A parsimonious model of expectations to explain experimental forecasts

Domenico Colucci, Vincenzo Valori

DISEI - Università degli Studi di Firenze

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The Original Experiment

P. Heemeijer, C. Hommes, J. Sonnemans, J. Tuinstra - JEDC 2009.

- Price forecasting in two different environments: with *positive* and *negative* feedback of expectations on prices.
- **78** subjects divided in **13** groups of **6**.
- Subjects only had graphical and analytical information about previous price realizations and forecasts.

Positive and Negative Feedback

Negative Feedback Price Dynamics

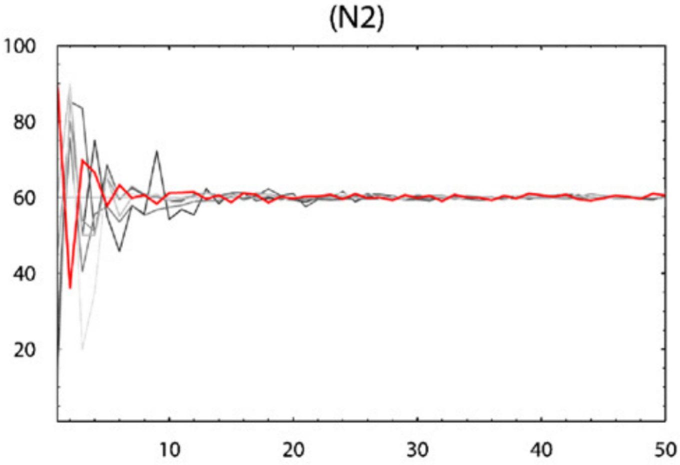
$$p_t = 60 - \frac{20}{21}\left(\bar{p}_t^e - 60\right) + \varepsilon_t$$

Positive Feedback Price Dynamics

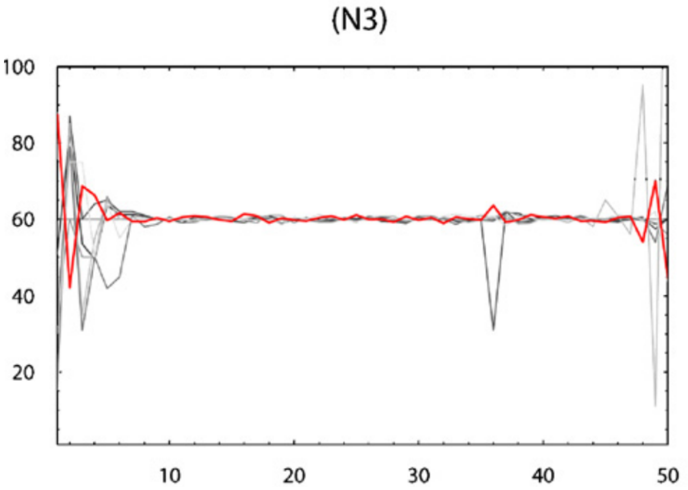
$$p_t = 60 + \frac{20}{21}\left(\bar{p}_t^e - 60\right) + \varepsilon_t$$

$\bar{p}_t^e \longrightarrow$ time t average price forecast of group members
$\varepsilon_t \longrightarrow$ white noise (same over all the groups)

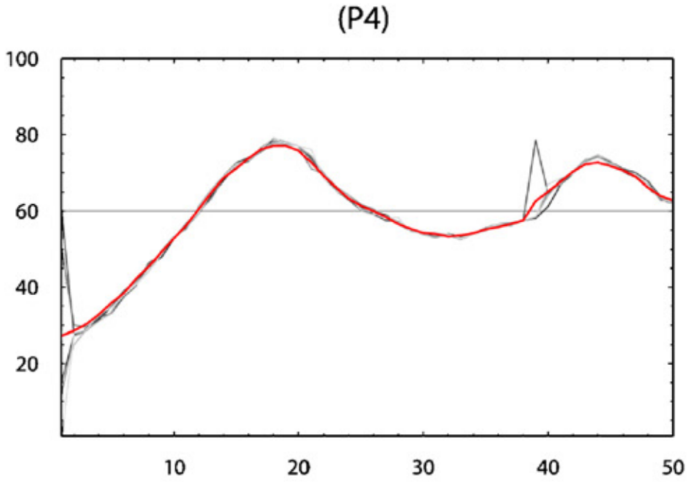
Qualitative features - Negative (1)



