

Inflation Expectations, Learning and Supermarket Prices

Evidence from Field Experiments

Alberto Cavallo
MIT Sloan

Guillermo Cruces
CEDLAS-UNLP

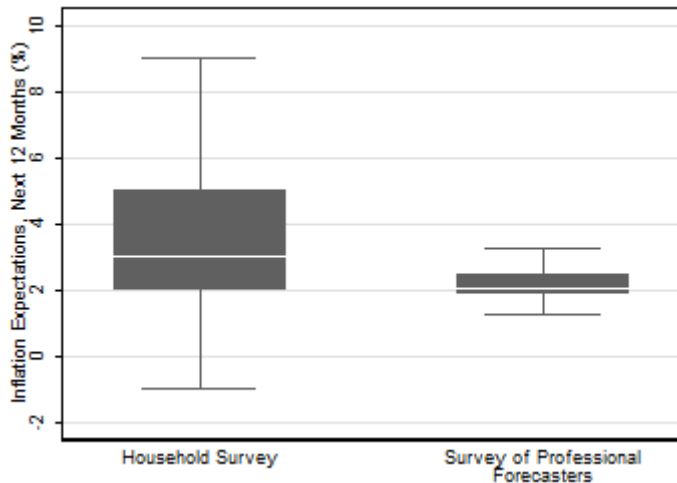
Ricardo Perez-Truglia
Microsoft Research

May 2016

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

- 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)



- 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.

- 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.

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

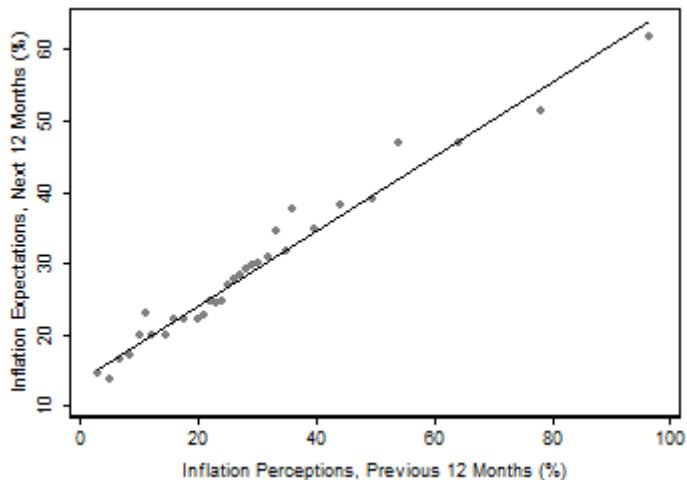
Expectations Equation

- 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

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

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

- α is a function of relative precision between prior and signal.

- Combine learning and expectation equations:

$$\pi_{i,t+1} = \gamma_0 + \underbrace{\gamma_1}_{\beta} \pi_{i,t}^0 + \underbrace{\gamma_2}_{\alpha \cdot \beta} (\pi_{i,t}^T - \pi_{i,t}^0)$$

- Can estimate α and β with this simple regression.

Disentangling Genuine and Spurious Learning

- Important concern is spurious learning.
 - E.g.: desirability bias of Goffman (1963), numerical anchoring of Tversky and Kahneman (1974).
- Strategy: define “true learning” as reactions that are “consistent.”
 - Over time.
 - Across beliefs.
- Boils down to estimating model with alternative dependent variables (e.g., $\pi_{i,t+1}^{\text{follow-up}}$, $i_{i,t}$).

