Bank Loan Reliance and Inflation Inattention[1]

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EEA Congress 2025, Bordeaux

[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

Three natural questions:

1. Why do firms' inflation expectations and attentiveness matter?
   - ⋆ Firms' decisions on financing, investment, etc.
   - ⋆ Effectiveness of monetary policy
2. Do firms' financing structures affect attention to inflation?
   - ⋆ External and internal financing have different exposures to inflation
3. How does a firm's reliance on bank loans affect their inflation expectation formation and learning?
   - ⋆ Firms with higher loan reliance have more incentive to learn about inflation

Identification is challenging without reliable instruments and micro-level data

Empirics

- **Causal empirical evidence on how financing composition (loan reliance) affects inflation attentiveness and expectations**
  - Data: merged administrative and survey microdata on Italian firms
  - Identification: two independent approaches
    1. Bartik instrument for loan reliance
    2. Randomized Controlled Trial
       – Exogenous information provision: current inflation
  - Empirical Findings:
    1. Higher loan reliance ⇒ Smaller absolute inflation forecast errors
    2. Higher loan reliance ⇒ Less responses in posterior inflation expectations to information treatment in the RCT

▸ Related Literature

Theory

- **Partial-equilibrium model with rational inattentive firms**
  1. Firms choose the optimal combination of external (bank loans) vs. internal (own money) financing to finance investment
  2. Inflation affects the real spread (relative cost of external v.s. internal financing) through sticky banking market
  3. Higher loan reliance $\Rightarrow$ larger exposure to inflation (financing cost) $\Rightarrow$ more incentive to acquire and process information
- **Replicating the empirical findings**
  1. Negative relationship between loan reliance and inflation inattention
  2. Simulated RCT: highly loan-reliant firms respond less
- **Novel policy implications**
  1. Inattention leads to underreaction
  2. More aggressive inflation-targeting rule $\Rightarrow$ firms pay more attention

Data

- Data (2006 - 2019, quarterly)
  1. Survey of Inflation and Growth Expectations (SIGE)
     Firms' inflation expectations, a representative sample, RCT (since 2013Q1), conducted by the Bank of Italy
  2. Central Credit Registry (CCR)
     Firms' credit positions with banks and financial institutions
  3. Analytical Survey of Interest Rates (TAXIA)
     Loan interest rates, loan spread
  4. Company Accounts Data Service (CADS)
     Firm-level balance sheet data

▸ Survey Question

Measurement

- Two main 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
   - i, j, t for bank, firm, and time respectively
   - Term loan ($\sim$ 50% of total loans): loans mainly used for investment purposes (e.g. leasing, mortgages, and personal loans)
   - Asset: total balance sheet size
2. Inflation inattention: $\text{Inattention}_{j,t}^{(\pi)} \equiv \left| \pi_t^{(12m)} - F_j \pi_t^{(12m)} \right|$ ▸ plot
   - $\pi_t^{(12m)}$: 1-year ahead inflation
   - $F_j \pi_t^{(12m)}$: 1-year ahead inflation forecast

▸ Decomposition

Causal Evidence I: Bartik Instrument

1. **Benchmark regression**

$$\text{Inattention}_{j,t}^{(\pi)} = \beta_{2SLS}\widehat{\text{Loan Reliance}}_{j,t} + \text{controls} + \epsilon_{j,t}.$$

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

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

- $Exposure_{i,j,t-1}$: (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)

$$\ln R_{i,j,t}^{B} - \ln R_t = \underbrace{\delta_{i,t}}_{\text{credit supply}} + \underbrace{\lambda_{j,t}}_{\text{credit demand}} + \epsilon_{i,j,t}.$$

- $\ln R_{i,j,t}^{B}$: net loan interest rate between firm j and bank i at time t
- $\ln R_t$: net ECB deposit facility rate

▸ Back to Local Projection ▸ Back to λ_κ calibration

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: Driscoll and Kraay (1998) standard errors are reported in parentheses.

Takeaway: 10 pp increase in loan reliance (0.6 std) $\rightarrow$ 1 pp decrease in inattention (mean = 1.2 pp).

▸ Descriptive statistics ▸ 2SLS Regression ▸ Back to λ_κ calibration

Causal Evidence II: RCT

- Randomized Controlled Trial (RCT) ▸ Survey 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: ▸ Theory Prediction

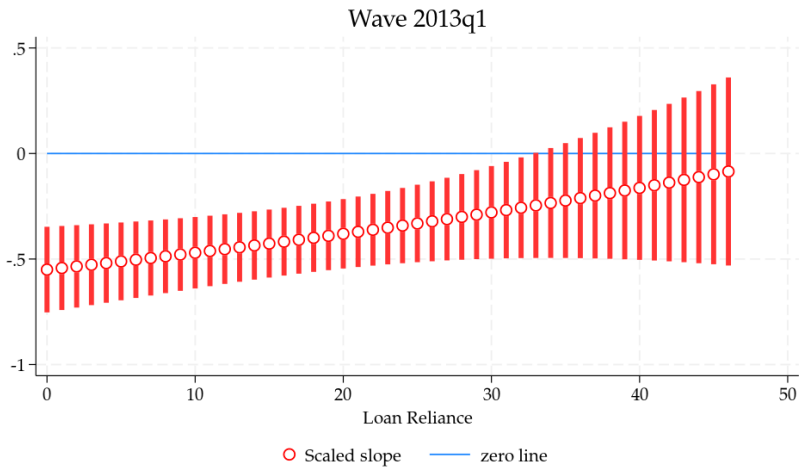
$$\text{Posterior}_j = \alpha_1 \times \text{Prior}_j + \alpha_2 \times \text{Loan Reliance}_j \times \text{Prior}_j + \gamma_1 \times \mathbb{I}_j \times \text{Prior}_j + \gamma_2 \times \mathbb{I}_j \times \text{Loan Reliance}_j \times \text{Prior}_j + \cdots + \epsilon_j.$$

