expenditures).
- $\sum_{yr} \text{Expo}_{i,t}$: Accumulated monthly QE exposure measure.

Firm decisions and QE exposure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	LT Debt	ST Debt	Int. Exp.	Inventory	Revenue	PrCost	R&D Inv	M&E	FA Inv
<i>Panel A: All firms</i>									
Expo _{i,t}	0.0226** (0.0105)	0.0080 (0.0106)	0.0022 (0.0032)	0.0231** (0.0097)	0.0061 (0.0068)	0.0092 (0.0072)	-0.0007 (0.0010)	0.0312** (0.0138)	0.0092* (0.0052)
Expo _{i,t-1}	0.0559 (0.0411)	-0.0315 (0.0350)	-0.0018 (0.0051)	-0.0021 (0.0163)	0.0106 (0.0151)	0.0075 (0.0172)	-0.0013 (0.0011)	0.0016 (0.0229)	0.0079 (0.0088)
<i>Panel B: High-Lev firms</i>									
Expo _{i,t}	0.0626* (0.0348)	0.0504 (0.0326)	-0.0013 (0.0015)	0.0242* (0.0136)	-0.0088 (0.0079)	-0.0063 (0.0088)	-0.0031* (0.0018)	0.0080 (0.0188)	0.0239* (0.0141)
Expo _{i,t-1}	0.0276 (0.0684)	-0.0007 (0.0581)	0.0022* (0.0012)	0.0042 (0.0136)	-0.0096* (0.0053)	-0.0032 (0.0046)	-0.0001* (0.0001)	-0.0603* (0.0327)	0.0044 (0.0087)
<i>Panel C: Low-Lev firms</i>									
Expo _{i,t}	0.0103 (0.0235)	-0.0182 (0.0285)	-0.0033 (0.0107)	0.0162 (0.0106)	0.0193* (0.0106)	0.0231** (0.0112)	0.0013 (0.0013)	0.0344* (0.0193)	0.0143* (0.0082)
Expo _{i,t-1}	0.0343 (0.0597)	-0.0404 (0.0460)	0.0127 (0.0193)	0.0052 (0.0089)	0.0240 (0.0170)	0.0179 (0.0192)	-0.0008 (0.0020)	0.0286 (0.0369)	0.0129 (0.0131)
Control	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Ind-Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Cluster FE	FIRM	FIRM	FIRM	FIRM	FIRM	FIRM	FIRM	FIRM	FIRM

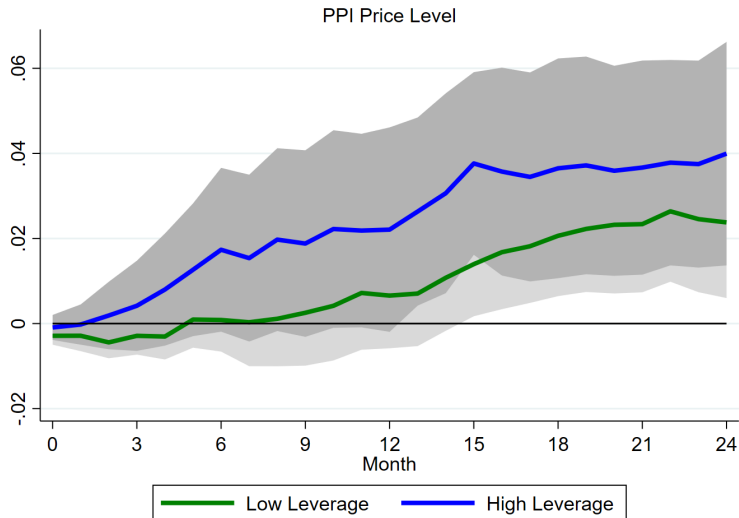
- **High leverage firms:**

- Increase in long-term debt to finance fixed asset investment (loosening of future collateral constraint), raise in interest rate expenses (marginal costs go up).
- Higher inventories, no significant change in revenues.

- **Low leverage firms:**

- Higher investment in R&D, machines and equipment (increase in productivity, no significant change in marginal costs).
- Higher revenues, increase in market share.

Conventional monetary policy shock



Comparing conventional and unconventional policies

- Difference in price responses less pronounced for exogenous changes in the repo rate.
- Based on our estimates, back-of-the-envelope calculation.
- QE intervention of 1% of GDP leads to a price increase of $\sim 0.8\%$.
- 25bps reduction in repo rate raises prices by $\sim 1.1\%$.

$\Rightarrow$ QE of 1.3% of GDP would induce a similar price reaction as a 25bps reduction in the repo rate.