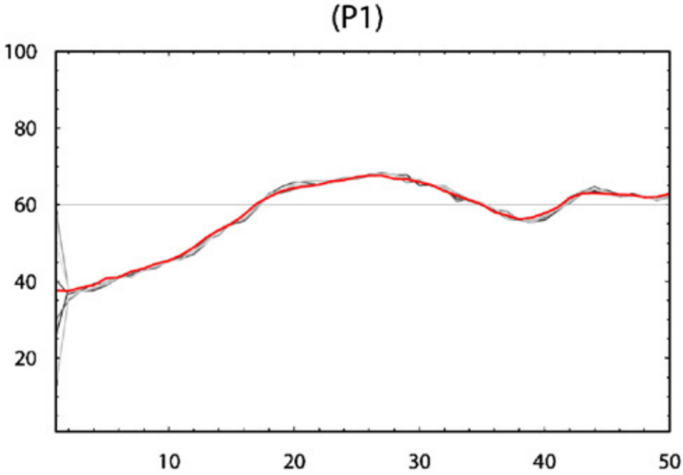
Qualitative features - Negative (2)



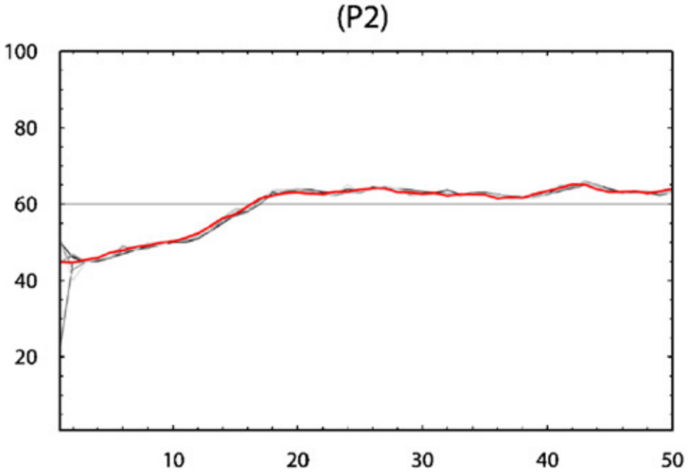
Qualitative features - Positive (1)



Qualitative features - Positive (2)



Qualitative features - Positive (3)



Qualitative features (6) - Summary

Negative Feedback

- Quick convergence to the equilibrium
- Forecasts do not coordinate until the equilibrium is reached

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Positive Feedback

- Persistent oscillations and out of the equilibrium path
- Forecasts quickly coordinate
- Dependence on initial conditions

HHST 2009 - Results

- *Individual* perspective → Estimate two linear models with 7 and 5 parameters (various lags in prices and in expectations, fundamental value)
- *Heterogeneity?* **YES**!
- Effects of *positive/negative* environment? **YES**!

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"... in the positive feedback environment participants tend to base their prediction on a weighted average of the last price and the last prediction, and extrapolate trends in past prices from there ..."

"... typically, predictions in that [negative feedback] treatment are a weighted average between the last observed price and the equilibrium price level ..."

AHP 2011 - Results

M.Anufriev, C.H.Hommes, R.H.S.Philipse - JEvolEc 2013

- *Aggregate* perspective.
- Propose *Heuristic Switching Mechanism* (**HSM**)
- Available rules of thumb: *adaptive* and *trend following* expectations.

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The **HSM** does well in reproducing some experimental "stylized facts"

- Negative feedback $\longrightarrow$ strong oscillations followed by quick convergence
- Positive feedback $\longrightarrow$ persistent deviations from equilibrium and slow oscillations
- Dependence on the initial conditions
- Effects of *positive/negative* environment on estimated parameters? Again **YES**!

A question

Can we find a heuristic which is:

1. behaviourally viable (a *sufficiently simple* rule of thumb);
2. analytically tractable (possibly both in the *representative agent* and in the *heterogeneous agents* case);
3. fitting well the experimental data both in the *positive* and in the *negative* feedback scenario;
4. able to reproduce qualitative stylized facts shown by experimental data?

