

GRANULAR SENTIMENTS

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MOTIVATION

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Question: does sentiment of a small number of agents drive the economy?

ANTECEDENTS

1. Pigouvian Cycles: *Beaudry and Portier (2004, 2007), Lorenzoni (2009), Christiano et al. (2010), Chahrour and Jurado (2018), Lageborg (2022)...*

- Coordinated waves of optimism/pessimism
- ... drive business cycles \implies **whose sentiment?**

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2. Granularity: *Gabaix (2011), Carvalho et al. (2013), Gaubert and Itskhoki (2021), Tahbaz-Salehi et al. (2022), Galaasen et al. (2023) ...*

- Shocks to large firms matter
- Propagation through networks/tails \implies **what characteristic?**

Q: Whose sentiment is important for macro and why?

THIS PAPER

1. Empirical Measurement:

- Measure sentiment in firm-level texts of quarterly earnings calls.
- Construct model-free measure of **Granular Sentiment**:
 - Variation in aggregate output explained by each firm's sentiment.
 - Portfolio sentiment for the **N** most explanatory firms.

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- Who are these **N** firms?

3. Model of Information Centrality:

- Rationalize the choice of **N** firms.
- Can granular sentiment shocks drive fluctuations?

OUTLINE OF TALK

1. Empirical Data:

- Refinitiv earnings calls
- Firm-level sentiment

3. Model Framework:

- Competitive framework
- W/ heterogeneous industries

2. Empirical Evidence:

- Cross section
- Time series

4. Quantitative Results:

- Model calibration
- Business cycle moments

Empirical Evidence

DATA OVERVIEW

Firm-level Sentiment:

- Quarterly earnings calls of listed firms from Refinitiv StreetEvents.
- S&P500 firms. 2006q4-2021q4.
- Measurement: sentiment dictionary (Loughran and McDonald, 2011).
- Robustness: FinBERT, analyst EPS forecasts (I/B/E/S).
- Main firm-level construct: net sentiment (positive - negative).

Aggregate Variables:

- Main macro outcome: U.S. real GDP.
- Others: GDP p.c., industrial production, CPI, unemployment rate.

RANKING OF FIRM INFORMATIVENESS

1. Regression of **macro outcome** Y_t on **sentiment** $s_{i,t}$, for every firm:

$$Y_t = \alpha_i + \beta_i s_{i,t} + \varepsilon_{i,t} \quad , \quad \forall i$$

2. Collect the $N \times 1$ vector of **coefficients of determination** (R_i^2).

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5. Run regressions of Y_t on **portfolio-level** sentiment $s_{p,t}$

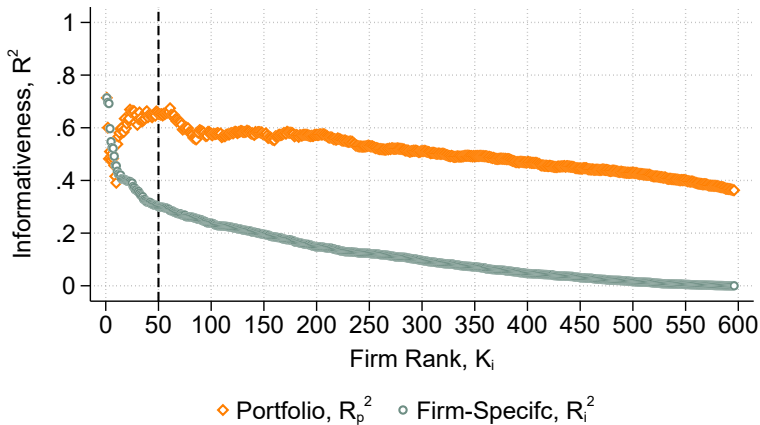
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6. Collect portfolio-level R_p^2 and compare.

GRANULAR SENTIMENT FIRMS



50 firms explain $\sim 60\%$ of fluctuations: **Granular Sentiment Residual Γ**

FinBERT

Forecasters

GDP Per Capita

Unemployment

Industrial Production

CPI

Alternative De-Trend

Robustness

CROSS-SECTIONAL RESULTS

- Who are the 50 firms in Γ ?
- Are they simply large?
- Agnostic approach: array of firm characteristics X_i :
 - Market beta, book assets, investment, market valuation, Tobin's q , idiosyncratic volatility, leverage, liquidity.
 - Firm-level averages over the period 2006q4-2021q4.

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Empirical Specifications:

1. Cardinal: outcome variable is R_i^2 . OLS.
2. Binary: outcome variable is $1_i = 1$ if $i \in \Gamma$. Probit model.
3. Ordinal: outcome variable is the ranking K_i . Ordinal probit model.

