

# Uncovering Subjective Models from Survey Expectations

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# Table of contents

1. Introduction

2. Stylized Facts

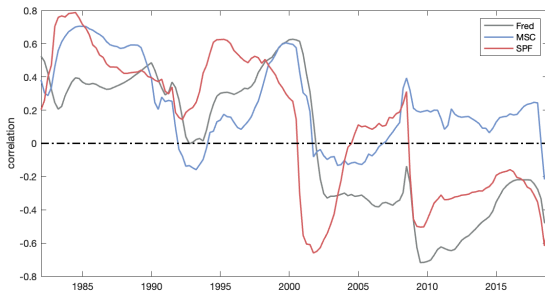
3. Joint Learning Test

4. Mechanisms

Evidence I: Self-reported News Exposure

Evidence II: Directly Measured Newspaper Topic Coverage

## $\pi_t$ and $\Delta U_t$ : Actual versus Perceived



Correlation using 10-year rolling window, 1982-2018. Grey line: realized data from FRED. Blue line: expectations from MSC. Red line: expectations from SPF.

# Intro

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- Macroeconomic expectation are formed **jointly** regarding multiple variables
- 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 (Kamdar, 2019)
  - people just *don't like* inflation (Shiller, 1997; Stantcheva, 2024)
  - households see PE but not GE mechanisms

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  - $\pi$  news is always perceived to be bad, whereas the  $un$  news is neutral
  - $\pi_t$  not  $un_t$  drives newspapers to draw connections between inflation and unemployment rates

- 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)
    - correlated expectations

# Facts

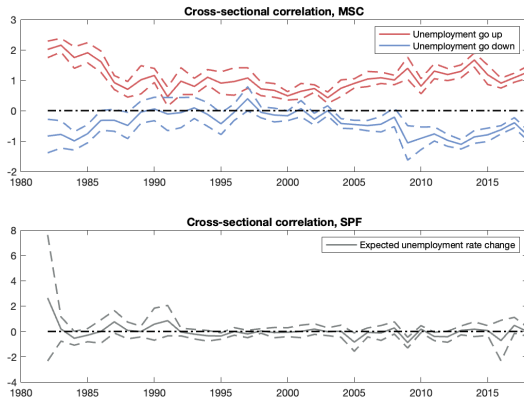
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# Correlation in consensus expectations

**Table 1:** Correlations: 1981q3-2018q4

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

# Time variations of the perceived correlation



MSC: estimates  $\beta_1$  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  $\beta_1$  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 the expected change of unemployment rate from SPF.



# 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.

# **A Formal Test of Joint Learning**

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# A multivariate noisy information + subjective model

$$\mathbf{L}_{t+1,t} = A\mathbf{L}_{t,t-1} + \mathbf{w}_{t+1,t} \quad (1)$$

$$\mathbf{s}_t^i = G\mathbf{L}_{t,t-1} + \mathbf{v}_t^i + \eta_t \quad (2)$$

$$\mathbf{L}_{t+1,t} = \hat{A}\mathbf{L}_{t,t-1} + \mathbf{w}_{t+1,t} \quad (3)$$

$$\mathbf{w}_{t+1,t} \sim N(0, Q) \quad \epsilon_{i,t} := \mathbf{v}_t^i + \eta_t \sim N(0, R) \quad (4)$$

- $A$ : 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)

$$\begin{aligned} FE_{t+1,t|t}^i &\equiv L_{t+1,t} - L_{t+1,t|t}^i \\ &= \hat{A}(I - KG)FE_{t,t-1|t-1}^i \\ &\quad + \underbrace{M}_{(A - \hat{A}KG - \hat{A}(I - KG))} L_{t,t-1} + w_{t+1,t} - \hat{A}K(v_t^i + \eta_t) \end{aligned}$$

- $K$ : 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  $\hat{A}(I - KG)$

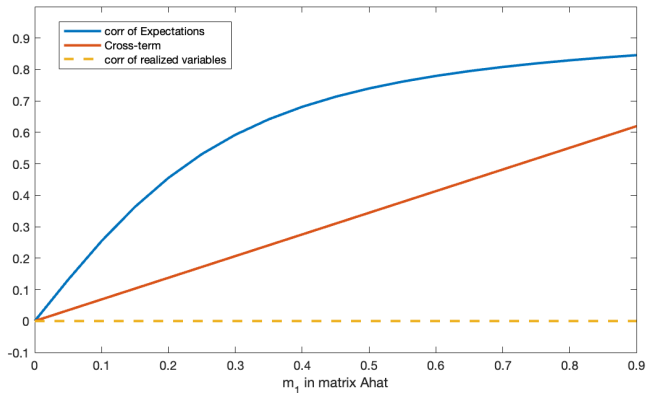
## Joint-learning scenario 1: subjective model, i.e. $\hat{A} \neq A$