1. Control group: receive nothing, posterior = prior, $\alpha_1 = 1$
2. Treated group: receive treatment
   - 2.1 Treatment is new: rely less on posterior, $\alpha_1 + \gamma_1 < 1$
   - 2.2 Treatment isn't new = control group

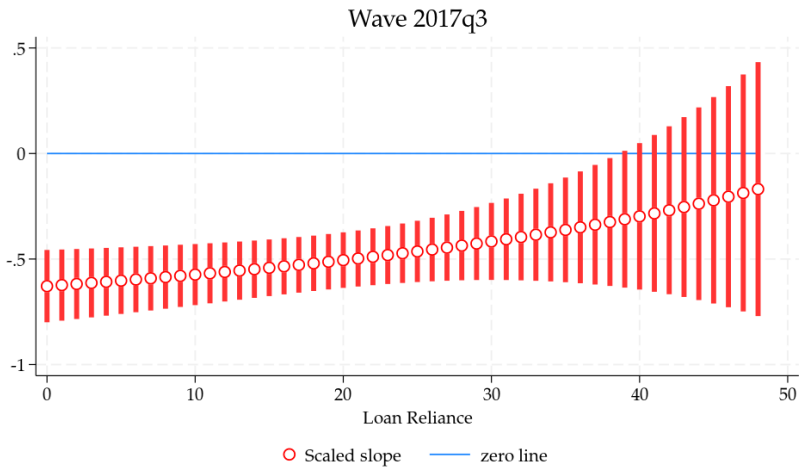
$$\text{Relative responses of expectations} = \frac{\hat{\gamma}_1 + \hat{\gamma}_2 \text{Loan Reliance}}{\hat{\alpha}_1 + \hat{\alpha}_2 \text{Loan Reliance}}$$

Causal Evidence II: RCT

$$\text{Relative responses of expectations} = \frac{\hat{\gamma}_1 + \hat{\gamma}_2 \text{Loan Reliance}}{\hat{\alpha}_1 + \hat{\alpha}_2 \text{Loan Reliance}}$$



(a) First RCT

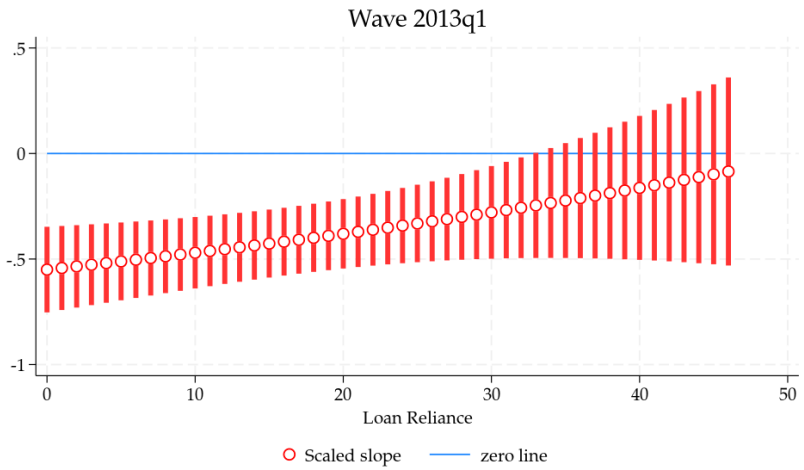


(b) Reshuffling

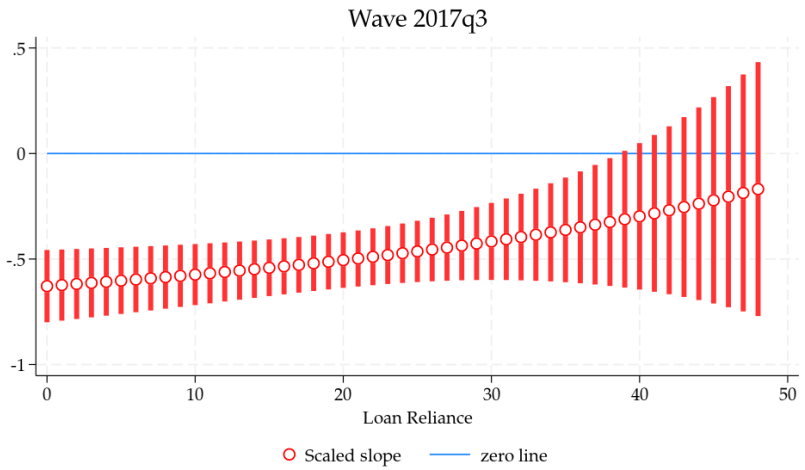
- $\hat{\gamma}_1 < 0$: treated firms rely less (60%) on priors, more on the news
- $\hat{\gamma}_2 > 0$: high loan-reliant treated firms respond less

Causal Evidence II: RCT

$$\text{Relative responses of expectations} = \frac{\hat{\gamma}_1 + \hat{\gamma}_2 \text{Loan Reliance}}{\hat{\alpha}_1 + \hat{\alpha}_2 \text{Loan Reliance}}$$



