Uncovering Subjective Models from Survey Expectations

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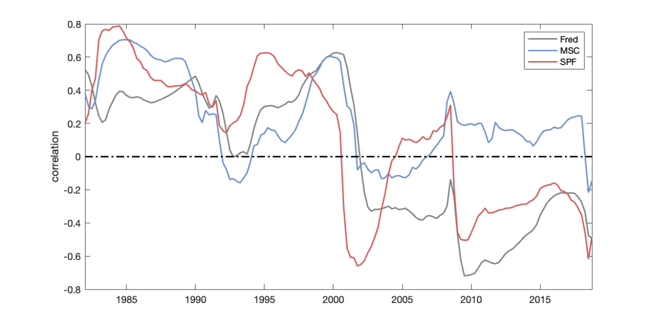
π_t and ΔU_t: Actual versus Perceived



Correlation using 10-year rolling window, 1982-2024. Grey line: realized data from FRED. Blue line: expectations from MSC. Red line: expectations from SPF.

Intro

Theme of the paper

- Macroeconomic expectation are formed jointly regarding multiple variable**s**
- Deviation from FIRE is due to both incomplete information and subjective models
- Inflation expectations are somewhat special...
  - supply view versus demand view (Andre et al., 2022; Han, 2023)
  - optimistic versus pessimistic sentiment factor (Bhandari et al., 2019; Kamdar, 2019)
  - people just *don't like* inflation (Shiller, 1997; Stantcheva, 2024)
  - households see PE but not GE mechanisms

Key findings

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  - newspapers draw connections between inflation and unemployment rates when π_t is high not un_t
- Explanations: inflation negativity

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  - newspapers draw connections between inflation and unemployment rates when π_t is high not un_t
- Explanations: inflation negativity
  - π news is always perceived to be bad, whereas the un news is neutral

Modeling framework

- Formal tests of expectation formation (Coibion and Gorodnichenko, 2012, 2015)
  - A Noisy information model Lucas (1976); Woodford (2001); Sims (2003)
  - Multivariate expectation formation ("Joint learning")
  - Subjective models (perceived law of motion $\neq$ actual law of motion) $\rightarrow$ correlated expectations

Facts

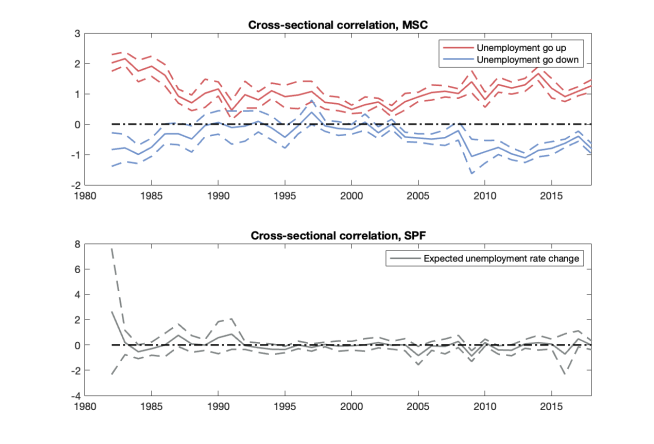
Correlation in consensus expectations

Table 1: Correlations: 1981q3-2018q4

	MSC	SPF	FRED
$corr(E\pi, Eun)$	0.16^{**}	0.03	0.00
$corr(E\pi, Ey)$	-0.25^{***}	-0.01	0.08

- Similar evidence as in Bhandari et al. (2019) and Candia et al. (2020)

Time variations of the perceived correlation in consensus expectations



MSC: estimates β_1 from: $E_{i,t}\pi_{t+12,t} = \beta_0 + \beta_1 U_{t+12,t} + \theta\mu_i + D_t + \epsilon_{i,t}$, where $U_{t+12,t}$ stands for two dummy variables indicating the MSC consumer believes the unemployment rate will go up or down in the next 12 months. SPF: estimated β_1 from: $E_{i,t}\pi_{t+4,t} = \beta_0 + \beta_1 E_{i,t}un_{t+4,t} + \theta\mu_i + D_t + \epsilon_{i,t}$. Where $E_{i,t}un_{t+4,t}$ stands for

Controlling for individual FE and time FE

$$E_{i,t}\pi_{t+12,t} = \beta_0 + \beta_1 E_{i,t} un_{t+12,t} + \beta_2 E_{i,t} i_{t+12,t} + \theta X_{i,t} + D_t + \mu_i + \epsilon_{i,t}$$

Table 2: FE Panel Regression

	MSC		SCE		SPF
Unemployment up	0.30^{***}	$\hat{\beta}_1$	0.012^{***}	$\hat{\beta}_1$	-0.17^{***}
	(0.05)		(0.002)		(0.06)
Unemployment down	-0.22^{***}				
	(0.05)				
FE	Y		Y		Y
Time dummy	Y		Y		Y

* Controlling for individual and time-varying characteristics, individual fixed effect, and time-fixed effect. Standard errors are adjusted for heteroscedasticity and autocorrelation.

