Testing the Rational Expectations Equilibrium Hypothesis: Surveys and RCTs

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Questions Motivating Analyses

What key evidence should a model of expectations formation be able to account for?

- What drives movement in expectations?

- How quickly do they respond to changes in policy and fundamentals?

- How much do they matter for individual choices?

Seminal papers ⟡ Carroll (2003); Mankiw, Reis & Wolfers (2003)

◈ **Mankiw, Reis & Wolfers (2003)**

Document how median inflation expectations and disagreement about expected inflation vary over time and with economic activity, across different subsamples of the population

Use Michigan Consumer Survey (cross section of general public) to construct consistent quarterly time series for median inflation expectations and dispersion of inflation expectations from 1954Q4 to 2002-Q1

Also analyze the Survey of Professional Forecasters (market economists), the Livingston survey (firms), and FOMC forecasts ranges (policymakers)

Emphasize usefulness of dispersion moments for disciplining macro models and that dispersion/disagreement $\neq$ uncertainty as agents can be very certain about their forecasts but still disagree

MRW03 Findings I: Median Forecast Errors

- Small bias: median forecasts tend to under-predict inflation

- Forecasts errors are somewhat predictable for consumers (but not for experts)
  - evidence of auto-correlation in forecast errors reflects persistence of errors over time

- Forecasts do not incorporate all publicly available info
  - macro series such as the inflation rate, T-bill rate, and unemployment rate are statistically significant predictors of forecast errors

- Agents appear to under-react to news when forming their expectations of inflation

MRW03 Findings II: Disagreement

1. There is substantial disagreement within both naive and expert populations about the expected future path of inflation

2. There are larger levels of disagreement among consumers than among experts

3. Disagreement within different groups tends to have similar time series patterns, though of different amplitudes

4. Dispersion rises with the level of inflation and with the magnitude of the change in inflation, but shows no clear relationship with measures of real activity

MRW03 Findings II: Disagreement
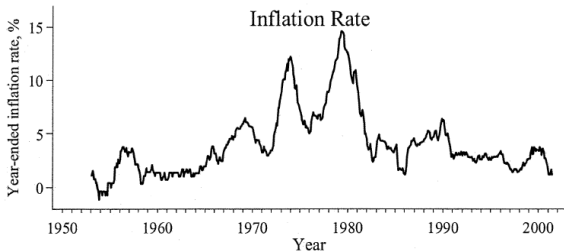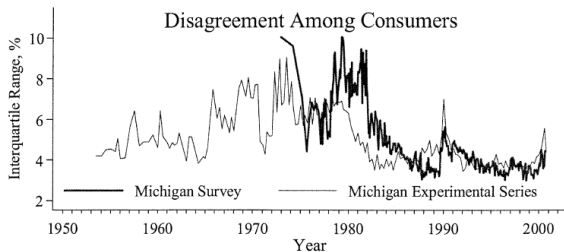
◈ Mankiw et al. (2003)

MRW03 Findings II: Disagreement
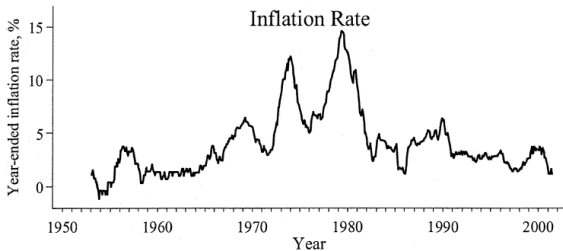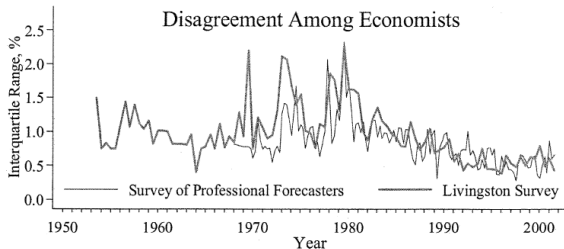
◈ Mankiw et al. (2003)

MRW03: Implications

- Conclude that expectations formation process is somewhere between RE and AE

- Data fit several predictions of the sticky information model of
  ◈ Mankiw & Reis (2002)
  - Compare the distribution of inflation expectations predicted by the model with that in the Michigan and Livingston surveys

  - Estimate that firms update info sets every 10 months and consumers update every 12.5 months

  - Both model and data predict forecastable forecast errors and positive rel. between forecast dispersion and changes in inflation

  - Unlike in the model, data suggests relationship between disagreement and level of inflation

Discussion I

Why would dispersion rise with the **level** of inflation?

