

**INFLATION EXPECTATIONS, LEARNING,  
AND SUPERMARKET PRICES:**

***EVIDENCE FROM FIELD EXPERIMENTS***

Cavallo, A., G. Cruces, and R. Perez-Truglia

# Outline

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- Introduction
- Experimental Design
- Result and Interpretation
- The Supermarket Experiment
- Conclusion



# Introduction



# Introduction

- How household inflation expectation are formed or can be affected?
- This series of online and offline survey:
  - ▣ To assess the role of rational inattention
    - Low-inflation context and High-inflation context
    - Also, Inflation Statistic or Price Change?
  - ▣ To assess the role of personal consumer experience (apart from rational inattention)
    - even it is biased
- The experiment subjects mainly to spurious problem



# Experimental Design

# Estimating Learning Rates - Model

- Future Inflation Expectation follows AR(1) process with a linear specification:

$$\pi_{i,t+1} = f(\pi_{i,t}) \longrightarrow \pi_{i,t+1} = \mu + \beta\pi_{i,t}$$

- And the point is to establish:

$$\pi_{i,t} = g(\pi_{i,t}^0, \pi_{i,t}^T)$$

- Assume a Bayesian Learning Model and Gaussian distribution:

$$\pi_{i,t} = \frac{\left(\frac{1}{\sigma_{i,t}^0}\right)^2}{\left(\frac{1}{\sigma_{i,t}^0}\right)^2 + \left(\frac{1}{\sigma_{i,t}^T}\right)^2} \pi_{i,t}^0 + \frac{\left(\frac{1}{\sigma_{i,t}^T}\right)^2}{\left(\frac{1}{\sigma_{i,t}^0}\right)^2 + \left(\frac{1}{\sigma_{i,t}^T}\right)^2} \pi_{i,t}^T, \quad \sigma_{i,t} = \sqrt{\frac{(\sigma_{i,t}^0 \cdot \sigma_{i,t}^T)^2}{(\sigma_{i,t}^0)^2 + (\sigma_{i,t}^T)^2}}$$

# Estimating Learning Rates - Model

- Then, we have:

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

- So forward-looking equation will be:

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

- Run above empirical model to obtain  $\hat{\alpha}$  and  $\hat{\beta}$

# Estimating Learning Rates - Model

- To disentangle the genuine learning rate from spurious learning:
  - They further conduct:

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

- Preferred method – salient effect removed as well

- And also:

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

# Structure of the Survey

1. Eliciting subjects' inflation perceptions: i.e., the perception of the annual inflation rate over the previous twelve months. This constitutes the individual's prior belief ( $\pi_{i,t}^0$  in the model in the following section).
2. Providing the subject with information related to the inflation rate over the previous twelve months, which constitutes the signal ( $\pi_{i,t}^T$ ). In the case of the control group with no information provision, there is no signal. Some of the treatments provided information on average price changes from one or more sources, such as recent official inflation statistics or a table with the historical prices of specific products.
3. Eliciting subjects' expectations about inflation (i.e., the expected annual inflation rate over the following twelve months,  $\pi_{i,t+1}$ ) and other nominal variables (e.g., the nominal interest rate,  $i_{i,t+1}$ ).

# Treatment Arms

- Control Group
- Statistic (1.5%) treatment arm
- Product treatment arm (include sub-treatment of product price change range from -2 to 7%)
- Statistic (1.5%) + Product treatment arm
- Hypothesis treatment arm

Figure 1: Example of *Products* (various levels), *Statistics* (1.5%) and *Hypothetical* (10%) Treatments, U.S. Online Experiment

a) *Products* (-2%)

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

b) *Products* (2%)

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

c) *Statistics* (1.5%)

Official Statistic	Average Annual Change in Prices
Consumer Price Index <sup>1</sup>	2.0%
Personal Consumption Expenditures Price Index <sup>2</sup>	1.1%
Gross Domestic Product Deflator <sup>3</sup>	1.5%
<b>Average of the three statistics:</b>	<b>1.5%</b>

Sources: 1 Bureau of Labor Statistics, 2 and 3: Bureau of Economic Analysis.

d) *Hypothetical* (10%)

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%

Notes: The *Products* treatment arm consisted of 10 tables similar to those presented here in panels (a) and (b). The average price changes in these tables ranged from -2% to 7% in 1 percentage point increments. The prices were obtained from scrapped online supermarket prices from one of the largest supermarket chains in the United States.

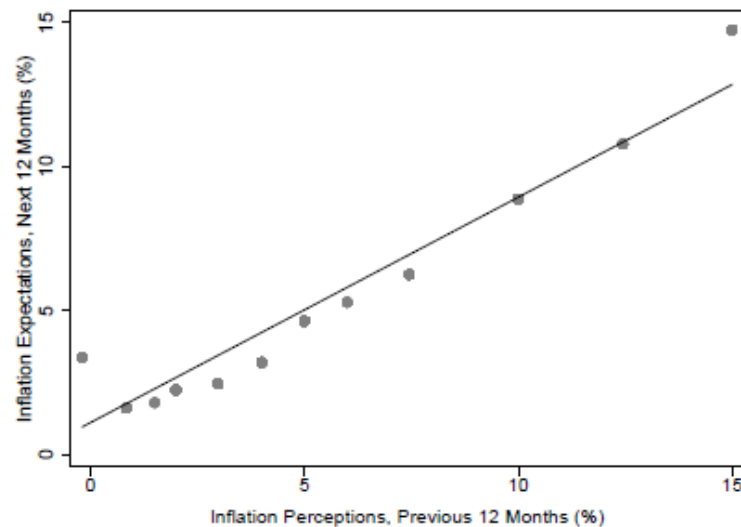
# Result and Interpretation

- **USA**  
(Inflation rate was 1.8% on five-year average)
- **Argentina**  
(Inflation rate was 22.5% on five-year average)