The A-T heuristic

Inspired by the simple *trend chasing* heuristic. The A-T heuristic is

$$p_{t+1}^{e} = p_{t+1}^{A} + \gamma p_{t+1}^{T}$$

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$$p^e_{t+1} = p^A_{t+1} + \gamma p^T_{t+1}$$

where

$$\begin{aligned} p^A_{t+1} &= \alpha p_t + (1-\alpha)\, p^A_t && \rightarrow \text{ the anchor} \\ p^T_{t+1} &= \beta\,(p_t - p_{t-1}) + (1-\beta)\, p^T_t && \rightarrow \text{ the trend component} \end{aligned}$$

and $\alpha, \beta, \gamma \in (0,1)$.

Model estimation

Coefficients estimated minimizing the *mean squared error* (**MSE**) between simulated and observed *price* using the same set of parameters at various layers:

- over all groups pooled together
- separately for positive and negative treatment
- at group level

To compare models with different degrees of freedom we use →

- the *Akaike Information Criterion* (**AIC**)
- the *Bayesian Information Criterion* (**BIC**)

Fitting experimental data (1)

Negative feedback treatment

	MSE	*AIC*	*BIC*
Adaptive	2.30	236.88	240.52
Trend	1.92	185.96	189.60
HSM	1.92	194.25	212.46
A-T	**1.46**	**112.72**	**123.64**

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Positive feedback treatment

	MSE	*AIC*	*BIC*
Adaptive	1.82	171.15	174.79
Trend	0.75	-79.88	-76.24
HSM	0.71	-87.37	-69.17
A-T	**0.68**	**-102.85**	**-95.57**

Fitting experimental data (2)

Both treatments

	MSE	*AIC*	*BIC*
Adaptive	2.37	488.19	492.53
Trend	2.29	470.29	474.62
HSM	1.51	240.60	262.27
A-T	**1.48**	**226.01**	**239.01**

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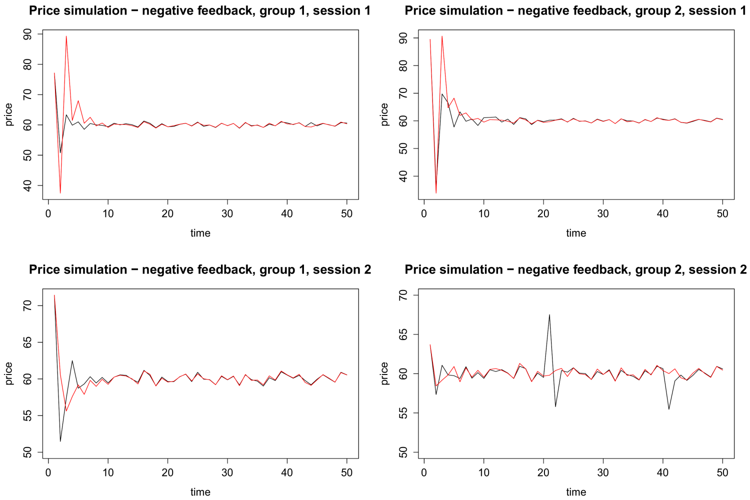
The A-T model fits the data better than HSM in all cases

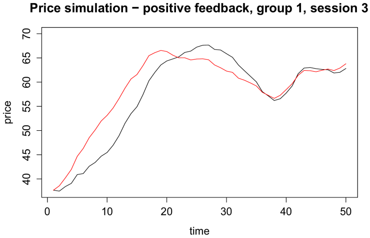
Simulations (of price series)

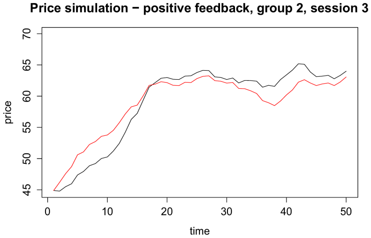
- Various sets of simulations with model optimized at *aggregate, treatment and group* level
- Observed expectations initialize the model
- For each group, a set of 50 prices is generated by the model
- **Remark**: these are *representative agent* simulations