DOWNSTREAMNESS

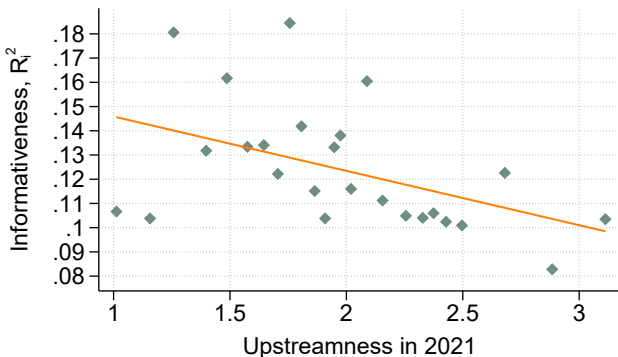
Key Characteristic: proximity to the end consumer

- Industry downstreamness w_j (Antras et al. 2011).
- Continuous measure on $[1, 4.65]$.
- Most downstream industry: automobiles ($w_j = 1$).
Most upstream: petrochemicals ($w_j = 4.65$).
- 55 unique BEA sectors. Assume that all $i \in j$ share the same w_j .
- Robustness to Atalay (2017) and Chahrour et al. (2021) sectors.

CROSS-SECTIONAL REGRESSIONS

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	Probit	Probit	Ordinal Probit	Ordinal Probit
Upstreamness in 2021	-0.020** (0.009)	-0.022** (0.009)	-0.342*** (0.131)	-0.343** (0.141)	-0.157* (0.086)	-0.196** (0.094)
Log (Assets)	0.006 (0.006)	0.013 (0.016)	-0.029 (0.085)	-0.391 (0.332)	0.085 (0.057)	0.217 (0.138)
Market Beta		-0.009 (0.008)		-0.011 (0.112)		-0.125* (0.067)
Book-to-Market		-0.006 (0.009)		0.042 (0.152)		-0.062 (0.080)
Investment		-0.013** (0.005)		-0.036 (0.094)		-0.124*** (0.046)
Valuation		-0.004 (0.013)		0.395 (0.251)		-0.127 (0.126)
Leverage		-0.013* (0.006)		-0.089 (0.122)		-0.136** (0.054)
Liquidity		-0.018** (0.009)		-0.157 (0.133)		-0.153** (0.070)
Tobin's Q		0.007 (0.011)		-0.086 (0.188)		0.063 (0.098)
Return Volatility		0.019 (0.012)		0.231** (0.117)		0.141* (0.078)
Observations	531	469	531	469	531	469
R ²	0.011	0.047				

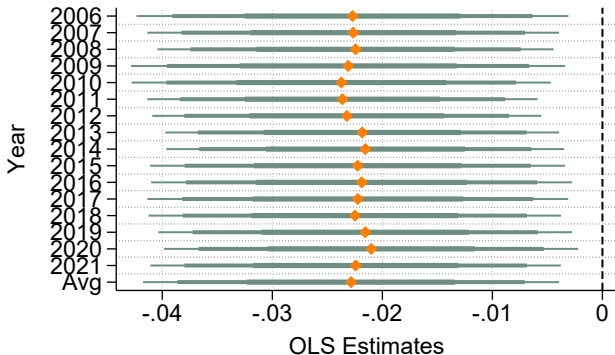
DOWNSTREAMNESS AND INFORMATIVENESS



Notes: Binned scatterplot includes all controls.

Granular sentiment firms are downstream.

DOWNSTREAMNESS AND INFORMATIVENESS OVER TIME



Notes: Lines are 68%, 90%, and 95% confidence intervals.

Coefficient stability over time.

ROBUSTNESS

- ✓ Probit specification instead of OLS. Probit
- ✓ Ordinal probit specification instead of OLS. Ordinal Probit
- ✓ Atalay (2017) sectors instead of BEA. Atalay (2017) Sectors
- ✓ Chahrour et al. (2021) sectors instead of BEA. Chahrour et al. (2021) Sectors
- ✓ FinBERT sentiment instead of dictionary. Scatterplot Time Stability
- ✓ Analyst forecast errors instead of dictionary. Scatterplot Time Stability
- ✓ Lagged sentiment instead of contemporaneous. Scatterplot Time Stability
- ✓ Results for alternative macro outcomes. Scatterplot Time Stability
- ✓ Alternative de-trend instead of HP filter. Scatterplot Time Stability
- ✓ Further robustness: firm FE or TFP, balance sheet, aggregate controls. Scatterplot Time Stability
- ✓ Placebo regressions. Placebo Regressions

TIME SERIES

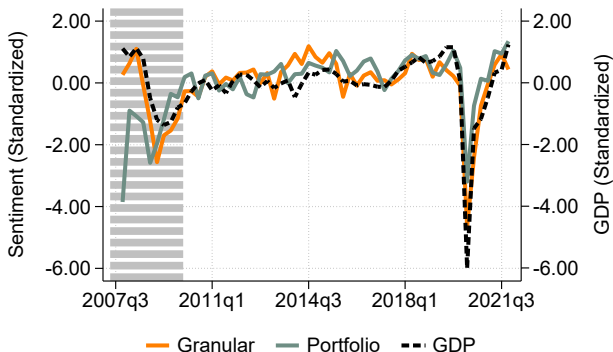
1. S_t : downstreamness-weighted average sentiment of 50 informative firms:

$$S_t = \sum_{i \in \Gamma} \omega_{i,t-4} S_{i,t}$$

2. \mathcal{P}_t : sentiment of the high-downstreamness portfolio decile:

$$\mathcal{P}_t = \sum_{i \in P10_t} \omega_{i,t-4} S_{i,t}$$

GRANULAR SENTIMENT AND BUSINESS CYCLES



Granular sentiment S_t as a **sufficient statistic** for Pigouvian business cycles.