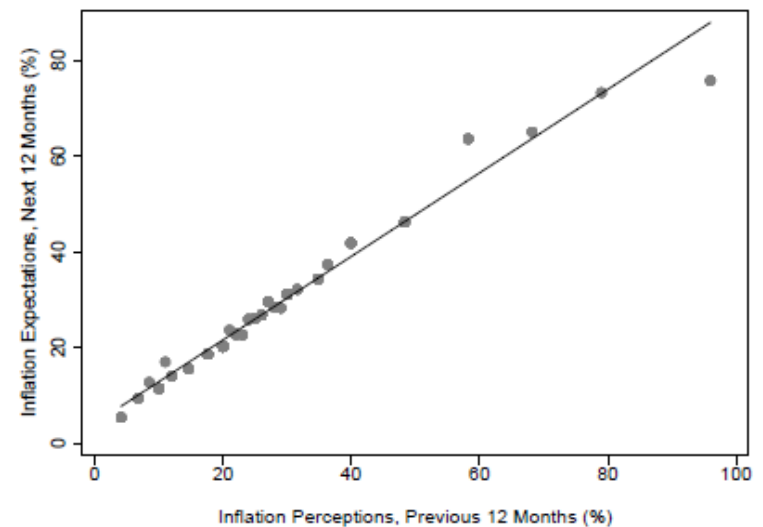
# Result from Online Experiment - US

Figure 2: Past Inflation Perceptions and Future Inflation Expectations, Individuals in the *Control* group, U.S. and Argentina Online Experiments

a) U.S.



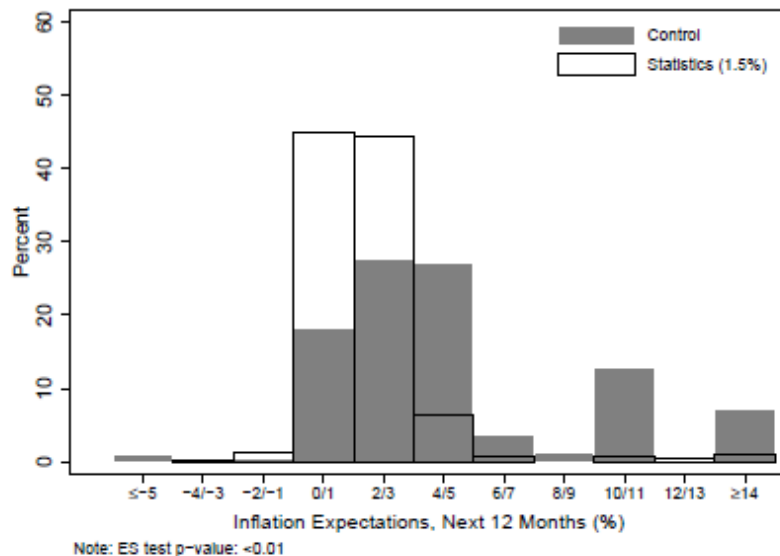
b) Argentina



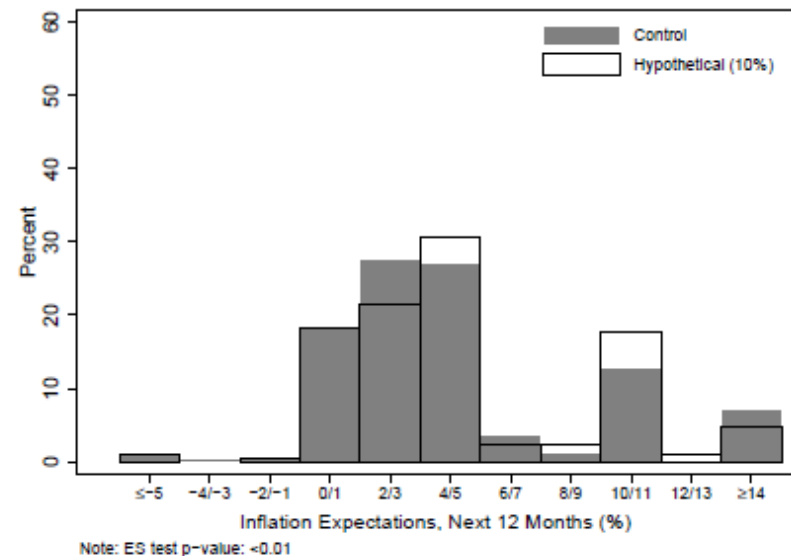
# Result from Online Experiment - US

Figure 3: Inflation Expectations by Informational Treatments, U.S. Online Experiment