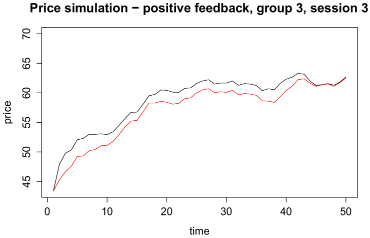
Simulated vs. experimental price - negative

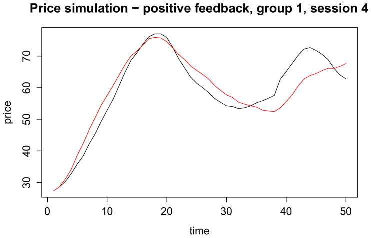


Simulated vs. experimental price - positive









Model estimation

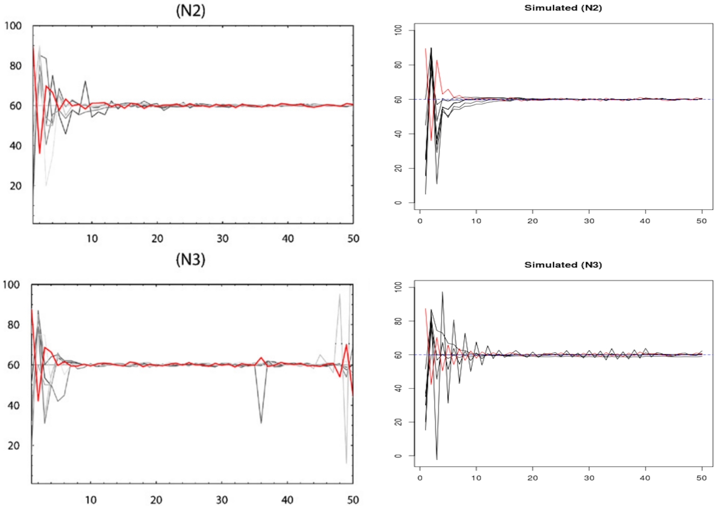
Parameters are estimated to minimize the *mean squared error* between simulated and observed *expectations*.

- The A-T model fits the data better then HHST in over 80% of the cases
- The model suits most but not all subjects

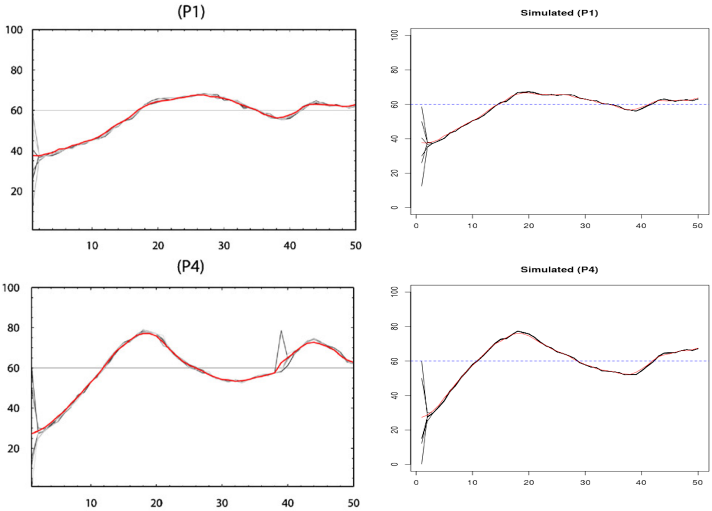
Simulations (of individual expectations)

- Simulations with model optimized at *individual* level
- Observed expectations initialize the model
- For each group, 50x6 expectations and 50 prices are generated by the model
- **Remark**: these are *heterogeneous agents* simulations

Simulated expectations and price - negative



Simulated expectations and price - positive



To conclude

1. Two different paradigms confront to explain observed experimental data: the HSM, relying on a basket of possible heuristics and the A-T which reduces behaviour to a unique mechanism.
2. A-T performs better than HSM (although still in a comparable way) in reproducing the data.
3. A-T is also capable of reproducing qualitative features of experimental time series in long run simulations.

Appendix

Criteria for model selection.

- Akaike Information Criterion

$$AIC = n \ln (MSE) + 2k$$

- Bayesian Information Criterion

$$BIC = n \ln (MSE) + k \ln (n)$$

where n is the *number of observations* and k is the *number of parameters*.