$$\begin{aligned}\hat{A}(I - KG) &= \begin{pmatrix} \rho_1 & m_1 \\ m_2 & \rho_2 \end{pmatrix} \times \begin{pmatrix} \frac{\sigma_{1,s}^2}{\sigma_1^2 + \sigma_{1,s}^2} & 0 \\ 0 & \frac{\sigma_{2,s}^2}{\sigma_2^2 + \sigma_{2,s}^2} \end{pmatrix} \\ &= \begin{pmatrix} \frac{\sigma_{1,s}^2 \rho_1}{\sigma_1^2 + \sigma_{1,s}^2} & \frac{\sigma_{2,s}^2 m_1}{\sigma_2^2 + \sigma_{2,s}^2} \\ \frac{\sigma_{1,s}^2 m_2}{\sigma_1^2 + \sigma_{1,s}^2} & \frac{\sigma_{2,s}^2 \rho_2}{\sigma_2^2 + \sigma_{2,s}^2} \end{pmatrix} \quad (5)\end{aligned}$$

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



# Scenario 1: an example



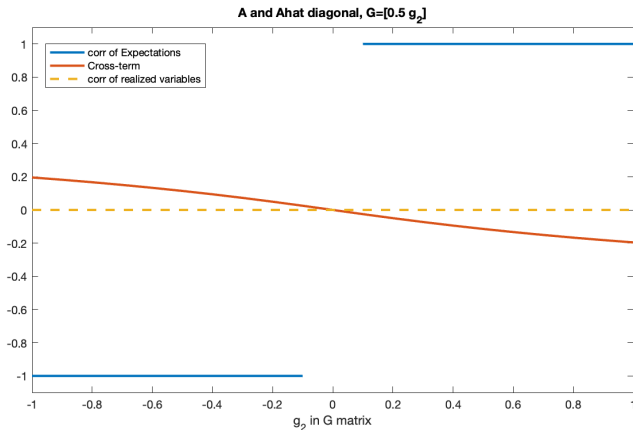
$$A = \begin{pmatrix} 0.9 & 0 \\ 0 & 0.9 \end{pmatrix}, \hat{A} = \begin{pmatrix} 0.9 & m_1 \\ 0 & 0.9 \end{pmatrix}.$$

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

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

- $G = [g_1, g_2]$ : 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



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

**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: $m_i \leq 0, m_j = 0$ , $G$ diagonal	$\beta_{ij} \leq 0, \beta_{ji} = 0,$ $corr(E\pi, Edun) \leq 0$
Joint Learning: $m_1 = m_2 = 0, G = \begin{pmatrix} g_1 & g_2 \end{pmatrix}, g_1 g_2 \leq 0$	$\beta_{12} \geq 0, \beta_{21} \geq 0,$ $corr(E\pi, Edun) \leq 0$

$$\begin{pmatrix} fe_{t+1,t|t}^{\pi} \\ fe_{t+1,t|t}^{un} \end{pmatrix} = \beta_0 + \begin{pmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{pmatrix} \begin{pmatrix} fe_{t,t-1|t-1}^{\pi} \\ fe_{t,t-1|t-1}^{un} \end{pmatrix} + \theta X_{t,t-1} + e_t \quad (7)$$

- $\beta_{12}$  and  $\beta_{21}$ : between-variable serial correlations of forecast errors
- Predictions: if only correlated signals but not subjective model,  $\beta_{12}$  and  $\beta_{21}$  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 (1)	1990-2018 (2)	1981-2018 (3)	1990-2018 (4)
$\beta_{11}$	0.61*** (0.066)	0.65*** (0.085)	0.63*** (0.056)	0.61*** (0.086)
$\beta_{12}$	-0.15 (0.094)	-0.02 (0.102)	-0.17 (0.181)	0.00 (0.221)
$\beta_{21}$	0.10*** (0.036)	0.20*** (0.059)	0.03 (0.032)	0.06 (0.053)
$\beta_{22}$	0.59*** (0.080)	0.50*** (0.092)	0.41*** (0.101)	0.40*** (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

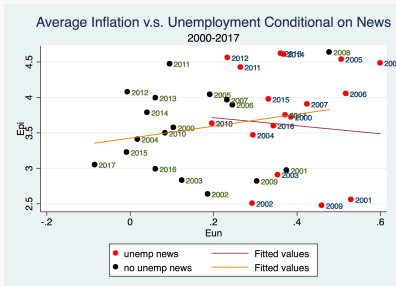
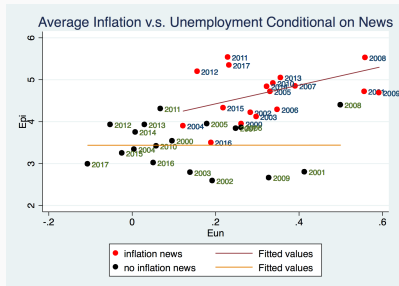
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## Expectations conditional on the type of news heard

