The Inflationary Effects of Quantitative Easing

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Motivation

- 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.

  $\Rightarrow$ 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.

Literature

- **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.

Remarks

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

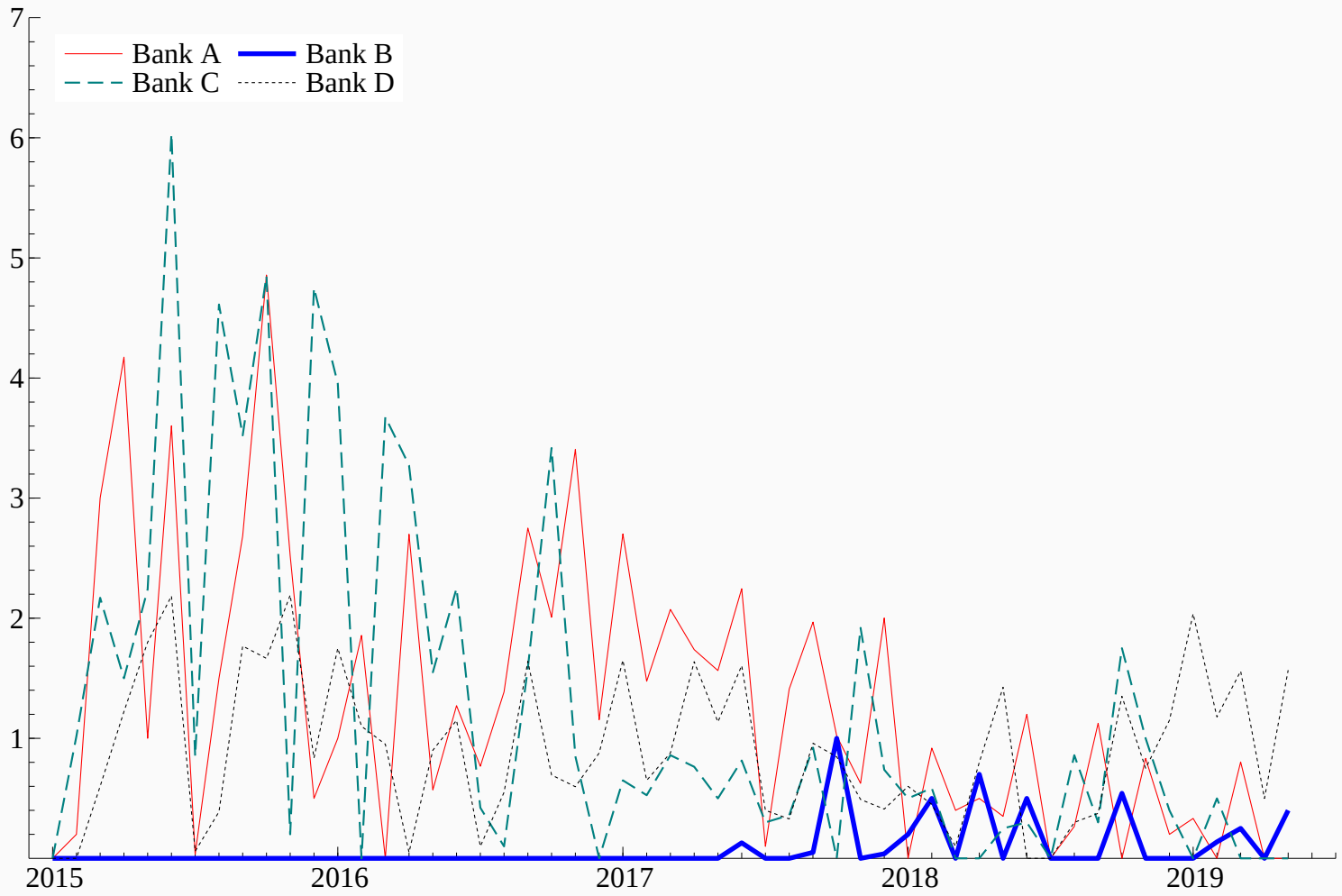
Data

- 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} faction 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.
  $\rightarrow$ 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:

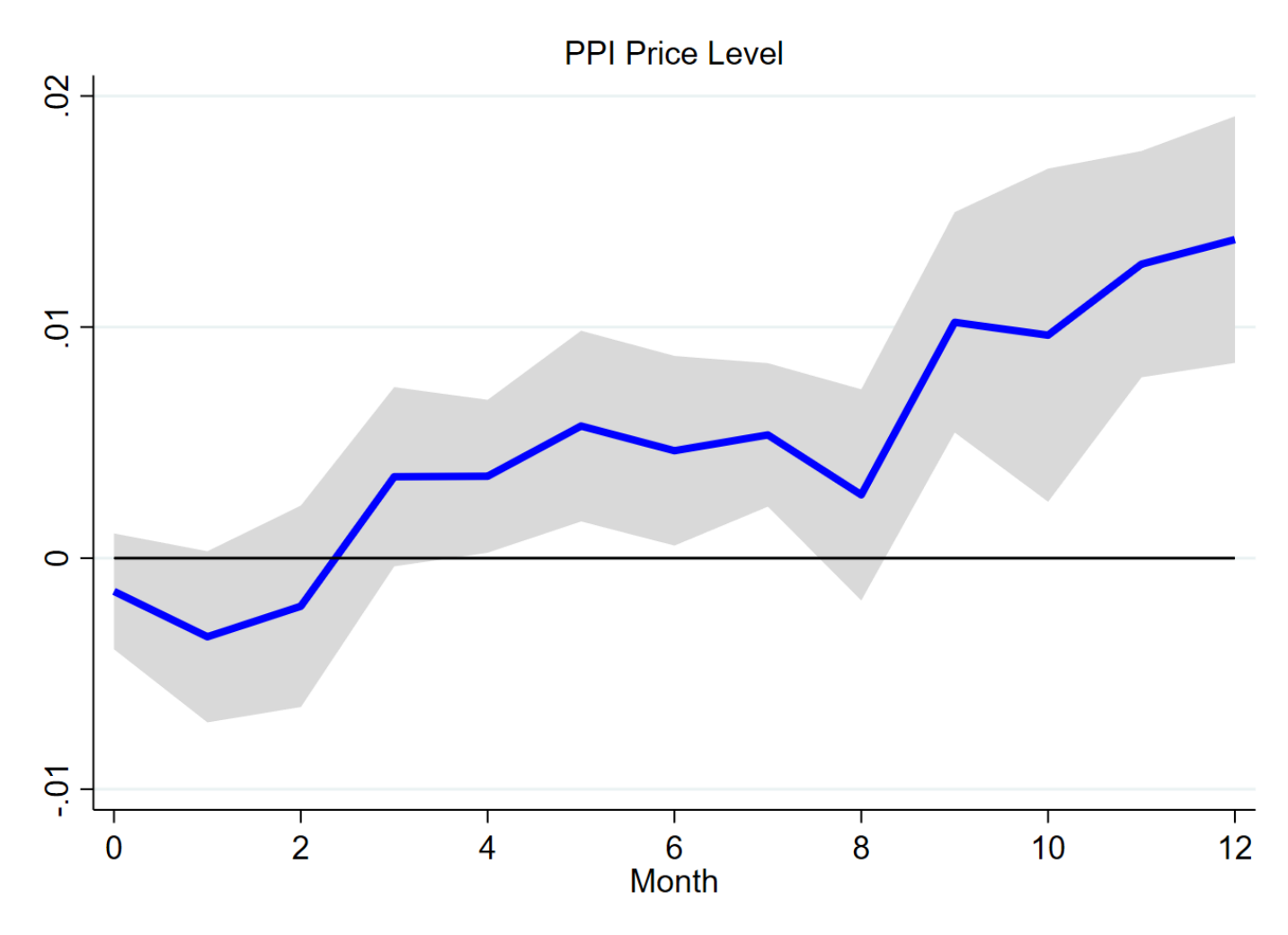
$$log(y_{i,j,t+h}) - log(y_{i,j,t-1}) = \beta_h \text{Expo}_{i,t} + \gamma_h X_{i,t} + \alpha_{g,h} + \alpha_{m,h} + u_{i,j,t+h}.$$

- **Non-linear specification**:

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

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

Producer prices and QE exposure

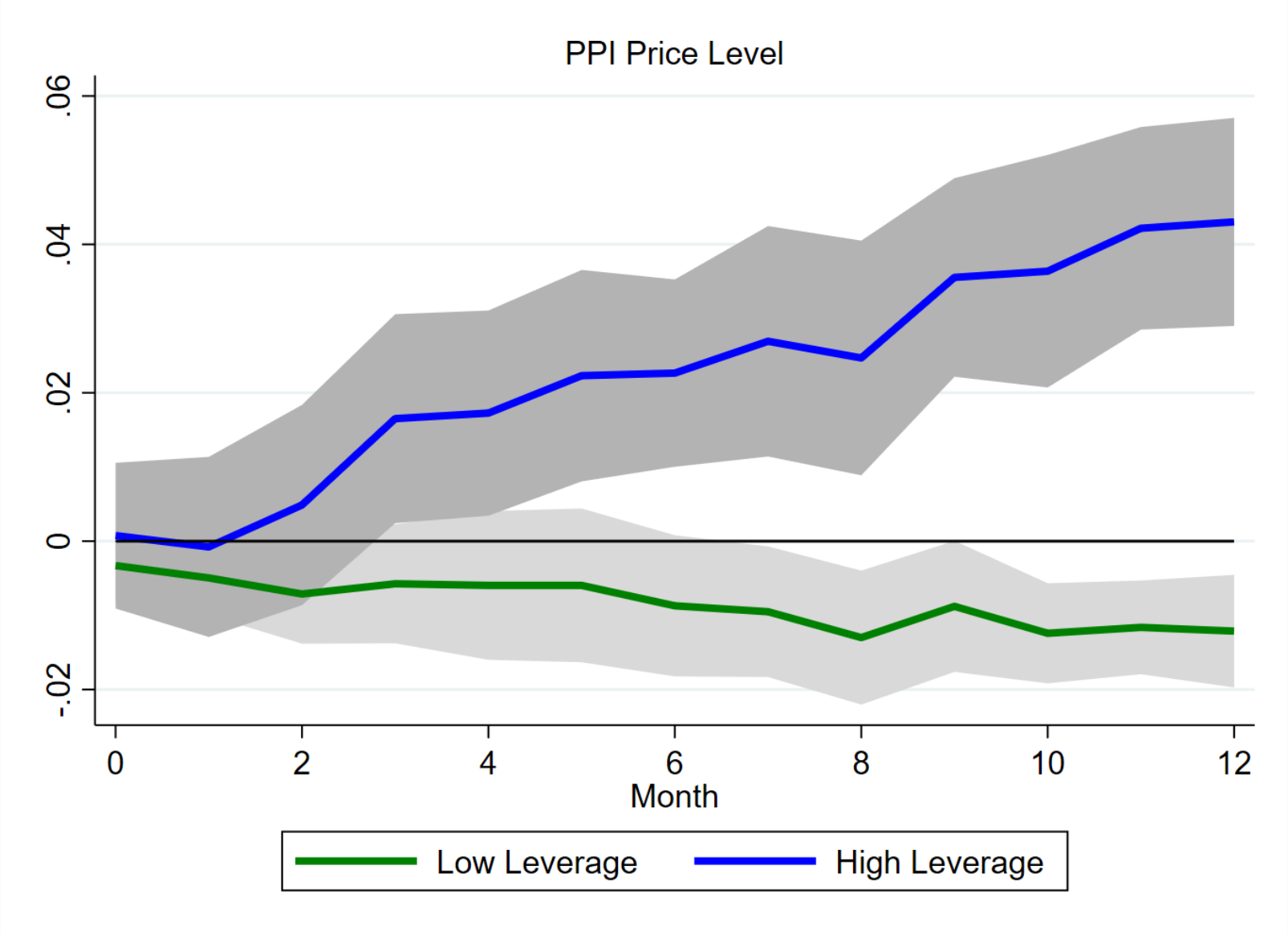


- Back-of-the-envelope calculation: QE of 1% of GDP increases prices by $\sim$ 0.8%.