FinBERT

Forecasters

Alternative De-Trend

Robustness

LOCAL PROJECTIONS

$$Y_{t+h} = \delta_h + \boxed{\beta_h \times Z_t} + \sum_{\ell=1}^2 \gamma_{h\ell} X_{t-\ell} + u_{ht}$$

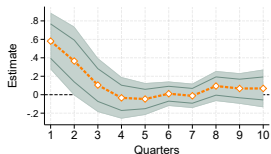
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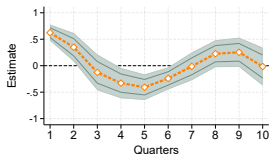
- Jordà (2005)-style time-series local projection.
- Y_{t+h} : h-quarter ahead HP filtered outcome.
- Z_t : granular sentiment S_t or high-downstream portfolio P_t .
- $X_{t-\ell}$: TFP, uncertainty, Fed Funds Rate, real stock market.
- Outcomes: aggregate sentiment, macro.

THE IMPACT OF S_t

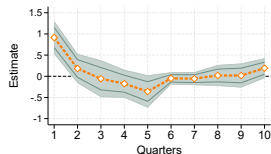
(A) Conference Board LEI



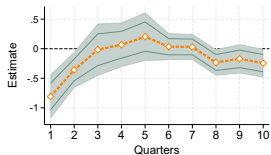
(B) Sentix Sentiment



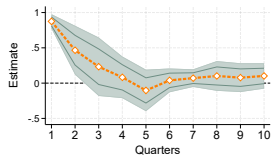
(C) GDP



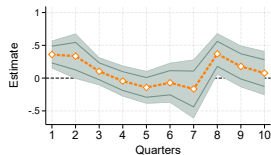
(D) Unemployment Rate



(E) Industrial Production



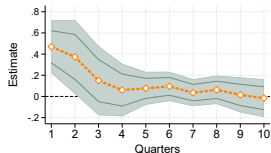
(F) CPI



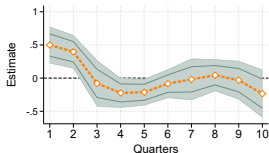
Note: Lines are 68% and shaded areas are 90% confidence intervals.

THE IMPACT OF \mathcal{P}_t

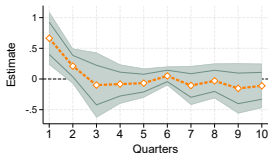
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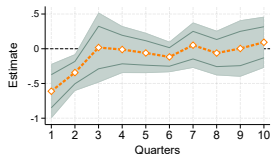
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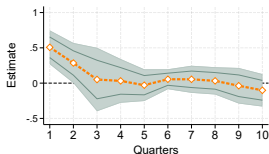
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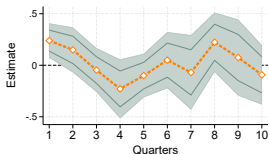
(D) Unemployment Rate



(E) Industrial Production



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TAKEAWAY

- S_t and \mathcal{P}_t have explanatory power for the macroeconomy.
- Results not driven by TFP, uncertainty, or monetary policy.
- S_t and \mathcal{P}_t behave like “noise shocks”.
- Theory: business cycles driven by sentiment of a select few firms.

TIME SERIES ROBUSTNESS

- ✓ U.S. mass shootings instrument (Lageborg et al. 2023): [Link](#)
- ✓ FinBERT sentiment instead of dictionary. [Link](#)
- ✓ Analyst forecast errors instead of dictionary. [Link](#)
- ✓ Alternative de-trend instead of HP filter. [Link](#)
- ✓ Further robustness: firm fixed effect control, firm TFP control, firm balance sheet controls, aggregate controls. [Link](#)

Theoretical Framework

BASILINE ENVIRONMENT

Sectors and Firms:

$$Q_{it} = Z_{it} \left(\prod_j X_{ijt}^{\alpha_{ij}} \right) L_{it}^{\delta_i}$$

- Two sectors:
 - upstream ($i = u$) and downstream ($i = d$)
- Upstream doesn't use downstream ($\alpha_{ud} = 0$)
- Decreasing returns to scale: $\sum_j \alpha_{ij} + \delta_i = 1 - \gamma$, $\gamma \in (0, 1)$
- Competitive output and input markets
- Firms max. **expected** profits:

$$\Pi_{it} = P_{it}Q_{it} - W_t L_{it} - \sum_j P_{jt} X_{ijt}$$

BASELINE ENVIRONMENT

Household:

$$U_t = C_t - \frac{1}{1 + 1/\nu} \left(\sum_i L_{it} \right)^{1+1/\nu}$$

- $C_t = W_t \sum_i L_{it} + \sum_i \Pi_{it}$
- C_t downstream consumption: P_{dt} normalized to one

