In Search of a Nominal Anchor: What Drives Inflation Expectations?

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Motivation

- Successful monetary policymaking relies on \textit{anchored} inflation expectations.
  - Despite recent past, stability of long-run inflation expectations not an inherent feature of the economy.

- Yet: do not know much about what drives long-term expectations.
  - Under what conditions are expectations anchored?

- In most macro-models \textit{long-term} inflation expectations are:
  - Assumed to be constant; or
  - Assumed to drift exogenously.
This Paper

- Simple model of expectation formation based on learning.
- Price-setting agents act as econometricians: estimate average long-run inflation mean.

- **Key feature 1**: state-dependent sensitivity of long-run inflation expectations to short-term inflation surprises.
  \[\Rightarrow\] Generates unanchoring (high sensitivity) of long-term inflation expectations in response to large and persistent surprises.

- **Key feature 2**: with nominal rigidities expected future inflation matters for current prices.
  \[\Rightarrow\] Expectations are partially self-fulfilling, producing an endogenous inflation trend.
Objective

Can such a model explain the evolution of long-term inflation expectations as measured by survey forecasts?

- Estimate the model using only actual inflation and survey-based measures of short-term inflation forecasts.

- Evaluate predictions for long-term survey forecasts for US and 11 other countries:
  - Consensus Forecasts dataset: Canada, France, Germany, Italy, Japan, Netherlands, Norway, Spain, Sweden, Switzerland, UK.
Introduction

Literature

- Inflation dynamics under learning
  - Chevillonné et al. (2010), Cornea et al. (2013), Lansing (2008), Milani (2005), Primiceri (2008), Sargent et al. (2005).

- Inflation drift

- State dependent gain/ Model selection
A Simple Model

Forecasting model of price-setting agents:

$$\pi_t = (1 - \gamma_p) \bar{\pi}_t + \gamma_p \pi_{t-1} + \varphi_t.$$

- $\bar{\pi}_t$: agents estimate (possibly drifting) long-term inflation mean

$$\hat{E}_t \lim_{T \to \infty} \pi_T = \bar{\pi}_t.$$

- $\varphi_t$: a zero mean stationary “short-run component”

$$\varphi_t = s_t + \mu_t$$

$$s_t = \rho_s s_{t-1} + \epsilon_t.$$

- $s_t, \mu_t$: relate to marginal cost and cost-push shocks in NK model.
A Simple Model - ctd.

True inflation DGP:

\[ \pi_t = (1 - \gamma_p) \Gamma \bar{\pi}_t + \gamma p \pi_{t-1} + \varphi_t. \]

- \( \Gamma \): measures **feedback** from beliefs to actual inflation.

\[ \Rightarrow \text{In NK model: feed-back to price-setting decisions.} \]

- True DGP for inflation has a constant mean which agents will eventually learn.
  - \( \Gamma < 1 \): restricted to ensure \( \pi_t \) is stationary.
Learning about the Inflation Trend

- We assume the following learning algorithm:

\[
\bar{\pi}_t = \bar{\pi}_{t-1} + k_{t-1}^{-1} \times f_t \quad \text{where} \quad f_t = \pi_t - \hat{E}_{t-1}\pi_t.
\]

- In the spirit of Marcet and Nicolini (2003), learning gain \( k_t > 1 \):

\[
k_t = \begin{cases} 
  k_{t-1} + 1, & \text{if } \frac{\left| \hat{E}_{t-1}\pi_t - E_{t-1}\pi_t \right|}{\sqrt{\mathbb{E}[\pi_t - E_{t-1}\pi_t]^2}} < \nu \\
  \bar{g}^{-1}, & \text{otherwise.}
\end{cases}
\]

- \( E_{t-1}\pi_t \): model-consistent forecast.

\( \Rightarrow \) Captures effort to protect against structural change.

\( \Rightarrow \) Use statistical tools to detect time-variation in their model’s intercept.
Learning about the Inflation Trend - ctd.

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\end{cases}
\]

• More intuition on switching criterion:

\[
\left| \hat{E}_{t-1}\pi_t - E_{t-1}\pi_t \right| = \left| (1 - \gamma_p) (1 - \Gamma) \left[ \bar{\pi}_0 + \sum_{\tau=0}^{t} k_{\tau}^{-1} f_{\tau} \right] \right|, \text{ given } \bar{\pi}_0, f_0, k_0.
\]

⇒ Large when past forecast errors are of same sign for a few periods.
Anchored Expectations?

- **Anchored expectations**: agents learn about a constant long-run mean of inflation (Least Squares).

  \[ k_{t}^{-1} \rightarrow 0. \]

- **Unanchored expectations**: agents doubt the constancy of long-run inflation and put more weight on recent inflation (Constant gain).

  \[ k_{t}^{-1} = \bar{g}. \]
Lower Bound on Rationality

1. Parameters $\nu$ and $\bar{g}$ such that agents eventually learn.
   - Here $\bar{\pi}_t \rightarrow \pi$.

2. Claim: $\nu$ and $\bar{g}$ nearly optimal within the learning algorithm.
   - No individual agent has strong incentives to deviate.
   - Key role of feed-back effects ($\Gamma$ high enough).

Implication: learning mechanism not policy invariant.
Data: US

- **Strategy**: given agents’ updating rule use measures of short-term forecasts and inflation to infer their long-term forecasts.

- **Goal**: evaluate the model’s ability to explain long-term inflation forecasts observed in survey data.

- **Data**: CPI inflation (quarterly), 1955Q1-2015Q2.