Conclusion

- New evidence on the inflationary effects of QE using very granular data on the Swedish economy.
- Government bond purchases effective tool to increase prices.
- Significant variation in firms' responses.
- High leverage firms raise prices, low leverage firms do not adjust.
- Less pronounced for standard monetary policy shocks.
⇒ Transmission mechanism of QE to inflation different to conventional interest rate policy.
- **Outlook....**

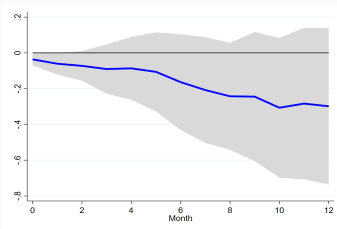
- New data arrived in January.
- Include most recent time period (up until October 2022).
- On top of price data, we also ordered micro data underlying official industrial production index.
- Granular *price* and *quantity* measures at high frequency.
- Can be linked to other firm datasets.

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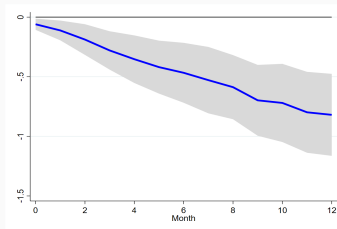
Thank you!

Additional slides

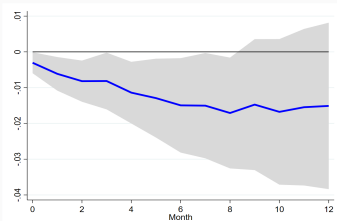
Decomposition

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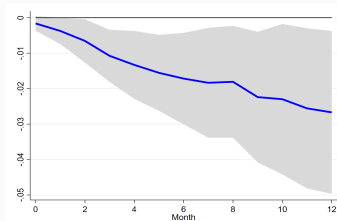
(a) Frequency positive



(b) Frequency negative

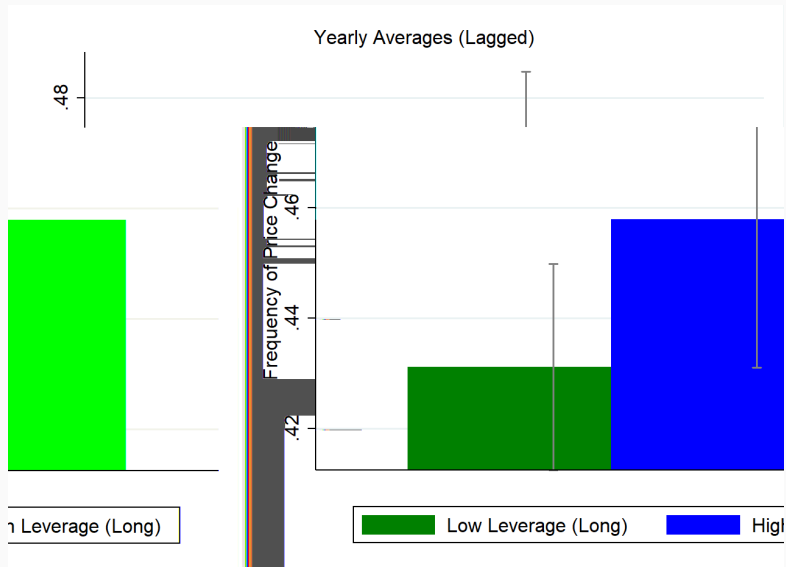


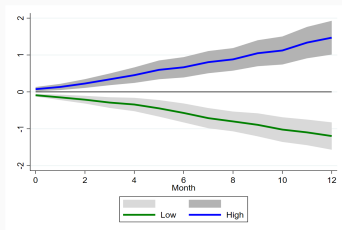
(c) Size positive



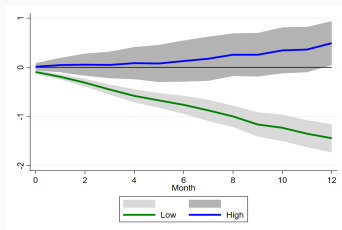
(d) Size negative

Price changing frequency

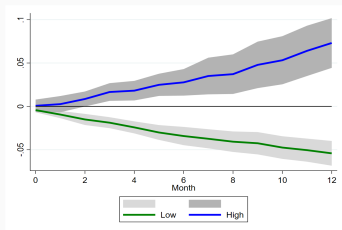




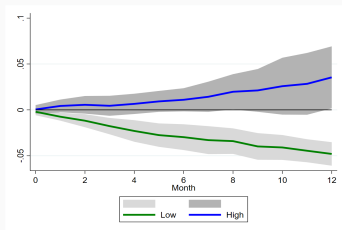
(e) Frequency positive



(f) Frequency negative



(g) Size positive



(h) Size negative