(c) First RCT



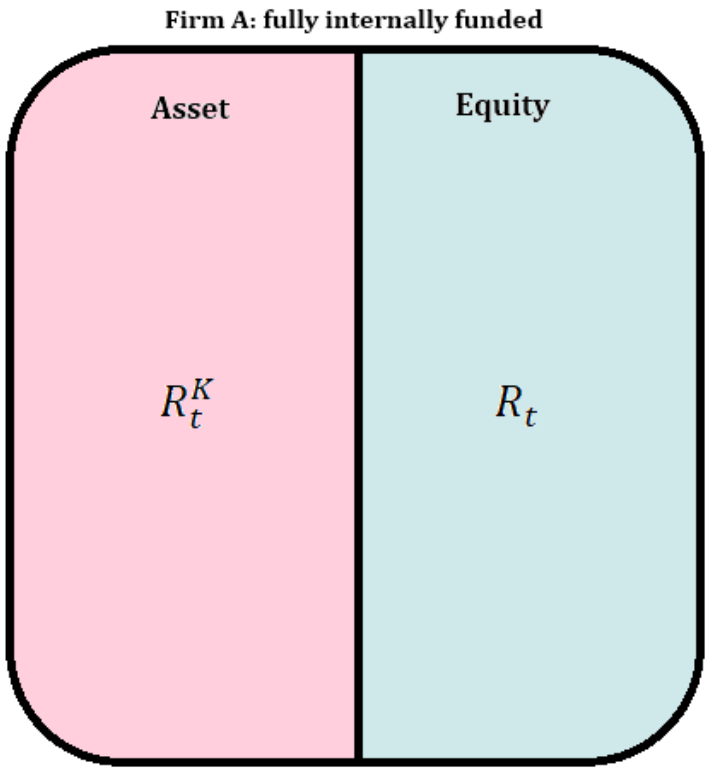
(d) Reshuffling

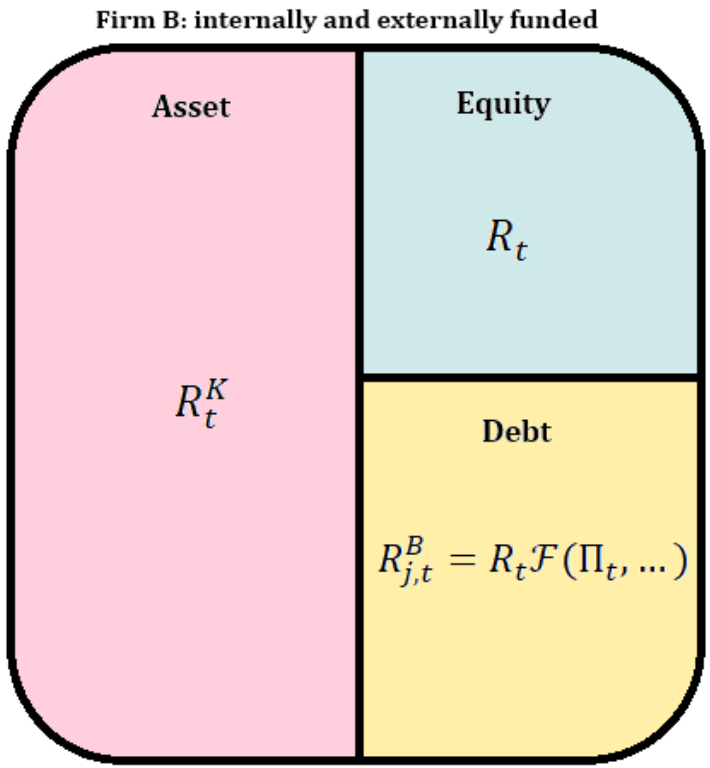
- $\hat{\gamma}_1 < 0$: treated firms rely less (60%) on priors, more on the news
- $\hat{\gamma}_2 > 0$: high loan-reliant treated firms respond less

Current inflation is already known by highly loan-reliant firms!

The Model: Why Do Firms Care about Inflation?

Firms choose financing composition and make investment decisions





Channel: $\underbrace{\pi_t \Rightarrow \text{loan spread } \mathcal{F}(\pi_t, \Phi_j)}_{\text{Banking market}} \Rightarrow$ financing cost $\Rightarrow$ capital

Inflation affects a firm's real value depending on its bank loans reliance

The Model: Monetary Authority & Banks

– Inflation follows an AR(1) process: $\log \Pi_t = \rho_\pi \log \Pi_{t-1} + \epsilon_{\pi,t}$

– Monetary authority follows the Taylor rule: $R_t = R \cdot \Pi_t^{\tau_\pi}$,

– The banks operate in a monopolistically competitive market:

- Input: deposits (R_t)
- Output: bank loans (R_t^B)
- *Prob*(cannot reset loan rates) > 0: Calvo-type stickiness

Transition mechanism

1. Higher inflation ($\epsilon_{\pi,t}$) triggers increases in the policy rate, R_t
2. Higher $R_t \rightarrow$ higher R_t^B, but **lower** loan spread $\left(\frac{R_{j,t}^B \uparrow}{R_t \uparrow\uparrow}\right) \downarrow$

▸ Local projection

The Model - Rational Inattention

Firm j chooses the amount of attention κ_j, and signal structure h_j:

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

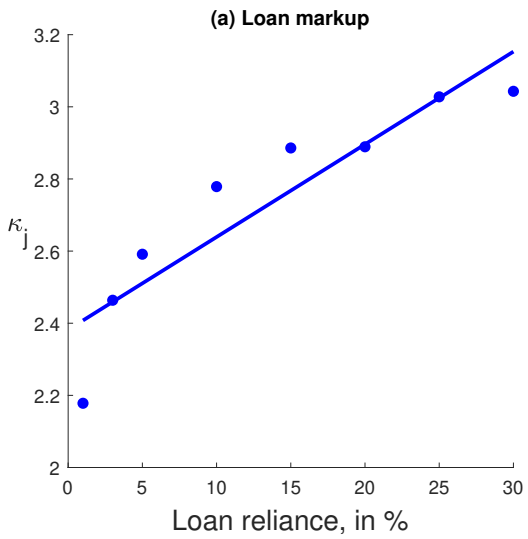
Optimal capital: $\hat{k}^*_{j,t} = p_1 \hat{k}^*_{j,t-1} + p_2 \hat{k}^*_{j,t-2} + q^j_1 \epsilon_{\pi,t} + q^j_2 \epsilon_{\pi,t-1} + q^j_3 \epsilon_{\pi,t-2},$