- Also true for individual's own perceived job loss probabilities

Time-varying correlations across individuals

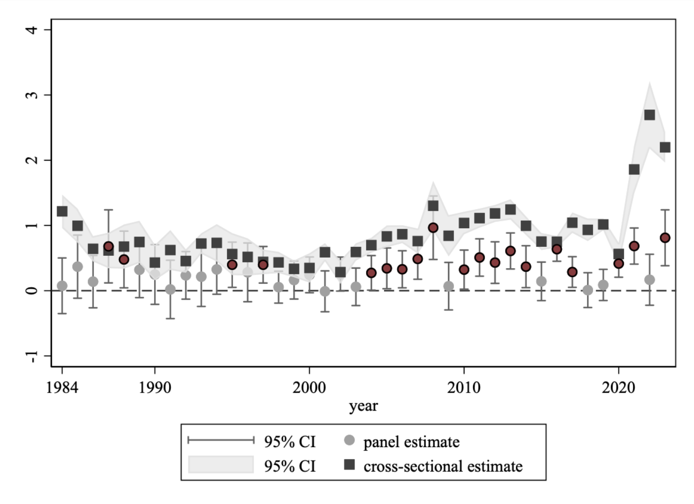


Figure 1: Individual level correlation between $E_{i,t}\pi_{t+4,t}$ and $E_{i,t}\Delta un_{t+4,t}$ in each year. The square marks: without individual FE but with controls for characteristics. The circle marks: with individual FE.

A Formal Test of Joint Learning

A multivariate noisy information + subjective model

$$\boldsymbol{L}_{t+1,t} = A\boldsymbol{L}_{t,t-1} + w_{t+1,t} \tag{1}$$

$$\boldsymbol{s}_t^i = G\boldsymbol{L}_{t,t-1} + v_t^i + \eta_t \tag{2}$$

$$\boldsymbol{L}_{t+1,t} = \hat{A}\boldsymbol{L}_{t,t-1} + w_{t+1,t} \tag{3}$$

$$w_{t+1,t} \sim N(0, Q) \quad \epsilon_{i,t} := v_t^i + \eta_t \sim N(0, R) \tag{4}$$

- A: Actual law of motion (ALM)
- $\hat{A}$: Perceived law of motion (PLM)
- G: signal mixture
  - Correlated signals: G is non-diagonal
  - Uncorrelated signals: G is diagonal

Serial correlations of forecast errors (FE)

$$
\begin{aligned}
FE^i_{t+1,t|t} &\equiv \boldsymbol{L}_{t+1,t} - \boldsymbol{L}^i_{t+1,t|t} \\
&= \hat{A}(I - KG)FE^i_{t,t-1|t-1} \\
&+ \underbrace{M}_{(A - \hat{A}KG - \hat{A}(I-KG))} \boldsymbol{L}_{t,t-1} + w_{t+1,t} - \hat{A}K\left(v^i_t + \eta_t\right)
\end{aligned}
$$

- K: Kalman gain

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- K: Kalman gain
- Diagonal terms of $\hat{A}(I-KG)$: auto-correlation
- Off-diagonal terms: between-correlation
- Special case of FIRE: $A=\hat{A}$ and $G=I$, $K=I \rightarrow \hat{A}(I-KG)=\mathbf{0}$
- Special case of independent learning: $\hat{A}$, G are diagonal $\rightarrow$ so is $\hat{A}(I-KG)$