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

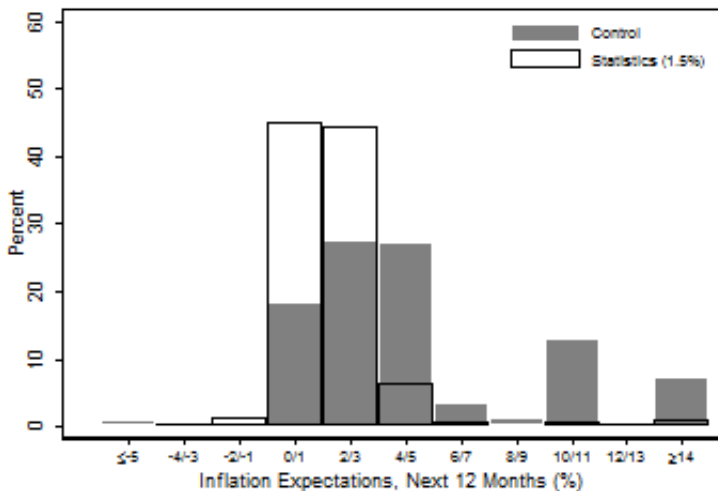
- Online experiment conducted in 2013.
- United States (inflation stable around 2%).
 - 3,945 individuals recruited from Amazon Mechanical Turk.
 - Inflation expectations similar to *Michigan Survey of Consumers*.
- Argentina (inflation stable around 25%).
 - 3,653 individuals recruited from regular online poll.
 - Inflation expectations similar to (equivalent of) *Michigan Survey of Consumers*.

Treatment Arm: Statistics (1.5%), U.S.

Official Statistic	Average Annual Change in Prices
Consumer Price Index ¹	2.0%
Personal Consumption Expenditures Price Index ²	1.1%
Gross Domestic Product Deflator ³	1.5%
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.”

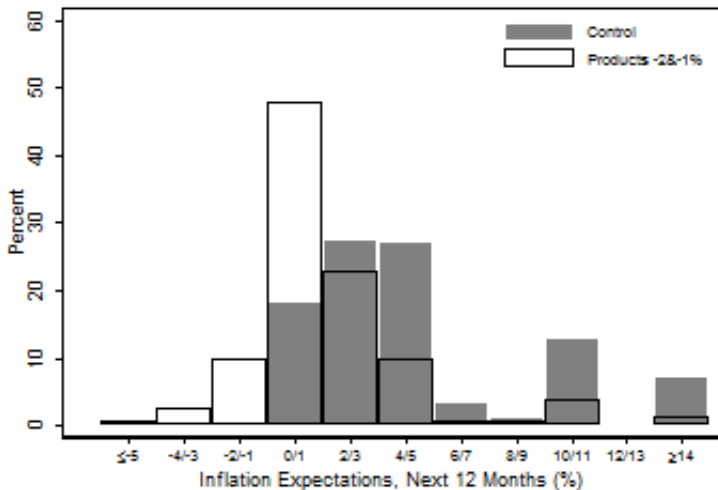
Products (-2%), U.S.

Product	Price on August 1, 2012	Price on August 1, 2013	Price change in %
Infant Formula (Enfamil Gentlease)	\$18 ⁶⁹	\$18 ⁶⁹	0.0%
Bread (Anzio & Sons Sub Rolls)	\$3 ⁵⁹	\$3 ⁵⁹	0.0%
Pasta Sauce (Barilla Marinara)	\$2 ⁷⁹	\$2 ⁸⁰	0.4%
Cereal (Cheerios Honey Nut)	\$5 ²⁹	\$4 ⁹⁹	-5.7%
Soda (Schweppes Ginger Ale)	\$1 ⁷⁹	\$1 ⁶⁷	-6.7%
Body Wash (Dial Spring Water)	\$6 ⁰⁹	\$6 ⁰⁹	0.0%
Average change:			-2.0%

Products (2%), U.S.