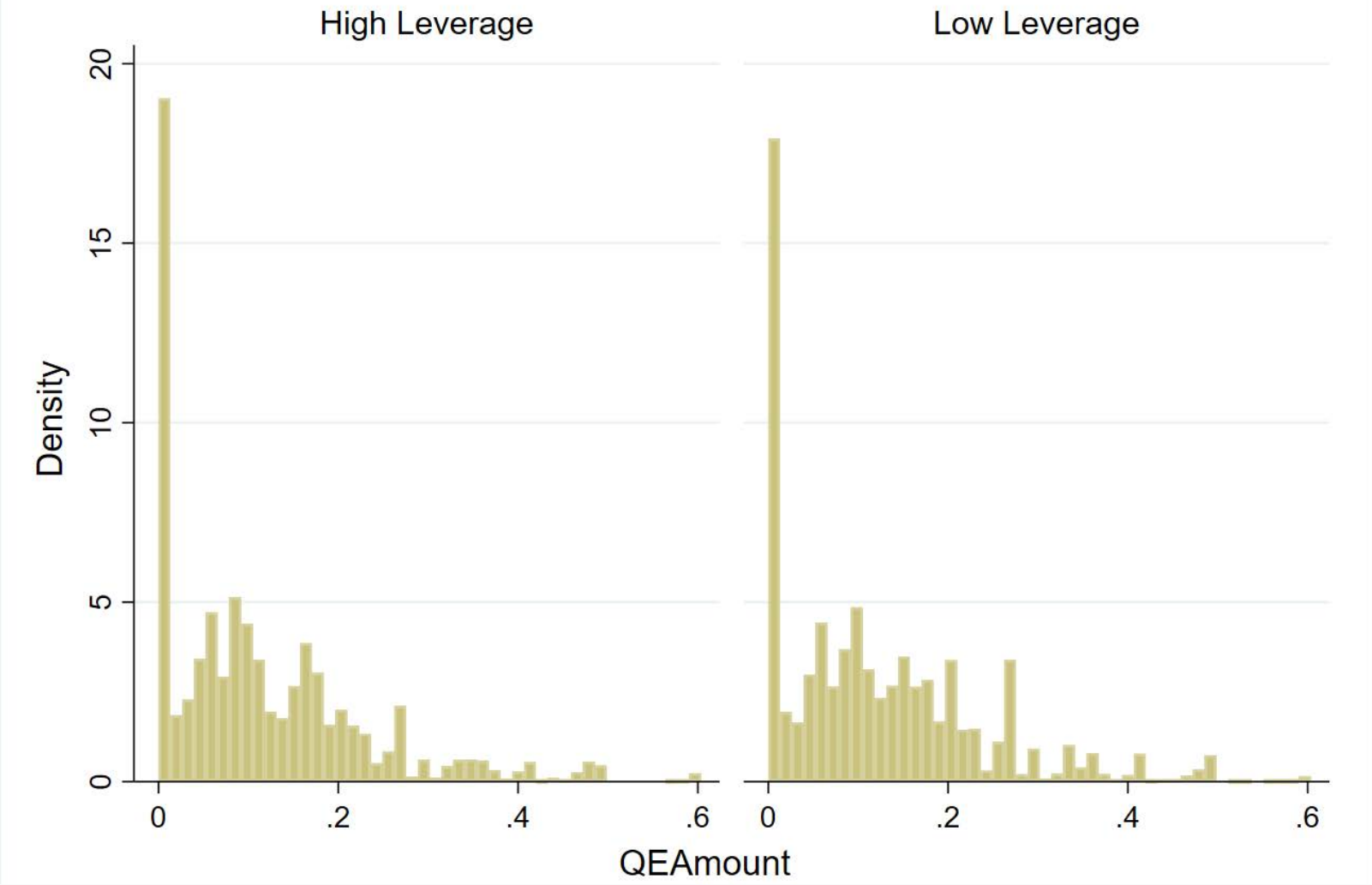
Decomposition

Producer prices, QE exposure, and firm leverage

Decomposition



QE exposure distribution



Further robustness

- **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

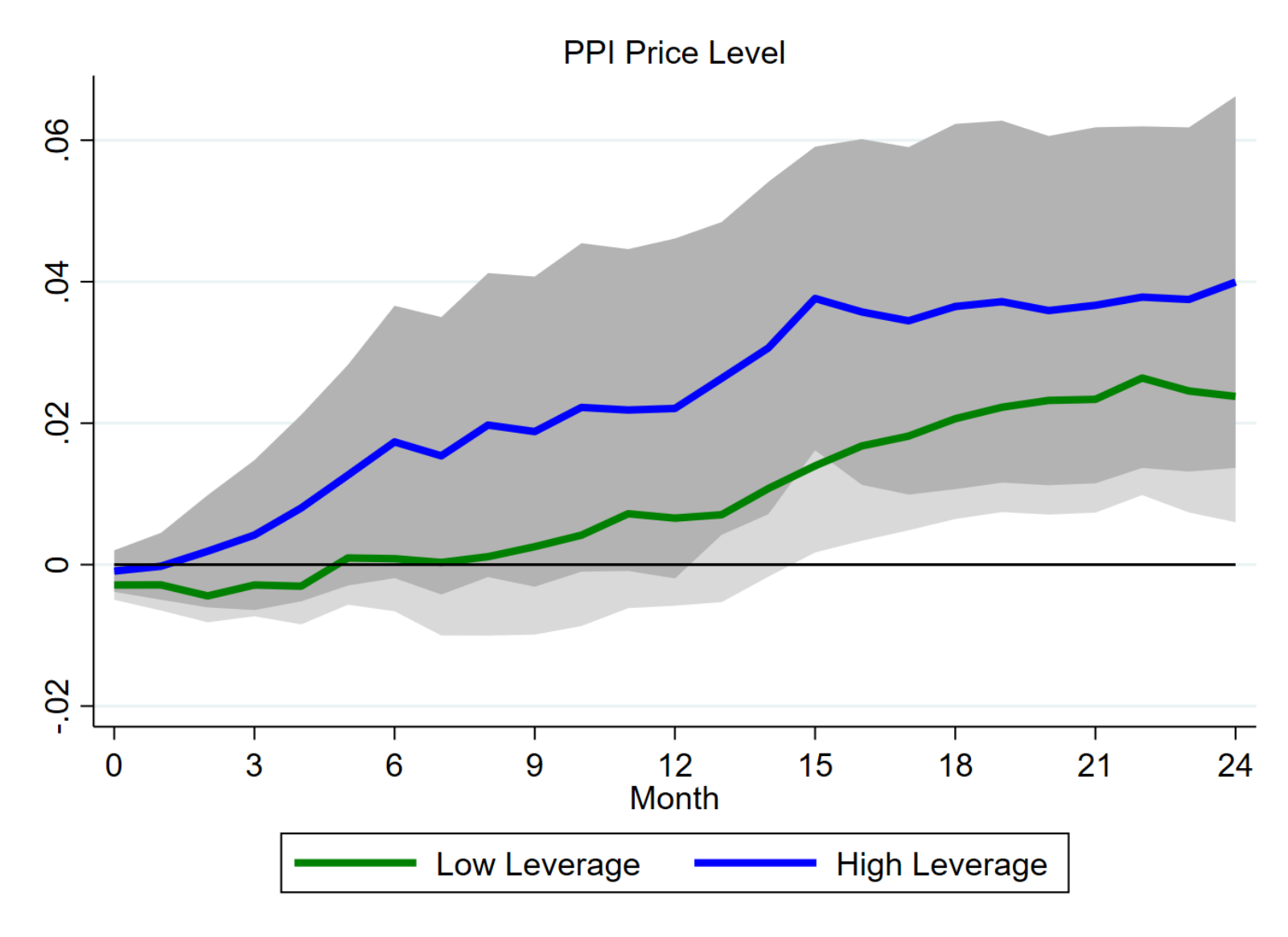
	(1) LT Debt	(2) ST Debt	(3) Int. Exp.	(4) Inventory	(5) Revenue	(6) PrCost	(7) R&D Inv	(8) M&E	(9) FA Inv
Panel A: All firms									
$Expo_{i,t}$	0.0226**	0.0080	0.0022	0.0231**	0.0061	0.0092	-0.0007	0.0312**	0.0092*
	(0.0105)	(0.0106)	(0.0032)	(0.0097)	(0.0068)	(0.0072)	(0.0010)	(0.0138)	(0.0052)
$Expo_{i,t-1}$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

Firm decisions and QE exposure

- **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.
  $\Rightarrow$ Transmission mechanism of QE to inflation different to conventional interest rate policy.