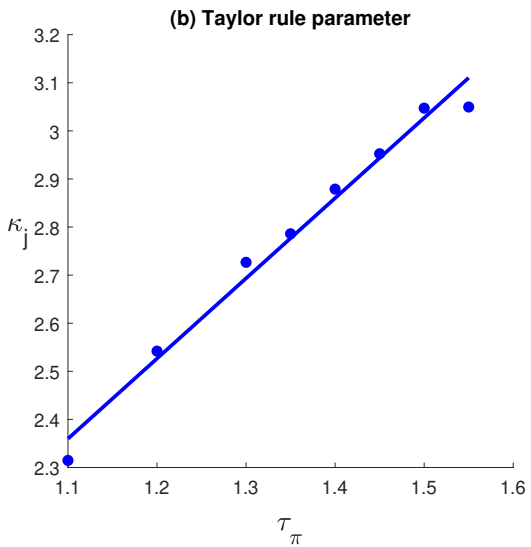
Signals: $S_{j,t} = h'_j z_{j,t} + \psi_{j,t}$, with $z_{j,t} = (\hat{k}^*_{j,t} \ \hat{k}^*_{j,t-1} \ \epsilon_{\pi,t} \ \epsilon_{\pi,t-1})'.$

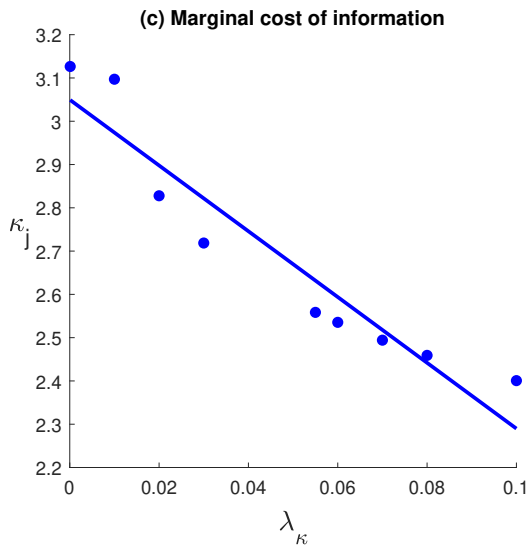
Proposition 1: $\partial q^j_1 / \partial \Gamma^B_{j,t} > 0$: higher loan-reliant firms have larger exposure to inflation shocks.

Comparative Statics

- Steady-state κ (amount of information processed) varies with:
  1. More loan-reliant firms (cheaper bank loans Φ_j)
  2. More aggressive central bank (higher τ_π)
  3. Higher information processing cost (higher λ_κ)







▸ Calibration Table

More Implications

- A reference range for the information processing unit cost
  ▸ λ_κ calibration
- Policy implication: responsiveness to cost-push shocks
  - Inattention leads to under-reaction ▸ IRFs
- A general equilibrium model with welfare analysis

Conclusion

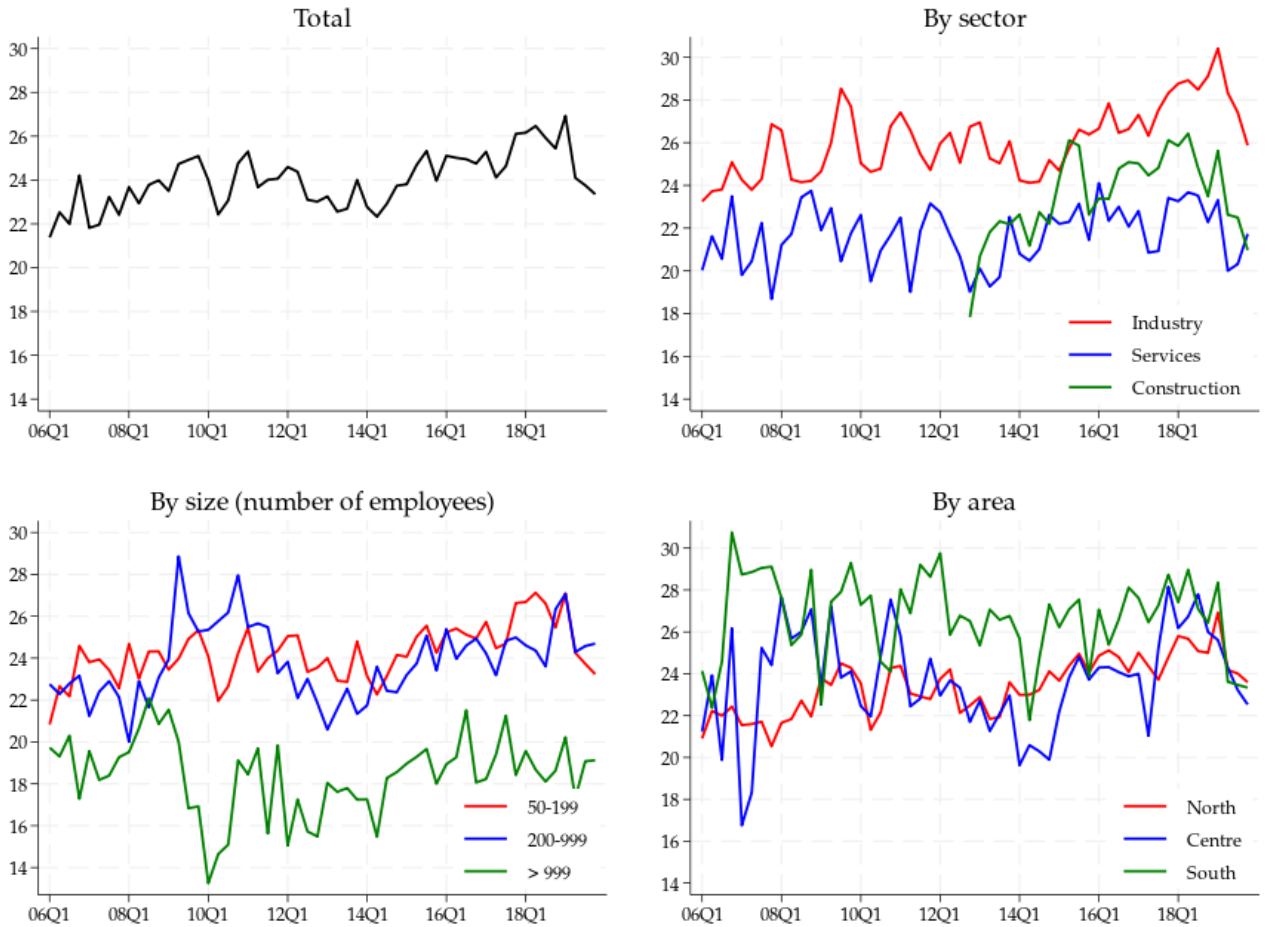
1. Financing composition as an important determinant for firms' inflation expectations
   - Incentive to acquire information
   - How firms learn from new information

