Bank Loan Reliance and Inflation Inattention [1]

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[1] The views expressed here should not be interpreted as representing the views of the Bank of Italy or any other institution with which the authors are affiliated.

Motivation

- **Central banks care about firms' inflation expectations**

  Janet Yellen (2016), former Fed Chair: How (firms') expectations are formed has taken on heightened importance, . . . many central banks have adopted policies that are directly aimed at influencing expectations of future interest rates and inflation.

  While ...
  - ⇒ Reduced policy effectiveness if firms do not pay attention
  - ⇒ Dispersed inflation expectations among firms
  - ⇒ Limited evidence on expectation formation

- **Costly information processing to form expectations**

  Christopher A. Sims (2010): why I don't (make fine adjustments in portfolio), the benefits would be slight, and I have more important things to think about.

  Then ...

  ⇒ what affects firms' incentive to acquire and process information on inflation?

This paper

- **Casual empirical evidence on how financing composition affects inflation attentiveness and inflation expectations**
  - Data: merged microdata on Italian firms
  - Identification: Bartik instrument & Randomized Controlled Trial
  - Findings:
    1. $\uparrow$ Loan reliance $\Rightarrow$ $\uparrow$ inflation forecast accuracy
    2. $\uparrow$ Loan reliance $\Rightarrow$ $\downarrow$ response to provided publicly-available news
- **A partial-equilibrium model with rational inattention replicates the empirical results**
  1. Inflation affects loan markup
  2. $\uparrow$ Loan reliance $\Rightarrow$ $\uparrow$ exposure to inflation (financing) $\Rightarrow$ $\uparrow$ incentive to acquire and process information
- **A general-equilibrium model with policy implications**

Related Literature

- **Firms' inflation expectations and action**
  Expectation ⇒ Actions Coibion et al. (2018, New Zealand), Coibion et al. (2019, US), Boneva et al. (2020, UK), Andrade et al. (2021, France), Ropele et al. (2022, Itlay), Ropele et al. (2024, Italy)
  Traits ⇒ Expectation Kumar (2020); Yang (2022); Afrouzi (2023)
  Contribution: causal evidence on financing structure affecting expectation formation

- **Rational inattention**
  Sims (2003); Woodford (2009); Maćkowiak and Wiederhold (2009); Matějka (2016); Maćkowiak et al. (2018); Weber et al. (2023);

