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Experimental analysis of survey-based inflation measures and dynamic financial education

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Abstract

We conduct an online experiment to assess the validity of the survey-based methods used by central banks and in macroeconomic research to measure inflation perceptions and expectations as well as test dynamic financial education interventions to improve household consumers' decision-making in inflationary conditions. Employing the intertemporal savings and consumption task known as the Savings Game (Lawrence et al., 2024), we test how well survey-based measures of inflation internalization (i.e. perceptions and expectations) correlate with and ultimately predict consumers' behavior when facing inflation. We also confirm the primary individual characteristics that relate to better adaptability and performance in the Savings Game. Further, considering the lack of impact generic financial education treatments have on subjects' in-task performance, we test how dynamic, personalized feedback and guidance impacts behavior. We find strong evidence confirming that survey methods provide valid measures, which indeed correlate with behavior (particularly qualitative internalizations); that subjects' numerical abilities, consistency of economic decision-making, and general adaptability are the primary individual-characteristic indicators of performance; and that treatments with dynamic, personalized feedback coupled with straightforward and actionable recommendations do improve subjects' decision-making and performance.

1. Introduction

With inflation a now resurgent issue in households' daily lives and decisions, understanding how rising prices and consumer behavior relate has become increasingly important. Over the last few decades, however, there has been limited research into both inflation—since it has been relatively absent from developed economies—as well as methods to help households better manage their finances when facing rising prices.

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Within the limited contemporary literature on inflation, the primary focus has been on the perceptions and expectations of inflation—*inflation internalization*. A small subset of the inflation literature has additionally investigated the relationship between household consumers' inflation internalization and their economic behavior. This research, however, primarily consists of macroeconomic analyses and, moreover, has found conflicting patterns (Gautier & Montornès, 2022). These inconsistent results may partly arise from comparisons across economies and time periods. But, in addition, this research typically uses survey methods, which can differ in methodologies, even simply in question wording, which presents another potentially confounding factor throughout the literature (Van Der Klaauw et al., 2008).

Households' inflation perceptions and expectations are difficult to measure by any means other than survey approaches (Gautier & Montornès, 2022). Being the case, though, comparing such perceptions and expectations to empirical economic behavior becomes difficult since most surveys cannot follow individual households for long, let alone consistently track their economic behavior. As a result, most analyses of the relationship between inflation internalization and consumer behavior rely on survey responses not only for perception and expectation data but for behavioral data as well. For instance, durables consumption is often measured simply through survey responses to having made any large purchases over the previous 12 months. This method poses significant data integrity challenges since the research ultimately relies on respondents accurately remembering a year's worth of consumption. Realistically speaking, though, there are few alternatives to effectively pair inflation estimations with economic behavior.

One such alternative is ad-hoc surveys that have been fielded, which match survey responses with corresponding micro-level data (D'Acunto et al., 2022). For example, the Chicago Booth Expectations and Attitudes Survey (CBEAS) and Chicago Booth Expectations and Communication Survey (CBECS) combine the Kilts-Nielsen Consumer Panel (KNCP), which captures non-durable consumption through scanner data, with broad surveys on economic choices and expectations (Coibion, Gorodnichenko, et al., 2021; D'Acunto et al., 2022). While such methods can provide micro-level data necessary to properly compare perceptions and real-life behavior, they are also highly resource intensive and therefore difficult to replicate. Further, they provide data only for a limited time period.

Another issue arising from the current approach is estimation precision and/or accuracy. Although ultimately necessary, relying on survey responses from households presents clear

problems when it comes to the reliability of their answers. Two of the most widely used surveys, the Michigan Survey of Consumers (MSC) and Federal Reserve Bank of New York Survey of Consumer Expectations (SCE), both present high frequencies around inflation estimates in multiples of five, suggesting a degree of uncertainty or at the very least imprecision in responses (Binder, 2017). Adding density forecast questions to surveys has offered one solution to this issue of response uncertainty, including in the SCE now (Binder, 2017; Bruine de Bruin et al., 2011); however, these exercises in probability estimation are far from intuitive for most people. Surprisingly, the measure that appears to most closely correlate with macroeconomic trends is qualitative responses, where participants simply say whether they think/expect prices have increased/will increase, as opposed to quantitative estimates (Andrade et al., 2023).

Finally, considering the negative impact inflation can have on households' economic well-being, developing methods to help consumers protect themselves against rising prices is imperative. And, this is an area where survey approaches have been particularly limited. There have been some attempts to include information interventions in surveys, which have demonstrated improvements (albeit short-lived) in perception and expectation accuracy (Armantier et al., 2016; Coibion, Georgarakos, et al., 2021; Coibion, Gorodnichenko, et al., 2021). But, assessing any intervention's impact on households' economic behavior falls generally outside the scope of surveys.

Taken together, there persist three challenges to a more holistically analyzing and understanding the relationship between inflation internalization and behavior:

1) connecting households' inflation perception, expectation, and uncertainty in survey-based data to their economic behavior;
2) unpacking the interplay of qualitative, quantitative, and uncertain responses in the survey data; and
3) developing and testing an effective intervention to improve consumers' resilience against inflation.

Experimental economic methods offer an effective solution. Through an experimental approach, we can overcome these three challenges through granular data that is easily comparable across the subject population, as it is collected in a controlled environment. This presents an opportunity to both study behavior and interventions more closely at the individual level as well as validate macroeconomic, large-scale survey-based results.

In Lawrence et al. (2024), we develop and test a novel intertemporal consumption simulation with changing inflationary conditions (the "Savings Game") to measure individuals' adaptability to inflation. We find that not only do subjects perform well below the maximum, but a significant portion of their underperformance results from their over-stocking in low-inflation and even stocking wastefully by purchasing more units of the good than necessary. Moreover, we find that:

- more accurate inflation perceptions and expectations correlate with better performance;
- subjects' who are numerate, capable of compound-interest calculation, and consistent in economic decision-making (i.e. few preference "switches") perform better; and
- a simple financial education intervention does not improve performance.

Ultimately, we find that subjects' in-task and real-life inflation perception and expectation capabilities are closely linked, suggesting that the Savings Game offers external validity. Building on the original experiment, our present study has two primary objectives. Our first objective is to better connect the behaviors we can measure in the Savings Game to the survey data normally collected in real-life. Our second is to identify a more effective intervention for improving the behavior of individuals facing inflation.

To better connect behavior and inflation internalization data, we simulate the survey method during the Savings Game by intermittently providing subjects with the inflation portion of a replica consumer survey questionnaire. The questionnaire is based off of France's Monthly consumer confidence survey (CAMME) for simple comparison to macroeconomic data and includes both qualitative and quantitative estimates. We then measure a proxy for estimation uncertainty by comparing the share of quantitative responses that are multiples of five (Binder, 2017; Gautier & Montornès, 2022; Reiche & Meyler, 2022). In general, this approach can allow us to:

- observe experimentally the relationships between inflation internalization (i.e. perception, expectation, and uncertainty) and consumption behavior and compare them to those observed macroeconomically as well as
- provide data on not only the self-reported consumption behaviors but on experimentally observed behavioral data too.

In our previous experiment, we found our simple financial education intervention—explaining the concepts of inflation and real interest rates and laying out the best strategy in terms of the

real interest rate—was not sufficiently impactful. We hypothesize that not only was the information presented too theoretical, but much of that information fell on deaf ears because subjects never received feedback regarding their previous performance. Without such feedback, subjects failed to recognize that they in fact needed to improve—an issue consumers face in real life as well (Georganas et al., 2014).[1] To identify intervention methods that improve performance and decision-making, we test and compare two new interventions that provide dynamic, performance-based feedback based on their first session of the Savings Game.

Intervention 1 focuses on how subjects' performance compares to the maximum they could earn and ultimately be remunerated for and where they make mistakes, rather than on more general economic concepts and optimal strategies. The intervention explains the three types of errors they can commit (over-, under-, and wasteful-stocking[2]) and asks subjects if they believe they committed each of these mistakes, fostering self-reflection. *Intervention 2* builds on Intervention 1 while also more concretely explaining not only the step-by-step process to assess what kind of inflationary conditions one currently faces and what the appropriate decision is, but how the opportunity costs arise from each mistake as well.

As such, we conduct an experiment to test the following hypotheses that:

1. individuals' inflation survey responses
    a. correlate with their in-task economic behaviors as well as that
    b. qualitative inflation-estimate (perceptions and expectations) and estimation-uncertainty measures correlate better with in-task economic behavior than quantitative measures;
2. across a wide array of individual characteristics related to financial education and behavioral economics, the primary indicators of in-task performance are numeracy, adaptability,[3] and consistency of economic decision-making; and
3. an intervention with dynamic performance-based feedback can improve performance in the Savings Game.

[1] "Small mistakes in consumption-savings decisions, however, are unlikely to provide informative negative feedback. Thus, consumers will feel little to no pressure to adapt their method of aggregation" (Georganas et al., 2014)
[2] See Section 2.1.4 in Lawrence et al. (2024) for an explanation of over-, under-, and wasteful-stocking.
[3] While the results of our initial experiment do not reveal adaptability to be a primary indicator, considering that the Savings Game inherently requires adaptability, we decide to continue investigating this potential relationship. In particular, our previous experiment may have lacked statistical power with the limited number of observations.

2. Method

2.1. Experimental procedure

The interface is developed using oTree, an open-source software development framework built on Python and Django (Chen et al., 2016). We conduct the experiment online in French using the hosting services of the S2CH Research Federation. We recruit subjects from the volunteer pool of the Laboratory of Experimental Economics in Paris (LEEP) through an online system (ORSEE).

The experiment takes place online over the course of one day for each subject, with multiple sessions run over the course of three weeks. Subjects first complete a questionnaire and a battery of knowledge and economic preference tests, the order of which is randomly assigned. Then, they receive instructions on how to play the Savings Game and complete the first of two rounds of the Savings Game. Afterwards, they receive their assigned treatment (Intervention 1, Intervention 2, or control[4]) and then play the second round of the Savings Game. On average, the experimental session takes about one and a half hours.

Subjects received a €5 participation fee as well as remuneration for their performance in the Savings Game and Wisconsin card sorting, Holt & Laury lottery, and lottery with loss tasks. Remuneration was only paid, however, if the subject completed all tasks in the session. The experimental currency unit was represented using the "₮" symbol, which had an exchange rate of $₮750 = €1$.

2.1.1. Savings Game parameters

We use the following parameters within the Savings Game for this experiment, which are the same as the previous experiment:

- initial endowment of ₮863.81,
- per-period income of ₮4.32,
- savings account interest rate of 1.9% per period,
- initial price of the good of ₮8.07.

Both rounds of the Savings Game follow the 4x30 inflation sequence, which alternates twice between a low- and high-inflation phase, each 30 periods long, over the course of 120 periods. In this 4x30 sequence, low-inflation phases produce an average per-period inflation of 0.04%

[4] The control consisted of receiving the numeracy and time preference tests in random order in between round 1 and round 2 of the Savings Game, rather than one of the interventions.

and low variability (between 0.00% and 0.08%), and high-inflation produces an average per-period inflation of 4.2% and higher variability (between 0.3% and 6.3%).

See Sections 2.1.1 and 2.1.2 in Lawrence et al. (2024) for a complete explanation of the rules of the Savings Game.

2.1.2. Inflation survey

To replicate the large-scale inflation survey methods used to produce perceived and expected inflation rates in real-life, we ask subjects questions based off the CAMME survey currently used in France. As per the CAMME procedure, subjects first must provide a qualitative estimate of their inflation perception by answering the question "Do you find that, over the past twelve months, prices have..."[5] with one of the following multiple-choice options:

- Increased rapidly
- Increased moderately
- Increased slightly
- Stayed the same
- Decreased

If subjects chose "Stayed the same," they proceed to the next period in the Savings Game; otherwise, they must then provide a *quantitative estimate* of the percentage by which they think prices changed.

We elicit inflation perceptions every twelve periods, starting at period $t = 12$ and ending at period $t = 120$.

We repeat this procedure for inflation expectations as well. Subject first provide a *qualitative estimate* of their inflation expectation, by answering a modified version of the inflation expectations question from the CAMME survey: "How do you expect prices to evolve over the next twelve months?"[6] Similar to qualitative perceptions, they can respond one of the following multiple-choice options:

[5] The English translation provided here is per Andrade et al. (2023).

[6] We must modify the question from its original form "In comparison with the past 12 months, how do you expect consumer prices will develop in the next 12 months? They will..." since we ask subjects for their expectations at period $t = 1$ to which they cannot compare any previous price changes. As a result, we must also adjust the original CAMME answer options: "increase more rapidly," "increase at the same rate," "increase at a slower rate," "stay about the same," or "fall" (Andrade et al., 2023). To maintain consistency and, thus, the comparability of the responses throughout the Savings Game, we maintain the question in its modified form.

- They will increase quickly
- They will increase moderately
- They will increase slowly
- They will stay the same
- They will decrease

If subjects chose "They will stay the same," they proceed to the next period in the Savings Game; otherwise, they must then provide a *quantitative estimate* of the percentage by which they think prices will change.

We elicit a first inflation expectation estimate at the end of period $t = 1$, regarding subjects' expectations in the range of periods $2 \leq t \leq 12$, to overcome a challenge in our previous experiment. In our previous experiment, we measure inflation expectations for the first time at period $t = 12$, which restricts us from correlating their behavior in the first twelve periods to their inflation expectations at the start of the Savings Game round. Subsequently, we elicit inflation expectations every twelve periods, from $t = 12$ to $t = 108$.

2.2. Measures of inflation internalization

2.2.1. Quantitative estimation

To measure subjects' abilities to *quantitatively* perceive and anticipate inflation, we use the bias (overall and low- and high-inflation) and sensitivity measures Lawrence et al. (2024). A positive (negative) bias represents an overestimation (underestimation) of perceived and expected inflation. The closer a subject's sensitivity to 1, the more accurately their estimations tracked the changes in inflation, whereas the closer to 0, the less they tracked inflation changes and the closer to -1, the more their estimations diverged.