2. An analytical model featuring endogenous financing composition and attention allocation
   - Explain the inflation-financing-cost channel
   - Provide a reference range for information cost
   - Policy implications

Thank you very much!

(Appendix)

A.1: Loan reliance



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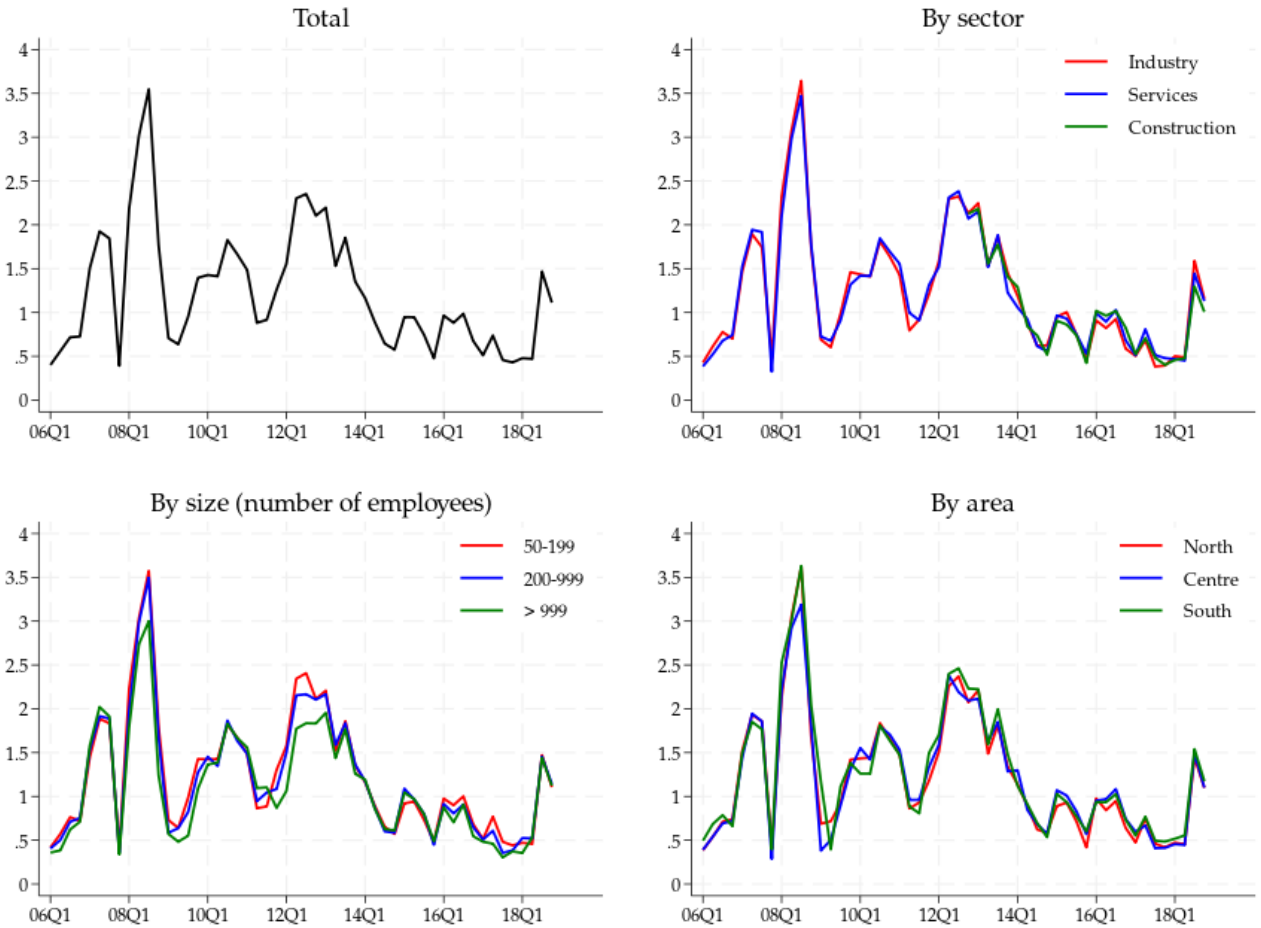
A.2: Inflation inattention