- **Outlook....**

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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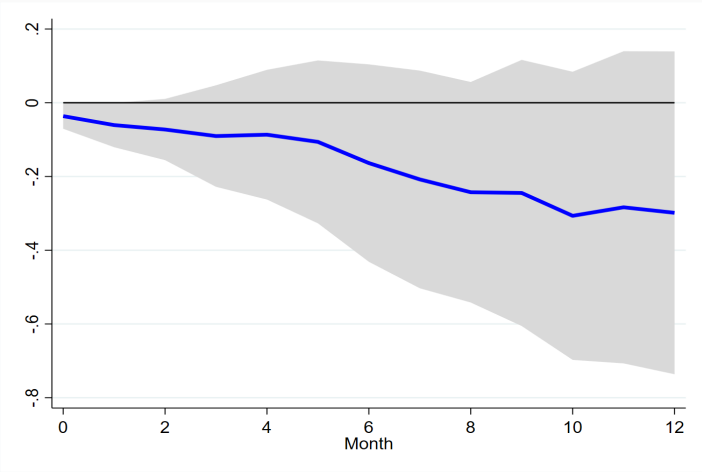
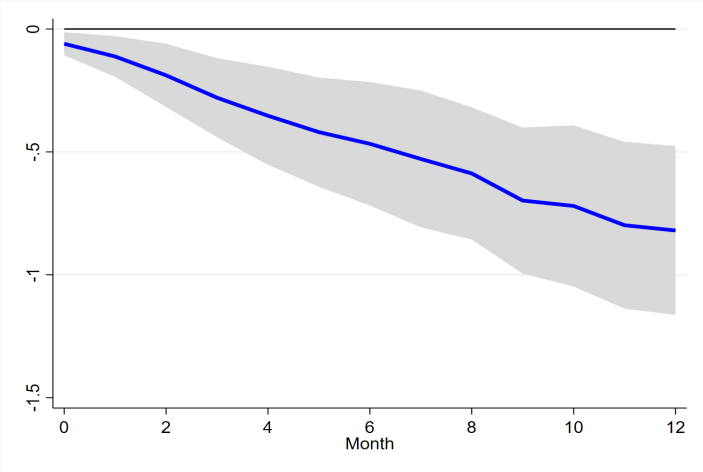
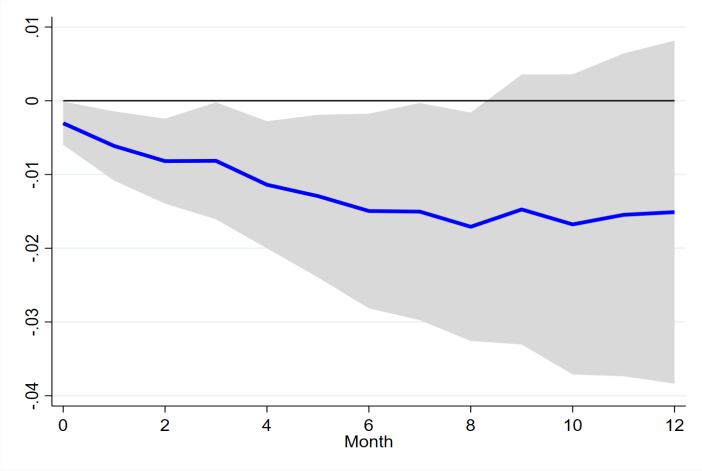