a) *Control and Statistics (1.5%)*



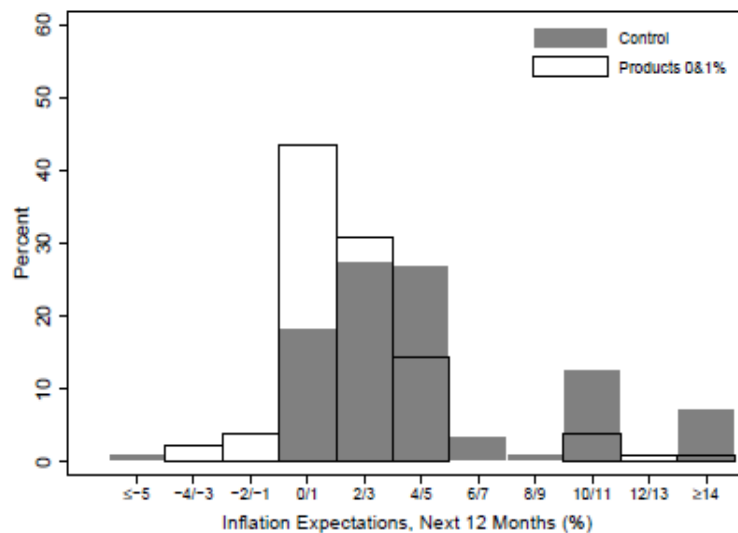
b) *Control and Hypothetical (10%)*



# Result from Online Experiment - US

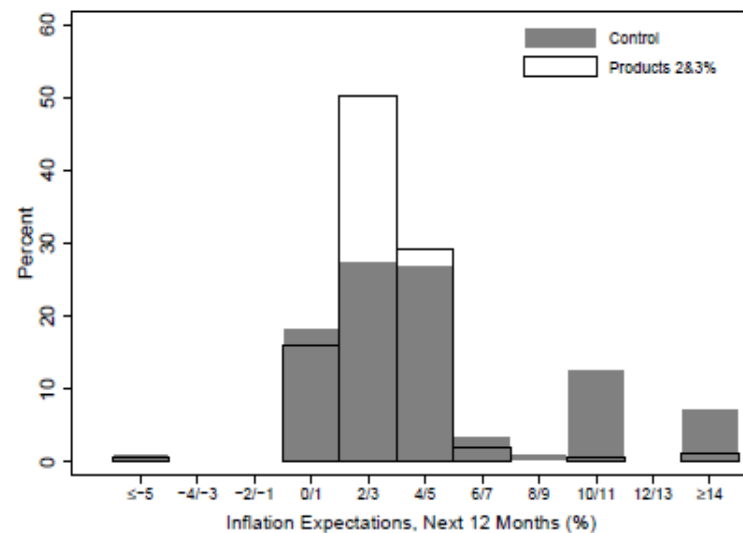
Figure 3: Inflation Expectations by Informational Treatments, U.S. Online Experiment

c) Control and Products (0&1%)



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

d) Control and Products (2&3%)

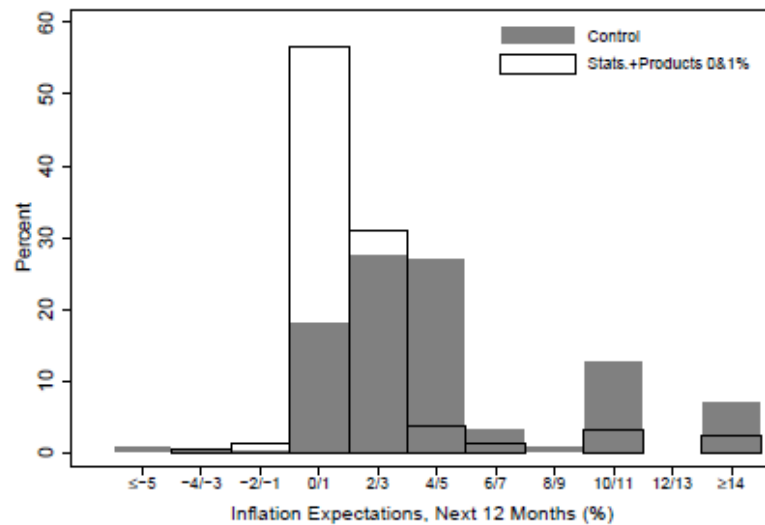


Note: ES test p-value: <math>< 0.01</math>

# Result from Online Experiment - US

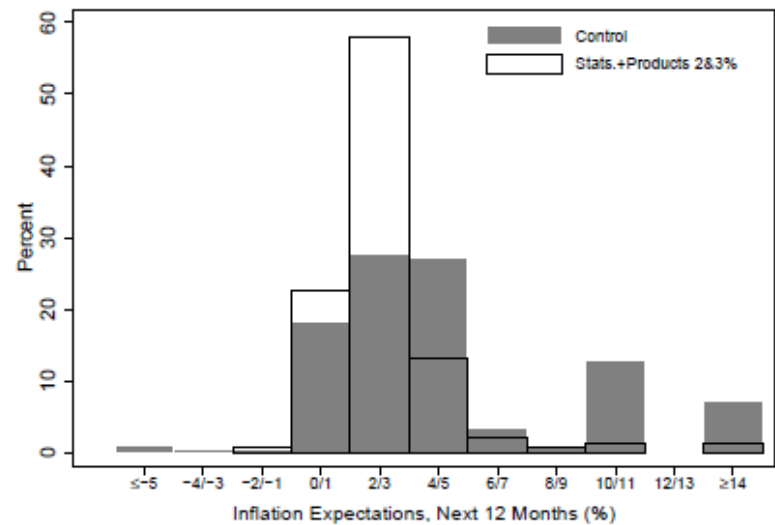
Figure 3: Inflation Expectations by Informational Treatments, U.S. Online Experiment

e) Control and Statistics (1.5%)+Products (0&1%)



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

f) Control and Statistics (1.5%)+Products (2&3%)