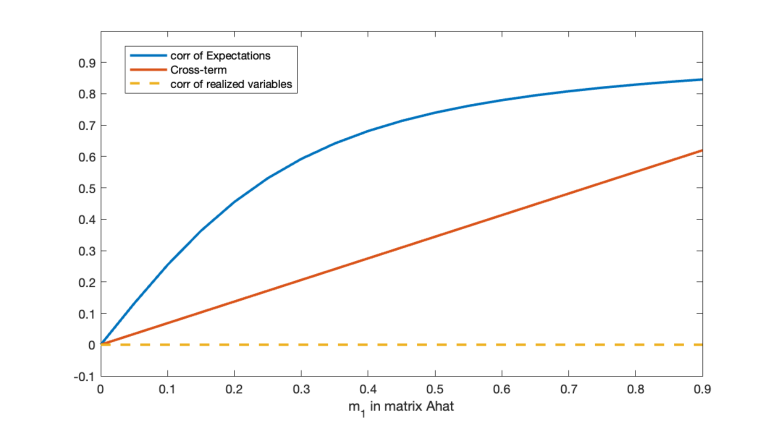
Joint-learning scenario 1: subjective model

$$\hat{A}(I - KG) = \begin{pmatrix} \rho_1 & m_1 \\ m_2 & \rho_2 \end{pmatrix} \times \begin{pmatrix} \frac{\sigma_{1,s}^2}{\sigma_1^2+\sigma_{1,s}^2} & 0 \\ 0 & \frac{\sigma_{2,s}^2}{\sigma_2^2+\sigma_{2,s}^2} \end{pmatrix}$$

$$= \begin{pmatrix} \frac{\sigma_{1,s}^2\rho_1}{\sigma_1^2+\sigma_{1,s}^2} & \frac{\sigma_{2,s}^2 m_1}{\sigma_2^2+\sigma_{2,s}^2} \\ \frac{\sigma_{1,s}^2 m_2}{\sigma_1^2+\sigma_{1,s}^2} & \frac{\sigma_{2,s}^2\rho_2}{\sigma_2^2+\sigma_{2,s}^2} \end{pmatrix} \tag{5}$$

- $G = I_2$: no signal correlation (can be any diagonal matrix)
- The signs of cross terms (the between-variable serial correlation of FEs) are the same as the perceived correlation

Scenario 1: an example



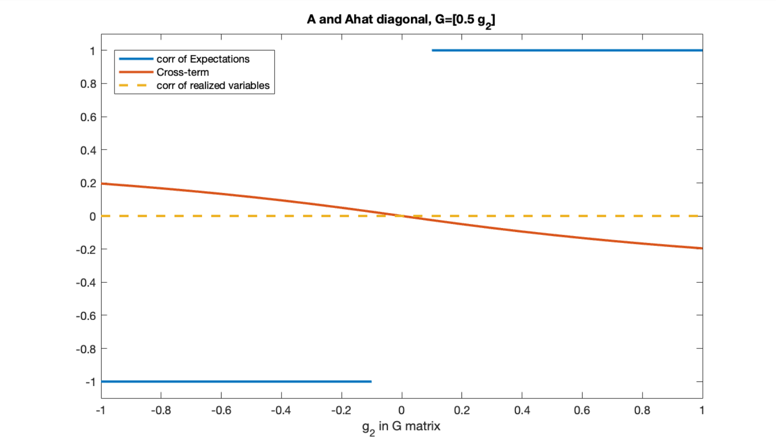
$$A = \begin{pmatrix} 0.9 & 0 \\ 0 & 0.9 \end{pmatrix}, \hat{A} = \begin{pmatrix} 0.9 & m_1 \\ 0 & 0.9 \end{pmatrix}.$$

Joint-learning scenario 2: mixed signals, i.e. G is not diagonal

$$\hat{A}(I - KG) = \begin{pmatrix} \rho_1 & 0 \\ 0 & \rho_2 \end{pmatrix} \begin{pmatrix} \frac{g_2^2\sigma_2^2+\sigma_s^2}{m} & -\frac{g_1 g_2 \sigma_1^2}{m} \\ -\frac{g_1 g_2 \sigma_2^2}{m} & \frac{g_1^2\sigma_1^2+\sigma_s^2}{m} \end{pmatrix}$$
$$= \begin{pmatrix} \rho_1 \frac{g_2^2\sigma_2^2+\sigma_s^2}{m} & -\rho_1 \frac{g_1 g_2 \sigma_1^2}{m} \\ -\rho_2 \frac{g_1 g_2 \sigma_2^2}{m} & \rho_2 \frac{g_1^2\sigma_1^2+\sigma_s^2}{m} \end{pmatrix} \tag{6}$$

- $m = g_1^2\sigma_1^2 + g_2^2\sigma_2^2 + \sigma_s^2$
- $G = [g_1, g_2]$: the vector of signals (due to "optimal signal selection")
- When signals go in the same direction, $g_1 g_2 > 0$, the cross terms are negative.