- **Short-term forecasts (consensus)**:
US: Actual Inflation and Short-Term Survey Forecasts
Estimation: US

- Model in state-space form:

\[ \xi_t = F(k_{t-1}^{-1})\xi_{t-1} + S_C\epsilon_t. \]

- Observation equation:

\[
Y_{tUS} = \begin{bmatrix}
\pi_t \\
E_{t}^{SPF} \pi_{t+1} \\
E_{t}^{SPF} \pi_{t+2} \\
E_{t}^{LIV1} \left( \frac{1}{2} \sum_{i=1}^{2} \pi_{t+i} \right) \\
E_{t}^{LIV2} \left( \frac{1}{2} \sum_{i=1}^{2} \pi_{t+i} \right)
\end{bmatrix} = \pi^* + H'_t\xi_t + o_t.
\]

- Estimate with Bayesian methods — structural parameters:

\[
\bar{\theta} = (\pi^* \nu \bar{g} \gamma_p \Gamma \rho_s \sigma^2_s \sigma^2_\mu)'.
\]
### US Estimates - Table of Priors and Posteriors

<table>
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<th>Prior</th>
<th>Dist.</th>
<th>Mean</th>
<th>Std</th>
<th>Mode</th>
<th>Mean</th>
<th>Std</th>
<th>5%</th>
<th>Med.</th>
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1Q Ahead Forecast Errors: Model-Implied and SPF
Long-term (6-10 Years) Model-Implied Inflation Forecasts
Adding Michigan Survey 6-10 Years
Introduction

Adding Blue Chip Economic Indicators 1-10 Years
Adding Blue Chip Economic Indicators 6-10 Years
Adding Blue Chip Financial Forecasts 6-10 Years
Adding Consensus Economics 6-10 Years
Adding Survey of Professional Forecasters 6-10 Years
Learning Gain
Comparing with Other Models

- **Exogenous drift**: popular approach both in reduced-form and DSGE models:

  \[ \bar{\pi}_{t+1} = \rho_\pi \bar{\pi}_t + e_{t+1}; \rho_\pi \approx 1. \]

  - Does not predict as well the sharp rise in long-term expectations over the 70s.

- **Constant gain**: widely used on the learning literature.

  - Produces excessive volatility in the second part of the sample.
Estimation: Other Countries

Data:


Data limitations:

- Limited sample of surveys + year-over-year forecasts.
  - Forecasts for current year include quarterly forecasts of 1-2 quarters ahead.
  - Forecasts for the following year give highest weight to 1-4 quarters ahead forecasts.
- Not a precise measure of one-quarter-ahead prediction errors.
Estimation: Other Countries - ctd.

Solution:

1. “Structural” params: use US posterior as prior for these countries.
   - For $\pi^*$ and obs. errors use same prior distrib. as for the US.

2. Down-weight foreign country’s Likelihood. Posterior:

\[ P^* \left( \theta^* | Y^*_t, Y^*_tUS, \theta^{US} \right) = \lambda^* \ln L(Y^*_t | \theta^{US}, \theta^*) + \ln \left[ L(Y^*_tUS | \theta^{US}) p(\theta^{US}) \right] + \ln p(\theta^*). \]

- Small $\lambda^*$: Model predictions using US posterior distribution.
Summary Results: Foreign Countries

1. Model characterizes well the evolution of long-term forecasts.
   - Survey-based forecasts are inside the 95% bands for most of the sample.
   - With the exception of France, Italy and Spain, posterior estimates with $\lambda^*$ up to 0.6 are very similar to US posterior distribution.

   - Japan and Switzerland: episodes of unanchoring in the past 15 years.
   - Canada, France, Sweden and the UK: more stable expectations.

3. Beyond inflation surprises: announcement effects?
   - Examples: some episodes in Canada, Japan and Sweden.
Japan: Consumer Price Inflation and Short-Term Forecasts
Japan: Model-Implied and Obs. 6-11 Years Forecasts: $\lambda^* = 0.1$
Japan: Model-Implied and Obs. 6-11 Years Forecasts: $\lambda^* = 0.3$
Japan: Learning Gain: $\lambda^* = 0.1$
France: Consumer Price Inflation and Short-Term Forecasts
France: Model-Implied and Obs. 6-11 Years Forecasts: $\lambda^* = 0.1$
France: Model-Implied and Obs. 6-11 Years Forecasts: $\lambda^* = 0.3$
France: Learning Gain: $\lambda^* = 0.1$
Germany: Consumer Price Inflation and Short-Term Forecasts
Germany: Model-Implied and Obs. 6-11 Years Forecasts: $\lambda^* = 0.1$
Germany: Model-Implied and Obs. 6-11 Years Forecasts: $\lambda^* = 0.6$
Germany: Learning Gain: $\lambda^* = 0.1$
Canada: Model-Implied and Obs. 6-11 Years Forecasts: $\lambda^* = 0.1$
Sweden: Model-Implied and Obs. 6-11 Years Forecasts: $\lambda^* = 0.1$
Introduction

Switzerland: Consumer Price Inflation and Short-Term Forecasts

[Graph showing Consumer Price Index (CPI) and short-term forecasts for Switzerland from 1980 to 2010.]
Switzerland: Model-Implied and Obs. 6-11 Years Forecasts: $\lambda^* = 0.1$
Switzerland: Learning Gain: $\lambda^* = 0.1$
Switzerland: Model-Implied and Obs. 6-11 Years Forecasts: $\lambda^* = 0.6$
Switzerland: Learning Gain: $\lambda^* = 0.6$
Conclusion

- Simple learning model which links long-term inflation expectations to short-term forecast errors.

- In model inflation and inflation expectations can become unmoored in response to large and persistence short-term forecast errors.

- Model describes long-term survey forecasts of inflation very well for number of countries even using only posterior distribution for the US.

- In our model short-term forecast errors are treated as exogenous...

- ...but in full general equilibrium model they depend on policy regime.