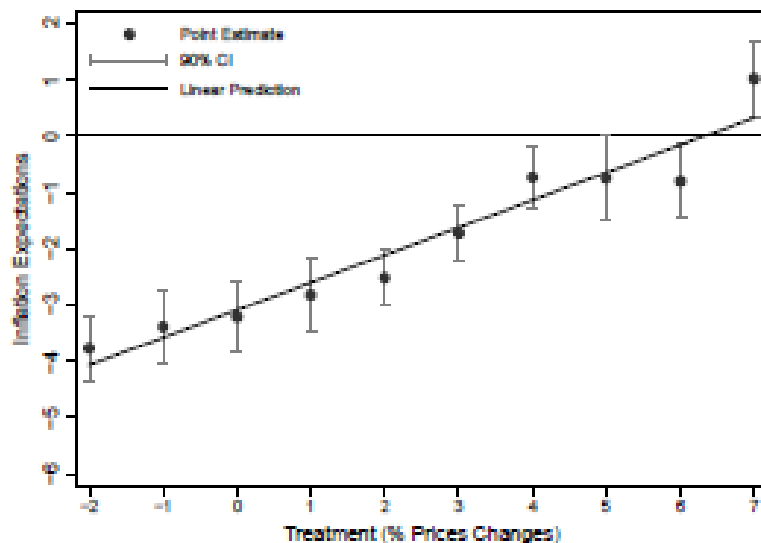


Note: ES test p-value: <math>< 0.01</math>

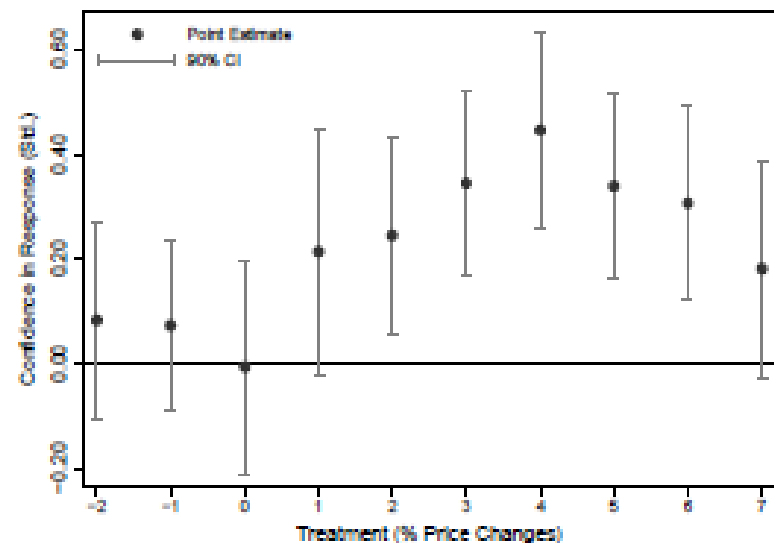
# Result from Online Experiment - US

Figure 4: Treatment Effects on Inflation Expectations and Confidence about Own Expectations by Levels of *Products* Treatment, U.S. Online Experiment

a) Effect on inflation expectations



b) Effect on confidence



# Result from Online Experiment - US

Table 1: Learning Model: Weight Given to the Information Provided in the Experiment Relative to Prior Beliefs ( $\alpha$ ), U.S. Online Experiment

	(1)	(2)	(3)	(4)	(5)
	$\pi_{i,t+1}$	$\pi_{i,t+1}$	$\pi_{i,t+1}$	$\pi_{i,t+1}^{follow-up}$	$i_{i,t+1}$
$\beta$	0.757*** (0.033)	0.817*** (0.058)	0.814*** (0.046)	0.438*** (0.055)	0.291*** (0.040)
<i>Statistics</i>					
$\alpha$	0.838*** (0.034)	0.283*** (0.063)	0.799*** (0.058)	0.360*** (0.138)	0.314 (0.212)
<i>Products</i>					
$\alpha$	0.689*** (0.036)	0.449*** (0.050)	0.697*** (0.045)	0.336** (0.150)	0.499*** (0.135)
<i>Hypothetical</i>					
$\alpha$	0.232*** (0.027)		0.215*** (0.046)	-0.021 (0.092)	0.131 (0.112)
Observations	3,141	1,587	1,073	1,073	3,141
Simultaneous treatments	No	Yes	No	No	No

# Result from Online Experiment - US

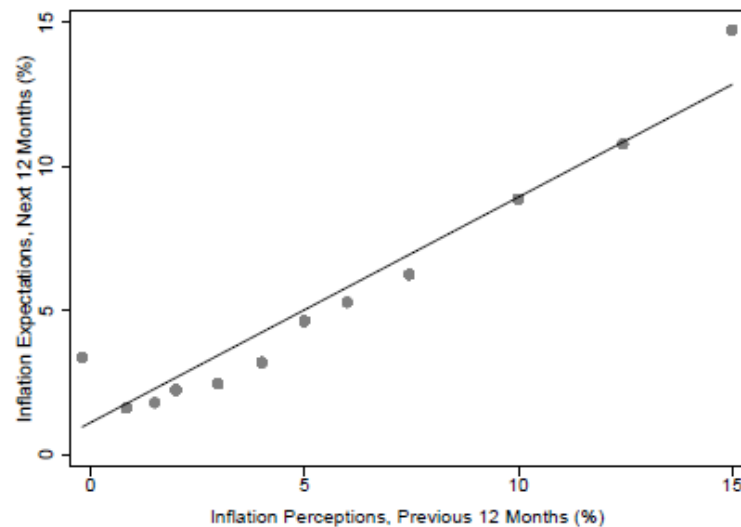
Table 2: Learning Model: Weight Given to the Information Provided in the Experiment Relative to Prior Beliefs ( $\alpha$ ), Robustness Checks, *Statistics* (1.5%) and *Products* Treatments, U.S. Online Experiment

Treatment:	<i>Statistics</i>		<i>Products</i>	
	(1)	(2)	(3)	(4)
	$\pi_{i,t+1}$	$\pi_{i,t+1}$	$\pi_{i,t+1}$	$\pi_{i,t+1}$
$\beta$	0.827*** (0.057)	0.822*** (0.059)	0.778*** (0.051)	0.775*** (0.051)
$\alpha$	0.918*** (0.049)		0.690*** (0.042)	
$\alpha^2$	0.007 (0.007)		-0.003 (0.005)	
$\alpha_+$		0.632*** (0.108)		0.606*** (0.078)
$\alpha_-$		0.859*** (0.037)		0.736*** (0.046)
Observations	1,590	1,590	1,546	1,546

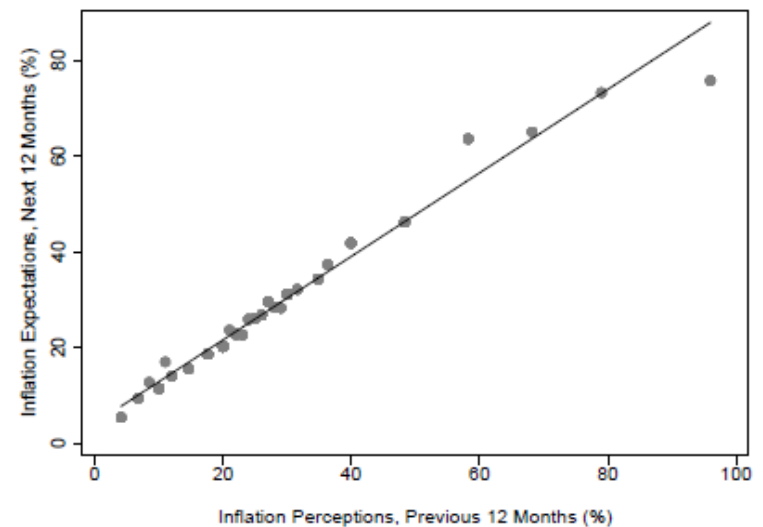
# Result from Online Experiment - Argentina

Figure 2: Past Inflation Perceptions and Future Inflation Expectations, Individuals in the *Control* group, U.S. and Argentina Online Experiments

a) U.S.