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A.3: Inflation forecast errors: decomposition

$$\pi_t^{(12m)} - F_j\pi_t^{(12m)} = \underbrace{\pi_t^{(12m)} - F^{PI}\pi_t^{(12m)}}_{\equiv FE_t^{PI}} + \underbrace{F^{PI}\pi_t^{(12m)} - F_j\pi_t^{(12m)}}_{\equiv RI_t^j}$$

- FE_t^{PI}: forecast error under perfect information, common across firms
- RI_t^j: firm-specific imperfect information deviation from perfect information due to rational inattention

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A.4: 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.5: 2SLS - regression specification

1. First-stage:

$$\text{Loan Reliance}_{j,t} = \beta_{\text{First}} \bar{\delta}_{j,t} + \text{controls}_{j,t} + \tau_j + \epsilon^1_{j,t},$$

2. Second-stage:

$$\text{Inattention}^{(\pi)}_{j,t} = \beta_{2SLS} \widehat{\text{Loan Reliance}} + \text{controls}_{j,t} + \tau_j + \epsilon^2_{j,t}.$$

- controls: size, ROE, asset liquidity
- τ_j: firm fixed effect
- $\beta_{\text{First}} < 0$: higher loan spread leads to less reliance on bank loans

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A.6: Randomized Controlled Trial

Survey Questionnaire:

- **Treated Group:** "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."

- **Controlled Group:** "What do you think consumer price inflation in Italy, measured by the 12-month change in the Harmonized Index of Consumer Prices, will be ... "

▸ Back to Data ▸ Back to RCT

A.6: Theoretical Predictions for Information Treatment Effects

Agents form expectations following the Bayesian rule:

$$\underbrace{\pi_j^{post}}_{\text{Posterior}} = \pi_j^{prio} + \text{Gains}_j \times (S_j - \pi_j^{prio}) \times \mathbb{I}_j$$

$$= \underbrace{1}_{\alpha_1+\alpha_2 LR_j} \times \underbrace{\pi_j^{prio}}_{\text{Prior}} + \text{Gains}_j \times S_j \times \mathbb{I}_j \underbrace{- \text{Gains}_j}_{\gamma 1+\gamma_2 LR_j} \times \pi_j^{prio} \times \mathbb{I}_j$$

Matched to the empirical design:

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

Back to RCT

A.7: The Model - Firms

Two-stage problem with cash-in-advance capital investment

1. Financing cost minimization
   - ⋆ An optimal bundle of internal funds ($\Gamma^I_{j,t}$) & bank loans ($\Gamma^B_{j,t}$)
   - ⋆ Internal funds and bank loans are imperfect substitutes

$$M_{j,t} \equiv \underset{\Gamma^I_{j,t},\Gamma^B_{j,t}}{\text{argmin}}\ \Gamma^I_{j,t} + R^B_{j,t}/R_t \cdot \Gamma^B_{j,t}, \text{ where: } R^B_{j,t}/R_t = \mathcal{F}(\pi_t, \Phi_j).$$

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

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

- $R^B_{j,t}/R_t$: interest rate spread between external and internal financing
- $M_{j,t}$: unit financing cost for financing bundle
- β: discount factor; $\phi < 1$: decreasing return to scale; δ: capital depreciation rate

▸ $R^B_{j,t}/R_t$: micro-foundation

A.7: Micro-foundation for $\Phi_{j,t}$

The loan spread between bank loans (R_t^B) and internal financing (R_t) matters for real profits:

$$\max \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} Q_{0,t} \left(\text{Revenue}_{j,t} - (1-\gamma) \cdot \text{Borrowing}_{j,t} - \gamma \cdot R_{t-1}^B \cdot \text{Borrowing}_{j,t-1} \right) \right\},$$

$$\Rightarrow \max \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} Q_{0,t} \left(\text{Revenue}_{j,t} - \left[(1-\gamma) + \gamma \cdot \frac{Q_{0,t+1}}{Q_{0,t}} R_t^B \right] \cdot \text{Borrowing}_{j,t} \right) \right\},$$

$$\Rightarrow \max \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} Q_{0,t} \left(\text{Revenue}_{j,t} - \left[(1-\gamma) + \gamma \cdot \frac{\mathbf{R_t^B}}{\mathbf{R_t}} \right] \cdot \text{Borrowing}_{j,t} \right) \right\}.$$

- $Q_{0,t}$: stochastic discount factor after introducing household's problem

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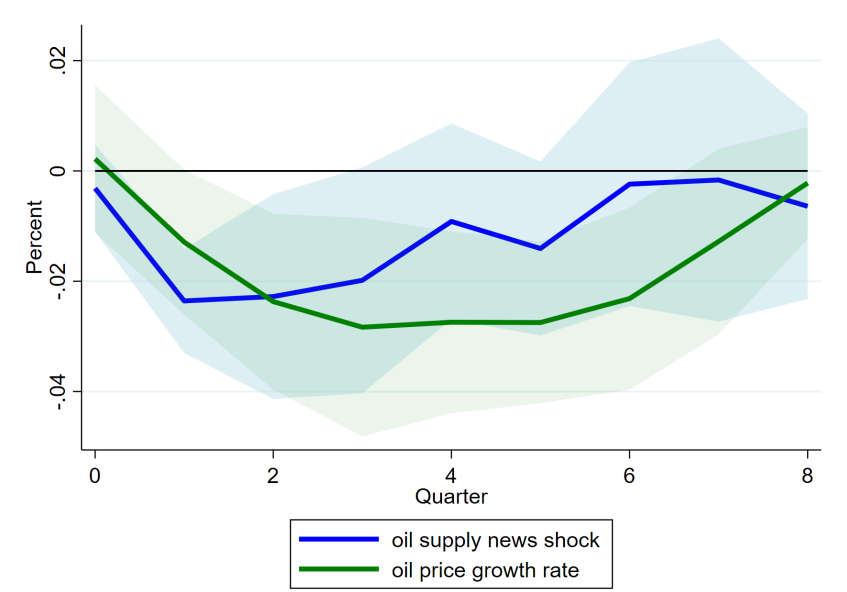
A.8: Local projection: inflation and loan markup