  Contribution: findings on state-dependent inattention

Empirics

- Data and Measure
- 2SLS with Bartik Instrument
- RCT

Theory

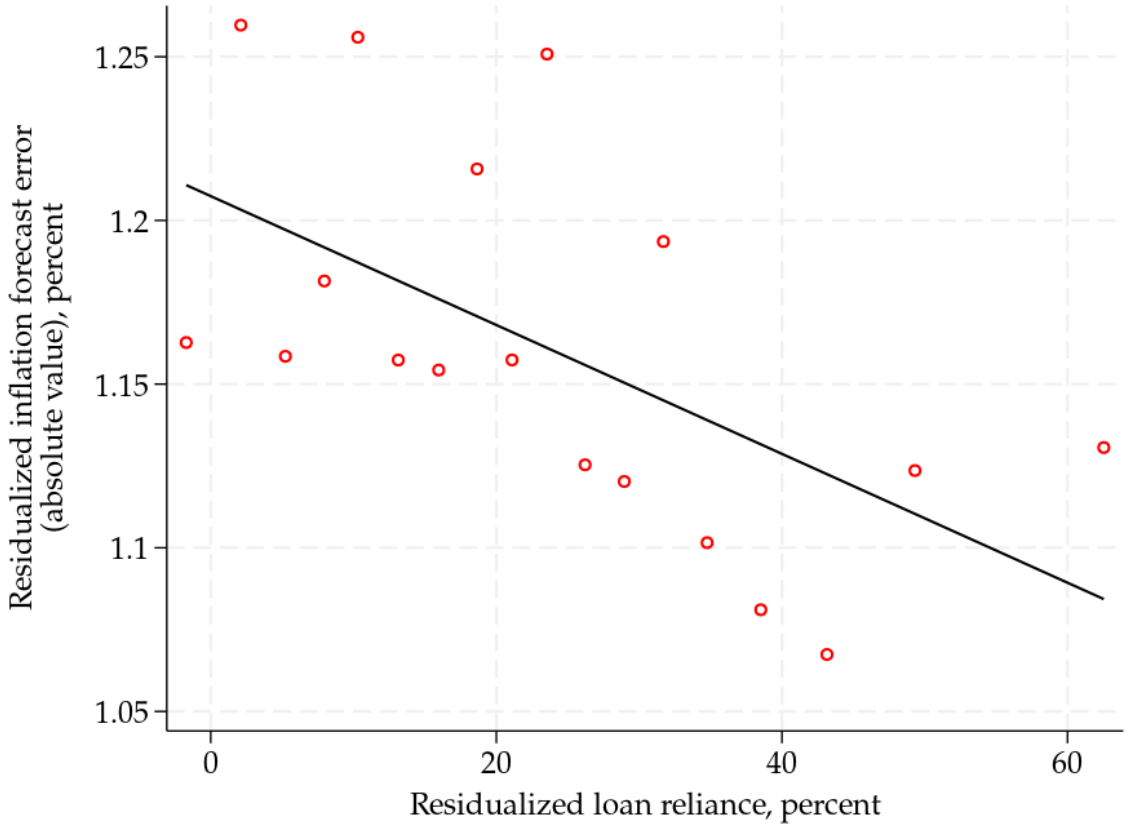
Data and measurement

- Data (2006 - 2019)
  - Survey of Inflation and Growth Expectations
    firms' inflation expectations, a representative sample, RCT (since 2013Q1), conducted by the Bank of Italy
  - Central Credit Registry
    credit position with banks and financial institutions, quarterly
  - Analytical Survey of Interest Rates
    loan interest rates, loan spread
  - Company Accounts Data Service
    firm-level balance sheet

- Measures
  1. Bank credit reliance: $\text{Loan Reliance}_{j,t} = \frac{\sum_{i \in \text{banks}} \text{Term Loan}_{i,j,t}}{\text{Asset}_{j,t}}$ plot
  2. Inflation inattention: $\text{Inattention}_{j,t}^{(\pi)} \equiv \left| \pi_t^{(12m)} - F_j \pi_t^{(12m)} \right|$ plot

Suggestive evidence: loan reliance and inflation inattention

Takeaway: higher loan-reliant firms exhibit lower forecast errors



Notes: loan reliance and inattention are residualized by controlling for observable fixed effects, including size, region, sector, and treatment status.

Causal evidence I: Bartik instrument

1. **Benchmark regression**

$$\text{Inattention}_{j,t}^{(\pi)} = \beta \text{ Loan Reliance}_{j,t} + \epsilon_{j,t}$$

2. **A Bartik instrument for loan reliance**

$$\bar{\delta}_{j,t} = \sum_{i \in \text{banks}} \underbrace{\frac{\text{Term Loan}_{i,j,t-1}}{\sum_{i \in \text{banks}} \text{Term Loan}_{i,j,t-1}}}_{\textit{Exposure}_{i,j,t-1}} \cdot \hat{\delta}_{i,t}$$

- $\textit{Exposure}_{i,j,t-1}$: (lagged) exposure of firm j to bank i
- $\hat{\delta}_{i,t}$: credit supply shock in bank i at time t (Khwaja and Mian 2008)

$$R^b_{i,j,t} - R_t = \underbrace{\delta_{i,t}}_{\text{credit supply}} + \underbrace{\lambda_{j,t}}_{\text{credit demand}} + \epsilon_{i,j,t}$$

Causal evidence I: 2SLS

	Dependent variable: Inattention$_{j,t}^{(\pi)}$					
	2SLS					OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Loan Reliance	-0.121**	-0.120**	-0.101**	-0.116**	-0.0998**	-0.00206
	(0.0562)	(0.0553)	(0.0467)	(0.0523)	(0.0459)	(0.00128)
log(employees)		0.293*			0.231*	
		(0.151)			(0.117)	
ROE			-0.00385***		-0.00357***	
			(0.00131)		(0.00128)	
Liquid asset ratio				-0.0182***	-0.0163***	
				(0.00568)	(0.00548)	
Observations	16,886	16,886	15,467	15,885	15,282	16,886
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
RCT FE	Yes	Yes	Yes	Yes	Yes	Yes
1st stage F stat	13.33	13.68	16.07	14.76	16.67	
1st stage coeffi.	-0.0540	-0.0550	-0.0660	-0.0580	-0.0660	

Notes: Standard errors reported in parentheses are as in Driscoll and Kraay (1998).

Takeaway: 1 std ↑ in loan reliance (17%) → 2 std ↓ in inattention (2%).

▸ Descriptive statistics

Causal evidence II: RCT

- Randomized Controlled Trial ▸ Question
  - Treatment: information on current inflation ($\mathbb{I}_j = 1$)
  - Prior: one-year ahead inflation forecast in last quarter
  - Posterior: one-year ahead inflation forecast in this quarter
  - Two waves: (1) RCT first introduced; (2) treated firms redrawn

- Empirical Design:

$$\text{Posterior}_j = \alpha_1 \times \text{Prior}_j + \alpha_2 \times \text{Loan Reliance}_j \times \text{Prior}_j + \gamma_1 \times \mathbb{I}_j \times \text{Prior}_j + \gamma_2 \times \mathbb{I}_j \times \text{Loan Reliance}_j \times \text{Prior}_j + \cdots + \epsilon_j.$$