Market Clearing:

$$\begin{aligned} C_t + X_{ddt} &= Q_{dt} \quad (\text{downstream}) \\ X_{uut} + X_{udt} &= Q_{ut} \quad (\text{upstream}) \end{aligned}$$

- Aggregate value added output $Y_t = C_t$

BASILINE ENVIRONMENT

Shock Structure:

- Productivity shocks

$$z_{it} = \vartheta_t + \eta_{it}, \quad \vartheta_t \sim \text{AR}(1)$$

- Sentiment shocks

$$\xi_{it} \sim \text{AR}(1)$$

BASILINE ENVIRONMENT

Shock Structure:

- Productivity shocks
- Sentiment shocks

$$z_{it} = \vartheta_t + \eta_{it}, \quad \vartheta_t \sim \text{AR}(1)$$

$$\xi_{it} \sim \text{AR}(1)$$

Information Structure:

$$s_{ijt}^z = z_{jt} + \xi_{jt} + m_{ij}^z \varepsilon_{ijt}$$

$$s_{ijt}^q = q_{jt-1} + m_{ij}^q e_{it}$$

- Symmetric signals: $i = \{d, u\}, j = \{d, u\}$
- Information set: $\Omega_{it} = (\mathbf{s}_i^t), \mathbf{s}_{it} = (\mathbf{s}_{it}^z, \mathbf{s}_{ijt}^q), j \neq i$
- Attention choices: $\{m_{ij}^z, m_{ij}^z, m_{ij}^q\}$ Attention costs: $K(m_i)$

BASELINE ENVIRONMENT

Timing of Events:

0.* Firms ex ante choose attention choices

1. Firms commit to labor choices: imperfect information

2. After labor choices sunk:

- Shocks realize
- Firms choose intermediate inputs
- Production and consumption takes place

Firms: labor choices may be ex post suboptimal

Household: labor supply is optimal

Model with capital

MODEL SOLUTION

Decision Rules:

2. Intermediate inputs

$$P_{jt}X_{ijt} = \alpha_{ij}P_{it}Q_{it}$$

1. Labor choice

$$L_{it} = \delta_i \cdot \lambda_i \cdot \frac{\mathbb{E}_{it}[C_t]}{\mathbb{E}_{it}[W_t]}$$

Labor Input Choice:

$\delta_i \sim$ input share $\lambda_i \sim$ network centrality

- Incentives to acquire information are higher when both are large
- Potential mistakes due to erroneous expectations are here larger

MODEL SOLUTION

Best Response: $L_{it} = \delta_i \cdot \lambda_i \cdot \frac{\mathbb{E}_{it} [\exp(\Lambda'[\mathbf{z}_t + \mathbf{k}_0 + \mathbf{k}_1 \cdot \ell_t])]}{\mathbb{E}_{it} \left[\left(\sum_j L_{jt} \right)^{1/\nu} \right]}$

- $\ell_{it} = \log(L_{it}) \quad \Lambda = (I - A')^{-1} \beta$
- $A = [\alpha_{dd}, \alpha_{du}; 0, \alpha_{uu}], \quad \beta = [1; 0]$

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1. Upstreamness: relationship to network centrality

$$U = [I - A']^{-2} \beta \otimes \left([I - A']^{-1} \beta \right)^{-1} \quad \Lambda = [I - A']^{-1} \beta$$

- Relationship: $u_u > u_d$ and $\lambda_d > \lambda_u$ iff. $\alpha_{du} < 1 - \alpha_{uu}$
- More downstream = more central \implies more attention to downstream

Hulten's Theorem

MODEL SOLUTION

Best Response:
$$L_{it} = \delta_i \cdot \lambda_i \cdot \frac{\mathbb{E}_{it} [\exp(\Lambda'[\mathbf{z}_t + \mathbf{k}_0 + \mathbf{k}_1 \cdot \ell_t])]}{\mathbb{E}_{it} \left[\left(\sum_j L_{jt} \right)^{1/\nu} \right]}$$

- $\ell_{it} = \log(L_{it})$ $\Lambda = (I - \mathbf{A}')^{-1} \beta$
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Strategic Interactions: relationship to downstreamness

- Captures standard GE effects of demand and costs
 - $k_{1j} > 0$: complementarity through demand amplifies downstream attention
 - $\nu > 0$: substitutability through costs dampens downstream attention
- $\nu > 1$ complementarity dominates

MODEL SOLUTION

Endogenous Signal:

$$s_{ijt}^q = q_{jt-1} + m_{ij}^q \varepsilon_{it}$$

2. Information Aggregation: relationship to downstreamness

- Downstream sector uses upstream inputs in production
- But the converse is not true in the baseline model
- **Downstream information aggregation** \implies more attention to downstream

PARAMETERIZATION

Technology:

- Decreasing returns to scale: $\gamma = 0.33$
- Factor shares: $A = [0.26, 0.00; 0.18, 0.24]$ $\beta = [0, 1]$
- Productivity shocks: $\rho_{\theta} = 0.85$, $\sigma_{\theta} = 1.00$ $\sigma_{\eta} = 1.00$

Household:

- Labor supply: $\nu = 3.00$

Information Structure:

- Sentiment shocks: $\rho_{\xi} = 0.66$, $\sigma_{\xi} = 1.00$ – Match moments of GSI
- Cost of precision: $\mu = 2.1e - 4$ – Match MSE from Duke CFO
- Cost function: sum of precision of signals.