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

- $\hat{\delta}_t = \text{mean}_i(\hat{\delta}_{i,t})$: credit supply component of loan spread ▸ $\hat{\delta}_{i,t}$
- Cost-push shock: 10 pp increase in real oil price ⇒ CPI increases by 0.4 pp (Känzig 2021) ⇒ loan spread decreases by 17 bp ($\beta^{(h)}_{0,0}$)



Notes: IRFs to 1 std shock in the oil price (1.8%). The oil supply news shocks are from Känzig (2021). Shaded areas: 90% confidence intervals with Newey-West standard errors.

▸ Back

A.9: The Model - Rational Inattention

Following Mackowiak, Matejka, and Wiederholt (2018),

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

subject to:

$$\text{Optimal capital: } \hat{k}^*_{j,t} = p_1 \hat{k}^*_{j,t-1} + p_2 \hat{k}^*_{j,t-2} + q^j_1 \epsilon_{\pi,t} + q^j_2 \epsilon_{\pi,t-1} + q^j_3 \epsilon_{\pi,t-2},$$

$$\text{Perceived optimal capital: } \hat{k}_{j,t} = \mathbb{E}(\hat{k}^*_{j,t} | \mathcal{I}_t),$$

$$\text{Signal structure: } S_{j,t} = h'_j z_{j,t} + \psi_{j,t} \text{ , with } z_{j,t} = (\hat{k}^*_{j,t} \ \hat{k}^*_{j,t-1} \ \epsilon_{\pi,t} \ \epsilon_{\pi,t-1})',$$

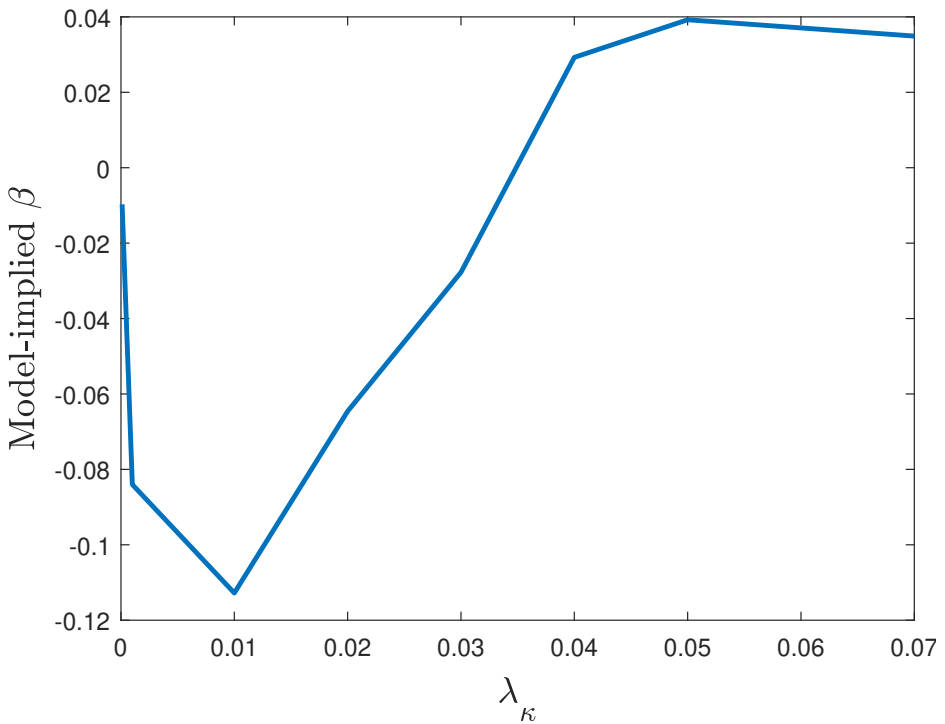
$$\text{Information set: } \mathcal{I}_{j,t} = \mathcal{I}_{-1} \cup \{S_{j,0}, \ldots, S_{j,t}\},$$

$$\text{Information processed: } \kappa_j = \frac{1}{1-\beta} \lim_{T \to \infty} \left[\mathcal{H}(\hat{k}^*_{j,T} | \mathcal{I}_{j,T-1}) - \mathcal{H}(\hat{k}^*_{j,T} | \mathcal{I}_{j,T}) \right].$$

Proposition 1: $\partial q^j_1 / \partial \Gamma^B_{j,t} > 0$: higher loan-reliant firms have larger exposure to inflation shocks.