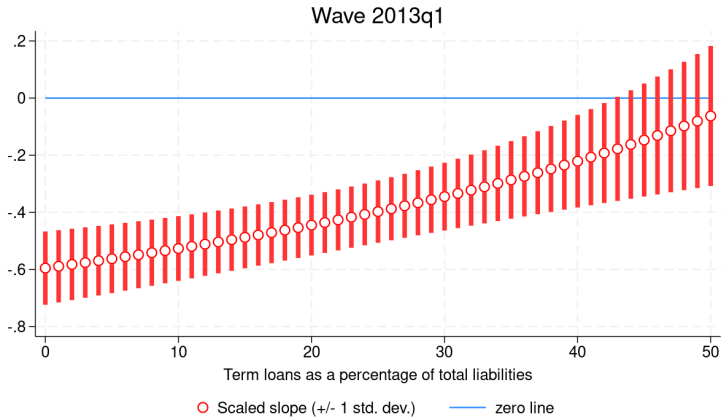
Within the treated group, how much they update posterior expectations:

$$\frac{\hat{\gamma}_1 + \hat{\gamma}_2 \text{Loan Reliance}}{\hat{\alpha}_1 + \hat{\alpha}_2 \text{Loan Reliance}}$$

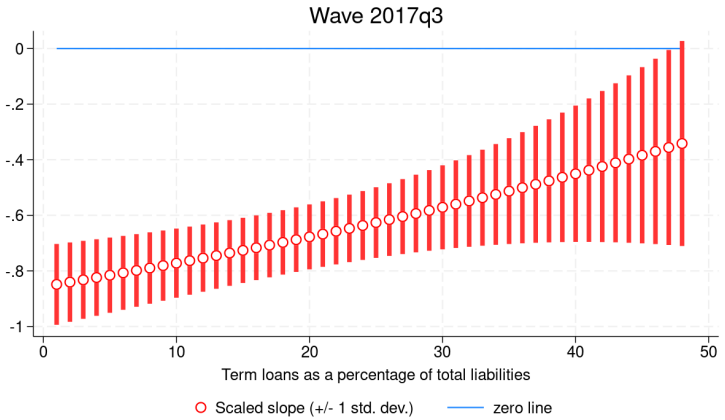
Empirical evidence: RCT

$$\text{Scaled coefficient} = \frac{\hat{\gamma}_1 + \hat{\gamma}_2 \text{Loan Reliance}}{\hat{\alpha}_1 + \hat{\alpha}_2 \text{Loan Reliance}}$$

- Response to treatment, $\hat{\gamma} < 0$: treatment group places less weight (60% - 80%) on priors, more weight on the information treatment
- High loan reliance firms respond less: already known!



(a) First RCT



(b) Reshuffling

Empirics

- High loan-reliant firms pay more attention
- High loan-reliant firms respond less to RCT

Theory

- Rational inattentive firms
- Banking market and inflation pass-through
- Implications: comparative statistics, simulated RCT, IRFs

The model: firms

- Two-stage problem
  1. Cost minimization: share of interval funds ($\Gamma^I_{j,t}$) & bank loans ($\Gamma^B_{j,t}$)

$$\mathbf{M_{j,t}} \equiv \min_{\Gamma^I_{j,t},\Gamma^B_{j,t}} \Gamma^I_{j,t} + \frac{R^b_{j,t}}{R_t}\Gamma^B_{j,t}, \text{ where: } \frac{R^b_{j,t}}{R_t} = \mathcal{F}(\Pi_t, \cdots)$$

  2. Profit maximization: optimal capital $K_{j,t}$

$$\max_{K_{j,t}} \mathbb{E}_0 \sum_{t=1}^{\infty} \beta^t \left[K^{\phi}_{j,t} - M_{j,t}[K_{j,t} - (1-\delta)K_{j,t-1}] \right].$$

  - $M_{j,t}$: unit financing cost for firm j at time t;
  - β: discount factor; $\phi < 1$: decreasing return to scale; δ: capital depreciation rate

- Why do firms care about inflation? $\underbrace{\pi_t \Rightarrow \mathcal{F}(\Pi_t, \cdots)}_{\text{Banking market}} \Rightarrow K_{j,t}$

▸ $R^b_{j,t}/R_t$: micro-foundation

The model: banks

The banks operate in a monopolistically competitive market with

- Input: deposits (R_t)
- Output: bank loans (R_t^b)
- Calvo-type stickiness in setting the loan interest rate
- Taylor rule: $R_t = R\left(\frac{\Pi_t}{\Pi}\right)^{\tau_\pi}$, where $\Pi_t = \Pi_{t-1}^{\rho_\pi} exp(\epsilon_{\pi,t})$

