Inflation Expectations, Learning and Supermarket Prices
Evidence from Field Experiments

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May 2016
Outline

1. Introduction
2. Experimental Design
3. Online Experiments
4. Supermarket Experiment
5. Conclusions
Introduction

- Inflation expectations may influence consumption and investment decisions.
- How do households form inflation expectations?
  - Key implications for monetary policy. E.g.: Bernanke, 2007.
  - Still no consensus. E.g.: Raynard et al., 2012.
The Puzzle (2012 U.S. Data)

Inflation Expectations

May 2016
Our Contribution

Two main hypotheses:

- Rational inattention. E.g.: Mankiw et al., 2003; Carroll, 2003; Coibion et al., 2015.
- Irrational learning. E.g.: Bruine de Bruin et al., 2011; Malmendier and Nagel, 2013.

Existing literature was unable to disentangle from each other!

Our contribution: design experiments to disentangle these mechanisms.
Experimental Design

- Survey experiment:
  - Pre-Treatment: Elicit perceived inflation over past 12 months.
  - Treatment: Provide (0/1/2) pieces of information related to past inflation.
  - Post-Treatment: Elicit expected inflation over next 12 months, expected nominal interest rate, etc.

- Reduced-form evidence: effect of treatment on distribution of post-treatment beliefs.

- Structural approach: use simple model to estimate “learning rates.”
Summary of Findings

- Rational inattention test.
  - Conduct experiments in low-inflation (U.S.) and high-inflation (Argentina).
  - Individuals learn at higher rates in higher inflation contexts.

- Irrational learning test.
  - Provide statistics and supermarket prices simultaneously.
  - Individuals over-weight supermarket prices.

- Remembered prices.
  - Price-elicitation experiment with supermarket customers.
  - Individuals use their price memories even though they are very biased.
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Goal: quantify the rate of learning.

\( \pi_{i,t} \): perceptions about inflation over the past 12 months.

\( \pi_{i,t+1} \): expectations about inflation over the next 12 months.

Expectations equation:

\[
\pi_{i,t+1} = \mu + \beta \cdot \pi_{i,t} + \epsilon_{i,t}
\]

Can take it as purely statistical model, but can accommodate:

- Adaptive learning (e.g., Sargent, 1993).
- Rational expectations (e.g., Barr and Campbell, 1997; Atkeson and Ohanian, 2001).
Expectations Equation (Argentina)
Learning Equation

- \( \pi_{0,i,t} \): prior belief about inflation over the past 12 months.
- \( \pi_{T,i,t} \): signal about inflation over the past 12 months.
- If prior and signal are normally distributed, posterior is also normal:

\[
\pi_{i,t} = (1 - \alpha) \pi_{0,i,t} + \alpha \pi_{T,i,t}
\]

- \( \alpha \) is a function of relative precision between prior and signal.
Inferring Learning Rates

- Combine learning and expectation equations:

\[
\pi_{i,t+1} = \gamma_0 + \gamma_1 \pi^0_{i,t} + \gamma_2 (\pi^T_{i,t} - \pi^0_{i,t})
\]

- Can estimate \(\alpha\) and \(\beta\) with this simple regression.
Important concern is spurious learning.


Strategy: define “true learning” as reactions that are “consistent.”

- Over time.
- Across beliefs.

Boils down to estimating model with alternative dependent variables (e.g., $\pi_{i,t+1}^{\text{follow-up}}$, $i_{i,t}$).
Online experiment conducted in 2013.
United States (inflation stable around 2%).
- 3,945 individuals recruited from Amazon Mechanical Turk.
- Inflation expectations similar to *Michigan Survey of Consumers*.
Argentina (inflation stable around 25%).
- 3,653 individuals recruited from regular online poll.
- Inflation expectations similar to (equivalent of) *Michigan Survey of Consumers*. 
## Treatment Arm: Statistics (1.5%), U.S.

<table>
<thead>
<tr>
<th>Official Statistic</th>
<th>Average Annual Change in Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer Price Index&lt;sup&gt;1&lt;/sup&gt;</td>
<td>2.0%</td>
</tr>
<tr>
<td>Personal Consumption Expenditures Price Index&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1.1%</td>
</tr>
<tr>
<td>Gross Domestic Product Deflator&lt;sup&gt;3&lt;/sup&gt;</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

**Average of the three statistics:** 1.5%

*Sources: 1 Bureau of Labor Statistics, 2 and 3: Bureau of Economic Analysis.*
Treatment Arm: Statistics (1.5%), U.S.

Note: ES test p-value: <0.01
Table of 6 products with the following message:

“The six products that appear in the following table were randomly selected from a database containing hundreds of products. All prices were obtained from the same supermarket.”

Prices scraped from largest supermarkets in each country.

No suggestion that prices were representative.

Algorithm chose products to “hold other constant other characteristics.”
### Products (-2%), U.S.