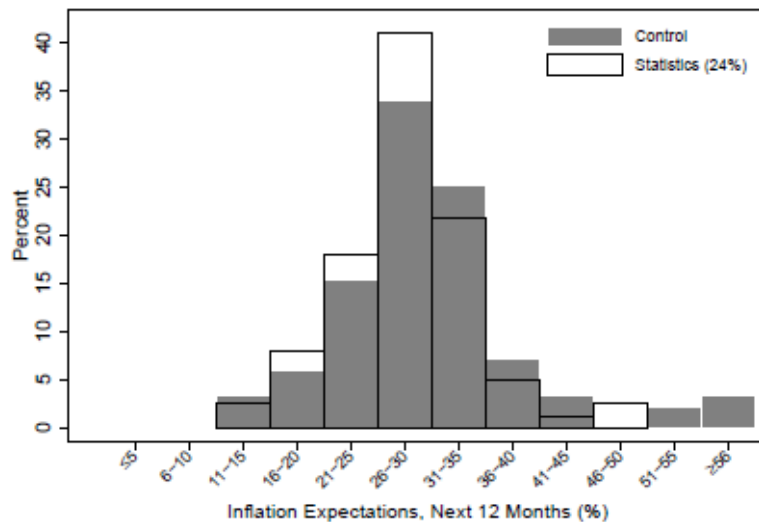
b) Argentina



# Result from Online Experiment - Argentina

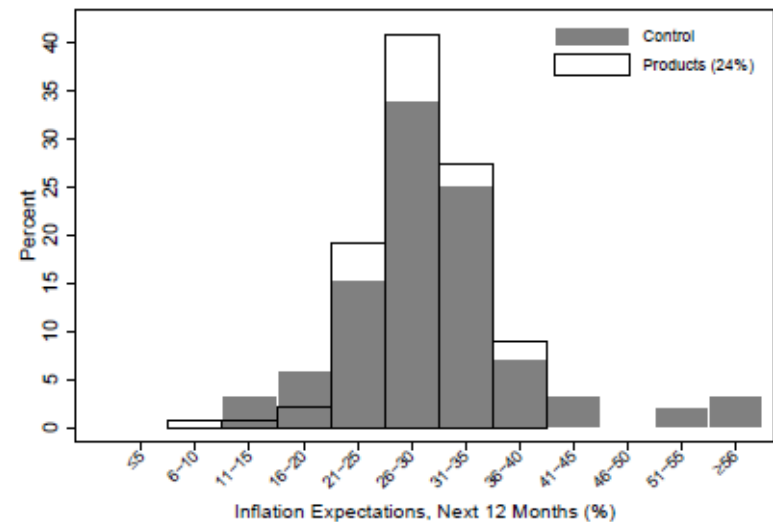
Figure 5: Inflation Expectations by Informational Treatments, Argentina Online Experiment

a) *Control and Statistics (24%), sample I*



Note: ES test p-value: 0.09

b) *Control and Products (24%), sample I*

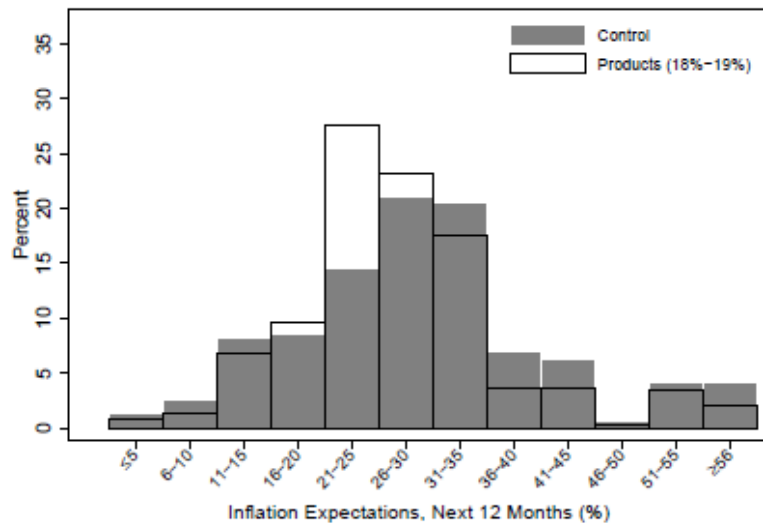


Note: ES test p-value: <0.01

# Result from Online Experiment - Argentina

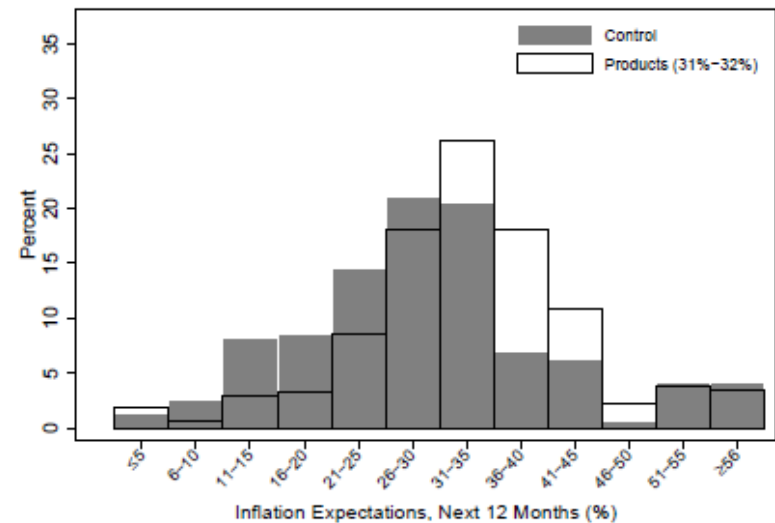
Figure 5: Inflation Expectations by Informational Treatments, Argentina Online Experiment