$\rightarrow$ not consistent with the model of ◈ Mankiw & Reis (2002)

What kind of model might have this prediction?

On the one hand, at high levels of inflation, pricing becomes more **state-dependent** so there should be less nominal and informational frictions and hence **less** price dispersion

Discussion I

Why would dispersion rise with the **level** of inflation?

$\rightarrow$ not consistent with the model of $\diamondsuit$ Mankiw & Reis (2002)

On the other hand, maybe high inflation

- is correlated with high aggregate **uncertainty**, which in turn generates dispersion?

- results in dispersion due to a loss of **CB credibility**?

- has **nonlinear** rel. with disagreement due to heterogeneity in private incentives to become informed about inflation?

Discussion II

Who knows what people are reporting in these surveys?

$\rightarrow$ Want to look at "their actions, not their words"

Maybe when they solve their consumption problem they are solving it correctly, but they cannot explicitly take out of that the expectations piece of the equation

They're not using *our* equations to solve their problems so it's not reasonable to ask them for pieces of these equations separately

Asking them about their inflation expectations is about as informative as asking them what their utility from a car is – they can give you a number but it will be meaningless

See also: Macro Annual discussions, Q&A vs. ◈ Manski (2004)

Subsequent Research

- Demonstrated economic content of survey data on expectations, their usefulness in distinguishing among models

- Documented inter-dependencies between beliefs, choices, and outcomes:
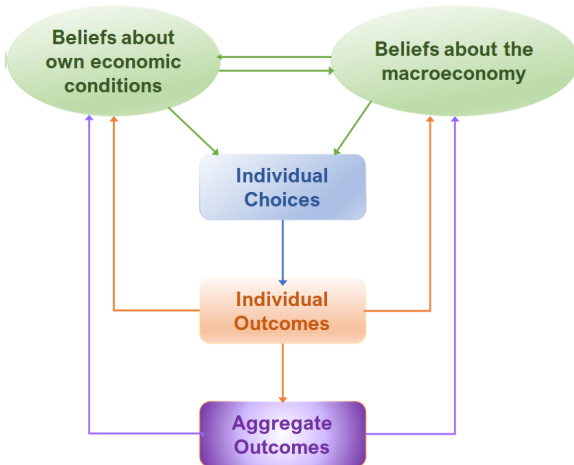
◈ **Coibion & Gorodnichenko (2012)**

- Consider the null hypothesis of FIRE against the alternative of imperfect info RE

    ○ sticky information a la ◈ Mankiw & Reis (2002)

    ○ noisy information a la ◈ Woodford (2003)

- Use the conditional responses of forecasts to economic shocks to test the hypothesis

    ○ FIRE predicts beliefs respond by the same amount as the variable being forecasted

    ○ both partial info models: more gradual response of beliefs

    ○ hence they predict serial correlation in the average forecast errors of agents, of the same sign as the forecasted variable

Coibion and Gorodnichenko (2012): Data

- For beliefs: use the average of forecasts of inflation from

  - U.S. Survey of Professional Forecasters

  - Michigan Survey of Consumers

  - firms in the Livingston Survey

  - FOMC members

- For shocks: use

  - TFP shocks (Gali, 1999)

  - oil shocks (Hamilton, 1996)

  - news shocks (⬨ Barsky & Sims, 2011)

  → Innovation rel. to ⬨ Mankiw et al. (2003): exog. shocks

Coibion and Gorodnichenko (2012): Results

1. Reject null of FIRE in favor of info frictions

   ○ forecast errors consistently move in the same direction as the
     variable being forecasted in response to various macro shocks

2. Recover the underlying degree of information rigidity

   ○ if assume responses of beliefs are driven by sticky information,
     conclude that forecasters update info sets every 6-7 quarters

   ○ if assume responses are driven by noisy information, conclude
     that forecasters put weight of 0.14 on new info ≡ forecast
     errors are reduced by a half in 3 quarters

Coibion and Gorodnichenko (2012): Results

3. Use dynamics of disagreement to discriminate between models of info frictions

   - sticky info predicts disagreement rises after a shock

   - noisy predicts disagreement is independent of the shock, unless there is heterogeneity in signal-to-noise ratios across forecasters

   - data fail to reject null of no change in disagreement after shock

   - hence data fails to reject null of noisy info with no heterogeneity signal-to-noise ratios

   - data also fails to reject null of no heterogeneity in priors about long run inflation (important for anchoring of LR inflation expectations!)