Scenario 2: an example



$$\hat{A} = A = \begin{pmatrix} 0.9 & 0 \\ 0 & 0.9 \end{pmatrix}, \; G = \begin{pmatrix} 0.5 & g_2 \end{pmatrix}.$$

Model predictions

Table 3: Summary of Models and Testable Implications

Model:	Implied Estimate Results
FIRE	$\beta_{11} = \beta_{12} = \beta_{21} = \beta_{22} = 0$, $corr(E\pi, Edun)$ same as realized $corr(\pi, dun)$
Independent Learning: $m_1 = m_2 = 0$, G diagonal	$\beta_{12} = \beta_{21} = 0$, $\beta_{11}, \beta_{22} \neq 0$, $corr(E\pi, Edun) = 0$
Joint Learning: $m_i \lesseqgtr 0$, $m_j = 0$, G diagonal	$\beta_{ij} \lesseqgtr 0$, $\beta_{ji} = 0$, $corr(E\pi, Edun) \lesseqgtr 0$
Joint Learning: $m_1 = m_2 = 0$, $G = \begin{pmatrix} g_1 & g_2 \end{pmatrix}$, $g_1 g_2 \lesseqgtr 0$	$\beta_{12} \gtreqless 0$, $\beta_{21} \gtreqless 0$, $corr(E\pi, Edun) \lesseqgtr 0$

Joint-learning tests for π and *un*

$$\begin{pmatrix} fe^{\pi}_{t+1,t|t} \\ fe^{un}_{t+1,t|t} \end{pmatrix} = \boldsymbol{\beta}_0 + \begin{pmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{pmatrix} \begin{pmatrix} fe^{\pi}_{t,t-1|t-1} \\ fe^{un}_{t,t-1|t-1} \end{pmatrix} + \boldsymbol{\theta} X_{t,t-1} + e_t \quad (7)$$

- β_{12} and β_{21}: between-variable serial correlations of forecast errors
- Predictions: if only correlated signals but not subjective model, β_{12} and β_{21} are both negative.
- With imputed point forecast of *un* in MSC
- Using FEs 3 months apart

Joint-learning tests with consensus expectations

Table 4: Aggregate Test on Joint Learning, MSC v.s. SPF

	MSC		SPF	
	1981-2018	1990-2018	1981-2018	1990-2018
	(1)	(2)	(3)	(4)
β_{11}	0.61***	0.65***	0.63***	0.61***
	(0.066)	(0.085)	(0.056)	(0.086)
β_{12}	−0.15	−0.02	−0.17	0.00
	(0.094)	(0.102)	(0.181)	(0.221)
β_{21}	**0.10***	**0.20***	0.03	0.06
	(0.036)	(0.059)	(0.032)	(0.053)
β_{22}	0.59***	0.50***	0.41***	0.40***
	(0.080)	(0.092)	(0.101)	(0.143)
Observations	150	116	150	116

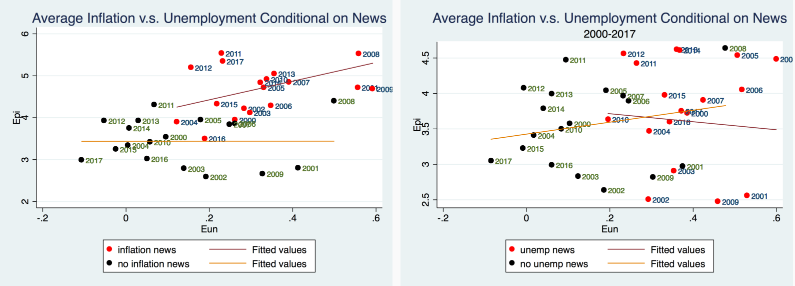
* The first and third columns are using full sample 1981-2018; the second and fourth columns are results for sub-sample 1990-2018. Newey-West standard errors are reported in brackets.