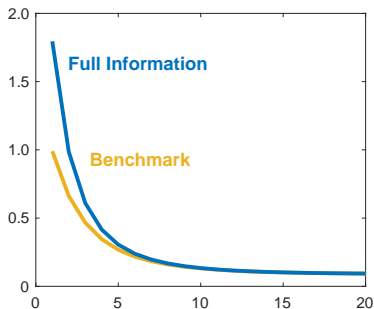
ATTENTION CHOICES

Productivity	Std. TFP	Λ	Attention (m_d^Z, m_u^Z, m_j^q)
Downstream	1.90	1.31	(1.00, 2.02, 10.00)
Upstream	1.90	0.34	(2.03, 3.05, 3.00)

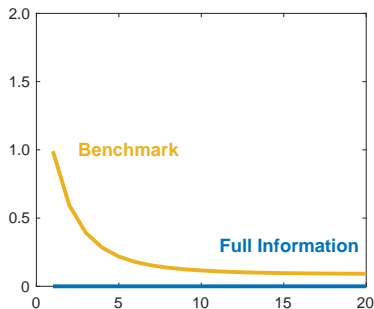
Pecking Order of Attention:

- Attention choice: downstream sectors \succ upstream sectors.
- Reason: importance for demand + information agglomeration.

SHOCK PROPAGATION



Panel a: Productivity shock



Panel b: Sentiment shock

- Dampened response to ϑ_t in limited vs full information economy.
- Erroneous responses to sentiment shock ξ_t .

BUSINESS CYCLE FLUCTUATIONS

	<i>Share of Output Variance $\mathbb{V}[y_t]$</i>	
	Benchmark	Full Information
Productivity	0.72	1.00
Sentiment	0.28	0.00
– downstream sector	0.25	0.00
– upstream sector	0.03	0.00
Total N of sectors	2	2
N of downstream sectors	1	1
N of upstream sectors	1	1

Sentiment shocks explain 28% of output variance.

89% of which is due to the downstream industry.

PARETO PRINCIPLE REVISITED

	<i>Share of Output Variance $\mathbb{V}[y_t]$</i>	
	Benchmark	27 Atalay Sectors
Productivity	0.72	0.81
Sentiment	0.28	0.19
– downstream sectors	0.25	0.18
– upstream sectors	0.03	0.01
Total N of sectors	2	27
N of downstream sectors	1	5 (20%)
N of upstream sectors	1	22 (80%)

Calibration to 27 U.S. industries according to Atalay (2017).

20% of sectors drive 90% of sentiment-driven business cycles.

Pareto principle revisited. Now for sentiment.

CONCLUSION

Final Remarks:

- We take a granular view of sentimental business cycles:
 - Measurement and characterization.
 - Quantification and implications.

CONCLUSION

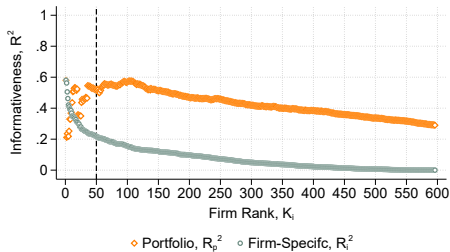
Final Remarks:

- We take a granular view of sentimental business cycles:
 - Measurement and characterization.
 - Quantification and implications.
- The granular hypothesis has been applied to:
 - Firms, banking, trade ...
 - Our paper: animal spirits.