Coibion and Gorodnichenko (2012): Summary

TABLE 1
SUMMARY OF PREDICTIONS OF DIFFERENT MODELS

				MODEL AND PREDICTIONS			
					Noisy Information		
							Model Heterogeneity
	Full-Information Rational Expectations (FIRE) (1)	Heterogeneous Loss Aversion under FIRE (2)	Sticky Information (3)	Baseline (4)	Strategic Interaction (5)	Heterogeneity about Long-Run Means (6)	Heterogeneity in Gains of the Kalman Filter (7)
Response of forecast errors to shocks	No response	All positive or negative, asymptotically decline	Same direction as forecasted variable, asymptotically decline	Same direction as forecasted variable, asymptotically decline	Same direction as forecasted variable, asymptotically decline	Same direction as forecasted variable, correlated with past levels of forecasted variable	Same direction as forecasted variable, correlated with past levels of forecasted variable
Speed of convergence of normalized forecast errors to shocks	Immediate convergence	Same across shocks	Same across shocks	May differ across shocks	May differ across shocks	May differ across shocks	May differ across shocks
Response of disagreement to shocks	No response	Positive for any shock	Positive for any shock	No response	No response	No response	Positive for any shock

NOTE.—This table summarizes predictions of the models presented in Sec. II.

◇ Coibion & Gorodnichenko (2015)

- Same goals, different approach: instead of studying conditional responses of average forecast errors to exogenous macro shocks, consider regressing the average forecast errors on the **average forecast revision**

The relationship between average year-ahead inflation forecast errors across agents and average forecast revisions in both sticky-information and noisy-information models can be expressed as

$$(11) \qquad \pi_{t+3,t} - F_t \pi_{t+3,t} = c + \beta(F_t \pi_{t+3,t} - F_{t-1} \pi_{t+3,t}) + error_t,$$

where $\beta > 0$ if information rigidities are present and $error_t$ is the rational expectations error which is orthogonal to information dated t and earlier, so equation (11) can be estimated by OLS. From 1969–2014, we find $\hat{\beta} = 1.19$ (s.e. = 0.50) as shown in panel B of Table 1. As a result, we reject the null of FIRE at the 5 percent level of statistical significance in a manner that is directly informative about the expectations formation process. First, the rejection of the null goes exactly in the direction predicted by models of information rigidities, so that this finding presents

CG2012 and CG2015: Discussion I

How sensitive are estimates to the
degree of strategic complementarity?

Note that strategic complementarity in info acquisition (which can arise from strategic complementarity in actions, as we will discuss later in the course) amplifies the persistence of forecast errors

Hence estimates reflect a combination of info frictions & real rigidities $\rightarrow$ not estimating a structural parameter

CG2012 and CG2015: Discussion II

Why are measures of info frictions so different?

	Sticky info	Noisy info
◈ Coibion & Gorodnichenko (2015)	6-7 months (SPF)	0.46
◈ Coibion & Gorodnichenko (2012)	6-7 quarters (SPF)	0.14
◈ Mankiw et al. (2003)	10 months (firms)	n.a.

Sticky info numbers report frequency with which agents update their information sets on average

Noisy info numbers report the weight agents place on new information on average (relative to the prior)

CG2012 and CG2015: Discussion III

More fundamentally, how sensitive are the
results to the **endogeneity of inflation**?