2.2.2. Qualitative estimation

To measure subjects' abilities to *qualitatively* perceive and anticipate inflation, we measure the average accuracy of their estimation. We determine an accurate qualitative expectation as answering either "They will stay the same" or "They will increase slowly" just before or during low-inflation phases and "They will increase moderately" or "They will increase quickly" just before or during high-inflation phases. Similarly, we determine accurate qualitative perceptions as answering either "Stayed the same" or "Increased slightly" during or following low-inflation phases and "Increased moderately" or "Increased rapidly" during or following high-inflation phases. A subjects' average accuracy, therefore, is the percentage

of accurate qualitative estimates they made among the ten in total that they must provide over the course of a round of the Savings Game.

2.2.3. Measure of estimation uncertainty

In our previous experiment, we are unable to produce a measure of uncertainty since the slider-based elicitation method we use does not ensure sufficient precision in the quantitative estimate subjects provide to evaluate their estimation certainty. With the survey-style method, whereby subject must directly type their point estimate, we gain this precision. Thus, we also introduce a measure of estimation uncertainty based Krifka's (2009) Round Numbers Round Interpretation Principle (RNRI), whereby one can interpret estimates in multiples of five as signal of estimation uncertainty (Binder, 2017; Reiche & Meyler, 2022). We therefore designate each estimation that is a multiple five as "uncertain" and calculate the percentage of responses that are uncertain.

2.3. Measures of individual characteristics

The measures of individual characteristics are nearly identical to those from Lawrence et al. (2024). The knowledge measures include:

- financial literacy, using the "Big Three" questions from Lusardi and Mitchell (2009);[7]
- numeracy, using the adaptive version of the Berlin Numeracy Test (Cokely et al., 2012); and
- ability to calculate compound interest, using the compound interest questions from Macchia et al. (2018).

The economic preference measures include:

- time preferences, using an intertemporal randomized choice sequence similar to Cohen et al. (2016) that presents subjects with choices between smaller-sooner and larger-later payments in two sets, one on a one-month time horizon and one on a one-year horizon;
- risk aversion, using a Holt and Laury (2002) lottery choice procedure;
- loss aversion, using a lottery choice task with loss, similar to Gächter, Johnson, and Herrmann (2022); and
- adaptability to changing environments, using a Wisconsin card sorting task (Axelrod et al., 1992; Leshem & Glicksohn, 2007).

[7] We do not include the additional question from Arrondel and Masson (2014).

Additionally, we develop proxy measures for subjects' inconsistency in economic decision-making (Kurtz-David et al., 2019) based on the number of times the subjects make conflicting choices during the time preferences and risk and loss aversion tasks. More specifically, we count the number of times they switch from one preference to the other. In each task, an economically consistent individual should only switch once.[8]

For the Wisconsin card sorting task (WCST), we also measure perseverative and set-loss errors (Kopp et al., 2021). Perseverative errors occur when subjects select the same card characteristic despite just having received negative feedback about that characteristic in the previous decision. Set-loss errors represent incorrect guesses in the WCST despite receiving feedback of a correct decision for the previous card.

2.4. Interventions

Subjects are randomly assigned to one of three treatment groups: Intervention 1, Intervention 2, or control.[9] The interventions aim to provide dynamic, performance-based feedback to subjects as well as concrete, practical explanations—as opposed to the theoretical explanations that subjects receive in our previous experiment in Lawrence et al. (2024).

Intervention 1 first informs subjects the maximum savings they could have achieved in round 1, providing them the total opportunity cost they incurred through their mistakes of either over-, under-, or wasteful-stocking. The intervention explains that appropriate stocking requires knowing whether one is in a low- or high-inflation phase and offers guidance to assess inflation using a simple price comparison. Afterwards, the interventions describe how mistake can occur and how they each relate to the relationship between inflation and the interest rate. After explaining each mistake, subjects are asked if they believe they made the given mistake and then responds whether or not they are correct and offers a piece of advice as to how they can avoid the mistake in the next round. As an attention check, we then ask subjects if they are convinced by the feedback.

Intervention 2 builds on Intervention 1. Additionally, prior to the feedback section, Intervention 2 provides, a concrete explanation of:

[8] In the time preferences task, since subjects face two sets of choices, up to two switches would represent consistency.

[9] For hands-on demos of Intervention 1 and Intervention 2, visit https://savings-game.onrender.com/demo/intervention_1 and https://savings-game.onrender.com/demo/intervention_2 respectively.

- when subjects should save or stock up on the good as a function of when the inflation rate is greater than or less than the interest rate earned on the savings account,
- the opportunity cost of stocking or savings inappropriately, and
- how to estimate the inflation rate.

See Appendix A: Interventions for a complete description of each intervention.

2.5. Hypotheses

Thus, as described above, the present experiment aims to investigate the hypotheses that:

1. individuals' inflation survey responses
    a. correlate with their in-task economic behaviors as well as that
    b. qualitative inflation-estimate (perceptions and expectations) and estimation-uncertainty measures correlate better with in-task economic behavior than quantitative measures;
2. across a wide array of individual characteristics related to financial education and behavioral economics, the primary indicators of in-task performance are numeracy, adaptability, and consistency of economic decision-making; and
3. an intervention with dynamic performance-based feedback can improve performance in the Savings Game.

3. Results

3.1. Subjects: Descriptive statistics

In total, 154 subjects complete the full experimental session, successfully finishing both rounds of the Savings Game. Their average age is 32.4, and 51% are female. The median subject holds a master's degree and reports being employed and earning between €1,001 and €2,000 per month as of the experimental session. Additionally, 81% report being able to save regularly with a median amount between €501 and €1,000, while 14% report having taken out some form of non-mortgage debt in the previous 12 months. 87% of subjects have a savings account (the government-regulated "Livret A"), while only 16% have a retirement plan. See Appendix B: Descriptive statistics for further descriptive statistics on participating subjects.

3.2. Behavior in the Savings Game

As can be seen in Figure 1 and Figure 2, average performance is well below the maximum, similar to our previous experiment. Overall, the average performance also does not improve

drastically between the two rounds of the Savings Game when taken across all treatment groups together. On average, subject's save 54% of the maximum possible per the "best" strategy in round 1 and 58% in round 2.

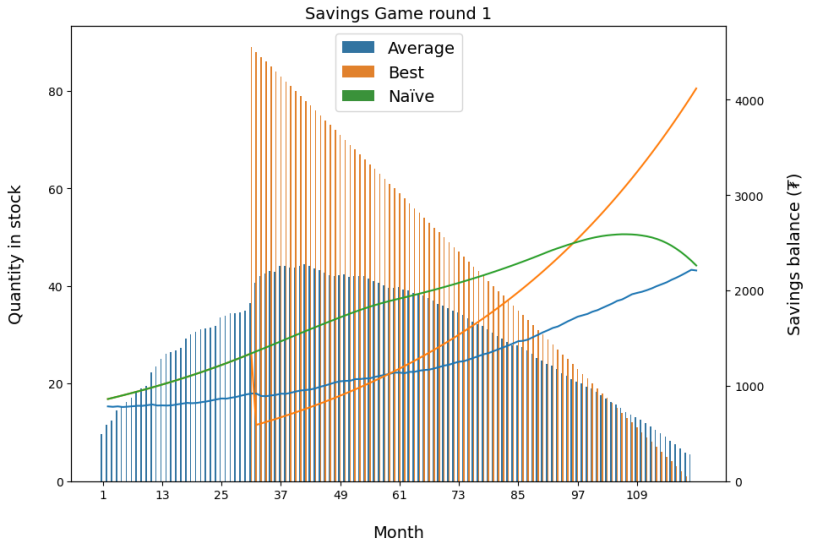

Figure 1 - Overall performance in Savings Game, round 1

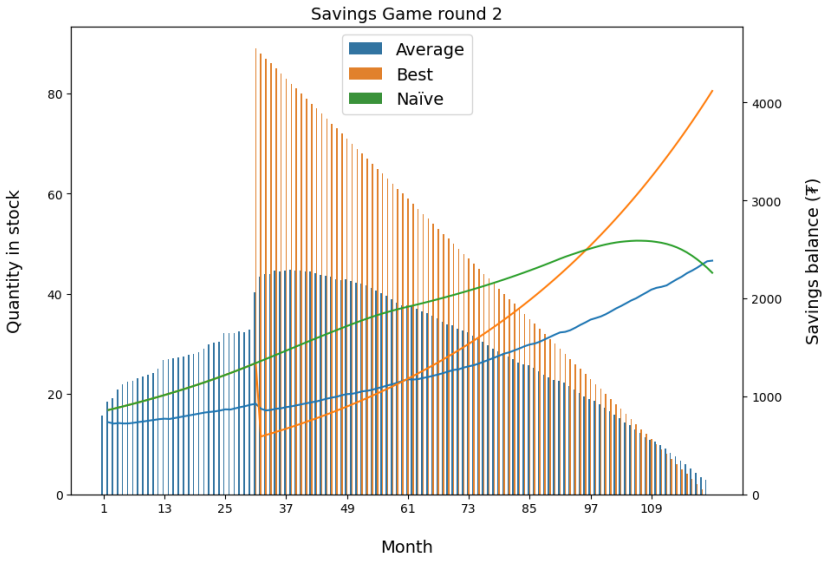

Figure 2 - Overall performance in Savings Game, round 2

3.2.1. Performance measures: Over- and wasteful-stocking and purchase adaptation

Table 1 shows the results from the first round of the Savings Game. Across all subjects, the average total savings as a percent of the maximum possible savings is 54%. Over- and wasteful-stocking account for 19% and 9% of the maximum possible performance.

Table 1 - Overall performance measures in round 1

	Mean	Standard deviation	Minimum	50%	Maximum
Total savings (%)	54	22	0	55	100
Over-stocking (%)	19	18	-1	15	72
Wasteful-stocking (%)	9	19	0	0	84
Purchase adaptation (units of good)	3.4	6.6	0.0	1.0	31.0

As can be seen in the boxplots in Figure 3, however, the mean wasteful-stocking measure is greatly skewed by outliers. Finally, average purchase adaptation, or the difference between the average quantity purchased in the three periods before and after the increase in inflation (between periods $28 \leq t \leq 30$ and $31 \leq t \leq 33$) is 3.4 units. Purchase adaptation, however, also presents significant outliers as shown in Figure 3; the median is 1 unit while the maximum is 31.[10]

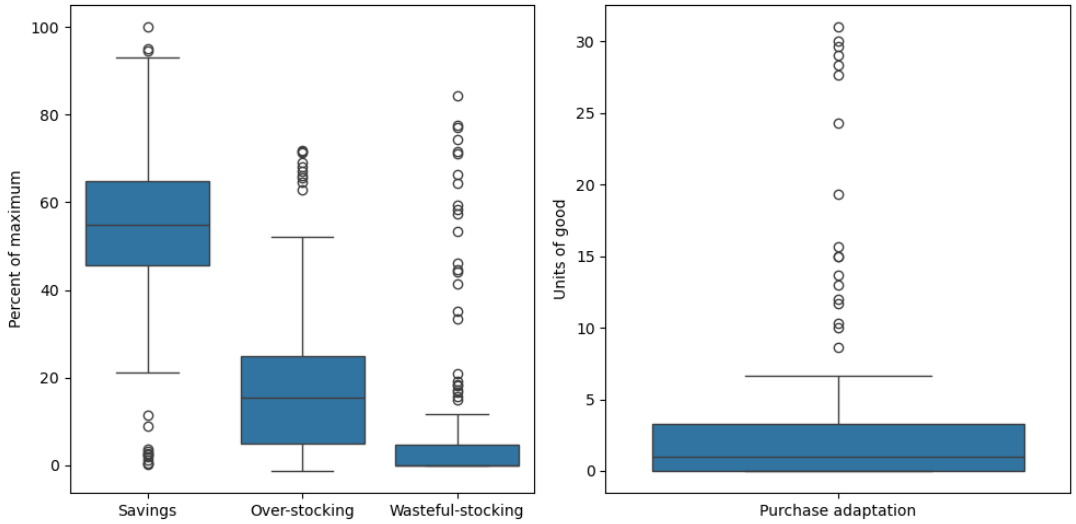

Figure 3 - Boxplot: Total savings, over-stocking, wasteful-stocking, and purchase adaptation

3.2.2. Quality of inflation expectations and perceptions and performance

We now analyze subjects' perceptions and expectations of inflation from the first round of the Savings Game.[11] As can be observed in Figure 4, subjects' perceptions and expectations of inflation generally follow actual inflation; however, their quantitative estimates are inaccurate. This pattern and discrepancy raise the possibility that subjects may have more accurate qualitative estimates than quantitative.

[10] For comparison, the best strategy requires a purchase adaptation of 29. See Section 3.3.1 in Lawrence et al. (2024) for further information.

[11] We restrict analysis to the first round for now so as to avoid any potential learning effects impacting the results.

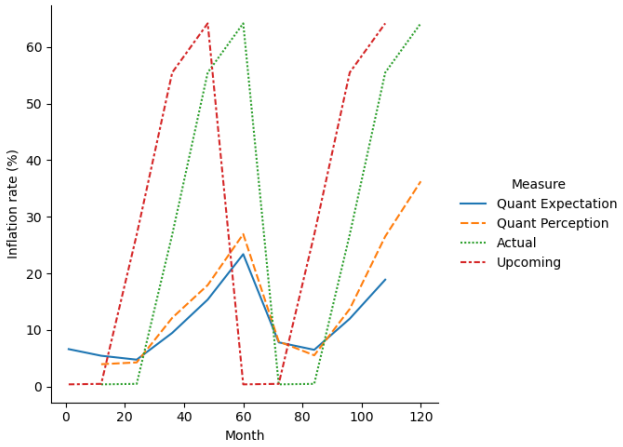

Figure 4 - Inflation in the Savings Game (round 1)

Table 2 shows the results of our inflation measures. Subjects' estimations exhibit significant biases in both low- and high-inflation phases, overestimating in low inflation and underestimating in high inflation. Their sensitivity to changes in inflation, though, is positive. Further, their qualitative estimates demonstrate greater accuracy, with subjects correctly perceiving the change in prices 78% of the time and expecting the change in prices 50%. Finally, the average subject provides uncertain estimates 41% of the time.