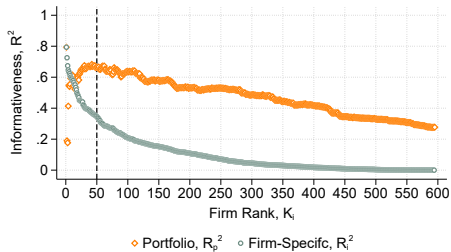
Appendix

ALTERNATIVE AGENCY

BACK



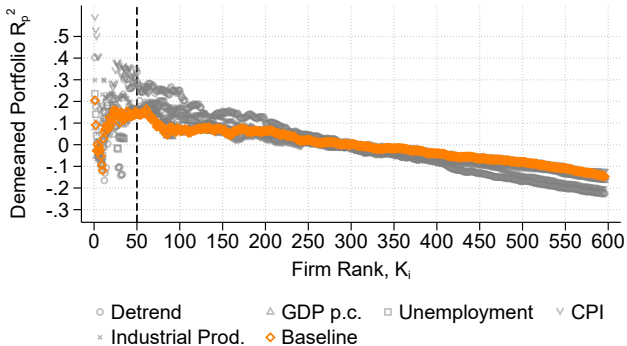
Panel a: FinBERT



Panel b: Analyst Forecasts

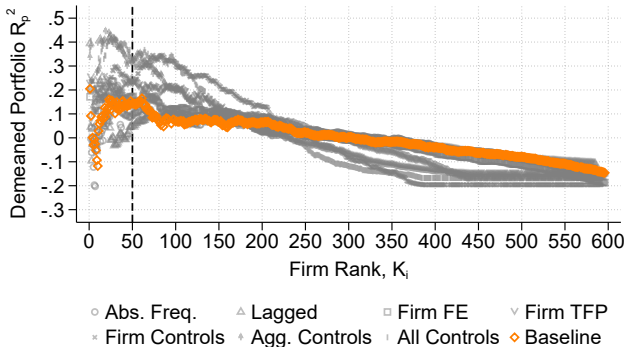
ALTERNATIVE MACRO OUTCOMES

BACK



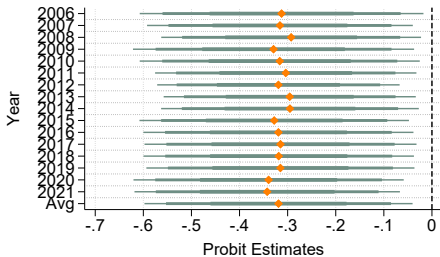
ROBUSTNESS TO SPECIFICATION

BACK

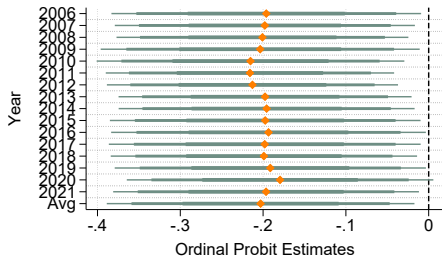


ROBUSTNESS TO SPECIFICATION

BACK



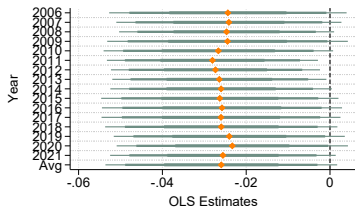
(A) Probit



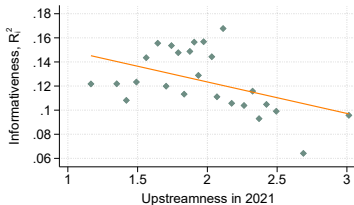
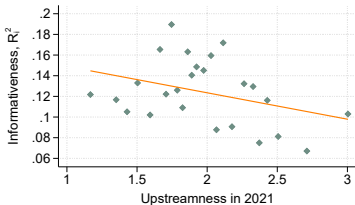
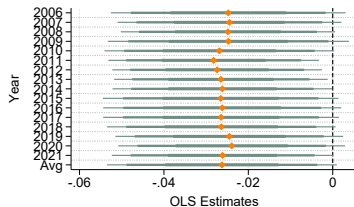
(B) Ordinal Probit

ALTERNATIVE SECTORS

(A) Atalay (2017)

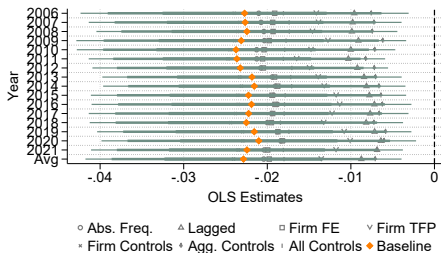
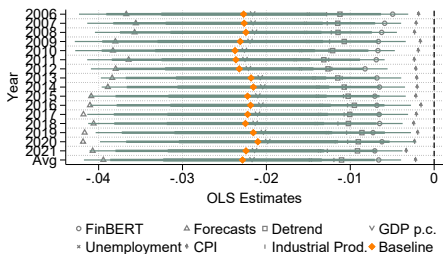


(B) Chahrour et al. (2021)



[Back](#)

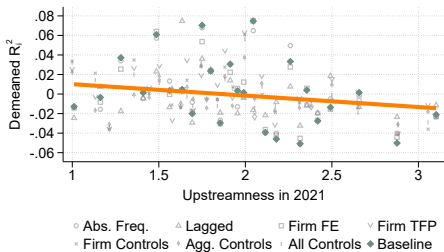
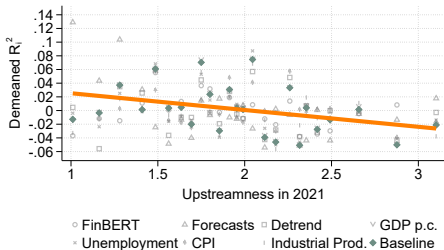
TIME STABILITY: ROBUSTNESS



Lines are 68%, 90%, and 95% confidence intervals.