Channel:

$$\text{Oil price shock } \epsilon_{\pi,t} \underbrace{\Longrightarrow}_{①} \text{Policy rate } R_t \underbrace{\Longrightarrow}_{②} \text{Loan rate } R_{i,t}^{b,*} \Longrightarrow \frac{R_t^b}{R_t}$$

1. Higher inflation triggers increases in the policy rate
2. Higher policy rate leads to higher input price for banks, affecting loan interest rate and markup

The model - rational inattention

Following Mackowiak, Matejka, and Wiederholt (2018),

$$\min_{\kappa_j, h_j} \sum_{t=0}^{\infty} \beta^t \mathbb{E}_{-1} \left[(k_{j,t} - k^*_{j,t})^2 \right] + \lambda_\kappa \kappa_j$$

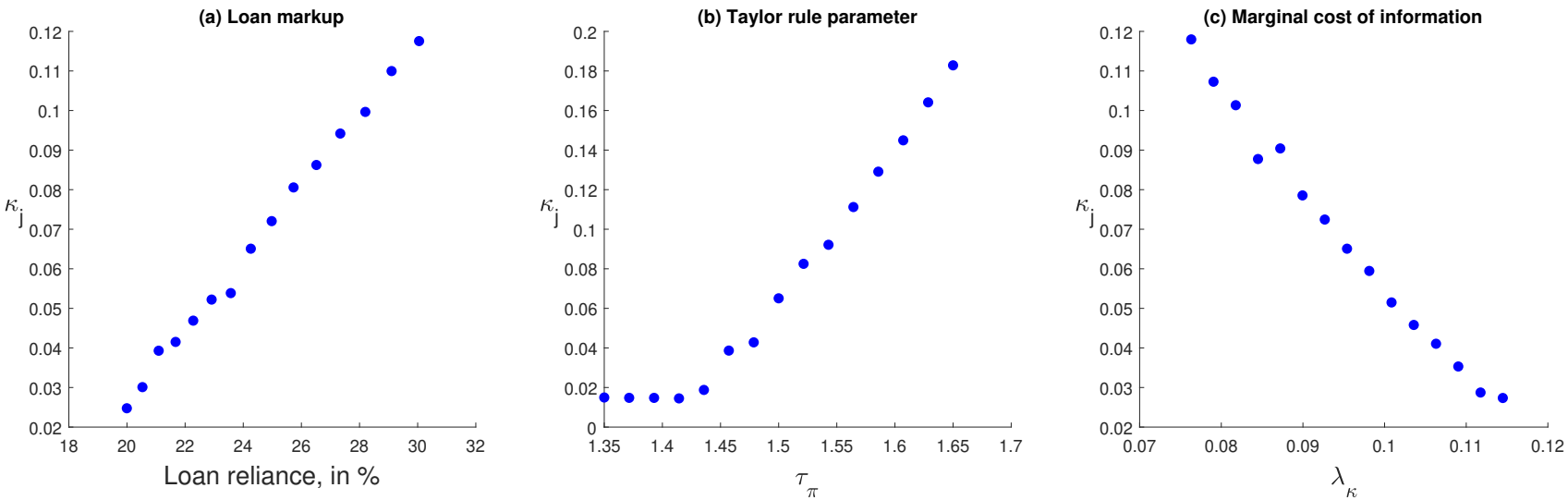
subject to:

$$\begin{aligned}
\text{Optimal capital:} \quad & k^*_{j,t} = p_1 k^*_{j,t-1} + p_2 k^*_{j,t-2} + q^j_1 \epsilon_{\pi,t} + q^j_2 \epsilon_{\pi,t-1} + q^j_3 \epsilon_{\pi,t-2} \\
\text{Perceived optimal capital:} \quad & k_{j,t} = \mathbb{E}(k^*_{j,t} | \mathcal{I}_t) \\
\text{Signal structure:} \quad & S_{j,t} = h'_j z_{j,t} + \psi_{j,t} \text{ , with } z_{j,t} = (k^*_{j,t} \; k^*_{j,t-1} \; \epsilon_{\pi,t} \; \epsilon_{\pi,t-1})' \\
\text{Information set:} \quad & \mathcal{I}_{j,t} = \mathcal{I}_{-1} \cup \{S_{j,0}, \ldots, S_{j,t}\} \\
\text{Information processed:} \quad & \kappa_j = \lim_{T \to \infty} \left[\mathcal{H}(k^*_{j,t} | \mathcal{I}_{j,t-1}) - \mathcal{H}(k^*_{j,t} | \mathcal{I}_{j,t}) \right]
\end{aligned}$$

- $\frac{\partial q^j_1}{\partial \Gamma^B_{j,t}} > 0$: higher loan-reliant firms have larger exposure to inflation