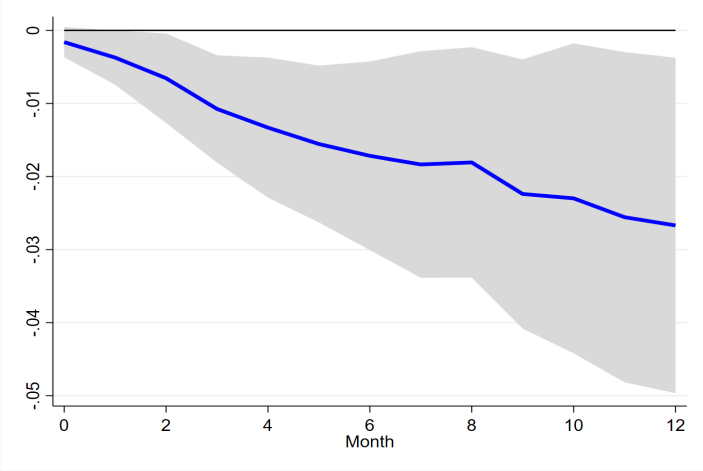
(a) Frequency positive



(b) Frequency negative

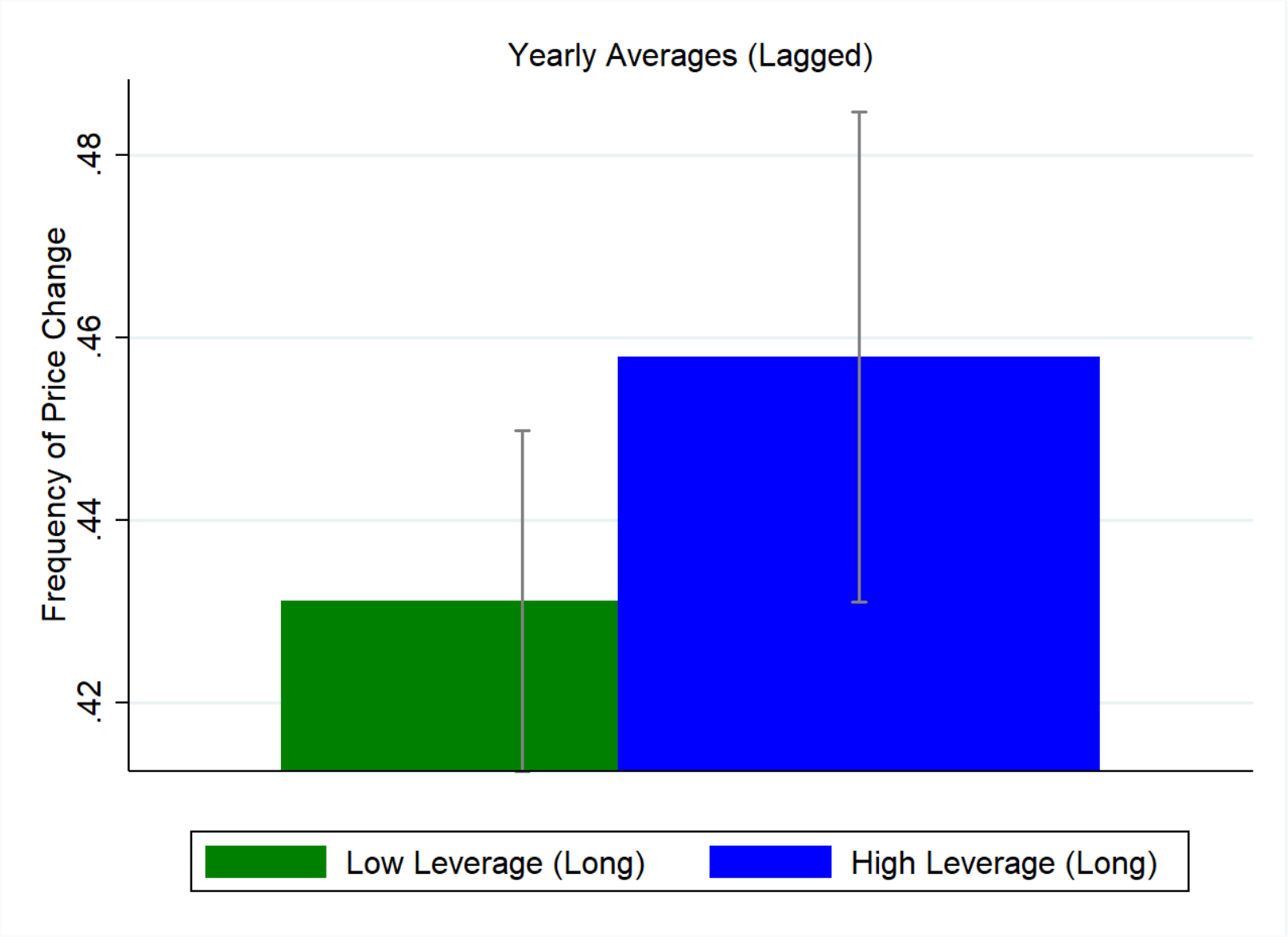


(c) Size positive



(d) Size negative

Price changing frequency



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