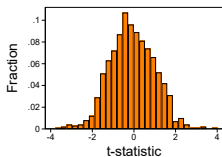
SCATTER: ROBUSTNESS

BACK

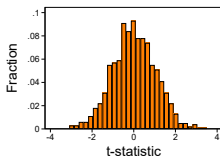


PLACEBO REGRESSIONS

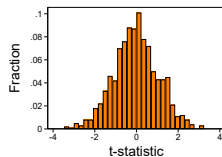
BACK



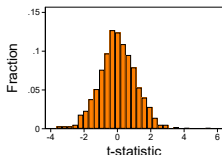
(A) 2017



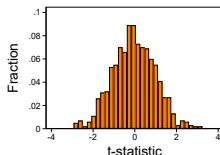
(B) 2018



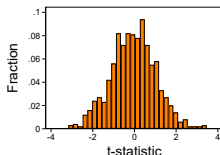
(C) 2019



(D) 2020



(E) 2021

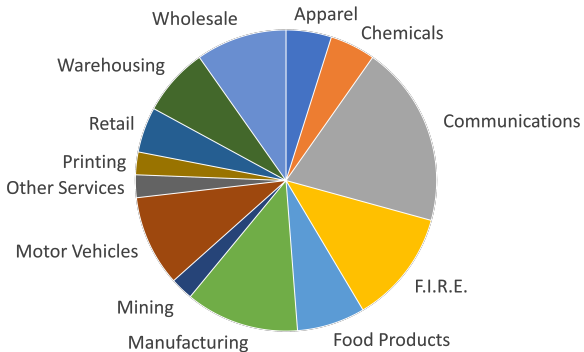


(F) 2022

t-statistic distributions from select placebo characteristics regressions where industry upstreamness has been randomly re-assigned, with replacement, across industries.

FIRMS PIE CHART

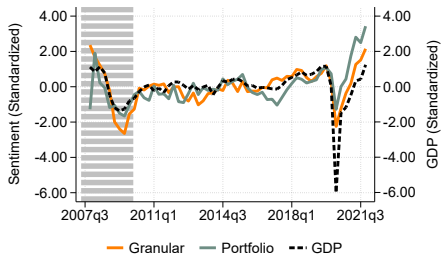
BACK



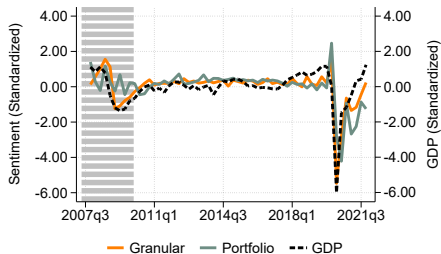
GRANULAR SENTIMENT: AGENCY

BACK

(A) FinBERT

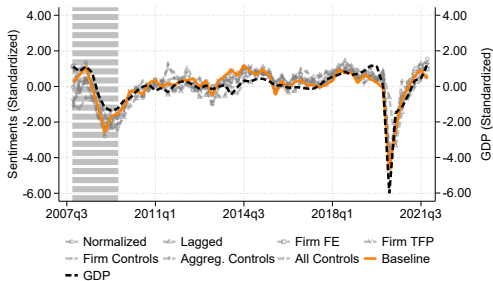
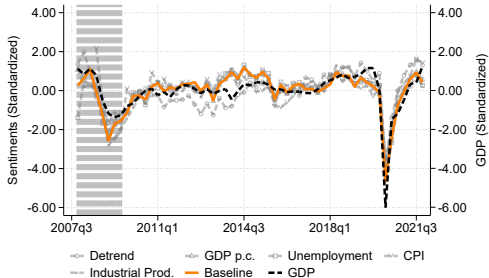


(B) Analyst Forecasts



GRANULAR SENTIMENT: ROBUSTNESS

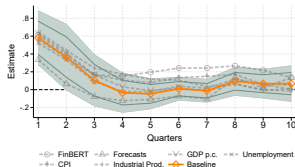
BACK



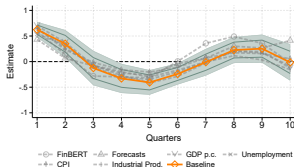
LOCAL PROJECTIONS: ROBUSTNESS 1

[BACK](#)

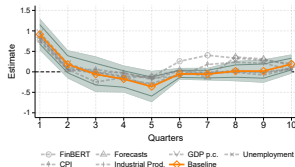
(A) Conference Board LEI



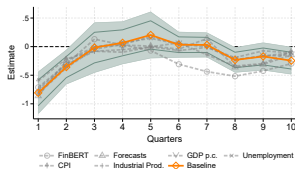
(B) Sentix Sentiment



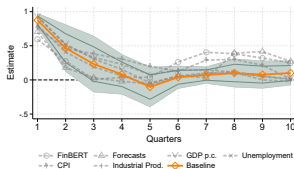
(C) GDP



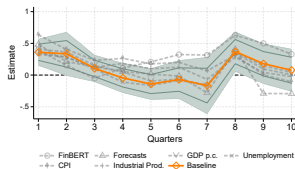
(D) Unemployment Rate



(E) Industrial Production



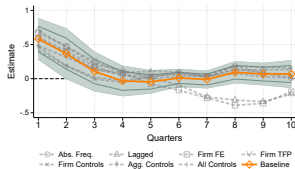
(F) CPI



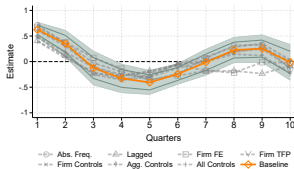
LOCAL PROJECTIONS: ROBUSTNESS 2

[BACK](#)