The qualitative results shown in Table 2 reflect subject responses converted to ordinal values as: -1, decrease; 0, stay the same; 1, slow increase; 2, moderate increase; 3, rapid increase. As such, the mean qualitative perception in low inflation of 1.24 suggests that subjects' qualitative perceptions were close, where a response of 0 ("Stayed the same") or 1 ("Increased slightly") would be considered correct, given the 12-period inflation rate in period $1 \leq t \leq 12$ is 0.38% and 0.47% in $13 \leq t \leq 24$. But, the mean being greater than 1 also implies that their qualitative perception was nonetheless biased upward. In high inflation, for which a response of 2 ("Increased moderately") or 3 ("Increased rapidly") is correct, we see that subjects' mean qualitative perception increases to 2.47, implying quite accurate qualitative perception. On the other hand, the average qualitative expectations in low and high inflation of 1.77 and 1.85 demonstrate the subjects essentially did not adjust their expectations. The average qualitative expectation being between 1 ("They will increase slowly") and 2 ("They will increase moderately") we might interpret as reflecting a general pessimism about future inflation but also uncertainty since between "slowly" and "moderately" may also be the least definitive of the answer options.

Table 2 - Descriptive statistics of inflation-internalization measures

	Mean	Standard deviation	Minimum	50%	Maximum
Qualitative perception, low inflation	1.24	0.64	0.00	1.25	3.00
Qualitative perception, high inflation	2.47	0.66	-1.00	2.67	3.00
Qualitative expectation, low inflation	1.77	0.66	-0.80	1.80	3.00
Qualitative expectation, high inflation	1.85	0.79	-1.00	1.80	3.00
Avg. qualitative perception accuracy	0.78	0.20	0.00	0.80	1.00
Avg. qualitative expectation accuracy	0.50	0.14	0.10	0.50	0.80
Average uncertain expectation	0.41	0.25	0.00	0.41	0.91
Perception bias, high inflation	-26.39	15.97	-49.84	-28.34	26.16
Perception bias, low inflation	4.97	8.92	-0.42	1.58	68.08
Perception sensitivity	0.57	0.39	-0.59	0.70	1.00
Expectation bias, high inflation	-32.17	15.46	-63.94	-37.74	22.06
Expectation bias, low inflation	-4.78	8.49	-14.58	-7.50	49.20
Expectation sensitivity	0.15	0.33	-0.56	0.19	0.79

Table 16 in Appendix C: Results of inflation measures shows a correlation matrix of the inflation measures. We find that perception and expectation sensitivity correlated positively with final savings ($p \leq 0.01$, $p \leq 0.01$ respectively). Perception and expectation biases in low-inflation phases correlate negatively with final savings ($p \leq 0.01$, $p \leq 0.1$). Interestingly, high-inflation perception and expectation biases correlate positively with performance ($p \leq 0.1$, $p \leq 0.01$ respectively). This makes intuitive sense since an overestimation of inflation in a high-inflation phase implies a greater sense of urgency to stock up, whereas as overestimation—and therefore urgency to stock up—in low inflation would produce an opportunity cost from over-stocking.

In terms of purchase adaptation (as percentage of cumulative quantity purchased), perception and expectation biases (in high-inflation) correlate positively with an increase in purchases ($p \leq 0.05$, $p \leq 0.01$ respectively). Expectation sensitivity also correlates positively with an increase in purchases ($p \leq 0.05$). Both of these correlations are consistent with the positive correlations between high-inflation biases and performance.

Subjects' qualitative perceptions in low inflation correlate negatively with final savings ($p \leq 0.01$), while expectations do not correlate statically significantly. Their qualitative perceptions as well as expectations in high-inflation phases correlate positively with final savings ($p \leq$

0.01, $p \leq 0.05$ respectively). These results as well are consistent with the previously mentioned correlations with performance and purchase adaptation.

Further, our measures of average accuracy of qualitative perception and expectation estimates correlate positively with final savings ($p \leq 0.01$, $p \leq 0.01$ respectively); however, average uncertainty demonstrates no correlation with performance. See Table 16 in Appendix C: Results of inflation measures for the complete data.

Overall, these results do reinforce the positive relationship between subjects' accurate perceptions and expectations of inflation and performance first identified in Lawrence et al. (2024), extending our understanding to qualitative internalizations of inflation as well. In particular, we validate that both the qualitative and quantitative measures typically employed in survey methods do demonstrate strong correlations with behavior.

3.2.3. Real life vs. savings game: Comparison to trends from surveys in real life

Numerous analyses of household surveys on inflation perceptions and expectations demonstrate a positive relationship both between actual (i.e. headline) inflation and perceptions and expectations as well as between perceptions and expectations themselves (Bignon & Gautier, 2022; Reiche & Meyler, 2022; Weber et al., 2023). We observe similar trends in our experimental data too.

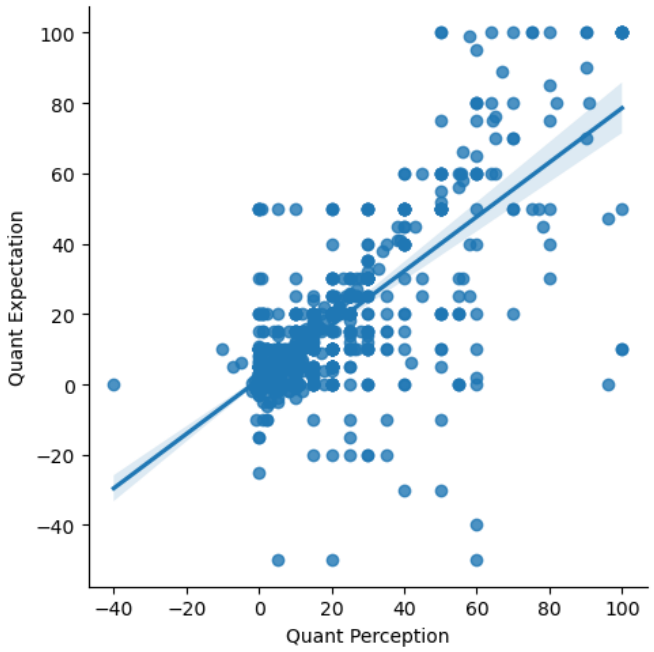

Figure 5 - Correlation between subjects' quantitative estimates of perceived and expected inflation

Firstly, like Weber et al. (2023) and Bignon and Gautier (2022), we find a clear positive correlation between quantitative perceptions and expectations ($p \leq 0.01$), as shown in Figure 5 and Table 3, as well as between qualitative perceptions and expectations ($p \leq 0.01$). These correlations may suggest that subjects report the same estimation for both or that they simply expect a continuation of the inflation they perceive at that time, another common pattern in real-life data (Ranyard et al., 2008). Generally speaking, though, these correlation provide evidence that subjects form expectations adaptively, rather than rationally (Rocheteau, 2023).

We also find positive correlations between actual inflation and quantitative both perceptions ($p < 0.01$) and expectations ($p \leq 0.01$). Similar to the observation by Weber et al. (2023) regarding real-life survey data, the correlation between quantitative perceptions and expectations is in fact stronger than the respective correlations with actual inflation. That said, however, of the qualitative measures, only perceptions demonstrate a (positive) correlation with actual inflation ($p \leq 0.01$). This nuance might offer further evidence that, at least qualitative, subjects base inflation expectations primarily on their present perceptions, anticipating a continuation of the conditions they currently perceive.

Table 3 - Correlation matrix: Estimates of perceived and expected inflation and actual inflation

	Actual	**Upcoming**	**Quantitative perception**	**Quantitative expectation**	**Qualitative perception**	**Qualitative expectation**
Actual	—					
Upcoming	0.43***	—				
Quantitative perception	0.46***	0.15***	—			
Quantitative expectation	0.31***	0.09***	0.77***	—		
Qualitative perception	0.54***	0.34***	0.52***	0.38***	—	
Qualitative expectation	0.03	-0.01	0.11***	0.41***	0.28***	—

Weber et al. (2023) further note that during the height of the COVID-19 pandemic, the dispersion of quantitative perception and expectation estimates increased. As can be seen in Figure 6, a similar pattern arises between low- and high-inflation phases, with the distribution of orange bars (estimates in high inflation) much wider than the blue bars (estimates in low inflation) widening greatly during high-inflation phases. Table 17 in Appendix C: Results of inflation measures confirms this; the standard deviation of quantitative perception and expectation estimates increases from 11.66 to 23.85 and 12.60 to 21.84 respectively between the low and high inflation phases. This doubling of standard deviations is in-line with the

doubling observed by Weber et al. (2023). We interpret this parallel as the effect of increased economic turmoil and, thus, uncertainty.[12] Further, Gautier and Montornès (2022) find a spike in inflation-expectation uncertainty in during the first quarantine period in France.

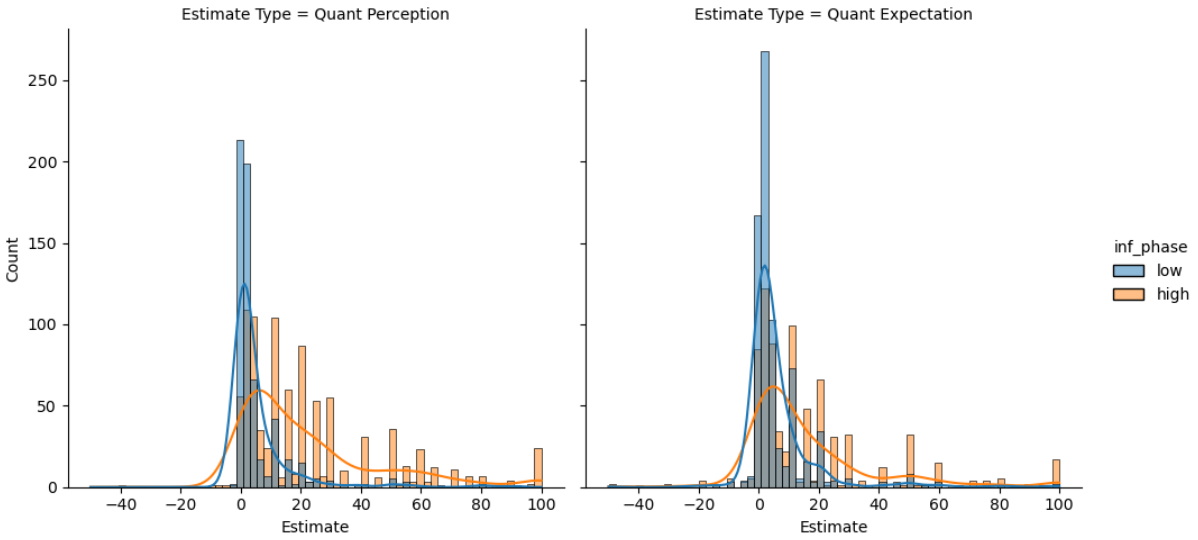

Figure 6 - Distribution of quantitative inflation estimates

To further investigate this possible relationship between uncertainty and turmoil (i.e. high-inflation phases in the Savings Game), we compare the share of uncertain responses over time. We graph the time series of actual and quantitative expected inflation with the share of uncertain responses in Figure 7. There are clear spikes in the share of uncertain estimates during high-inflation phases, rising from roughly a quarter of subjects to over half. This rise in uncertainty also confirms that estimating the inflation rate in high-inflation phases, where the 12-month rate ranges from 26.85% to 64.18%, is more difficult.

[12] Weber et al. (2023) do not directly link the onset of the COVID-19 pandemic in 2020 to "economic turmoil" or uncertainty; rather, they question whether the increased dispersion may arise from households perceiving higher inflation at that time. Considering CPI inflation did not rise until 2021, however, we consider the onset of the COVID-19 pandemic as a source of turmoil and, therefore, uncertainty.

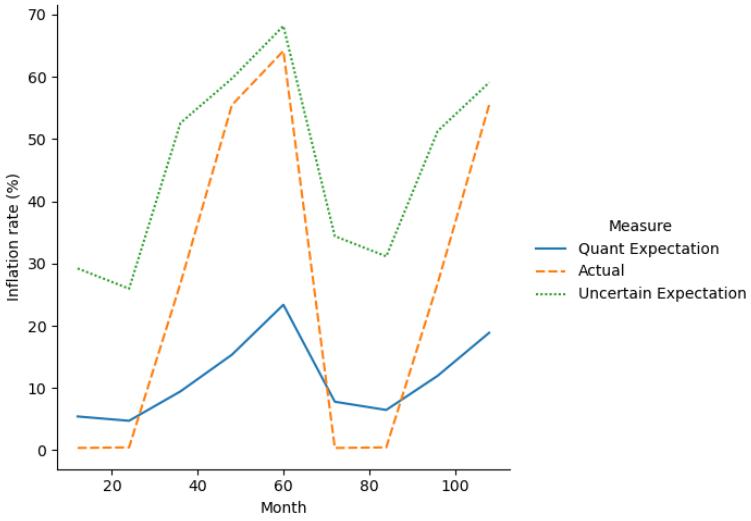

Figure 7 - Change in uncertainty of quantitative inflation expectations

Finally, we analyze the qualitative perceptions and estimations. As Andrade et al. (2023) observe, individuals' qualitative estimates are often more accurate than their quantitative ones. As shown in Figure 8, between low- and high-inflation phases, there are clear shifts to higher qualitative estimates in high-inflation phases. Additionally, as noted above, the average qualitative perception and expectation accuracy is 78% and 50%, which is markedly better than the 0.57 and 0.15 perception and expectation sensitivities from quantitative estimates.