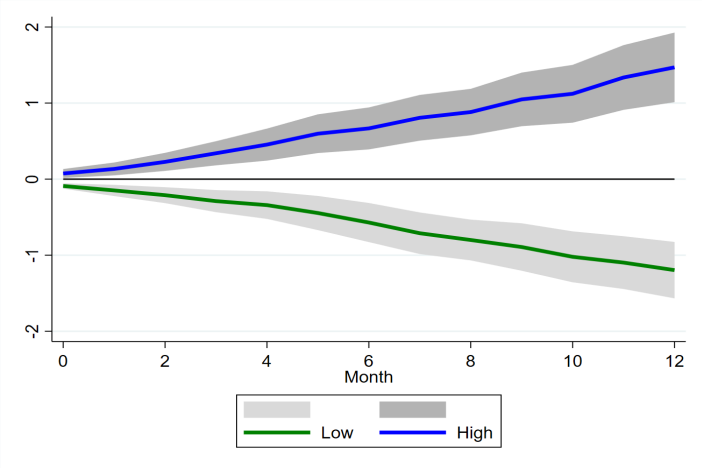
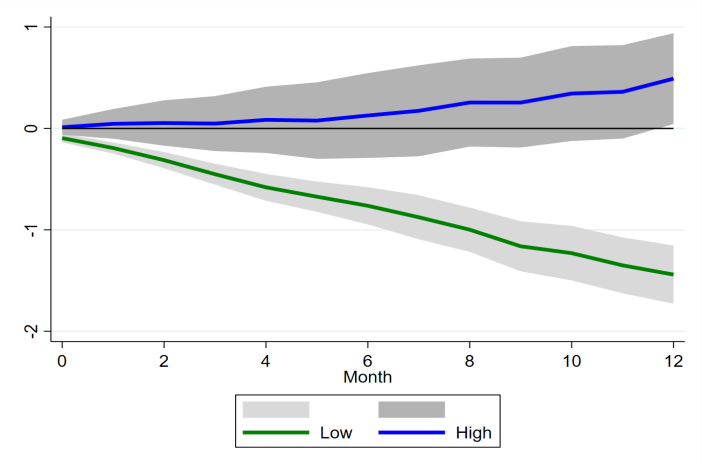
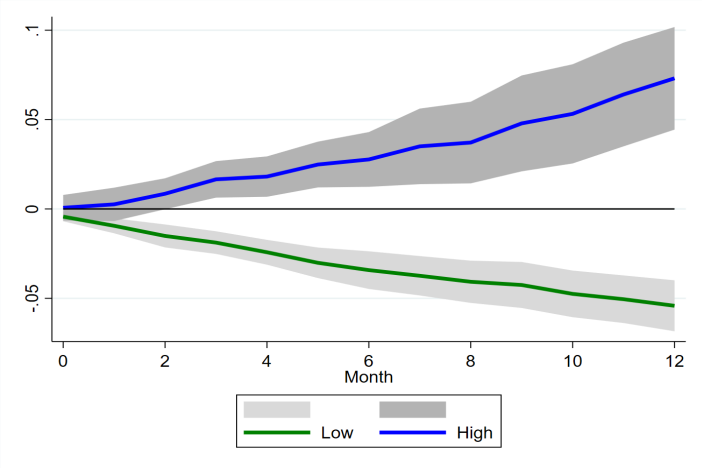


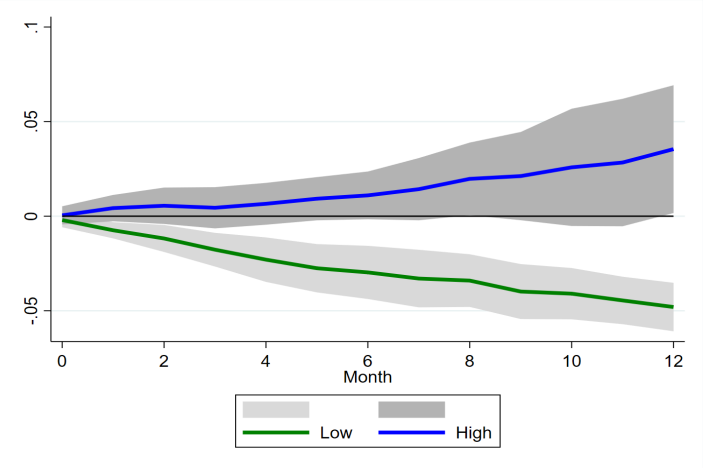
(e) Frequency positive



(f) Frequency negative



(g) Size positive



(h) Size negative