<table>
<thead>
<tr>
<th>Product</th>
<th>Price on August 1, 2012</th>
<th>Price on August 1, 2013</th>
<th>Price change in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant Formula (Enfamil Gentlease)</td>
<td>$18^{69}</td>
<td>$18^{69}</td>
<td>0.0%</td>
</tr>
<tr>
<td>Bread (Anzio &amp; Sons Sub Rolls)</td>
<td>$3^{59}</td>
<td>$3^{59}</td>
<td>0.0%</td>
</tr>
<tr>
<td>Pasta Sauce (Barilla Marinara)</td>
<td>$2^{79}</td>
<td>$2^{80}</td>
<td>0.4%</td>
</tr>
<tr>
<td>Cereal (Cheerios Honey Nut)</td>
<td>$5^{29}</td>
<td>$4^{99}</td>
<td>-5.7%</td>
</tr>
<tr>
<td>Soda (Schweppes Ginger Ale)</td>
<td>$1^{79}</td>
<td>$1^{67}</td>
<td>-6.7%</td>
</tr>
<tr>
<td>Body Wash (Dial Spring Water)</td>
<td>$6^{09}</td>
<td>$6^{09}</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

**Average change:** -2.0%
### Products (2%), U.S.

<table>
<thead>
<tr>
<th>Product</th>
<th>Price on August 1, 2012</th>
<th>Price on August 1, 2013</th>
<th>Price change in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant Formula (Similac with Iron)</td>
<td>$7^{29}</td>
<td>$7^{59}</td>
<td>4.1%</td>
</tr>
<tr>
<td>Bread (Pepperidge Farm Sliders)</td>
<td>$3^{00}</td>
<td>$2^{99}</td>
<td>-0.3%</td>
</tr>
<tr>
<td>Noodles (No Yolks)</td>
<td>$2^{79}</td>
<td>$2^{79}</td>
<td>0.0%</td>
</tr>
<tr>
<td>Cereal (Natures Path Envirokidz)</td>
<td>$4^{99}</td>
<td>$5^{39}</td>
<td>8.0%</td>
</tr>
<tr>
<td>Soda (Dr Pepper)</td>
<td>$1^{79}</td>
<td>$1^{79}</td>
<td>0.0%</td>
</tr>
<tr>
<td>Body Wash (Dial Spring Water)</td>
<td>$6^{09}</td>
<td>$6^{09}</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

**Average change:** 2.0%
Products (-2% | -1%), U.S.

Note: ES test p-value: <0.01
Products (0% | 1%), U.S.

Note: ES test p-value: <0.01
Products (2% | 3%), U.S.
Products (4% | 5%), U.S.
Products (6% | 7%), U.S.
Comparing learning rates:

- United States: 0.84 from statistics, 0.70 from supermarket prices.
- Argentina: 0.43 from statistics, 0.46 from supermarket prices.

Learning rates 55%-95% larger in United States.

Suggest that rational inattention is important.
Provide two sources of information simultaneously:

- Inflation statistics (e.g., CPI).
- Consumer experience (e.g., few familiar supermarket prices).

Rational learning hypothesis: conditional on statistics, consumer experience should not matter.
Statistics (1.5%) + Products (-2% | -1%), U.S.
Statistics (1.5%) + Products (0% | 1%), U.S.
Statistics (1.5%) + Products (2% | 3%), U.S.
Statistics (1.5%) + Products (4% | 5%), U.S.

Inflation Expectations

Note: ES test p-value: <0.01
Statistics (1.5%) + Products (6% | 7%), U.S.

Note: ES test p-value: <0.01
Please consider the following prices of a hypothetical product at two different moments.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Price on January 1st 2013:</td>
<td>$10.99</td>
</tr>
</tbody>
</table>

What is the approximate price change for this product over this period? Please do not use a calculator, pen, or pencil to calculate the exact figure. We want your best guess from eyeballing these prices.

- About 1%
- About 5%
- About 10%
- About 100%
Hypothetical (10%), U.S.

Note: ES test p-value: <0.01
Robustness Check: Spurious Learning

- Spurious learning explains around 50% of the reaction.
- However, qualitative evidence (rational inattention and irrational learning) is robust.
Evidence that individuals give too much weight to supermarket prices.

However:

- Does it mean that individuals would use their own price memories?
- How misleading can those memories be?
A Consumer Intercept Survey

- Collected data on:
  - Items purchased from supermarket receipt.
  - Actual historical prices for those same items.
  - Remembered prices.
  - Expected/perceived inflation.

- Randomize set of products for price-elicitation exercise.
  - Generate experimental variation in salience of price memories.
Price Memories Matter

Note: ES test p-value: <0.01
Price Memories are Inaccurate
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Conclusions

- Evidence that two channels are important:
  - Rational inattention.
  - Irrational learning.
- Policy implication: Central Banks may want to invest in communication strategy.
- Ongoing work: study how these misperceptions influence economic behavior.