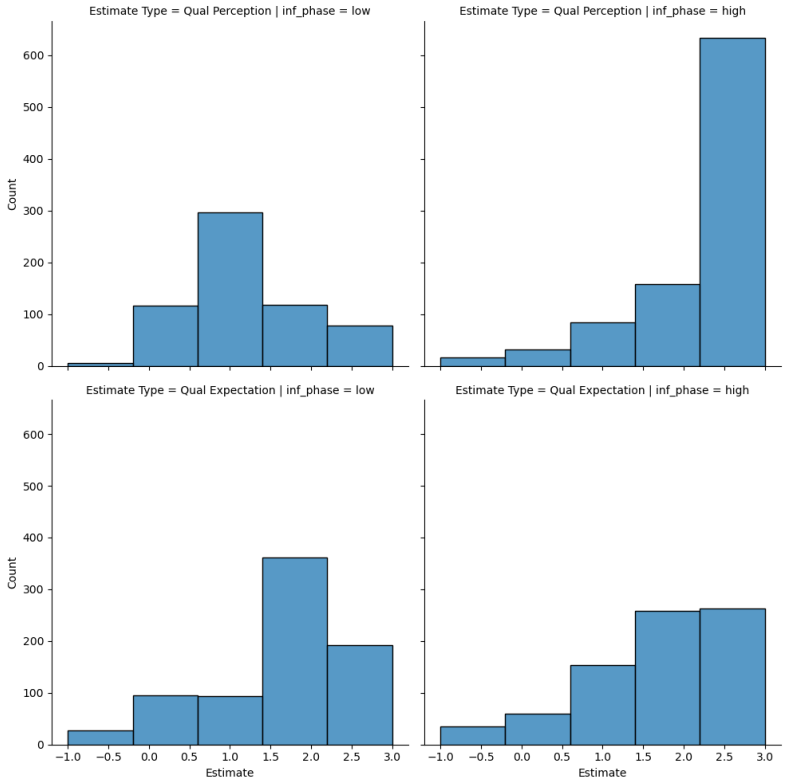

Figure 8 - Distribution of qualitative estimates of perceived and expected inflation in low- and high-inflation phases

3.2.4. Regression Analysis

3.2.4.1. Overall performance

We analyze the relationship between our performance measures (final savings, over-stocking, and wasteful-stocking as a percentage of the maximum) and inflation measures. Our objective is to assess and compare the explanatory power of the survey-elicited quantitative inflation measures to that of the qualitative inflation and uncertainty measures. We conduct three series of ordinary least squares (OLS) regressions, one for each performance measure, on the different types of inflation measures (i.e. quantitative versus qualitative and uncertainty) to compare which relate better to performance.

For our quantitative model, we repeat the OLS regressions on the original inflation measures from the previous experiment from Lawrence et al. (2024): expectation sensitivity, perception sensitivity, expectation bias, and perception bias.

Table 4 shows the results for this benchmark model; Table 18 in Appendix D: Supplemental results from previous experiment shows the results of the same model applied to the 4x30 inflation sequence from the previous experiment. We first note that as in the previous experiment, perception sensitivity demonstrates a positive relationship with final savings ($p < 0.01$ for both experiments) and negative relationship with wasteful-stocking ($p < 0.01$ for both experiments). Additionally, expectation sensitivity shows a positive relationship with final savings ($p \leq 0.05$) and negative relationship with over-stocking ($p \leq 0.1$). In the previous experiment, expectation sensitivity only showed a relationship with wasteful-stocking, which was positive ($p \leq 0.05$).

Table 4 - OLS regressions: Overall performance measures on inflation measures

Variables	(1) Final savings (%)	(2) Over-stocking (%)	(3) Wasteful-stocking (%)
Intercept	0.4721***	0.1847***	0.1772***
	(0.0458)	(0.0400)	(0.0416)
Expectation sensitivity	0.1204**	-0.0858*	-0.0532
	(0.0548)	(0.0478)	(0.0498)
Expectation bias	0.0045	-0.0014	-0.0022
	(0.0029)	(0.0025)	(0.0026)
Perception sensitivity	0.1336***	0.0233	-0.1233***
	(0.0479)	(0.0418)	(0.0435)
Perception bias	-0.0039	0.0015	0.0036
	(0.0027)	(0.0023)	(0.0024)
R-squared	0.1253	0.0239	0.0827
R-squared Adj.	0.1018	-0.0023	0.0581

Standard errors in parentheses.

* p<.1, ** p<.05, *** p<.01

In comparison, we repeat the three OLS regressions of performance measures, replacing the quantitative measures with the qualitative and uncertainty measures. Table 5 shows the results. Average qualitative expectation and perception accuracies each demonstrate positive relationships with final savings ($p \leq 0.01$, $p \leq 0.01$). They also both exhibit negative relationships with wasteful-stocking ($p \leq 0.1$, $p < 0.01$). Conversely, average expectation uncertainty demonstrates a negative relationship with final savings ($p \leq 0.05$) and positive relationship with wasteful-stocking ($p \leq 0.01$). We note that while the r^2 coefficients for over-stocking is lower with qualitative and uncertainty measures, the models for final savings and wasteful-stocking produce r^2 that are much higher, suggesting these measures do indeed provide greater explanatory power.

Table 5 - OLS regressions: Overall performance measures on qualitative inflation measures

Variables	(1) Final savings (%)	(2) Over-stocking (%)	(3) Wasteful-stocking (%)
Intercept	0.0856	0.2806***	0.4202***
	(0.0805)	(0.0739)	(0.0725)
Average qualitative expectation accuracy	0.3655***	-0.0815	-0.1826*
	(0.1117)	(0.1025)	(0.1006)
Average qualitative perception accuracy	0.4129***	-0.0915	-0.3883***
	(0.0838)	(0.0769)	(0.0754)
Average expectation uncertainty	-0.1353**	0.0560	0.1611***
	(0.0658)	(0.0604)	(0.0592)
R-squared	0.2024	0.0163	0.1796
R-squared Adj.	0.1865	-0.0034	0.1632

Standard errors in parentheses.

* p<.1, ** p<.05, *** p<.01

3.2.4.2. Purchase adaptation

Considering subjects' purchase adaptation—i.e. quick reaction to the increase in inflation by stocking up—is a key behavior for achieving a high final savings, we further analyze the potential contributing factors. We conduct an OLS regression of the average quantity purchased each month during a given 12-month interval on the quantitative and qualitative perceived and expected inflation, estimation uncertainty, and realized inflation. We treat the qualitative estimates as dummy variables, when subjects indicated they perceived or expected an increase in prices or not. Uncertainty is also treated as a dummy variable for the expectation estimate given in each interval.

Table 6 shows the results of the OLS. In the first interval, $1 \leq t \leq 12$, qualitative expectations and actual inflation increase the average quantity purchased ($p < 0.1$ and $p < 0.01$ respectively). As such, a subject with a qualitative expectation of high inflation as of period $t = 1$ purchases an additional 1.2 units of the good per period on average, leading to over 14 over-stocked units within 12 periods.

In the interval $12 < t \leq 24$, quantitative perceptions have a positive coefficient, albeit small ($p < 0.1$). In $24 < t \leq 36$, the reported quantitative expected inflation for the interval appears to have a surprisingly negative effect on the average quantity ($p < 0.1$). This coefficient suggests that those providing higher quantitative expected inflation estimates at $t = 24$ purchased less in the ensuing 12 months. One possible explanation for this is that such subjects stocked up prior to the start of the third interval at $t = 25$. In fact, the positive relationship between quantitative perceptions and the average quantity in the interval $12 <$

$t \leq 24$ offers support for this since the perception reported in this interval is at period $t = 24$ as well. In other words, considering the strong positive correlation between quantitative perceptions and expectations, if a subject reports a high perception estimate at $t = 24$, they are likely to not only stock up in the interval $12 < t \leq 24$, but report a high expectation at $t = 24$ as well. Having stocked up in $12 < t \leq 24$, though, they may not need to purchase units of the good in in the interval $24 < t \leq 36$.

Table 6 - OLS regressions: Average quantity purchased in given period

Variables	(1) Month 12	(2) Month 24	(3) Month 36	(4) Month 48
Intercept	1.8932***	0.5859	0.0017	0.0002
	(0.7165)	(0.6566)	(0.0011)	(0.0001)
Current qualitative perceptions, Increase	-0.4639	0.2097	-0.3204	0.0441
	(0.5907)	(0.6453)	(0.8605)	(0.4030)
Previous qualitative expectations, Increase	1.1989*	0.6865	1.0219	0.4129
	(0.7118)	(0.5375)	(0.6732)	(0.3188)
Uncertainty, Uncertain estimate	0.1412	0.0512	-0.0730	-0.2091
	(0.5324)	(0.3619)	(0.3856)	(0.2066)
Actual inflation	0.7194***	0.2754	0.0446	0.0095
	(0.2723)	(0.3086)	(0.0300)	(0.0070)
Current quantitative perceptions	0.0234	0.0633*	0.0276	0.0077
	(0.0288)	(0.0343)	(0.0182)	(0.0056)
Previous quantitative expectations	-0.0067	-0.0212	-0.0347*	-0.0034
	(0.0215)	(0.0252)	(0.0193)	(0.0090)
R-squared	0.0266	0.0458	0.0427	0.0279
R-squared Adj.	-0.0065	0.0136	0.0099	-0.0054

Standard errors in parentheses.

* p<.1, ** p<.05, *** p<.01

3.3. The role of individual characteristics and behavior

Across subjects, we find that 51% are financially literate, 30% are numerate, and 47% are capable of compound interest calculations as shown in Table 20 in Appendix E: Results of individual characteristic measures. Table 21 in Appendix E: Results of individual characteristic measures shows results from the economic preference tasks.

3.3.1. Correlations with task performance

We first correlate the measures of individual characteristics to measures from the Savings Game. We apply a Bonferroni correction to account for the interdependence of the in-task measures.

Table 22 in Appendix E: Results of individual characteristic measures shows the statistically significant point bi-serial correlations between our knowledge measures (financial literacy, numeracy, and compound-interest capability) and in-task performance measures (final savings, over-stocking, wasteful-stocking, and purchase adaptation). All knowledge measures demonstrate positive correlations with final savings. Financial literacy and compound-interest capability correlate negatively with wasteful-stocking, and numeracy and compound-interest capability correlate positively with purchase adaptation.

Table 23 in Appendix E: Results of individual characteristic measures shows the statistically significant Pearson correlations between our economic preference measures and in-task performance measures. We find that risk aversion and time preference switches correlate negatively with final savings and positively with wasteful-stocking. Conversely, the number of correct choices from the Wisconsin card sorting task (WCST)—an indicator of adaptability—correlate positively with final savings and negatively with wasteful-stocking. Further, the number of perseverative errors in the Wisconsin card sorting task—an indicator of an inability to adapt to a changing environment, repeating the same errors despite negative feedback— correlates negatively with final savings and positively with wasteful-stocking.

Taken together, these results indicate that subjects who are more knowledgeable, adaptable (as measured by the WCST), and consistent in their economic decisions tend to perform better in the Savings Game. Further, these results provide initial support for our Hypothesis 2, that the primary indicators of in-task performance are in fact numeracy, adaptability, and consistency of economic decision-making.

Overall, in-task inflation measures (perception and expectation bias and sensitivity) demonstrate less correlation with individual characteristics. As shown in Table 24, Table 25, and Table 26 in Appendix E: Results of individual characteristic measures, though, numeracy and number of correct choices in the Wisconsin card sorting task (i.e. adaptability) correlate positively with perception sensitivity, and time preference switches and perseverative errors correlate negatively with perception sensitivity. These correlations seem coherent. Greater perception accuracy in changing inflationary conditions requires better numerical reasoning as well as adaptability. On the other hand, those with less consistent economic preferences and/or a tendency to perseverate, continuing to commit the same errors, may be less capable of perceiving changes in inflation.

Finally, we find similar correlations between the characteristic measures and qualitative inflation measures (average qualitative perception and expectation accuracies and average expectation uncertainty). See Table 27, Table 28, and Table 29 in Appendix E: Results of individual characteristic measures. Similar to the quantitative measures, numeracy and adaptability correlate positively with qualitative perception accuracy, and time preference switches and perseverative errors correlate negatively. Additionally, we find that the number of smaller-sooner time preference choices (i.e. a high discount rate) correlates negatively with qualitative perception accuracy as well. These results are also coherent with the underlying abilities necessary for accurate qualitative perceptions: strong numerical reasoning and adaptability.

3.3.2. Regression Analysis

To more clearly observe the interplay of individual characteristics in overall performance, we conduct OLS regressions of total savings, over-stocking, and wasteful-stocking in round 1 on the different characteristic measures, where financial literacy, numeracy, and compound interest-capability are dummy variables. Table 7 shows the results. Final savings is positively impacted by compound interest-capability ($p < 0.05$) and negatively impacted by time preference switches ($p < 0.01$). The model for over-stocking does not produce any statistically significant coefficients, but wasteful-stocking demonstrates a negative relationship with financial literacy ($p < 0.1$) and positive relationship with time preference switches ($p < 0.01$). These are coherent considering that greater knowledge should contribute to better performance measures, as opposed to less consistency in economic decisions, which contributes to lower performance.

Table 7 - OLS regressions: Performance measures on individual characteristics (round 1)

Variables	(1) Final savings (%)	(2) Over-stocking (%)	(3) Wasteful-stocking (%)
Intercept	0.5618***	0.2213	-0.1049
	(0.1618)	(0.1563)	(0.1428)
Financially literate	0.0434	0.0019	-0.0606*
	(0.0348)	(0.0337)	(0.0308)
Numerate	0.0583	-0.0401	-0.0341
	(0.0376)	(0.0363)	(0.0332)
Compound interest-capable	0.0760**	-0.0288	-0.0288
	(0.0369)	(0.0356)	(0.0325)
WCST, number correct	0.0024	-0.0005	0.0014
	(0.0055)	(0.0053)	(0.0049)
WCST, set-loss errors	-0.0097	0.0002	0.0105
	(0.0090)	(0.0087)	(0.0079)
WCST, perseverative errors	-0.0008	-0.0010	0.0056
	(0.0069)	(0.0066)	(0.0061)
Risk aversion, safe choices	0.0059	-0.0030	0.0045
	(0.0086)	(0.0083)	(0.0076)
Risk aversion, switches	-0.0133	-0.0169	0.0189
	(0.0142)	(0.0137)	(0.0125)
Loss aversion, coin tosses	-0.0072	-0.0030	0.0098
	(0.0115)	(0.0111)	(0.0102)
Loss aversion, switches	0.0288	-0.0076	-0.0291
	(0.0241)	(0.0233)	(0.0213)
Time preferences, smaller-sooner choices	-0.0055	0.0029	0.0044
	(0.0038)	(0.0037)	(0.0034)
Time preferences, switches	-0.0501***	0.0193	0.0489***
	(0.0137)	(0.0132)	(0.0121)
R-squared	0.3034	0.0479	0.3109
R-squared Adj.	0.2441	-0.0331	0.2522

Standard errors in parentheses.

* p<.1, ** p<.05, *** p<.01

3.4. Changes in performance

3.4.1. Learning effect

Table 8 shows the change in performance measures between the first and second rounds of the Savings Game. We use purchase adaptation as a percentage of the total number of units of the good purchased before period $t = 28$. This measure can be interpreted as the percentage of the total units of the good the subject needs to buy as of period $t = 28$ to survive through $t = 120$ that they buy in the interval $31 \leq t \leq 33$. This measure facilitates comparison because the amount a subject should buy in this interval depends on how much they have bought up to

this point. Previously, we use the direct magnitude of purchase adaptation in terms of units of the good because it is more intuitive to interpret.