c) Control and Products (18&19%), sample II



Note: ES test p-value: <0.01

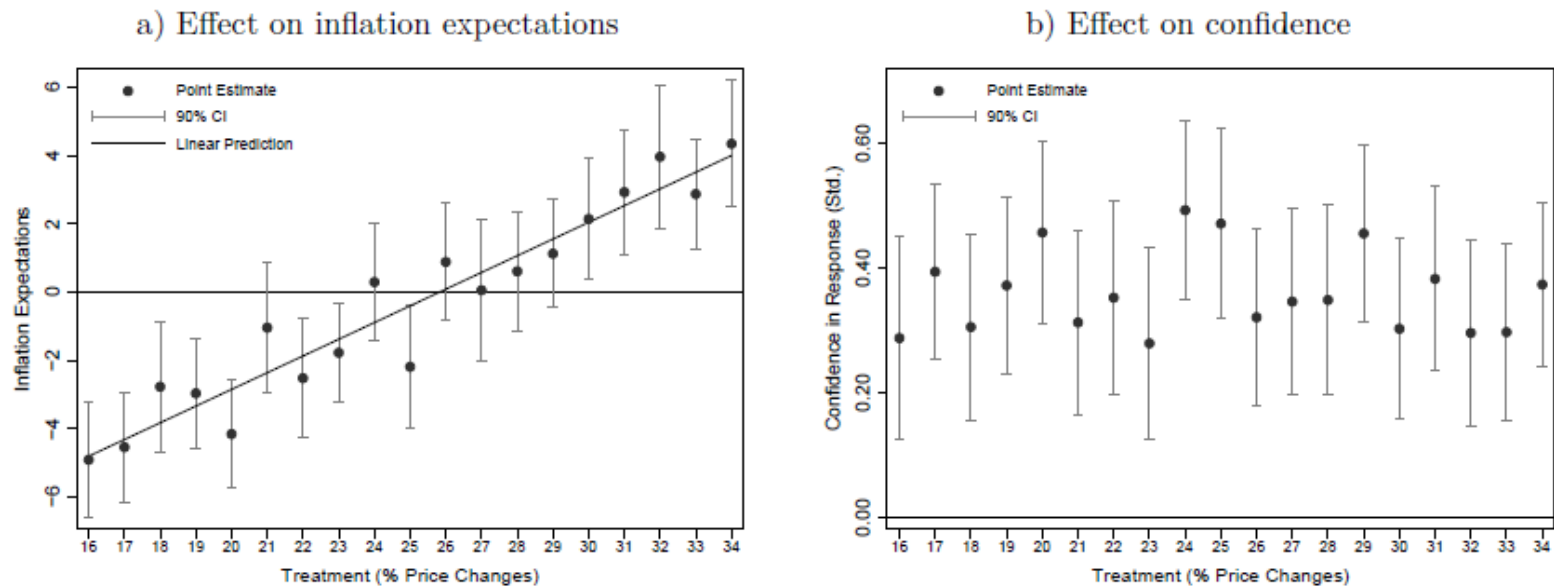
d) Control and Products (31&32%), sample II



Note: ES test p-value: <0.01

# Result from Online Experiment - Argentina

Figure 6: Treatment Effects on Inflation Expectations and Confidence about Own Expectations by Levels of *Products* Treatment, Argentina Online Experiment, Opinion Poll Sample



# Result from Online Experiment - Argentina

Table 3: Learning Model: Weight Given to the Information Provided in the Experiment Relative to Prior Beliefs ( $\alpha$ ), Argentina Online Experiment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$\pi_{i,t+1}$	$\pi_{i,t+1}$	$\pi_{i,t+1}$	$\pi_{i,t+1}$	$\pi_{i,t+1}$	$\pi_{i,t+1}^{follow-up}$	$i_{i,t+1}$	$\log(e_{i,t+1})$
$\beta$	1.138*** (0.118)	0.902*** (0.042)	0.909*** (0.043)	0.902*** (0.042)	0.963*** (0.041)	0.754*** (0.086)	0.155*** (0.035)	0.328*** (0.088)
<i>Statistics</i>								
$\alpha$	0.432*** (0.098)							
<i>Products</i>								
$\alpha$	0.458*** (0.062)	0.494*** (0.027)	0.472*** (0.025)		0.456*** (0.037)	0.208** (0.094)	0.468*** (0.133)	0.435** (0.173)
$\alpha^2$			-0.001 (0.001)					
$\alpha_+$				0.484*** (0.040)				
$\alpha_-$				0.497*** (0.037)				
Observations	691	3,653	3,653	3,653	1,320	1,320	3,373	1,660
Sample	I	II	II	II	II	II	II	II



# Further Experiment

## The Supermarket Experiment

# The Supermarket Experiment

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- Does individual really use price memories in forming inflation expectation? (even they know it could be biased)

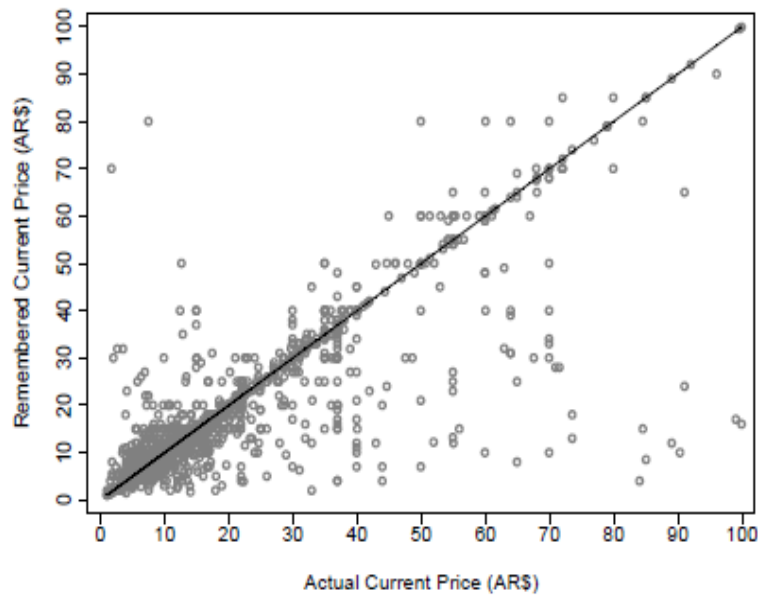
# Experimental Design

- First Information Treatment
  - ▣ Pick 4 items (include salient product) that relevant to subject
  - ▣ For 2 items, ask for its current price and past price (12 months earlier)
  - ▣ Other 2 items, tell subject the current price and ask them to recall the past price
- Second information treatment
  - ▣ Identical to online experiment