Implication 1 - Comparative statistics

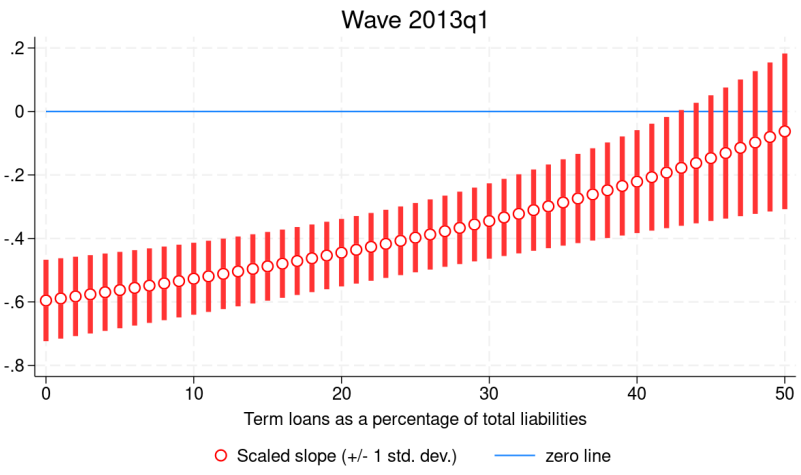
- Steady-state κ (amount of information processed) varies under:
  1. More loan-reliant firms (less expensive bank loans)
  2. More aggressive central bank
  3. Higher information processing cost



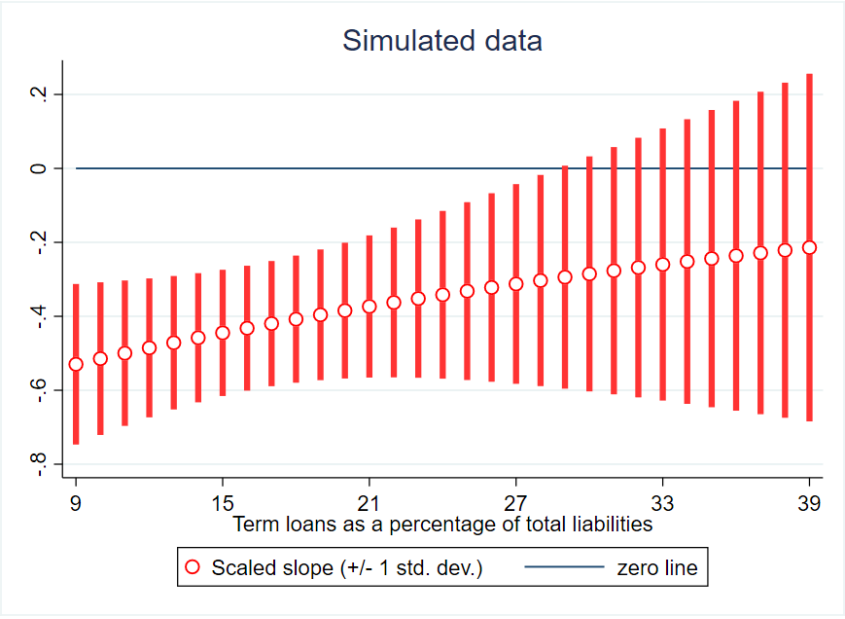
Implication 2 - Replicate RCT

1. Simulated firms with loan reliance matching the empirical distribution
2. RCT: one-time increase in signal precision

$$F_j\pi_t^{(12m)} = F_j\pi_{t-1}^{(12m)} + \text{signal-to-noise ratio} \cdot (S_t - S_{t|t-1})$$



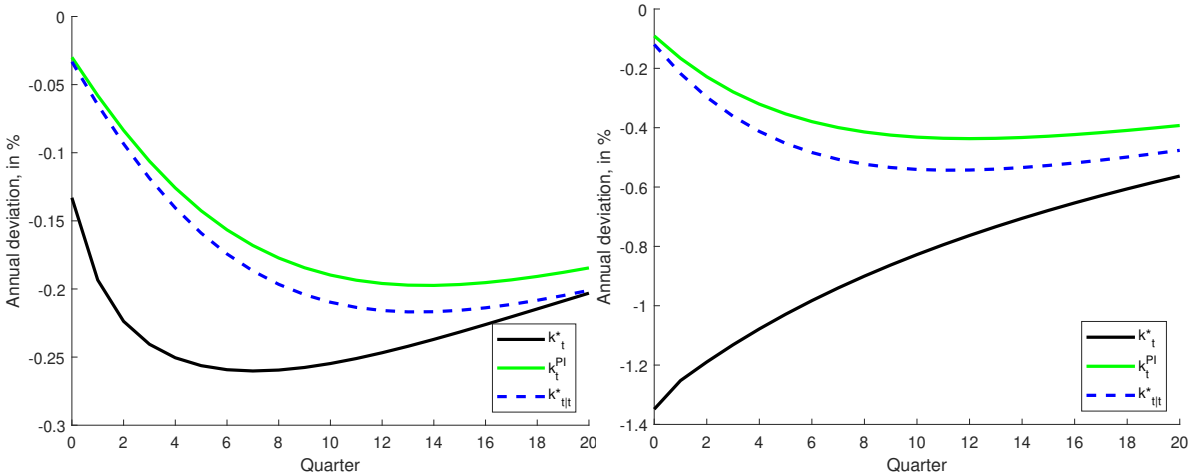
(c) First RCT



(d) Model implied

Implication 3 - Impulse Response of $k_{j,t}$

The IRFs are based on the general equilibrium with the endogenous inflation process:



(e) Monetary policy shock (f) Cost-push shock

Notes: This figure displays the impulse responses in capital level after one standard deviation monetary policy shock and cost-push shock. The y-axis is annualized and in percentage.

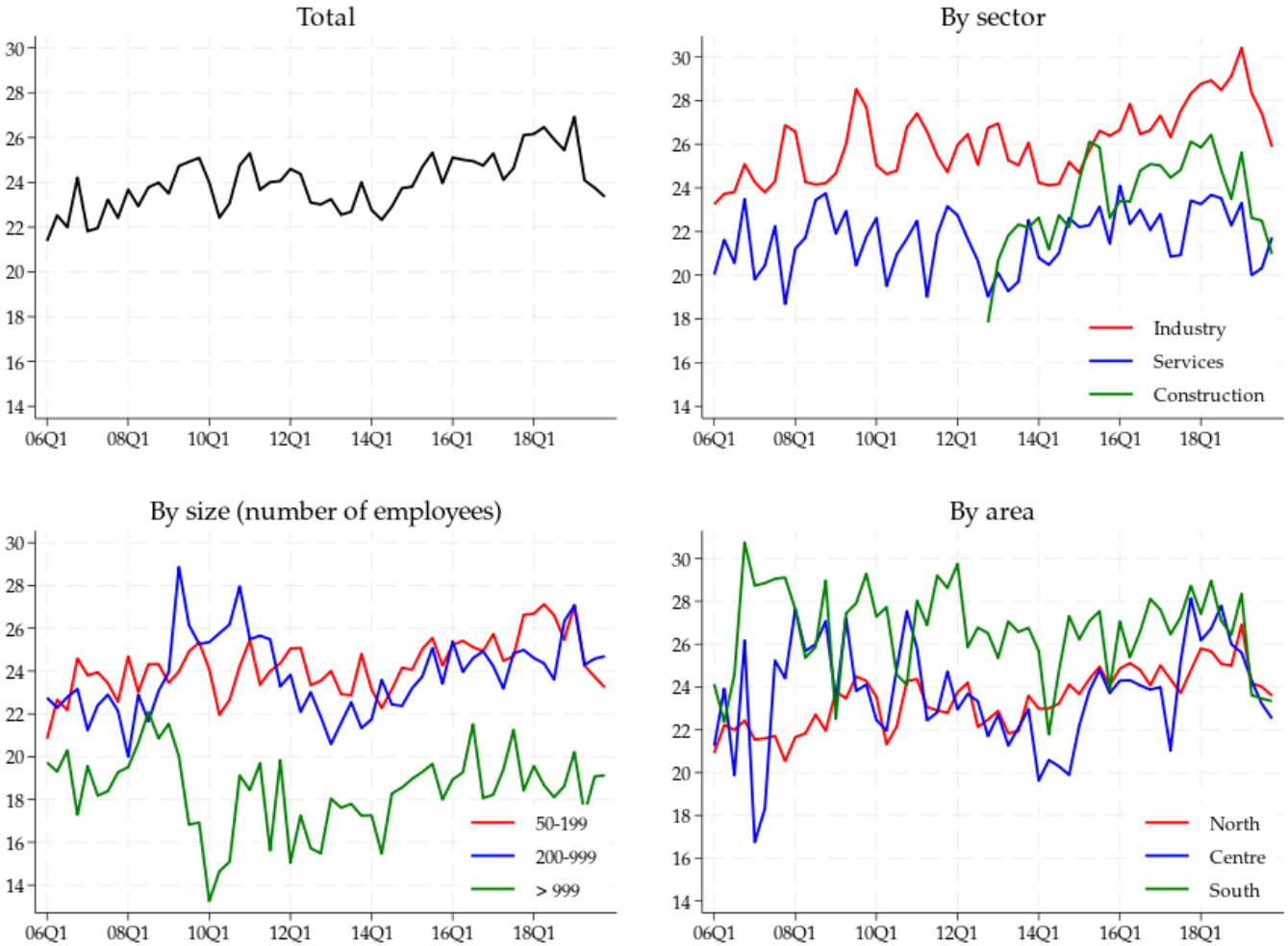
- Optimal capital levels under rational inattention (k_t^*) and perfect information (k_t^{PI}) are different
- Actual impacts on capital (k_t^{PI}) are reduced and delayed