Mechanisms

Expectations conditional on the type of news heard

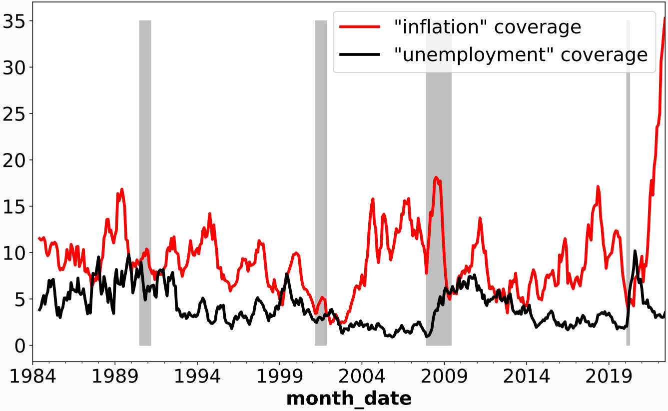
Expectation on:	Inflation	Likelihood Unemployment Increase
News on:	(1)	(2)
high inflation	0.50***	0.060***
	(0.09)	(0.011)
low inflation	−0.31***	−0.059***
	(0.10)	(0.016)
employment unfavorable	−0.001	0.10***
	(0.052)	(0.007)
employment favorable	−0.08	−0.14***
	(0.057)	(0.009)
financial market unfavorable	0.03	0.07***
	(0.074)	(0.011)
financial market favorable	−0.08	−0.08***
	(0.061)	(0.012)
Observations	163233	162369
R^2	0.68	0.69

Consensus expectations conditional on the news exposure



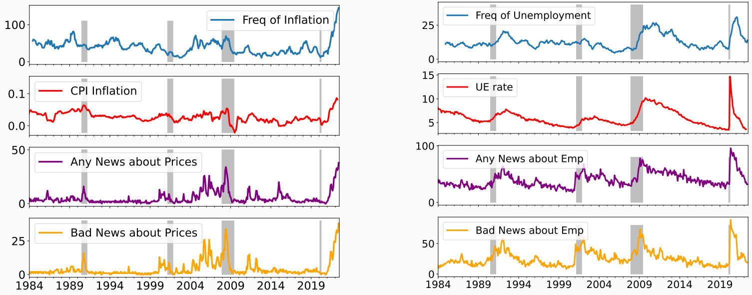
Scatter plot for consensus expected inflation and unemployment each year from 2000-2017. Left panel: conditional on having heard inflation news or not. Right panel: conditional on having heard unfavorable unemployment news.

Newspaper coverage of inflation and unemployment



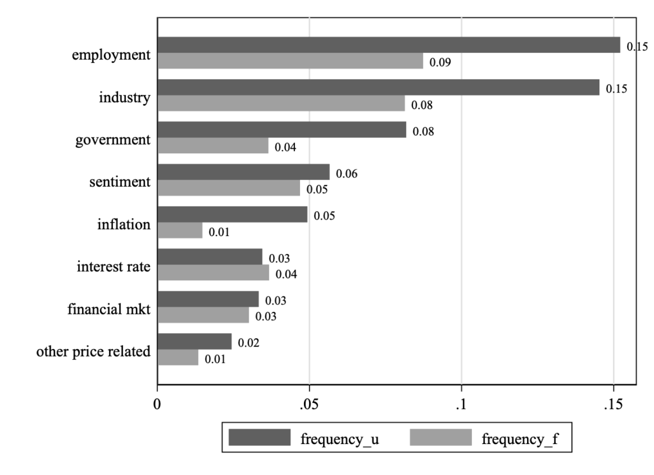
The news coverage is defined as the sum of ratios of the word frequency divided by the total number of words in each article.

News on inflation and unemployment are domain-specific



News coverage measured in the WSJ news archive.

Inflation news is always unfavorable



The fractions of favorable and unfavorable news in MSC.

Inflation news is always labeled as bad news

Table 5: News Coverage and Self-Reported News Exposure

Topic	Any News	Bad News	Good News
Inflation	0.605	0.627	-0.048
Unemployment	0.373	0.295	0.153

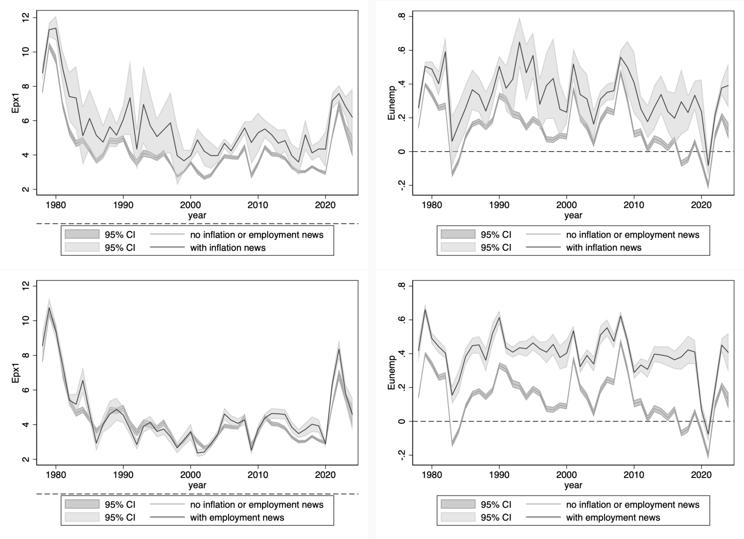
Inflation-unemployment associations in newspapers