CG2012 and CG2015 posit exogenous process for inflation. E.g. CG2012:

Suppose that inflation π_t is the variable of interest and follows an AR(1) process:[1]

$$\pi_t = \rho \pi_{t-1} + w_t, \tag{1}$$

where $\{w_{t-s}\}_{s=0}^{\infty}$ is a sequence of shocks. The impulse response of inflation at time $t+k$ to a shock at time t is given by

$$\frac{d\pi_{t+k}}{dw_t} = \rho^k \quad \forall k \geq 0. \tag{2}$$

and consequently, the impulse response of the forecast error to shocks is

$$\frac{dFE_{t+j,t+j+h}}{dw_t} = \rho^{j+h} \lambda^{j+1} = \left(\frac{d\pi_{t+j+h}}{dw_t} \right) \lambda^{j+1}. \tag{6}$$

Whose forecasts (and hence actions) pin down the response of
inflation itself and how does endogenous inflation respond to
shocks and forecast errors?

Further Work with Expectations Data I

- Surveys with info treatments to test how beliefs are updated

    - households' beliefs about inflation
      ◈ Cavallo, Cruces & Perez-Truglia (2017);
      ◈ Armantier, Nelson, Topa, Van der Klaauw & Zafar (2016);
      Coibion, Gorodnichenko & Weber (2022)

    - households' beliefs about house prices
      Armona, Fuster & Zafar (2019)

    - firm managers' beliefs about inflation
      ◈ Coibion, Gorodnichenko & Kumar (2018);
      Coibion, Gorodnichenko & Ropele (2020)

  $\rightarrow$ strong but transient information treatment effects

Further Work with Expectations Data II

- Micro data connecting beliefs to individual choices

  - CEOs' expectations of earnings growth and investment decisions Gennaioli, Ma & Shleifer (2016)

  - wealthy investors' beliefs about returns and portfolios Giglio, Maggiori, Stroebel & Utkus (2021)

  - consumers' inflation expectations and consumption choices D'Acunto, Malmendier, Ospina & Weber (2021)

  - households' beliefs about likelihood of recession and consumption Roth & Wohlfart (2020)

  $\rightarrow$ heterogeneous strength of correlations

Further Work with Expectations Data III

- Studies of how personal factors shape beliefs about the aggregate economy

  - traumatic lived experiences ⬥ Malmendier & Nagel (2016)

  - personal characteristics Das, Kuhnen & Nagel (2020)

  - personal experiences feeding back into expectations about the macroeconomy Kuchler & Zafar (2019)

    vs. information about the aggregate economy feeding back into expectations about own outcomes in Roth & Wohlfart (2020)

  $\rightarrow$ disproportionate weight on own experiences, recent news

Further Work with Expectations Data IV

- Strong evidence of the information channel of monetary policy

  - puzzle: an unexpected contractionary monetary policy shock results in strong response of interest rates and GDP growth expectations, weak response of inflation

  - cannot be reconciled with standard model of monetary transmission under full information

  - instead points to heterogeneous interpretation by private sector agents, with at least some interpreting shocks as good news about the state of the economy rather than as news about contractionary policy

    Romer & Romer (2000); ⟡ Campbell, Evans, Fisher & Justiniano (2012); ⟡ Andrade, Gaballo, Mengus & Mojon (2019); Miranda-Agrippino & Ricco (2021); Melosi (2017)

Breaking FIRE in Macro

- This evidence has emboldened macro modelers to unshackle expectations from FIRE's tight grip

- Properties of expectations data are increasingly used to guide model selection among different FIRE, non-FIRE, or behavioral models *e.g.*, Del Negro & Eusepi (2011); ◈ Angeletos, Huo & Sastry (2021);...

- Also increasingly used directly in the estimation of DSGE models *e.g.*, Aruoba & Schorfheide (2011); Carvalho, Eusepi, Moench & Preston (2021);...

- Importantly, non-FIRE expectations can generate systematic distortions at the individual level that are consequential for aggregate outcomes and policy objectives *e.g.*, ◈ Woodford (2003); Woodford (2010); Adam (2009); Maćkowiak & Wiederholt (2015); Paciello & Wiederholt (2014); Angeletos & La'O (2020); Angeletos & Huo (2021);...

What's Next in Survey Experiments?

- For papers reporting new survey data, pay close attention to the survey design, sampling, framing of questions, and connections between survey responses and observed economic choices

- Ask yourself how you might design such a survey to test a specific question of interest

- Check out https://www.prolific.co/researchers - BSOS has small grants for grad students

Some Public Survey Data on Expectations

- Survey of Professional Forecasters: additional information

- Michigan Survey of Consumers: additional information

- New York Fed Survey of Consumers: additional information

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