Conclusion

1. Financing composition as an important determinant for firms' inflation expectations (suggestive evidence for rational inattention theory)
   - Incentive to acquire information
   - How firms learn from new information

2. An analytical model featuring endogenous financing composition and attention allocation
   - Explain the inflation-financing-cost channel
   - Replicate the RCT results
   - Interesting implications: effectiveness of monetary policy

A.1: Loan reliance



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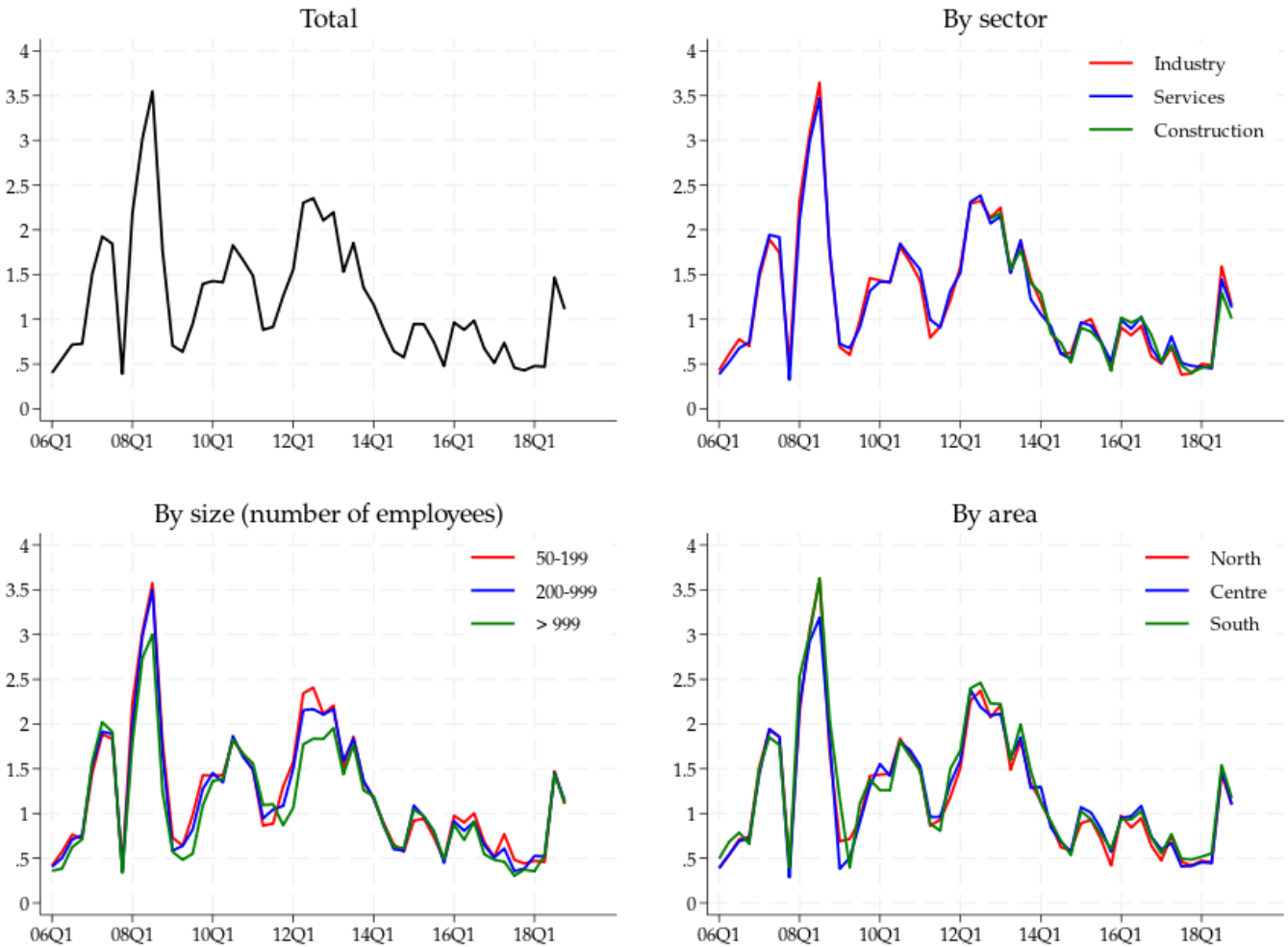
A.2: Inflation inattention



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A.3: Descriptive statistics

Table 1: Descriptive statistics

	p25	p50	p75	Mean	SD	N
Expected inflation (1-year ahead)	0.600	1.400	2.200	1.531	1.236	29793
Inflation inattention (in %)	0.400	1.000	1.700	1.160	0.997	26376
Term loan reliance (in %)	9.767	22.376	35.470	24.105	17.497	24805
Bank credit to debt ratio (in %)	58.156	94.649	100.000	73.184	36.817	27027
log(employees)	4.060	4.635	5.209	4.840	0.961	35316
ROE	0.102	4.105	11.924	4.119	25.967	28457
Liquid asset ratio (in %)	0.556	2.748	8.948	6.505	8.688	29091

Notes: The loan reliance based on term loans is calculated at the firm level. The summary statistics are computed with the sampling weights. The sample period is from 2006Q1 to 2019Q4.