	(1)	(2)	(3)
economy	1.07***	1.07***	1.07***
	(0.03)	(0.03)	(0.03)
fed	0.22***	0.21***	0.21***
	(0.03)	(0.03)	(0.03)
growth	0.60***	0.61***	0.61***
	(0.03)	(0.03)	(0.03)
oil price	0.24***	0.24***	0.24***
	(0.05)	(0.05)	(0.05)
recession	0.48***	0.47***	0.47***
	(0.03)	(0.03)	(0.03)
uncertainty	0.14***	0.15***	0.15***
	(0.05)	(0.05)	(0.05)
π_t		**3.73*****	**3.62*****
		(0.93)	(0.96)
u_t	-0.01		-0.00
	(0.01)		(0.01)
N	150465	150465	150465

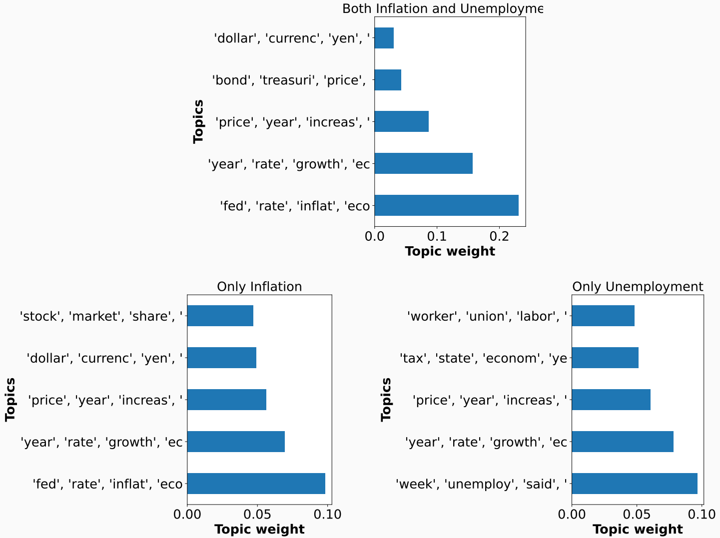
Conclusion

- Households think about macroeconomic variables jointly
- $E(\pi) \uparrow \rightarrow E(un) \uparrow$
- Formal tests suggest the role of the subjective model in addition to correlated information
- π news triggers associations of π and *un* in expectations
- ... as well as newspapers' narratives
- Negativity biases about inflation news is one possible explanation
- Caution: $E(\pi)$ may have unintended contractionary effects

π news drives expectations across domains but *un* news drives domain-specific expectations

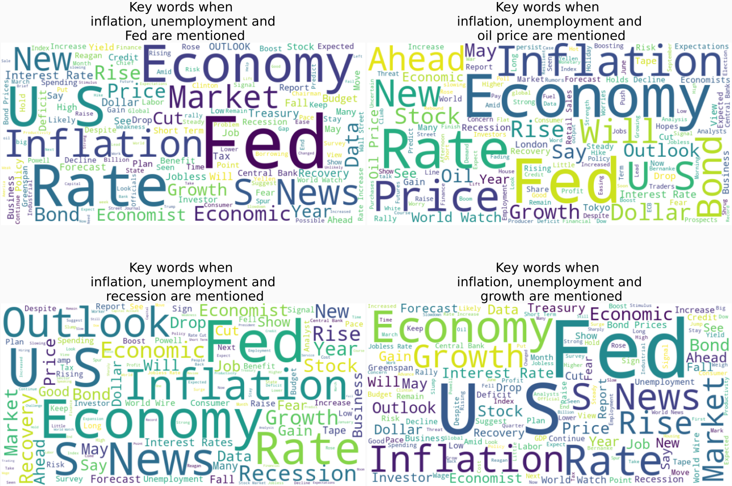


Topics in Inflation-Unemployment Narratives



Top five topics identified by the topic model. Topic weights are between 0-1.

Keywords in Different Inflation-Unemployment Narratives



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