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

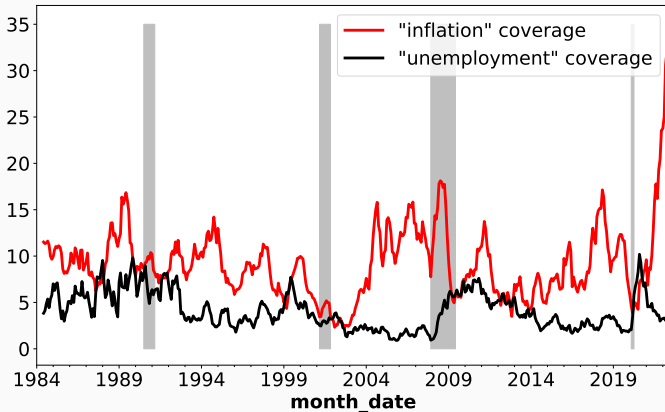


# Consensus expectations conditional on the news exposure



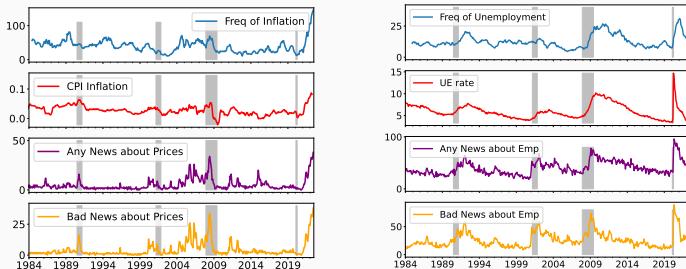
Scatter plot for consensus expected inflation and unemployment each year from 2000-2017. Left panel: conditional on having heard inflation news or not. Right panel: conditional on having heard unfavorable unemployment news.

# Newspaper coverage of inflation and unemployment



The news coverage is defined as the sum of the ratio of the frequency of the word being mentioned 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 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

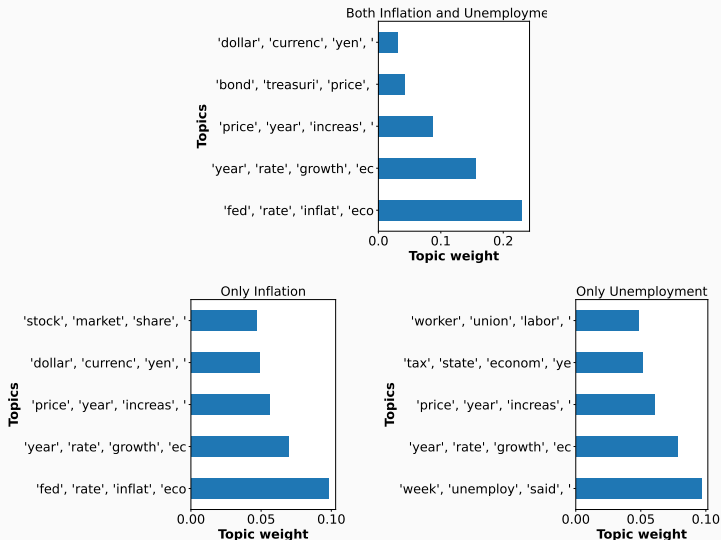
# Inflation-unemployment associations in newspapers

	(1)	(2)	(3)
economy	1.07*** (0.03)	1.07*** (0.03)	1.07*** (0.03)
fed	0.22*** (0.03)	0.21*** (0.03)	0.21*** (0.03)
growth	0.60*** (0.03)	0.61*** (0.03)	0.61*** (0.03)
oil price	0.24*** (0.05)	0.24*** (0.05)	0.24*** (0.05)
recession	0.48*** (0.03)	0.47*** (0.03)	0.47*** (0.03)
uncertainty	0.14*** (0.05)	0.15*** (0.05)	0.15*** (0.05)
$\pi_t$		3.73*** (0.93)	3.62*** (0.96)
$u_t$	-0.01 (0.01)		-0.00 (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
- $\pi$  news triggers associations of  $\pi$  and  $un$  in expectations
- ... as well as newspapers' narratives
- Caution:  $E(\pi)$  may have unintended contractionary effects

# 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

Key words when  
inflation, unemployment and  
Fed are mentioned



Key words when  
inflation, unemployment and  
oil price are mentioned



Key words when  
inflation, unemployment and  
recession are mentioned



Key words when  
inflation, unemployment and  
growth are mentioned





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