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A.4: RCT

- "In [previous month], consumer price inflation measured by the 12-month change in the Harmonized Index of Consumer Prices was [X.X]% in Italy and [Y.Y]% in the Euro area. What do you think it will be in Italy ... six-month ahead, one-year ahead, and two-year ahead."
- "What do you think consumer price inflation in Italy, measured by the 12-month change in the Harmonized Index of Consumer Prices, will be ... "

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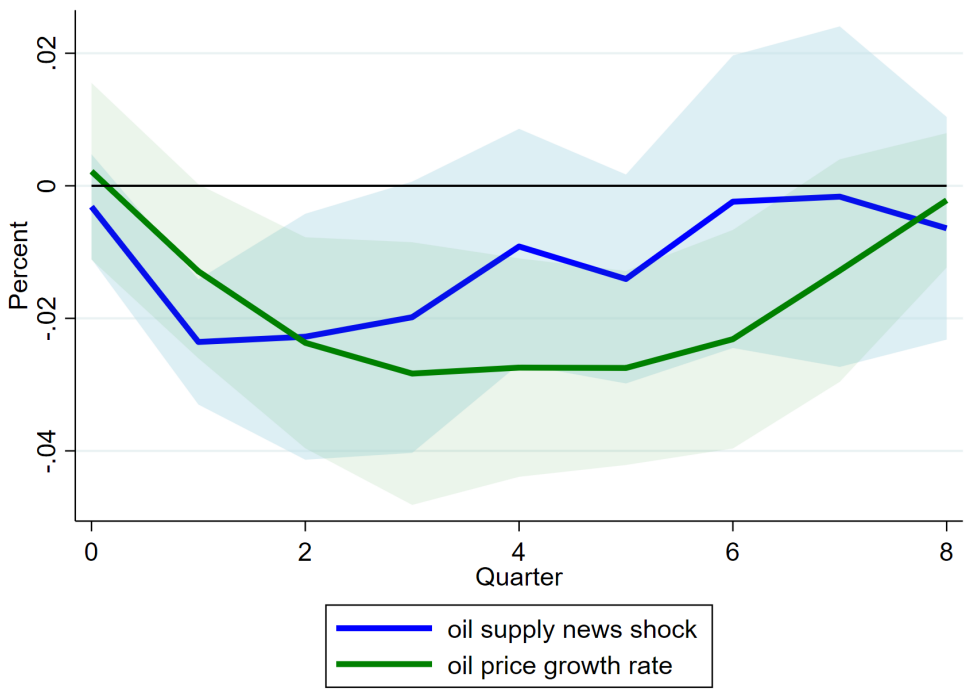
A.5: Inflation and loan markup

$$\phi_{t,t+h} = \sum_{q=1}^{4} \phi_{t-q} + \sum_{m=0}^{4} \beta_{0,m}^{(h)} \epsilon_{t-m}^{\pi} + \sum_{n=1}^{4} \text{control}_{t-n} + u_{t+h|t},$$



Notes: The oild supply new shocks are from Känzig (2021). The Φ_t is constructed from the decomposition by taking the average across banks. The shaded areas are 90% confidence intervals.

A.6: Microfoundation for $\Phi_{j,t}$

Relative cost $\Phi_{j,t}$ between bank loans (R_t^b) and internal financing (opportunity cost R_t^s)

$$\max \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \frac{\Lambda_t}{\Lambda_0} \left(\text{Revenue}_{j,t} - R_{t-1}^b \gamma \text{Borrowing}_{j,t-1} - (1-\gamma) \text{Borrowing}_{j,t} \right) \right]$$

$$= C_{-1} + \max \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \frac{\Lambda_t}{\Lambda_0} \left(\text{Revenue}_{j,t} - \left[(1-\gamma) + \beta \frac{\Lambda_{t+1}}{\Lambda_t} R_t^b \gamma \right] \text{Borrowing}_{j,t} \right) \right]$$

$$= C_{-1} + \max \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \frac{\Lambda_t}{\Lambda_0} \left(\text{Revenue}_{j,t} - \left[(1-\gamma) + \gamma \frac{R_t^b}{R_t^s} \right] \text{Borrowing}_{j,t} \right) \right]$$

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