Wasteful-stocking shows the only statistically significant change ($p \leq 0.05$), decreasing. This makes sense considering it is the most obvious mistake to subjects as they see that they finish a round with stock remaining. Otherwise, we find no learning effect.

Table 8 - Change in performance between first and second round

	Session 1	**Session 2**	**Change in performance**
Final savings (%)	54	58	4
(std)	(22)	(23)	(22)
Over-stocking (%)	19	20	1
(std)	(18)	(23)	(26)
Wasteful-stocking (%)	9	5	-4**
(std)	(19)	(14)	(14)
Purchase adaptation (%)	9.38	15.37	5.99
(std)	(21.32)	(31.11)	(30.21)

3.4.2. Treatment

As Table 9 reveals, recipients of Intervention 2 improve savings, over-stocking, and purchase adaptation ($p \leq 0.05$, $p \leq 0.01$, and $p \leq 0.05$ respectively); recipients of Intervention 1 only demonstrate improve wasteful-stocking ($p \leq 0.05$). The lack of significant reduction in wasteful-stocking among the Intervention 2 group appears mainly due to the fact that its mean cost incurred was already three times less in round 1 than amongst recipients of Intervention 1.

Finally, amongst the control group, the only statistically significant changes in performance are in fact an increase in over-stocking ($p \leq 0.01$) and decrease in purchase adaptation ($p \leq 0.05$). Increased over-stocking is a natural reaction after the first session for subjects who do not properly recognize the importance of protecting purchasing power. Instead, they become more pessimistic about future inflation and simply ensure they buy as much as possible at a low price. Increased over-stocking can also reduce purchase adaptation since fewer subjects may still require buying any units of the good by $t = 31$.

Table 9 - Change in performance between sessions 1 and 2 for each treatment group

	Intervention 1	Intervention 2	Control
Final savings (%)	8	6**	-2
(std)	(21)	(21)	(23)
Over-stocking (%)	-1	-8***	15***
(std)	(2)	(25)	(26)
Wasteful-stocking (%)	-7**	-1	-6
(std)	(17)	(7)	(17)
Purchase adaptation (%)	8.99	9.63**	-0.99**
(std)	(37.19)	(32.81)	(15.88)

3.4.3. Regression analysis

3.4.3.1. Overall performance

To assess the treatments' and learning effect's impacts more directly, we conduct OLS regressions of the change in each performance measure (i.e. the difference between rounds 1 and 2) on the treatment received as dummy variables. Additionally, given the correlation between inflation measures and performance, we also regress the change in inflation measures on the treatment.

As shown in Table 10, both Intervention 1 and Intervention 2 demonstrate positive effects on final savings ($p < 0.01$, $p \leq 0.01$) and negative effects on over-stocking ($p < 0.01$, $p \leq 0.01$). Amongst inflation measures, Intervention 1 increases expectation sensitivity ($p \leq 0.01$), while decreasing uncertainty ($p \leq 0.1$). Conversely, Intervention 2 demonstrates no statistically significant impact on any inflation measures.

Table 10 - OLS regressions of performance and inflation measures on treatment

Variables	(1) Final savings (%)	(2) Over-stocking (%)	(3) Wasteful-stocking (%)	(4) Qualitative perception accuracy	(5) Qualitative expectation accuracy	(6) Uncertainty	(7) Perception sensitivity	(8) Perception bias	(9) Expectation sensitivity	(10) Expectation bias
Intercept	-0.1782***	0.1784***	-0.0174**	0.0020	0.1120***	0.0255	0.0868***	0.1506	0.1327***	1.8896**
	(0.0331)	(0.0271)	(0.0081)	(0.0178)	(0.0173)	(0.0275)	(0.0326)	(0.8989)	(0.0408)	(0.9199)
Intervention 1	0.2557***	-0.1969***	-0.0176	0.0393	-0.0163	-0.0768*	-0.0516	-1.2114	0.1591***	-0.5458
	(0.0478)	(0.0391)	(0.0117)	(0.0258)	(0.0250)	(0.0397)	(0.0471)	(1.2986)	(0.0589)	(1.3288)
Intervention 2	0.2929***	-0.2681***	0.0139	0.0083	-0.0154	0.0090	-0.0135	0.8255	-0.0141	0.5437
	(0.0451)	(0.0370)	(0.0111)	(0.0243)	(0.0236)	(0.0375)	(0.0445)	(1.2267)	(0.0556)	(1.2552)
R-squared	0.1356	0.1529	0.0248	0.0084	0.0019	0.0185	0.0042	0.0086	0.0343	0.0024
R-squared Adj.	0.1299	0.1473	0.0184	0.0019	-0.0047	0.0121	-0.0023	0.0021	0.0280	-0.0042

Standard errors in parentheses.

* p<.1, ** p<.05, *** p<.01

3.4.3.2. Purchase adaptation

Next, we repeat the average quantity purchased regressions initially reported in Table 6 to assess the possible impacts of a learning or treatment effect during the same four intervals as before. Table 11 shows the results.

The first interval, $1 \leq t \leq 12$ (which takes place during low inflation), is especially relevant to identifying potential learning and treatment effects because it represents the only purely independent interval. Subsequent intervals' decisions depend on purchases made previously. In the first interval, qualitative expectations and actual inflation increase the average quantity purchased ($p < 0.01$ and $p < 0.01$ respectively). There is a positive impact (i.e. negative coefficient[13]) for Intervention 2 ($p < 0.01$). The positive coefficients of the interaction terms for each intervention with the pre-treatment dummy variable ($p < 0.01$, $p \leq 0.01$) further suggest an improvement due to the interventions since this implies that post-treatment sees a reduction in the average quantity purchased, which is strategically better. Further, the interaction term of receiving Intervention 1 and quantitative expectations is positive ($p \leq 0.05$), which suggests that Intervention 1 recipients that had overly pessimistic expectations about inflation did at least make an appropriate purchase decision, given their expectations. In other words, these subjects did apply the strategy appropriately of increasing their purchases when they expect higher inflation; they just were misguided in their expectations. That said, we also observe a counter-productive learning effect in the first interval (i.e. negative coefficient for the pre-treatment variable, $p < 0.01$), implying the average quantity increased in round 2 across all subjects.

In the second interval, $12 < t \leq 24$ (when inflation still remains low), quantitative perceived ($p \leq 0.05$) and actual inflation ($p < 0.01$) increase the quantity purchased. There is also a positive interaction term between Intervention 1 and qualitative perceptions ($p \leq 0.1$).

The third interval, $24 < t \leq 36$ (the first interval with high inflation), is positively impacted by the interaction of Intervention 2 and the pre-treatment dummy variable (i.e. negative coefficient, $p < 0.1$), actual inflation ($p < 0.1$), and quantitative perceived inflation ($p < 0.1$).

Finally, the fourth interval, $36 < t \leq 48$ (high inflation), exhibits a positive coefficient for the pre-treatment variable ($p < 0.05$), suggesting that subjects purchased less in round 2,

[13] A negative coefficient represents a positive impact since the average quantity per month should be one unit in the first period.

which is coherent with the negative interaction term for Intervention 2 and pre-treatment ($p < 0.01$) since subjects would have stocked up in the previous interval(s) and not needed to make any purchases in the fourth. Qualitative perceptions have a relatively strong negative impact ($p \leq 0.01$), while its interaction term with both interventions is positive ($p \leq 0.05$ for both) as well as for Intervention 2 and quantitative perceptions ($p \leq 0.1$), suggesting positive impact from the interventions. Qualitative expectations exhibit a positive effect ($p \leq 0.1$). Additionally, actual inflation has a slight positive impact on the average quantity in the fourth interval ($p < 0.01$).

Overall, these results do suggest that both interventions alter and strengthen the factors relating to the average quantities purchased during these intervals, particularly the first interval, adding greater power to subjects' perceptions and expectations and in-line with the overall improvements in performance observed as well.

Table 11 - OLS regressions: Average quantity purchased on treatment effects

Variables	(1) Month 12	(2) Month 24	(3) Month 36	(4) Month 48
Intercept	3.5888***	1.5329***	0.0028*	0.0005***
	(0.6509)	(0.4868)	(0.0016)	(0.0002)
Treatment, Intervention 1	-1.6176	-0.9973	-1.8579	-0.3438
	(1.3301)	(0.8887)	(1.7683)	(0.9351)
Treatment, Intervention 2	-3.2086***	-1.1124	1.0499	-1.0797
	(1.1052)	(0.7307)	(1.4632)	(0.7552)
Round, Pre-treatment	-1.9799***	0.2098	0.2580	0.5769**
	(0.5369)	(0.3119)	(0.4506)	(0.2268)
Uncertainty, Uncertain estimate	-0.2670	-0.2132	-0.1481	-0.0262
	(0.6177)	(0.3742)	(0.5270)	(0.2672)
Current qualitative perceptions, Increase	-0.8970	-0.7867	-0.5858	-1.5895***
	(0.7049)	(0.4799)	(1.1838)	(0.6004)
Previous qualitative expectations, Increase	1.9553***	0.1534	-0.5579	0.7199*
	(0.7205)	(0.5399)	(0.7435)	(0.4261)
Treatment, Intervention 1 × Round, Pre-treatment	2.3099***	-0.2216	-0.5687	-0.3893
	(0.7660)	(0.4590)	(0.6469)	(0.3329)
Treatment, Intervention 2 × Round, Pre-treatment	2.9121***	0.2618	-1.0285*	-0.8193***
	(0.7251)	(0.4325)	(0.6138)	(0.3036)
Treatment, Intervention 1 × Uncertainty, Uncertain estimate	-0.2544	0.8249	0.5699	-0.3792
	(0.8891)	(0.5223)	(0.7616)	(0.3778)
Treatment, Intervention 2 × Uncertainty, Uncertain estimate	0.8666	0.4242	0.0263	0.1694
	(0.8783)	(0.5382)	(0.7438)	(0.3680)
Treatment, Intervention 1 × Current qualitative perceptions, Increase	0.1250	1.2893*	2.0848	1.7909**
	(1.0524)	(0.7220)	(1.6834)	(0.8754)
Treatment, Intervention 2 × Current qualitative perceptions, Increase	0.9820	0.7064	-0.5199	1.6919**
	(0.9072)	(0.6207)	(1.5384)	(0.8128)
Treatment, Intervention 1 × Previous qualitative expectations, Increase	-1.8182	-0.0003	1.3834	-1.1897
	(1.2197)	(0.8650)	(1.2803)	(0.7229)
Treatment, Intervention 2 × Previous qualitative expectations, Increase	-1.0567	0.2546	1.3198	-0.4570
	(1.0391)	(0.7054)	(1.0397)	(0.6405)
Actual inflation	1.3637***	0.7205***	0.0743*	0.0281***
	(0.2474)	(0.2288)	(0.0433)	(0.0104)
Current quantitative perceptions	-0.0309	0.0823**	0.0442*	0.0005
	(0.0639)	(0.0378)	(0.0267)	(0.0076)
Treatment, Intervention 1 × Current quantitative perceptions	0.0561	-0.0239	-0.0376	0.0012
	(0.0679)	(0.0465)	(0.0395)	(0.0102)
Treatment, Intervention 2 × Current quantitative perceptions	0.1279	-0.0539	-0.0046	0.0164*
	(0.0885)	(0.0480)	(0.0377)	(0.0094)
Previous quantitative expectations	-0.0128	-0.0018	-0.0156	-0.0081
	(0.0230)	(0.0339)	(0.0305)	(0.0127)
Treatment, Intervention 1 × Previous quantitative expectations	0.0838*	-0.0131	-0.0207	0.0084
	(0.0426)	(0.0441)	(0.0401)	(0.0162)
Treatment, Intervention 2 × Previous quantitative expectations	0.0356	-0.0354	-0.0348	-0.0083
	(0.0322)	(0.0445)	(0.0418)	(0.0160)
R-squared	0.1793	0.1284	0.1023	0.1064
R-squared Adj.	0.1219	0.0674	0.0393	0.0430

Standard errors in parentheses.

* p<.1, ** p<.05, *** p<.01

3.4.3.3. Individual characteristics

We then analyze the relationship between treatment and individual characteristics through OLS regressions of the change in performance from round 1 to 2, measuring the interaction terms between each treatment and the characteristic measures. While overall not statistically significant, there are a few notable results. Table 12 shows abbreviated results with statistically significant relationships.

The results demonstrate that the interaction term of Intervention 1 and set-loss errors has a negative impact on final savings ($p < 0.05$). This may suggest that those who do not properly maintain behaviors after feedback do not benefit from, or are even misguided by, the feedback of Intervention 1.

The interaction term of risk aversion safe choices and Intervention 1 produces more wasteful-stocking ($p \leq 0.01$). Conversely, the interaction term of control and risk aversion switches is positive ($p < 0.05$) for final savings and negative for over-stocking ($p \leq 0.05$). At first glance, this is a surprising result; however, risk aversion switches correlate strongly with wasteful-stocking at baseline. As a result, the improvement may arise from the across-the-board learning effect, reducing excess quantities purchased in round 1 and leading to higher final savings in round 2.

Interaction terms are positive ($p \leq 0.01$) and negative ($p \leq 0.05$) between loss aversion switches and control and Intervention 1 respectively for wasteful-stocking. Finally, Intervention 1 has a positive interaction term with time preference smaller-sooner choices and final savings ($p \leq 0.01$) and negative terms with over- ($p \leq 0.1$) and wasteful-stocking ($p \leq 0.05$), while the control has a negative interaction term with final savings ($p \leq 0.1$). This suggests that more present-focused subjects improve their performance with Intervention 1.

For the complete results, see Table 30 in Appendix F: Ordinary least squares regression of individual characteristics and treatment.