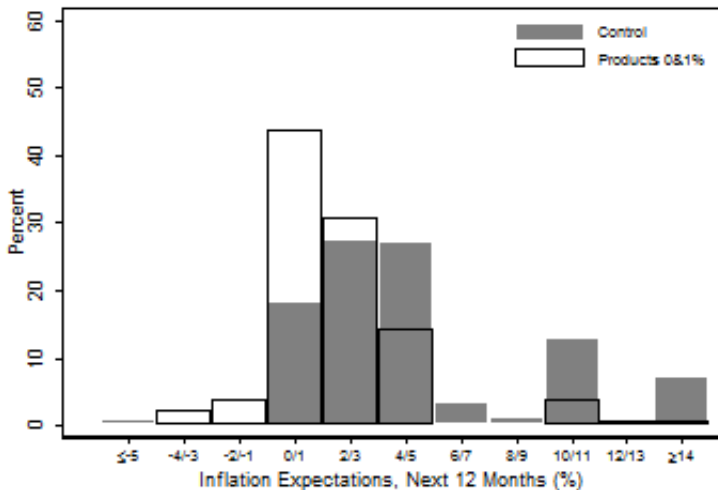
Product	Price on August 1, 2012	Price on August 1, 2013	Price change in %
Infant Formula (Similac with Iron)	\$7 ²⁹	\$7 ⁵⁹	4.1%
Bread (Pepperidge Farm Sliders)	\$3 ⁰⁰	\$2 ⁹⁹	-0.3%
Noodles (No Yolks)	\$2 ⁷⁹	\$2 ⁷⁹	0.0%
Cereal (Natures Path Envirokidz)	\$4 ⁹⁹	\$5 ³⁹	8.0%
Soda (Dr Pepper)	\$1 ⁷⁹	\$1 ⁷⁹	0.0%
Body Wash (Dial Spring Water)	\$6 ⁰⁹	\$6 ⁰⁹	0.0%
Average change:			2.0%

Products (-2% | -1%), U.S.



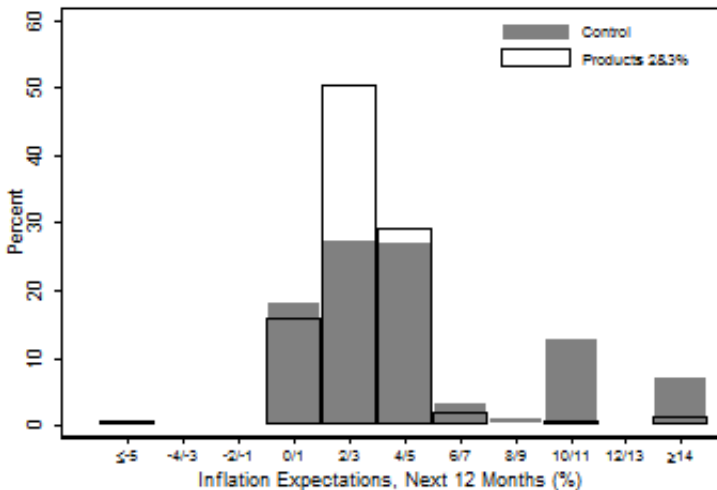
Note: ES test p-value: <math>< 0.01</math>

Products (0% | 1%), U.S.



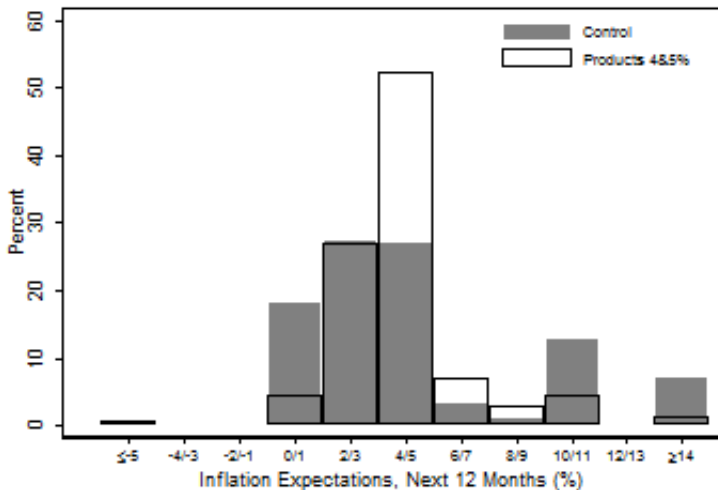
Note: ES test p-value: <math>< 0.01</math>

Products (2% | 3%), U.S.