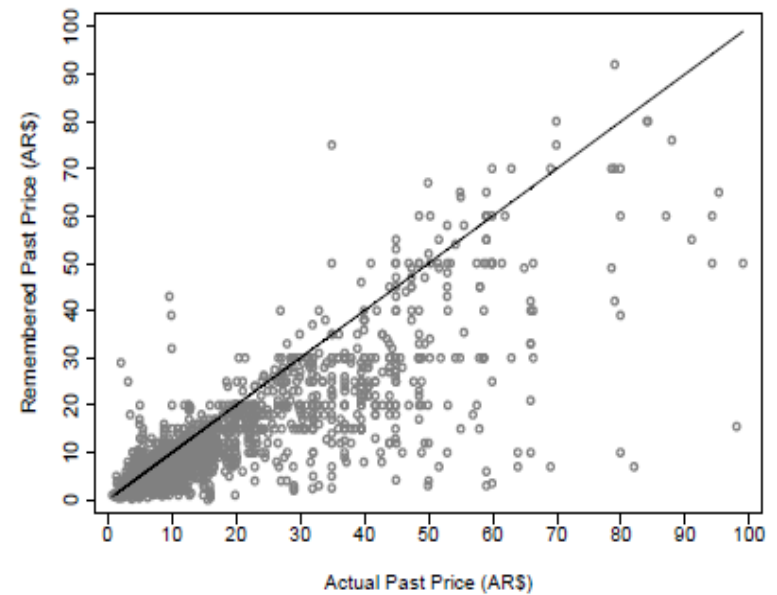
# Result from the Supermarket Experiment

Figure 7: Remembered and Actual Past Prices, Implicit Price Changes and Inflation Expectations, Supermarket Experiment, Argentina

a) Current prices (in Pesos): Actual and remembered



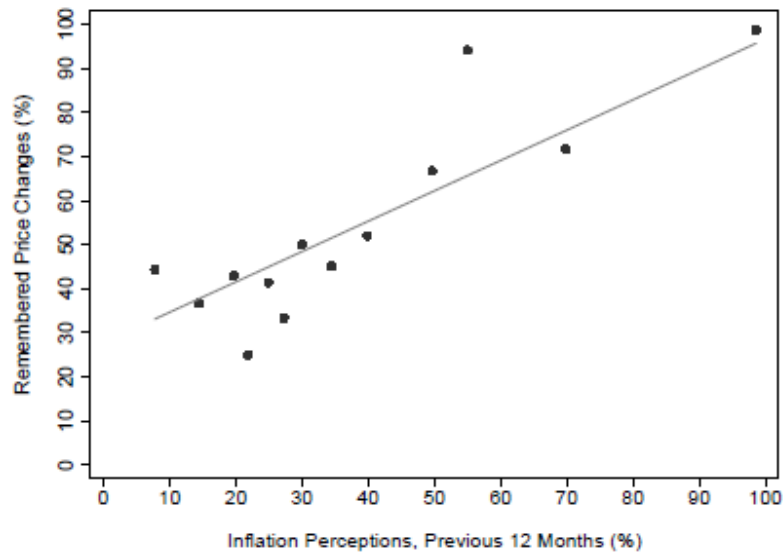
b) Past prices (in Pesos): Actual and remembered



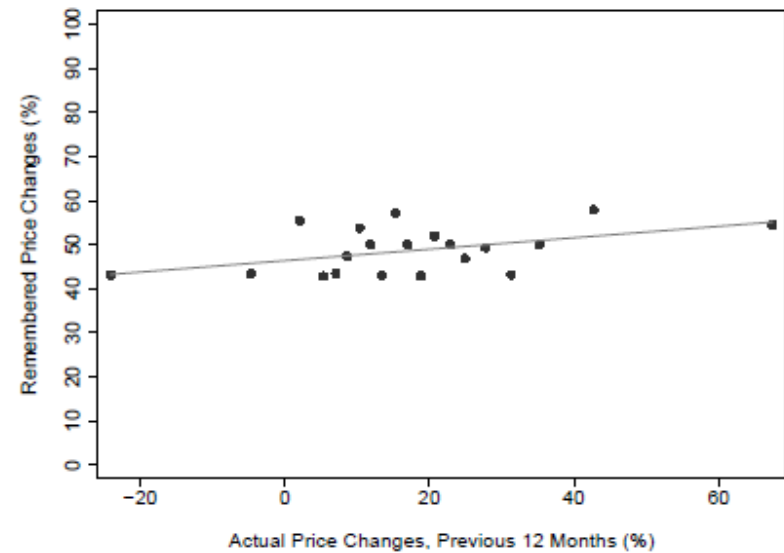
# Result from the Supermarket Experiment