Table 12 - OLS regressions: Change in performance on treatment and individual characteristics (abbreviated results)

Variables	(1) Final savings (%)	(2) Over-stocking (%)	(3) Wasteful-stocking (%)
Treatment, Control × WCST, set-loss errors	-0.0110	0.0147	-0.0032
	(0.0266)	(0.0219)	(0.0061)
Treatment, Intervention 1 × WCST, set-loss errors	-0.0711**	0.0372	0.0099
	(0.0313)	(0.0258)	(0.0072)
Treatment, Intervention 2 × WCST, set-loss errors	-0.0027	-0.0104	0.0027
	(0.0250)	(0.0207)	(0.0057)
Treatment, Control × Risk aversion, safe choices	0.0217	-0.0218	0.0043
	(0.0291)	(0.0240)	(0.0067)
Treatment, Intervention 1 × Risk aversion, safe choices	0.0109	-0.0356	0.0196***
	(0.0274)	(0.0226)	(0.0063)
Treatment, Intervention 2 × Risk aversion, safe choices	-0.0120	0.0178	-0.0027
	(0.0278)	(0.0229)	(0.0064)
Treatment, Control × Risk aversion, switches	0.0949**	-0.0985**	0.0109
	(0.0479)	(0.0395)	(0.0110)
Treatment, Intervention 1 × Risk aversion, switches	-0.0625	0.0465	0.0068
	(0.0512)	(0.0422)	(0.0117)
Treatment, Intervention 2 × Risk aversion, switches	-0.0441	0.0444	-0.0057
	(0.0506)	(0.0417)	(0.0116)
Treatment, Control × Loss aversion, switches	0.0371	-0.0795	0.0426***
	(0.0643)	(0.0531)	(0.0147)
Treatment, Intervention 1 × Loss aversion, switches	0.0753	-0.0086	-0.0436**
	(0.0927)	(0.0765)	(0.0212)
Treatment, Intervention 2 × Loss aversion, switches	0.0359	0.0083	-0.0097
	(0.0938)	(0.0774)	(0.0215)
Treatment, Control × Time preferences, smaller-sooner choices	-0.0231*	0.0165	-0.0004
	(0.0135)	(0.0112)	(0.0031)
Treatment, Intervention 1 × Time preferences, smaller-sooner choices	0.0407***	-0.0197*	-0.0079**
	(0.0142)	(0.0118)	(0.0033)
Treatment, Intervention 2 × Time preferences, smaller-sooner choices	-0.0069	0.0035	0.0019
	(0.0105)	(0.0087)	(0.0024)
R-squared	0.3064	0.3109	0.3185
R-squared Adj.	0.0930	0.0989	0.1088

Standard errors in parentheses.

* p<.1, ** p<.05, *** p<.01

3.4.3.4. Mediation analysis

Finally, we conduct a mediation analysis of the treatments to assess whether any of the impact from the intervention was through a mediator variable related to inflation. For each treatment, we conduct a mediation analysis of the change in overall performance with the changes in: average qualitative perceptions, average qualitative expectations, average uncertainty, perception sensitivity, perception bias, expectation sensitivity, and expectation bias. Table 13 and Table 14 show the statistically significant results.

Intervention 1 demonstrates a mediation path ($p \leq 0.05$), whereby the treatment reduces uncertainty, which in turn improves performance. Intervention 2, however, demonstrates strictly a direct effect between the treatment and performance change outcome. As a result, we find that for Intervention 1, the change in inflation estimation uncertainty is a mediator. Further, this effect represents a full mediation ($p < 0.05$). Intervention 2, however, demonstrates a direct effect on the change in performance rather than mediation.

See Appendix G: Mediation analysis results for the full results.

Table 13 - Mediation analysis of Intervention 1 (abbreviated results)

Path	Coefficient	STE	p value
Change in average expectation uncertainty ~ Intervention 1	-0.08	0.03	0.02
Change in expectation sensitivity ~ Intervention 1	0.17	0.05	0.00
Change in final savings ~ Change in average expectation uncertainty	-0.30	0.08	0.00
Total	0.10	0.04	0.03
Direct	0.07	0.05	0.14
Indirect Change in average uncertainty	0.02	0.01	0.02

Table 14 - Mediation analysis of Intervention 2 (abbreviated results)

Path	Coefficient	STE	p value
Change in expectation sensitivity ~ Intervention 2	-0.09	0.05	0.06
Change in final savings ~ Change in average expectation uncertainty	-0.30	0.08	0.00
Total	0.17	0.04	0.00
Direct	0.20	0.04	0.00

4. Discussion

Considering the results described above, we first remark how these results bolster those of the previous experiment. See Section 3 of Lawrence et al. (2024). Comparing the present results to the results of the previous experiment's 4x30 sequence, we observe that final savings, over-stocking, and wasteful-stocking as a percentage of the maximum possible final savings all fall well within a standard deviation: 54% versus 48%, 19% versus 31%, and 9% versus 9% for the present and previous experiment respectively. The quantitative inflation sensitivity measures are quite similar (0.15 versus 0.12 and 0.57 versus 0.59 for expectations and perceptions in the present and previous experiment's 4x30 sequence respectively). We find similar correlations between the two experiments' 4x30 sequences for final savings and: perception bias in low inflation, perception sensitivity, and expectation bias in low inflation. For purchase adaptation, we find similar correlations for: perception bias in high inflation, expectation bias in high inflation, and expectation sensitivity. See Table 19 in Appendix D:

Supplemental results from previous experiment for all correlations from the previous experiment's 4x30 inflation sequence.

Additionally, the correlations between individual characteristics on the one hand and performance and inflation estimate measures on the other hand are generally similar too. In particular, the relationships between numerical abilities (i.e. numeracy and compound interest-capability) and performance as well as between consistency of economic decisions (i.e. number of switches) and performance are quite evident from both experiments. The results in our previous experiment regarding adaptability lack power to draw a firm conclusion on the characteristic's relation to Savings-Game performance. With a 48% larger sample size in the present study, we see much clearer positive correlations between performance and adaptability as well as negative correlation with perseverative errors.

The regressions of overall performance measures demonstrate the same relationships for perception sensitivity (see Table 4 and Table 5 as well as Table 18 in Appendix D: Supplemental results from previous experiment). Qualitative perception accuracy also exhibits a very strong and positive relationship ($p \leq 0.01$). Further, we observe other variables having statistically significant contributions to performance in this experiment. This difference may arise from the change in estimation elicitation method (slider versus survey-style) and thus precision. In fact, it is possible that the slider elicitation method acts somewhat as a hybrid between quantitative and qualitative, given the lower precision. In that case, a positive relationship with perception sensitivity in the previous experiment could be considered consistent with the positive relationship observed in the present experiment in terms of qualitative perceptions.

Similar to the previous experiment, we also observe a learning effect, although only in decreased wasteful-stocking, which is in fact the same magnitude as the previous experiment. In the previous, we observe a learning effect on final savings but not in the present experiment. Considering subjects complete twice as many rounds of the Savings Game in the previous experiment, this larger and statistically significant learning effect in the former is not surprising. Nevertheless, in the current shortened procedure, learning does seem to consistently occur between rounds. We further observe what is essentially a learning effect within the control group, whereby they increase their over-stocking cost. This too is consistent with results from the previous experiment; we consider this counter-productive learning effect a natural, pessimistic reaction to the experience of the previous round(s).

We consider the clear similarity between results of the two experiments a clear reflection of the replicability of the Savings Game. This is especially encouraging considering the critical importance of experimental replicability for scientific progress and the challenges the literature currently faces in reproducing results. In fact, a recent study of 100 psychology experiments published in the top three psychology journals manage to reproduce results simply in the same direction for 36% of all the experiments (Camerer et al., 2016). The same is true for economics. In systematically replicating 18 economics experiments from the *American Economic Review* and the *Quarterly Journal of Economics*, Camerer et al. (2016) reproduce results in the same direction as the original for 61% of the experiments (11 experiments). Overall, the results across our two experiments are consistent with the baseline replicability.

We now examine the results in regards to the hypotheses tested that:

1. individuals' inflation survey responses
    a. correlate with their in-task economic behaviors as well as that
    b. qualitative inflation-estimate (perceptions and expectations) and estimation-uncertainty measures correlate better with in-task economic behavior than quantitative measures;
2. across a wide array of individual characteristics related to financial education and behavioral economics, the primary indicators of in-task performance are numeracy, adaptability, and consistency of economic decision-making; and
3. an intervention with dynamic performance-based feedback can improve performance in the Savings Game.

4.1. Hypothesis 1

For Hypothesis 1a, the regression of subjects' average quantity purchased in given intervals on qualitative and quantitative estimations reveals some degree of decision-making predictability. We do indeed find that, of the inflation estimation variables, qualitative expectations in the first interval ($1 \leq t \leq 12$) are the strongest predictor of average quantity purchased during that interval ($p < 0.1$). In the second interval ($12 < t \leq 24$), quantitative perceptions are the strongest predictor ($p < 0.1$) as are quantitative expectations in the third interval ($p \leq 0.1$). A key challenge of assessing the relationship between decision-making and inflation internalization is that when subjects demonstrate significant over-stocking, they must ultimately purchase few quantities throughout the rest of the round of the Savings Game,

limiting the degree of behavioral change for the model to explain. Nevertheless, the results provide some initial evidence that the survey responses correlate to behavior on a period-by-period basis.

The regressions of performance measures (Table 4 and Table 5) demonstrate that the measures based off subjects' survey responses correlate with their overall performance behavior. In particular, subjects who demonstrate greater expectation sensitivity save more ($p \leq 0.05$) while over-stocking less ($p \leq 0.1$). Those with greater perception sensitivity also save more ($p \leq 0.01$) while wasteful-stocking less ($p \leq 0.01$).

Alternatively, subjects who qualitatively anticipate inflation more accurately, save more ($p \leq 0.01$) and wasteful-stock less ($p \leq 0.1$), while those who qualitatively perceive inflation more accurately perform save more ($p \leq 0.01$) and wasteful-stock less ($p \leq 0.01$). Additionally, subject who exhibit greater uncertainty in their expectation estimations save less ($p \leq 0.05$) and wasteful-stock more ($p \leq 0.01$).

Moreover, regarding Hypothesis 1b, we observe that the models of qualitative and uncertainty measures provide greater explanatory power than the quantitative measures for final savings and wasteful-stocking. For over-stocking, only (quantitative) expectation sensitivity demonstrates predictive power.

Being the case, we interpret these results as a validation that inflation survey responses, and particularly measures based off of the responses, offer predictability of behavior. We additionally conclude that qualitative inflation estimates and inflation estimation uncertainty are better predictors of overall behavior than quantitative inflation estimates.

Future research with the Savings Game could aim to better understand the early over-stocking tendency and underlying pessimism about inflation, which appears at the beginning of each round of the Savings Game in both experiments. The persistent difficulty in directly linking estimations to purchase decisions that arises from severe over-stocking, though, presents a challenge to be addressed through new variations of inflation sequences and/or designs of the Savings Game.

In summary, the results provide support for Hypotheses 1a and 1b.

4.2. Hypothesis 2

Similar to our previous experiment, we do find that numerical abilities and economic-decision consistency are the primary individual characteristics that relate to stronger performance in

the Savings Game. We also find evidence that adaptability is a strong indicator too. This hypothesis is validated both by the correlations between these characteristics and the in-task performance and inflation internalization measures as well as the OLS regression on individual characteristics.

Our results, therefore, also support Hypothesis 2.

4.3. Hypothesis 3

We find that both interventions have a positive impact on performance. Compared to the lack of general impact from the simple intervention in our previous experiment with no feedback, we find that performance-based feedback coupled with more pragmatic recommendations demonstrates a clear improvement on performance.

Per the difference-in-difference (Table 9) and OLS regression (Table 10) analyses, Intervention 1 demonstrates less impact on overall performance than Intervention 2; however, Intervention 1 does show positive impact on auxiliary factors: qualitative perception accuracy, expectation sensitivity, and uncertainty. We observe a similar pattern in the mediation analysis, Intervention 1 appears to produce impact by reducing the uncertainty, which subsequently improves performance. Intervention 2, on the other hand, demonstrates no mediator relationship. Rather, Intervention 2's effect on performance is direct. This is surprising considering that although both interventions explain how to estimate inflation, Intervention 2 places greater emphasis on the explanation. One possible interpretation of the lack of a mediation through decreased uncertainty may suggest that Intervention 1's simpler explanation of inflation estimation is more effective in reducing subjects' uncertainty.

Nevertheless, the more detailed process that Intervention 2 provides subjects overall—emphasizing the origin of the opportunity costs associated with each mistake—clearly has a significant direct effect on their performance. As such, we conclude that performance-based feedback is necessary to improve performance, estimation explanations should be straightforward, and the origins of opportunity costs as they relate to the possible mistakes are necessary to ensure subjects internalize an intervention's recommendations.

Our results support Hypothesis 3 as well, therefore.

4.4. General analysis

The results of the present experiment, and in fact the previous experiment as well, reinforce the difficulty that individuals face in perceiving and anticipating (i.e. internalizing) inflation.

We also find reaffirming evidence that individuals' internalizations of inflation play a key role in their consumption and savings decisions. In our previous experiment in Lawrence et al. (2024), we find evidence of the positive relationship between the accuracy of subjects' inflation perceptions and expectations and their performance. Our new results reinforce this relationship as well as reveal a broader connection between performance and inflation internalization, demonstrating the important role that qualitative internalizations and uncertainty play. Indeed, the stronger relationships we find between qualitative internalizations and performance suggest that compared to their quantitative percentage estimates, household consumers' intuitions on inflation may be both more accurate reflections of the inflation they perceive and expect as well as a better predictor of their behavior.

Reinforcing the relationship between how individuals internalize inflation and ultimately make decisions, therefore, also underscores the importance of providing them sufficient information to better perceive and anticipate inflation. This may be especially important considering the adaptive, rather than rational, expectations they demonstrate (Rocheteau, 2023). As our interventions suggest, ensuring individuals understand inflation's impact on purchasing power and the real interest rate facilitates better decision-making. Thus, communication from central banks on inflation is clearly important, and tools such as simulators of personal inflation rates based on individuals' unique consumption basket are helpful. Being so, communication and information on the real interest rate is, nonetheless, rarely discussed or readily made available for household consumers. Indeed, although governments, banks, and the press communicated the increase in nominal interest rates on savings accounts during the most recent rise in inflation in developed economies, knowing the real interest rate, which remained negative, required households to personally calculate it.

Additionally, the replicability that we demonstrate between the previous experiment in Lawrence et al. (2024) and the present is encouraging. As alluded to above, the replicability challenge across research fields that is increasingly coming to light poses a significant risk to scientific progress. Not only does research into the replicability of psychology and economics research reveal pronounced difficulty in reproducing results, but the findings also emphasize the need across the literature to develop experimental tasks and procedures that can be easily adopted by other researchers (Camerer et al., 2016). For this reason, the Savings Game is freely available for use at https://github.com/o-nate/savings-game and may be freely tested at https://savings-game.onrender.com (Lawrence, 2024b, 2024a).