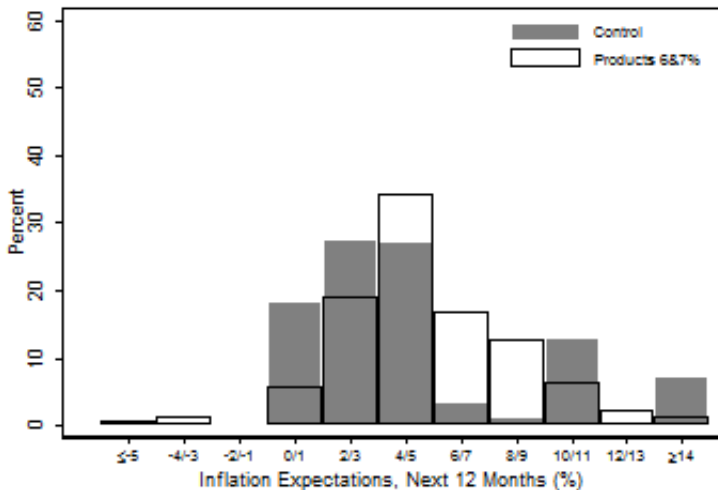
Note: ES test p-value: <0.01

Products (4% | 5%), U.S.



Note: ES test p-value: <0.01

Products (6% | 7%), U.S.



Note: ES test p-value: <0.01

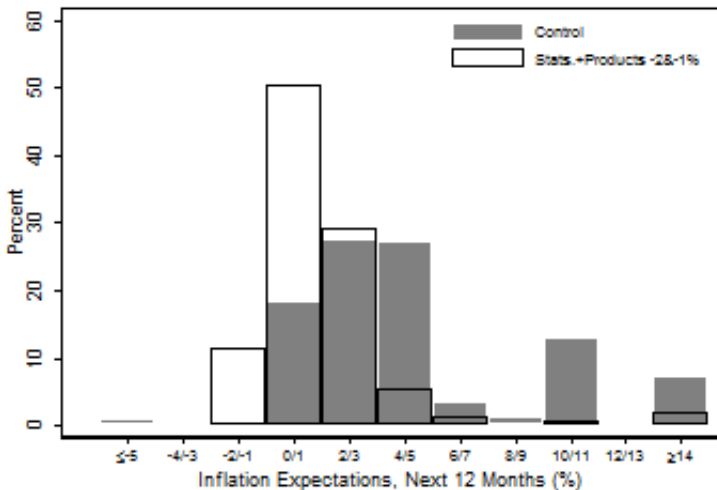
First Test: Rational Inattention

- 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.

Second Test: Irrational Learning

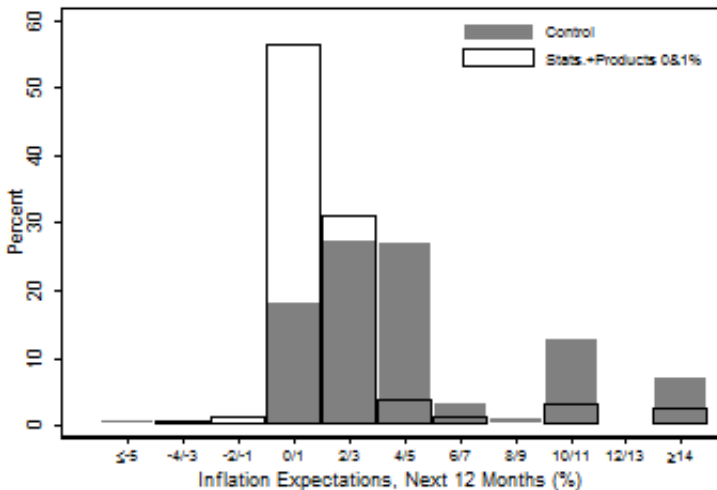
- Provide two sources of information simultaneously:
 - Inflation statistics (e.g., CPI).
 - Consumer experience (e.g., few familiar supermarket prices).
- Rational learning hypothesis: conditional on statistics, consumer experience should not matter.

Statistics (1.5%) + Products (-2% | -1%), U.S.



