Heterogeneous Expectations, Learning and European Inflation Dynamics, by Anke Weber

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This Paper:

Addresses question: how do households and professional forecasters in Europe forecast inflation?
This Paper:

Forecasting model:

\[ \pi_t = a_{t-1} + b'_{t-1}X_t + \varepsilon_t \]

Q: How are \( a_t, b_t \) determined?
Adaptive learning: let $\theta' = (a, b)$

$$
\begin{align*}
\theta_t &= \theta_{t-1} + \gamma_t R_{t-1}^{-1} X_t \left( \pi_t - \theta'_{t-1} X_t \right) \\
R_t &= R_{t-1} + \gamma_t \left( X_t X'_t - R_{t-1} \right)
\end{align*}
$$

where $R$ is sample-second moment matrix of regressors.

Recursive least squares: $\gamma_t = 1/t$

Constant gain (discount l.s.): $\gamma_t = \gamma$, $0 < \gamma < 1$. 
Out-of-sample forecasting exercise (e.g. Stock and Watson (1996), Branch and Evans (2006)):

1. initialization period, for $a_0, b_0, R$
2. in-sample period: find best constant gain $\gamma$.
3. out-of-sample period: generate forecasts and compute squared forecast errors.
4. find constant gain that best explains survey data.
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- Gains are larger in professional survey: Germany (.13-.17), France(.1-.21), Italy (.15-.3)
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- Evidence that learning is converging, but slowly.
Outline of Discussion

1. Why are results important/interesting?
2. Interpreting the results?
Learning is important:

- Constant gain learning and economy: Marcet and Nicolini (2003), Orphanides and Williams (2003), Milani (2007)
- Constant gain learning and large deviations: Sargent (1999), Cho, Williams, and Sargent (2003), Branch and Evans (2010).

and, this paper provides evidence in favor of learning.
Interpreting the results:

Simple model (e.g. Branch (2010)):

\[ i_t = E_t (\pi_{t+1} - \bar{\pi}) + r_t \]

\[ i_t = \alpha (\pi_t - \bar{\pi}) \]

or,

\[ \pi_t = \frac{(\alpha - 1)}{\alpha} \bar{\pi} + \alpha^{-1} E_t \pi_{t+1} + \alpha^{-1} r_t \]
Adaptive learning:

Forecast model: \( \pi_t = a + \varepsilon_t \iff E_t \pi_{t+1} = a_{t-1}. \)

Recursive least squares:

\[
a_t = a_{t-1} + \gamma^{-1} (\pi_t - a_{t-1})
\]

Constant gain:

\[
a_t = a_{t-1} + \gamma (\pi_t - a_{t-1})
\]
Why opt $\gamma > \text{Survey } \gamma$?

![Graphs showing No Structural Change and Structural Change with MSE vs $\gamma$.]
Constant gain can arise from an (approximate) Kalman Filter when perceive

\[ a_t = a_{t-1} + \eta_t \]

where \( Q_t = E\eta_t^2 \).

- RLS: \( Q_t \to 0 \)
- Constant gain: \( Q_t \to Q \)
Convergence

1. If RLS, $a_t \rightarrow \bar{\pi}$ with probability 1.

2. If constant gain, for large $t$ and large $\gamma_t$,

$$a_t \sim N(\bar{\pi}, \gamma C)$$
Convergence in Prob. vs. Dist.
Convergence of Constant Gain:
Testing for convergence:

Recall,

\[ a_t = a_{t-1} + \eta_t \quad E(\eta_t^2) = Q_t \]

Test \( H_0 : \lambda = 1 \) against \( \lambda < 1 \) where

\[ Q_t = \lambda^2 Q_{t-1} \]

Find \( \lambda < 1 \), but very close to 1.

Q: What is learning converging to?
$RLS, Q_t = \lambda Q_{t-1}$

$\gamma = 0.05, Q_t = \lambda Q_{t-1}$
Figure: $Q_t - Q = \lambda^2 (Q_{t-1} - Q)$. 
Nice paper, intriguing results.

Explaining expectations critical policy issue.

Questions that policymakers would like to know answers to:

1. Why are priors on structural change so different across countries, and across professionals versus households.
2. Are beliefs converging? Does this mean the inflation target is credible?
3. Are there ways to improve on the survey data?