Further, as Camerer et al. (2016) postulate, economics experiments may demonstrate greater replicability than psychological ones through proper incentivization—offering appropriate financial remuneration to motivate subjects. We find that the Savings Game achieves this incentivization as well, in particular by tying remuneration to subjects' savings rather than consumption. Doing so both more closely simulates the decision-making process subjects face in real life—where saving money can itself produce utility—as well as consolidate the in-task inflation's insidious effect, facilitating subjects' inflation internalization.

Finally, given the replicability of the Savings Game, there are a number of directions that future research can take in applying and varying the experimental task. For one, testing new inflation sequences offers a straightforward path. New sequences can allow us to study the role that variance in inflation plays on behavior as well as how deflation may impact behavior. We can also add new levels of complexity to the Savings Game as a means of approaching decisions that subjects more commonly face in real life, such as including additional goods, offering credit, or simulating monetary policy by adjusting the interest rate. Informational—rather than educational—interventions approaches might also be tested, such as providing the inflation rate or even the real interest rate on the screen. The possibility of informational interventions also raises the question of what information subjects pay attention to or utilize most during the Savings Game. Eye-tracking technology offers one option for tracking attention. Another, simpler method is to implement the Mouselab programming language within the interface, hiding each piece of information on the screen behind individual boxes, requiring the subject to click on each to reveal the information while measuring the order and amount of time spent collecting each piece of information (Gabaix et al., 2003).

As such, the Savings Game, and experimental methods of inflation research generally, offer a number of future possibilities not just for understanding how rising prices affect household consumers' behavior, but for uncovering the underlying relationships contributing to consumption and savings decision-making as well as effective methods to help households develop more productive financial habits and attain greater financial security.

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Appendix A: Interventions[14]

Intervention 1

Your performance

We would like to take a moment to reflect on your performance. The maximum that could have been achieved was {{max_performance}}. Your final {{savings_account}} balance was {{performance}}.

You earned {{percent_max}}% of the maximum.

Improving your performance

On the following pages, we will explore how you can improve your performance to maximize your savings.

Comprehension questions

You must also answer some questions to confirm you understand the new information.

Cost of mistakes

The difference between the maximum amount and the amount you earned represents the cost of mistakes during the game. Your cost was XXXX.

There are three mistakes that can occur:

- Stocking up too early
- Not stocking up enough
- Stocking up too much

Timing

Stocking up at the appropriate time requires recognizing when the price of Food is changing by less or more than the interest earned. The interest rate is 1.9%, so if the price of Food increases by more than 1.9% ("high inflation"), you should buy more than one unit of Food. This is because the price of Food is increasing faster than your savings account is accruing

[14] For hands-on demos of Intervention 1 and Intervention 2, visit https://savings-game.onrender.com/demo/intervention_1 and https://savings-game.onrender.com/demo/intervention_2 respectively.

interest. Otherwise, you are in low inflation, and your savings account is accruing faster than the price of Food is increasing.

For example, if the price last month was ₮10.00 and the new price is ₮10.30, then the price has increased by 3.0%. This is high inflation. You should buy more than one unit ("stock up").

But, if the price last month was ₮10.00 and the new price is ₮10.10, then the price has increased by 1.0%. This is low inflation. You should buy one unit.

Comprehension

If the price of Food increased from ₮12.00 to ₮12.12, are you in high or low inflation?

- High
- Low

Stocking too early

This occurs when you buy more than one unit during low inflation. This lowers your savings account balance more than necessary. While you may avoid some price increase, you sacrifice more money to earn interest than you save.

Do you think any of your cost was due to stocking too early?

- Yes
    - True
        - That is correct. It is important to resist the urge to stock up and sacrifice interest that can be earned. In the future, check whether you are in high or low inflation before stocking up.
    - False
        - It appears that you did not have any opportunity cost due to stocking too early.
- No
    - True
        - It appears that you did not have any opportunity cost due to stocking too early.
    - False

        - It appears that you did have opportunity cost due to stocking too early. It is important to resist the urge to stock up and sacrifice interest that can be earned. In the future, check whether you are in high or low inflation before stocking up.
- Maybe
    - True
        - It appears that you did have opportunity cost due to stocking too early. It is important to resist the urge to stock up and sacrifice interest that can be earned. In the future, check whether you are in high or low inflation before stocking up.
    - False
        - It appears that you did not have any opportunity cost due to stocking too early. It is important to resist the urge to stock up and sacrifice interest that can be earned. In the future, check whether you are in high or low inflation before stocking up.

Are you convinced that you incurred cost due to stocking too early?

- Yes
- No

Not stocking enough

This occurs when you do not buy enough units in the beginning of high inflation. While you may maintain a higher balance to earn interest, you pay even more for Food than you earn in interest.

Do you think any of your opportunity cost was due to not stocking enough?

- Yes
    - True
        - That is correct. It is important to act decisively when high inflation appears. Remember to pay attention to prices to check whether you are in high or low inflation.
    - False
        - It appears that you did not have any opportunity cost due to not stocking enough.

- No
    - True
        - It appears that you did not have any opportunity cost due to not stocking enough.
    - False
        - It appears that you did have opportunity cost due to not stocking enough. It is important to act decisively when high inflation appears. Remember to pay attention to prices to check whether you are in high or low inflation.
- Maybe
    - True
        - It appears that you did have opportunity cost due to not stocking enough. It is important to act decisively when high inflation appears. Remember to pay attention to prices to check whether you are in high or low inflation.
    - False
        - It appears that you did not have any opportunity cost due to not stocking enough. It is important to act decisively when high inflation appears. Remember to pay attention to prices to check whether you are in high or low inflation.

Are you convinced that you incurred cost due to not stocking enough?

- Yes
- No

Stocking too much

This occurs when you buy more Food than necessary to survive until the end of the game. You spend more money than necessary and sacrifice interest that money could have earned.

Do you think any of your opportunity cost was due to stocking too much?

- Yes
    - True

        - That is correct. It is important to pay attention to how much stock you need to survive through Month {{NUM_ROUNDS}}. Your stock should never be greater than {{NUM_ROUNDS}} + 1.
    - False
        - It appears that you did not have any opportunity cost due to stocking too much.
- No
    - True
        - It appears that you did not have any opportunity cost due to stocking too much.
    - False
        - It appears that you did have opportunity cost due to stocking too much. It is important to pay attention to how much stock you need to survive through Month {{NUM_ROUNDS}}. Your stock should never be greater than {{NUM_ROUNDS}} + 1.
- Maybe
    - True
        - It appears that you did have opportunity cost due to stocking too much. It is important to pay attention to how much stock you need to survive through Month {{NUM_ROUNDS}}. Your stock should never be greater than {{NUM_ROUNDS}} + 1.
    - False
        - It appears that you did not have any opportunity cost due to stocking too much.

Are you convinced that you incurred [no] cost due to stocking too much?

- Yes
- No

Intervention 2

Tips to improve your performance

Let’s take a moment to think about your performance. The maximum performance that could have been achieved is {{max_performance}}. The final balance of your savings account was {{performance}}.

You have gained {{percent_max}}% of the maximum performance.

On the following pages, we’ll explain how you can improve your performance to maximize your earnings.

We’ll ask you a few questions to check your understanding of the advice provided.

Mistakes that reduce performance

The difference between the maximum win and your win comes from several types of purchasing decision errors during the game. Your performance loss is {{max_performance - performance}}.

Three types of mistakes can occur:

- Stocking up too early
- Stocking up too little or too late
- Stocking up too much

We’ll consider the first two first.

The interest rate is 1.9% per month. If the price of food rises by less than 1.9% each month, inflation is lower than the interest rate, and in this case, you don’t need to stock up, you need to buy only the unit of food you need to survive. This is because the interest you accumulate in your savings account rises faster than the price of food, and you gain more by letting your money grow in your savings account than by tying it up in a food stock up. Stocking up on food when inflation is lower than the interest rate is what we call **stocking up too soon**.

Conversely, when the inflation rate is higher than the interest rate, you should stock up (buy more than one unit of food) because the price of food rises faster than the interest accumulated in your savings account. Not stocking up in this situation is what we call **stocking up too little or too late**.

How to identify the inflation phase

To identify the inflation phase, you need to pay attention to the variation in the price of a unit of food and compare it with the interest rate.

To find out whether inflation is higher or lower than the interest rate, we need to track price trends. If last month's price was ₮10.00 and the new price for the current month is ₮10.10, then the price has risen by 1.0%. Inflation is lower. You need to buy only the unit of food you need to survive. If you already have a stock, don't bother buying.

If the price of a unit of food last month was ₮10.00 and the new price is ₮10.30, then the price has risen by 3.0%. Inflation is higher. You should buy more than one unit ("stock up").

Comprehension

If the price of a unit of food has risen from ₮12.00 to ₮12.12, are you in a period of?

- Inflation higher than the 1.9% interest rate
- Inflation lower than the 1.9% interest rate

Why shouldn't we stock up when inflation is low?

When inflation is lower than the interest rate, buying food in advance that you won't consume until later costs you money.

For example, suppose you want to buy ₮10.00 a unit that you won't consume until 12 months later, when inflation over those 12 months will be 1% per month. Instead of buying this unit, it would be better to leave this sum in your savings account.

At the end of 12 months with an interest rate of 1.9% per month (i.e. 25% over 12 months), you have ₮12.50 in your savings account. However, the price of food has only risen by 12.7%. The price is therefore ₮11.27. Buying the unit at this price in 12 months' time gives you a gain of ₮12.50 - ₮11.27 = ₮1.23, which will continue to earn you interest for the remaining time.

To give you an idea of how your savings and prices will evolve over time:

- with an **interest rate** of 1.9% per month, the sum invested doubles after **36 months**
- with an **inflation rate** of 1% per month, the price doubles after **70 months**

Comprehension

Do you think part of your performance loss is due to having stocked up too early?

- Yes
- No
- Maybe

Feedback to responses:

Yes

- *True*
    - *That is correct. It is important to resist the urge to stock up and sacrifice interest that can be earned. In the future, check whether you are in high or low inflation before stocking up.*
- *False*
    - *It appears that you did not have any opportunity cost due to stocking too early.*

No

- *True*
    - *It appears that you did not have any opportunity cost due to stocking too early.*
- *False*
    - *It appears that you did have opportunity cost due to stocking too early. It is important to resist the urge to stock up and sacrifice interest that can be earned. In the future, check whether you are in high or low inflation before stocking up.*

Maybe

- *True*
    - *It appears that you did have opportunity cost due to stocking too early. It is important to resist the urge to stock up and sacrifice interest that can be earned. In the future, check whether you are in high or low inflation before stocking up.*
- *False*
    - *It appears that you did not have any opportunity cost due to stocking too early. It is important to resist the urge to stock up and sacrifice interest that can be earned. In the future, check whether you are in high or low inflation before stocking up.*

Note: The 12-month interest rate is 25% (1.9% per month). If you estimate that the 12-month inflation rate is less than 25%, you should not stock up.

Are you convinced that [you have sustained no losses | you have sustained losses] as a result of stocking up too early?

- Yes

- No

Why should we stock up during a period of high inflation?

When inflation is higher than the interest rate, you lose money by not stocking up on food in advance.

For example, suppose the price of a unit of food is ₮10.00 and you prefer not to anticipate the purchase of the unit you will consume 12 months later when inflation over those 12 months will be 3% per month. You leave ₮10.00 in your savings account, which after 12 months with an interest rate of 1.9% per month, i.e. 25% over 12 months, will become ₮12.50 in your savings account. Now the price of food has risen by 42.6%, and the price is ₮14.26. You're short ₮14.26 - ₮12.50 = ₮1.76, which you'll have to dip into your savings.

To give you an idea of how your savings and prices will evolve over time:

- with an **interest rate** of 1.9% per month, the sum invested doubles after **36 months**
- with **inflation** at 3% per month, the price doubles after **24 months**

Comprehension

Do you think that part of your performance loss is due to stocking up too little or too late?

- Yes
- No
- Maybe

Feedback to responses:

Yes

- *True*
    - *That is correct. It is important to act decisively when high inflation appears. Remember to pay attention to prices to check whether you are in high or low inflation.*
- *False*
    - *It appears that you did not have any opportunity cost due to stocking too little or too late.*

No

- *True*

    - *It appears that you did not have any opportunity cost due to stocking too little or too late.*
- *False*
    - *It appears that you did have opportunity cost due to stocking too little or too late. It is important to act decisively when high inflation appears. Remember to pay attention to prices to check whether you are in high or low inflation.*

Maybe

- *True*
    - *It appears that you did have opportunity cost due to stocking too little or too late. It is important to act decisively when high inflation appears. Remember to pay attention to prices to check whether you are in high or low inflation.*
- *False*
    - *It appears that you did not have any opportunity cost due to stocking too little or too late. It is important to act decisively when high inflation appears. Remember to pay attention to prices to check whether you are in high or low inflation.*

Note: The 12-month interest rate is 25% (1.9% per month). If you estimate that the 12-month inflation rate is higher than 25%, you should store.

Are you convinced that [you incurred no losses OR you did incur losses] due to insufficient or too-late stock?

- Yes
- No

Small mistakes, big losses

The previous two examples may not seem so important to you in terms of losses. But by repeating these mistakes, you can accumulate significant losses.

Now let’s look at the third possible mistake: stocking up too much.

This happens when you buy more units of food than you need to survive to the end of the game. You spend more than you need to and sacrifice the interest your savings could have earned.

If you're in month T, the total amount of food you'll need to survive is 121 - T. It's unnecessary and costly to stock up more.

Comprehension

Do you think part of your loss is due to stocking up too much?

- Yes
- No
- Maybe

Feedback to responses:

Yes

- *True*
    - *That is correct. It is important to pay attention to how much stock you need to survive through Month {{NUM_ROUNDS}}. Your stock should never be greater than {{NUM_ROUNDS}} + 1.*
- *False*
    - *It appears that you did not have any opportunity cost due to stocking too much.*

No

- True
    - It appears that you did not have any opportunity cost due to stocking too much.
- False
    - It appears that you did have opportunity cost due to stocking too much. It is important to pay attention to how much stock you need to survive through Month {{NUM_ROUNDS}}. Your stock should never be greater than {{NUM_ROUNDS}} + 1.