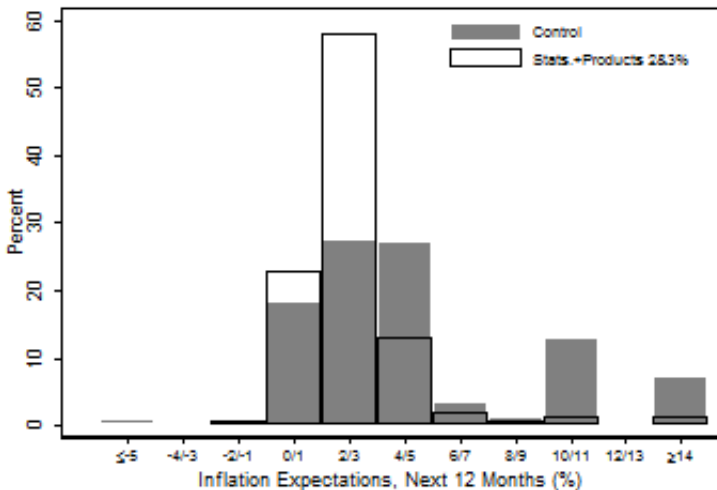
Note: ES test p-value: <math>< 0.01</math>

Statistics (1.5%) + Products (0% | 1%), U.S.



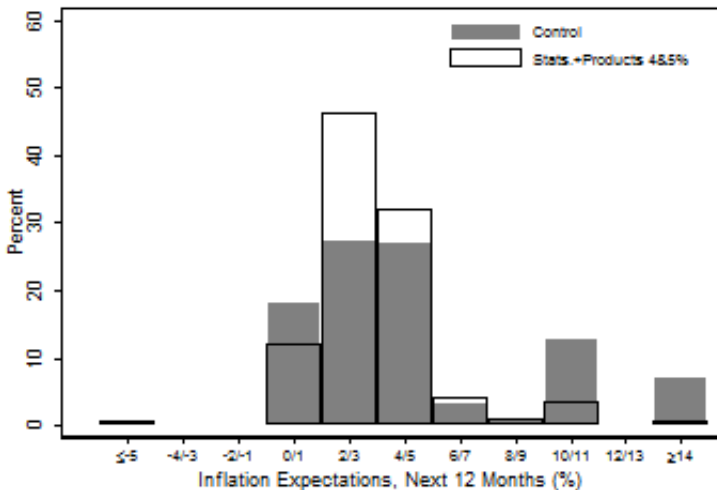
Note: ES test p-value: <0.01

Statistics (1.5%) + Products (2% | 3%), U.S.



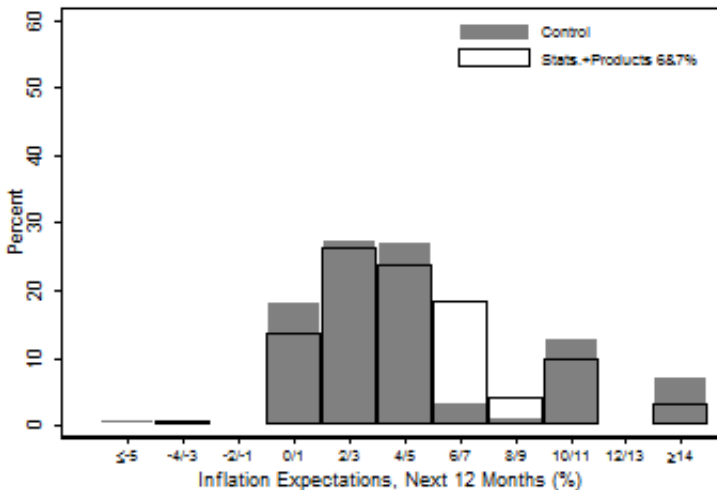
Note: ES test p-value: <math>< 0.01</math>

Statistics (1.5%) + Products (4% | 5%), U.S.



Note: ES test p-value: < 0.01

Statistics (1.5%) + Products (6% | 7%), U.S.



Note: ES test p-value: <math><0.01</math>

Spurious Learning: Hypothetical (10%), U.S.