Figure 7: Remembered and Actual Past Prices, Implicit Price Changes and Inflation Expectations, Supermarket Experiment, Argentina

c) Remembered annual price changes (%) and inflation perceptions



d) Annual price changes (%): Actual and remembered



# Result from the Supermarket Experiment

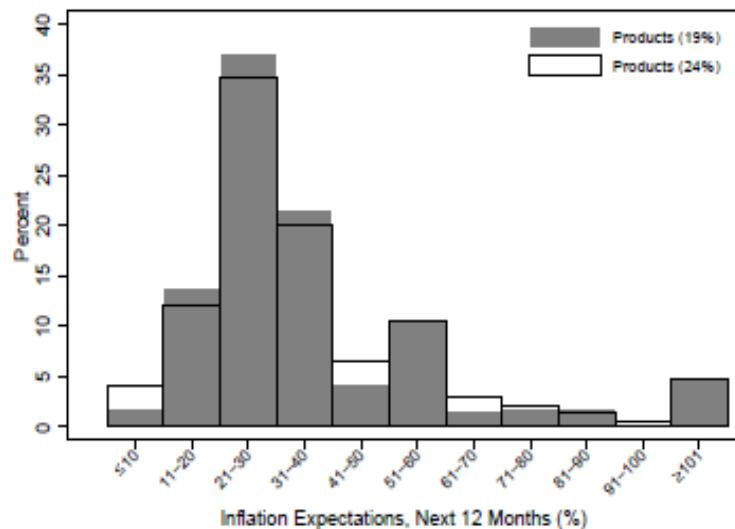
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- Interestingly, most of the subject are really confidence about their answer to question about the prices and inflation
- For the bundle of goods, same result

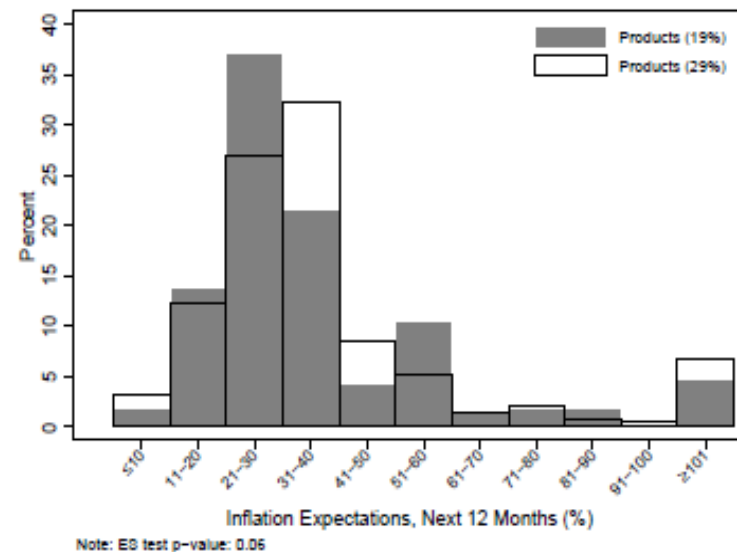
# Result from the Supermarket Experiment

Figure 8: Inflation Expectations by *Product* Treatment Levels and by Remembered and Actual Price Changes, Supermarket Experiment, Argentina

a) *Products (19%) and (24%)*

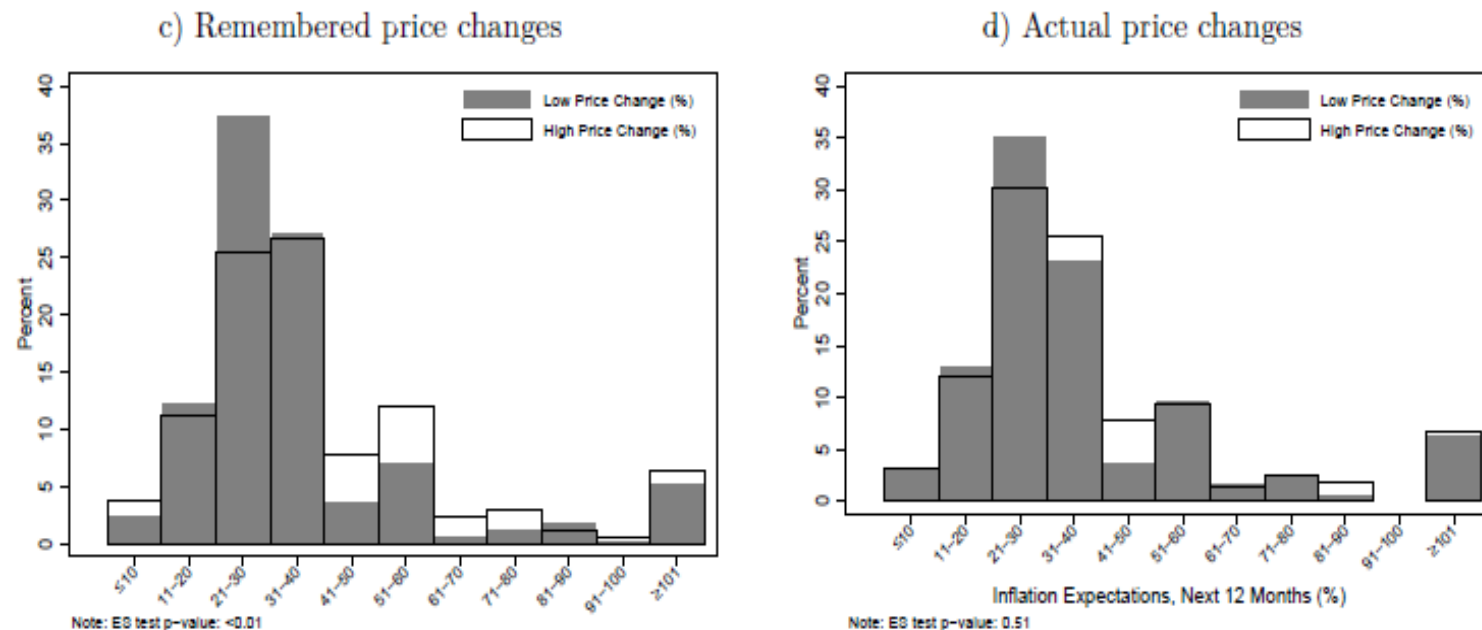


b) *Products (19%) and (29%)*



# Result from the Supermarket Experiment

Figure 8: Inflation Expectations by *Product* Treatment Levels and by Remembered and Actual Price Changes, Supermarket Experiment, Argentina





# Conclusion



# Conclusion

- Subjects are highly influenced by given inflation information in forming inflation expectation
- Rational Inattention – US vs Argentina
  - ▣ Also, easy to understand data
- Personal Consumer Experience
  - ▣ Even it is biased, consumer still use their memories about price change.
- Spurious Learning
- Efficiency of Monetary Policy



# Q&A