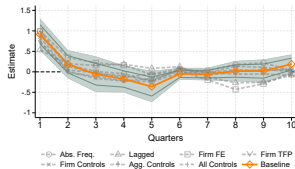
(A) Conference Board LEI



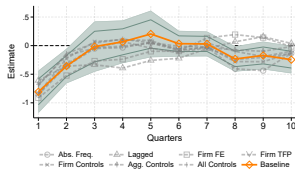
(B) Sentix Sentiment



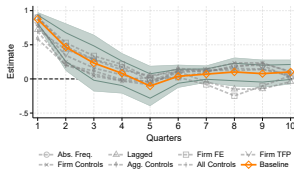
(C) GDP



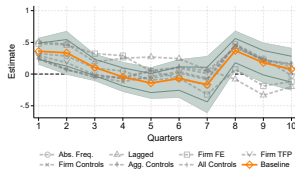
(D) Unemployment Rate



(E) Industrial Production



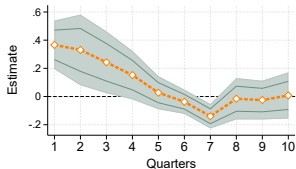
(F) CPI



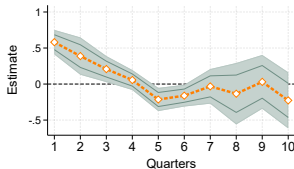
LOCAL PROJECTIONS: ALTERNATIVE DE-TREND

BACK

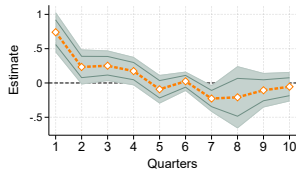
(A) Conference Board LEI



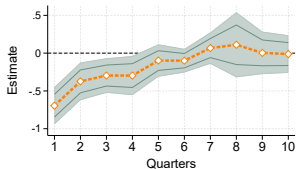
(B) Sentix Sentiment



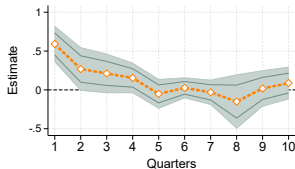
(C) GDP



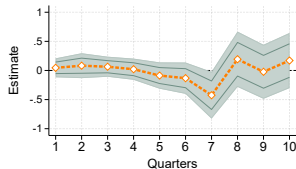
(D) Unemployment Rate



(E) Industrial Production



(F) CPI



Macro outcomes are residualized from the time FE instead of being HP filtered.

IV REGRESSIONS

[BACK](#)

Independent Variable: Granular Sentiment instrumented by Mass Shootings						
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	Conference Board LEI	sentix Sentiment	GDP	Unemployment	Ind. Prod.	CPI
Sentiment	0.769*** (0.261)	0.903*** (0.340)	0.521*** (0.161)	-0.744*** (0.201)	0.724** (0.299)	-0.108 (0.381)
Observations	45	45	45	45	45	45
All Controls	X	X	X	X	X	X
aR ²	0.725	0.431	0.587	0.258	0.638	-0.094
First stage F-stat	6.857	6.857	6.857	6.857	6.857	6.857

Independent Variable: Granular Sentiment instrumented by Mass Shootings						
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	Conference Board LEI	sentix Sentiment	GDP	Unemployment	Ind. Prod.	CPI
Sentiment	0.462** (0.233)	0.668** (0.335)	0.270* (0.164)	-0.610*** (0.202)	0.428 (0.296)	-0.457 (0.546)
Observations	45	45	45	45	45	45
All Controls	✓	✓	✓	✓	✓	✓
aR ²	0.808	0.581	0.791	0.676	0.749	-0.055
First stage F-stat	4.870	4.870	4.870	4.870	4.870	4.870

Production Technology:

$$Q_{it} = Z_{it} \left(\prod_j X_{ijt}^{\alpha_{ij}} \right) L_{it}^{\alpha_{iL}} \cdot K_{it}^{\alpha_{iK}}$$

- Two sectors:
 - upstream ($i = u$) and downstream ($i = d$)
- Upstream doesn't use downstream ($\alpha_{ud} = 0$)
- Decreasing returns to scale: $\sum_j \alpha_{ij} = 1 - \gamma$, $\gamma \in (0, 1)$
- Investment choice: $K_{it} = I_{it} + (1 - \delta)K_{it-1}$
- Labor choice ex-post; *investment choice ex-ante*
- One-period perfect state verification for simplification

W.I.P