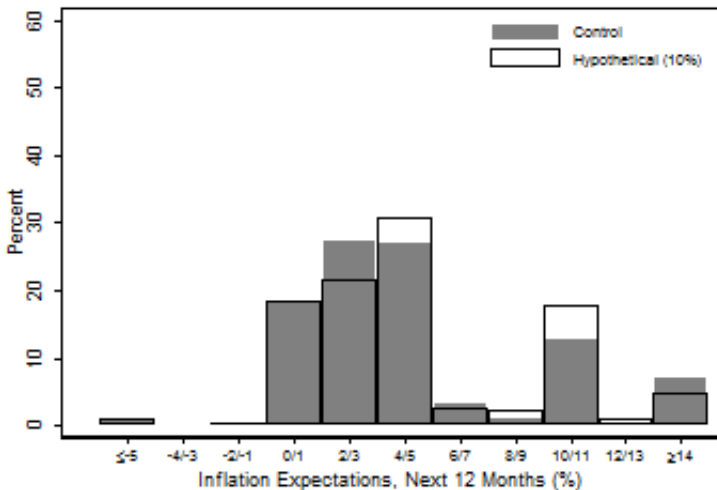
Please consider the following prices of a hypothetical product at two different moments.

Price on January 1st 2012:	\$9.99
Price on January 1st 2013:	\$10.99

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.

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

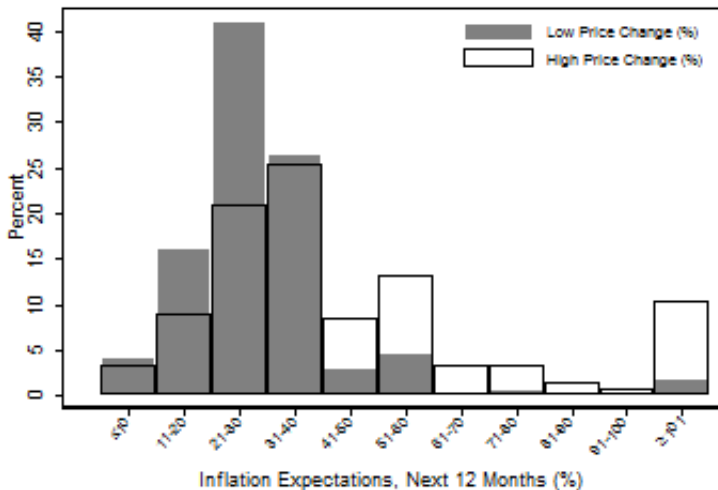
Remaining Hypotheses

- 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

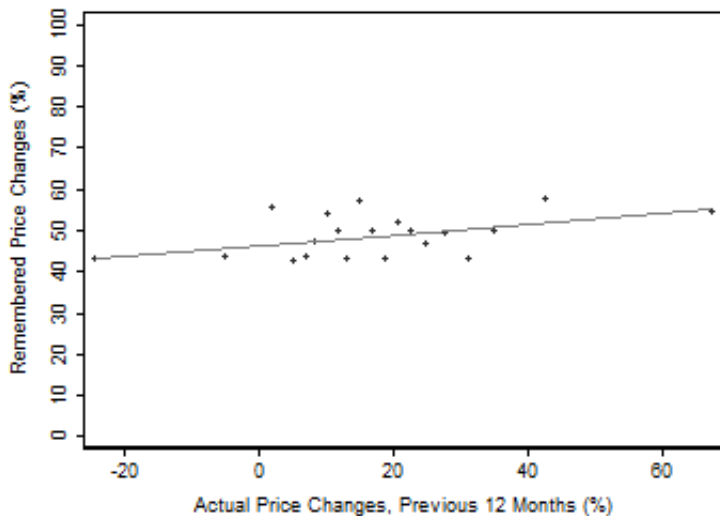
- Collected data on:
 - Items purchased from supermarket receipt.
 - Actual historical prices for those same items.
 - Remembered prices.
 - Expectedated/perceived inflation.
- Randomize set of products for price-elicitation exercise.
 - Generate experimental variation in salience of price memories.

Price Memories Matter



Note: ES test p-value: <0.01

Price Memories are Inaccurate



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