A.10: Reference Range for λ_κ

1. Simulated firms with average loan reliance matching the empirical distribution
2. Solve for each firm's rational inattention problem, simulate their signals and expectations, and measure inattention (absolute inflation forecast errors)
3. Calculate the correlation between loan reliance and inattention: ▸ $\hat{\beta}_{2sls}$



Magnitude: $\lambda_\kappa = 0.01$, steady-state information cost to profit ratio $= 0.01\%$

▸ More Details

A.10: More Details on Calibration: λ_κ

1. Simulate the firms with different firm-level loan markup, Φ_j drawn from Beta distribution
2. Solve each firm's optimization problem in choosing financing composition, model-simulated steady-state loan reliance distribution matches the distribution of mean loan reliance in the data
3. Simulate the aggregate inflation process following AR(1) process with parameters estimated from harmonized CPI data in Italy
4. Solve the rational inattention problem for each firm: resulting information structure, standard deviation of the noise, amount of information to process
5. Simulate the signals received by each firm, and calculate their inflation expectations based on the received signals and the accumulated information set
6. Cross-sectional simulated data on forecast errors and loan reliance, calculate the implied correlation, β^{model}
7. Update λ_κ until $\beta^{\text{model}} = \hat{\beta}_{\text{2SLS}}$

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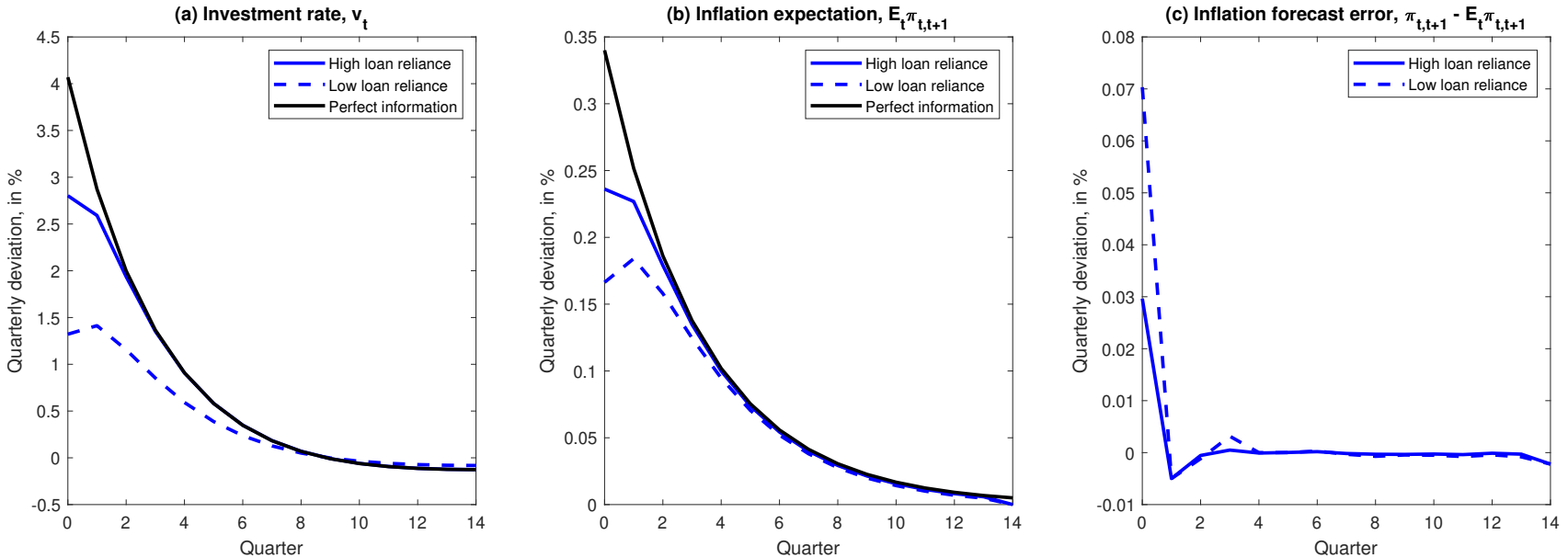
A.11: Impulse Response of $\hat{v}_{j,t}$

Investment rate $V_{j,t} \equiv \frac{K_{j,t} - (1-\delta)K_{j,t-1}}{K_{j,t-1}}$



Notes: The figures display the impulse response functions to 3 positive standard deviation shock in $\epsilon_{\pi,t}$, which increases the annualized inflation by 1.35%. The black line denotes the responses under the perfect information case without information costs. The solid blue line denotes the responses under the benchmark parameter values with firm-level loan markup $\Phi_j = 1.025$, corresponding to the average loan reliance of 24%. The dashed blue line denotes the responses under $\Phi_j = 2$, leading to the steady state loan reliance of 11%.

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A.10: More Details on calibration: other parameters

	Parameter	Value	Reference
β	Discount factor	0.99	Average annualized real interest rate of 4%.
ϕ	Return-to-scale	0.75	Steady-state capital-to-output ratio equals to 10 in quarterly frequency.
ρ	Elasticity of substitution between bank loans and internal funding	2	Steady-state loan reliance equals the mean of term loan reliance in the data (24%).
ω_b	Calvo (1983) stickiness in setting loan rate	0.74	Kok Sørensen and Werner (2006) find an average of 26% of dis-equilibrium is adjusted in one period for long-term loans to enterprises using data from euro area countries
δ	Capital depreciation rate	0.025	Standard.
Φ_j	firm-level loan markup	1.03	Annualized loan interest rate of 12%.
τ_π	Taylor rule parameter (inflation)	1.5	Standard.
λ_κ	Marginal cost of attention	0.01	Match the estimated β_{2SLS} between loan reliance and inflation inattention from the IV regression.
ρ_π	Autoregression for inflation	0.901	Estimated from Italian inflation time series to fit an AR(1) process.
σ_π	Standard deviation of ϵ_π	0.0011	Estimated from Italian inflation time series to fit an AR(1) process.

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A.11: Related literature

- **Firms' inflation expectations and action**
  From Expectations to 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. (2020, Italy), Ropele et al. (2024, Italy)
  From Traits to Expectations: Kumar (2020); Yang (2022); Afrouzi (2023); Weber et al. (2023): economic environment

  My Contribution: the first 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);

  My Contribution: empirical findings on state-dependent inattention, the reference range for the information processing cost parameter

Back to empirics