Maybe

- *True*
    - *It appears that you did have opportunity cost due to stocking too much. It is important to pay attention to how much stock you need to survive through Month {{NUM_ROUNDS}}. Your stock should never be greater than {{NUM_ROUNDS}} + 1.*
- *False*
    - *It appears that you did not have any opportunity cost due to stocking too much.*

Are you convinced that [you incurred no losses | you have incurred losses] due to stocking up too much?

- Yes
- No

Appendix B: Descriptive statistics

Table 15 - Descriptive statistics of subjects

	Mean	Standard deviation	Minimum	50%	Maximum
Age	32.43	8.38	18.00	30.50	59.00
Gender (% female)	51	—	—	—	—
Education level	2.58	—	0.00	3.00	4.00
Employment status	1.07	—	0.00	1.00	4.00
Monthly income	2.29	—	0.00	2.00	5.00
Ability to save (% able)	81	—	0.00	1.00	1.00
Monthly savings	2.85	—	0.00	3.00	7.00
Acquired debt in last 12 month (%)	14	—	0.00	0.00	1.00
Amount of debt held	0.69	—	0.00	0.00	7.00
Holds stocks (%)	32	—	0.00	0.00	1.00
Holds mutual funds (%)	6	—	0.00	0.00	1.00
Holds bonds (%)	8	—	0.00	0.00	1.00
Holds savings accounts (%)	87	—	0.00	1.00	1.00
Holds life insurance (%)	40	—	0.00	0.00	1.00
Holds retirement accounts (%)	16	—	0.00	0.00	1.00
Holds cryptocurrencies (%)	21	—	0.00	0.00	1.00

Appendix C: Results of inflation measures

Table 16 - Correlation matrix: Inflation measures

	Qualitative perception, low inflation	Qualitative perception, high inflation	Qualitative expectation, low inflation	Qualitative expectation, high inflation	Avg Qualitative perception Accuracy	Avg Qualitative expectation Accuracy	Average Uncertain Expectation	Perception bias, high inflation	Perception bias, low inflation	Perception sensitivity	Expectation bias, high inflation	Expectation bias, low inflation	Expectation sensitivity	Purchase adaptation	Purchase adaptation (%)	Final savings
Qualitative perception, low inflation	1.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Qualitative perception, high inflation	0.09	1.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Qualitative expectation, low inflation	0.3***	0.36***	1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
Qualitative expectation, high inflation	0.21***	0.43***	0.5***	1.0	—	—	—	—	—	—	—	—	—	—	—	—
Avg Qualitative perception Accuracy	-0.47***	0.74***	0.15*	0.19**	1.0	—	—	—	—	—	—	—	—	—	—	—
Avg Qualitative expectation Accuracy	0.12	0.31***	0.42***	0.7***	0.13	1.0	—	—	—	—	—	—	—	—	—	—
Average Uncertain Expectation	0.11	0.4***	0.35***	0.17**	0.27***	0.16**	1.0	—	—	—	—	—	—	—	—	—
Perception bias, high inflation	-0.04	0.46***	0.27***	0.17**	0.37***	0.12	0.49***	1.0	—	—	—	—	—	—	—	—
Perception bias, low inflation	0.56***	-0.06	0.25***	0.05	-0.39***	0.02	0.29***	0.32***	1.0	—	—	—	—	—	—	—
Perception sensitivity	-0.44***	0.64***	0.12	0.25***	0.71***	0.19**	0.22***	0.44***	-0.34***	1.0	—	—	—	—	—	—
Expectation bias, high inflation	0.05	0.35***	0.37***	0.46***	0.24***	0.29***	0.46***	0.78***	0.28***	0.31***	1.0	—	—	—	—	—
Expectation bias, low inflation	0.34***	0.02	0.44***	0.12	-0.19**	0.11	0.44***	0.42***	0.82***	-0.14*	0.43***	1.0	—	—	—	—

Expectation sensitivity	-0.07	0.38***	0.04	0.24***	0.34***	0.24***	0.17**	0.18**	-0.18**	0.36***	0.2**	-0.22***	1.0	—	—	—
Purchase adaptation	-0.02	0.13	0.1	0.14*	0.11	0.15*	0.07	0.18**	0.01	0.1	0.26***	0.04	0.16**	1.0	—	—
Purchase adaptation (%)	-0.05	0.12	0.07	0.12	0.13	0.13	0.06	0.17**	-0.04	0.1	0.25***	-0.01	0.18**	0.97***	1.0	—
Final savings	-0.22***	0.27***	0.12	0.19**	0.36***	0.26***	-0.02	0.15*	-0.24***	0.29***	0.21***	-0.15*	0.26***	0.47***	0.48***	1.0

Table 17 - Quantitative estimate statistics

		High inflation	Low inflation
Quantitative perception estimates	Mean	22.22	5.42
	Std	23.85	11.66
Quantitative expectation estimates	Mean	15.81	6.21
	Std	21.84	12.60

Appendix D: Supplemental results from previous experiment[17]

Table 18 - OLS regressions of performance measures for 4x30 inflation sequence, pre-treatment

Variables	(1) Final savings (%)	(2) Over-stock (%)	(3) Wasteful-stock (%)
Intercept	0.3342***	0.4038***	0.1952***
	(0.0489)	(0.0562)	(0.0389)
Expectation sensitivity	-0.0307	-0.1170	0.1268**
	(0.0648)	(0.0745)	(0.0515)
Expectation bias	-0.0001	0.0007	0.0006
	(0.0012)	(0.0014)	(0.0010)
Perception sensitivity	0.2481***	-0.1107	-0.2104***
	(0.0711)	(0.0817)	(0.0565)
Perception bias	0.0003	0.0004	-0.0005
	(0.0008)	(0.0009)	(0.0006)
R-squared	0.1149	0.0547	0.1612
R-squared Adj.	0.0788	0.0161	0.1270

Standard errors in parentheses.

* p<.1, ** p<.05, *** p<.01

Table 19 - Correlation matrix: Inflation measures (4x30 sequence)

	Perception bias, high inflation	Perception bias, low inflation	Perception sensitivity	Expectation bias, high inflation	Expectation bias, low inflation	Expectation sensitivity	Purchase adaptation	Purchase adaptation (%)	Final savings
Perception bias, high inflation	1.0	—	—	—	—	—	—	—	—
Perception bias, low inflation	0.61***	1.0	—	—	—	—	—	—	—
Perception sensitivity	0.29***	-0.36***	1.0	—	—	—	—	—	—
Expectation bias, high inflation	0.79***	0.56***	0.16***	1.0	—	—	—	—	—
Expectation bias, low inflation	0.62***	0.71***	-0.09***	0.79***	1.0	—	—	—	—
Expectation sensitivity	0.07**	-0.13***	0.11***	0.08***	-0.27***	1.0	—	—	—
Purchase adaptation	0.27***	0.14***	0.18***	0.19***	0.07**	0.16***	1.0	—	—
Purchase adaptation (%)	0.31***	0.21***	0.15***	0.19***	0.08***	0.14***	0.91***	1.0	—
Final savings	0.01	-0.09***	0.19***	-0.07**	-0.07**	0.05	0.15***	0.18***	1.0

[17] See Lawrence, N., Guille, M., & Vergnaud, J.-C. (n.d.). *Inflation and Behavior: An Experimental Analysis* (LEMMA Working Paper) [Working Paper]. Université Paris-Panthéon-Assas, LEMMA.

Appendix E: Results of individual characteristic measures

Table 20 - Knowledge measures

	Distribution of subject
Financially literate	51%
Numerate	30%
Compound interest-capable	47%

Table 21 - Economic preference task results

	Mean	Standard deviation	Minimum	50%	Maximum
Loss aversion, coin tosses	2.40	1.43	0.00	2.00	6.00
Loss aversion, switches	1.11	0.68	0.00	1.00	4.00
Risk aversion, safe choices	5.68	1.88	0.00	6.00	10.00
Risk aversion, switches	1.42	1.24	0.00	1.00	7.00
Time preferences, smaller-sooner choices	7.64	4.50	1.00	7.00	20.00
Time preferences, switches	2.14	1.23	0.00	2.00	12.00
WCST, number correct	17.08	6.32	1.00	18.00	25.00
WCST, perseverative errors	4.34	4.86	0.00	3.00	25.00
WCST, set-loss errors	1.82	2.06	0.00	1.00	10.00

Table 22 - Correlations: Knowledge measures and in-task performance measures

Measure	Performance measure	Correlation
Financially literate	Total savings	0.26
Financially literate	Wasteful-stocking	-0.28
Numerate	Total savings	0.27
Numerate	Purchase adaptation	0.24
Compound interest-capable	Total savings	0.33
Compound interest-capable	Wasteful-stocking	-0.27
Compound interest-capable	Purchase adaptation	0.24

Table 23 - Correlations: Economic preference measures and in-task performance measures

Measure	Performance measure	Correlation
Risk aversion, switches	Total savings	-0.28
Risk aversion, switches	Wasteful-stocking	0.32
Time preferences, switches	Total savings	-0.33
Time preferences, switches	Wasteful-stocking	0.37
WCST, number correct	Total savings	0.28
WCST, number correct	Wasteful-stocking	-0.28
WCST, perseverative errors	Total savings	-0.28
WCST, perseverative errors	Wasteful-stocking	0.30

Table 24 - Correlations: Knowledge measures and in-task inflation measures

Measure	Inflation measure	Correlation
Numerate	Perception sensitivity	0.24

Table 25 - Correlations: Time preferences and in-task inflation measures

Measure	Inflation measure	Correlation
Time preferences, switches	Perception sensitivity	-0.23

Table 26 - Correlations: Wisconsin card sorting task and in-task inflation measures

Measure	Inflation measure	Correlation
WCST, number correct	Perception sensitivity	0.24
WCST, perseverative errors	Perception sensitivity	-0.24

Table 27 - Correlations: Knowledge measures and in-task qualitative inflation measures

Measure	Inflation measure	Correlation
Numerate	Avg qualitative perception accuracy	0.26

Table 28 - Correlations: Time preferences and in-task qualitative inflation measures

Measure	Inflation measure	Correlation
Time preferences, smaller-sooner choices	Avg qualitative perception accuracy	-0.28
Time preferences, switches	Avg qualitative expectation accuracy	-0.22

Table 29 - Correlations: Wisconsin card sorting task and in-task qualitative inflation measures

Measure	Inflation measure	Correlation
WCST, number correct	Avg qualitative expectation accuracy	0.30
WCST, perseverative errors	Avg qualitative expectation accuracy	-0.29

Appendix F: Ordinary least squares regression of individual characteristics and treatment

Table 30 - OLS regressions: Change in performance on treatment and individual characteristics

Variables	(1) Final savings (%)	(2) Over-stocking (%)	(3) Wasteful-stocking (%)
Intercept	-0.2145	0.1981	-0.1085
	(0.3358)	(0.2771)	(0.0769)
Treatment, Control × Financially literate	-0.0755	-0.0006	-0.0060
	(0.1137)	(0.0938)	(0.0260)
Treatment, Intervention 1 × Financially literate	-0.1660	0.1020	-0.0083
	(0.1211)	(0.0999)	(0.0277)
Treatment, Intervention 2 × Financially literate	-0.0525	-0.0021	0.0034
	(0.1037)	(0.0855)	(0.0237)
Treatment, Control × Numerate	0.0057	-0.1123	0.0253
	(0.1623)	(0.1339)	(0.0372)
Treatment, Intervention 1 × Numerate	-0.0576	0.0616	-0.0115
	(0.1347)	(0.1111)	(0.0308)
Treatment, Intervention 2 × Numerate	-0.0095	-0.0067	0.0295
	(0.1017)	(0.0839)	(0.0233)
Treatment, Control × Compound	0.1434	-0.0755	0.0078
	(0.1205)	(0.0994)	(0.0276)
Treatment, Intervention 1 × Compound	0.2122	-0.1160	0.0202
	(0.1363)	(0.1124)	(0.0312)
Treatment, Intervention 2 × Compound	-0.0120	0.0527	0.0090
	(0.1020)	(0.0842)	(0.0234)
Treatment, Control × WCST, number correct	-0.0012	0.0023	0.0023
	(0.0148)	(0.0122)	(0.0034)
Treatment, Intervention 1 × WCST, number correct	-0.0013	0.0007	0.0021
	(0.0123)	(0.0102)	(0.0028)
Treatment, Intervention 2 × WCST, number correct	0.0215	-0.0174	0.0041
	(0.0149)	(0.0123)	(0.0034)
Treatment, Control × WCST, set-loss errors	-0.0110	0.0147	-0.0032
	(0.0266)	(0.0219)	(0.0061)
Treatment, Intervention 1 × WCST, set-loss errors	-0.0711**	0.0372	0.0099
	(0.0313)	(0.0258)	(0.0072)
Treatment, Intervention 2 × WCST, set-loss errors	-0.0027	-0.0104	0.0027
	(0.0250)	(0.0207)	(0.0057)
Treatment, Control × WCST, perseverative errors	-0.0027	0.0056	-0.0016
	(0.0177)	(0.0146)	(0.0040)
Treatment, Intervention 1 × WCST, perseverative errors	-0.0044	0.0064	-0.0005
	(0.0176)	(0.0145)	(0.0040)
Treatment, Intervention 2 × WCST, perseverative errors	0.0243	-0.0254	0.0064
	(0.0206)	(0.0170)	(0.0047)
Treatment, Control × Risk aversion, safe choices	0.0217	-0.0218	0.0043
	(0.0291)	(0.0240)	(0.0067)
Treatment, Intervention 1 × Risk aversion, safe choices	0.0109	-0.0356	0.0196***
	(0.0274)	(0.0226)	(0.0063)
Treatment, Intervention 2 × Risk aversion, safe choices	-0.0120	0.0178	-0.0027
	(0.0278)	(0.0229)	(0.0064)
Treatment, Control × Risk aversion, switches	0.0949**	-0.0985**	0.0109
	(0.0479)	(0.0395)	(0.0110)

Treatment, Intervention 1 × Risk aversion, switches	-0.0625	0.0465	0.0068
	(0.0512)	(0.0422)	(0.0117)
Treatment, Intervention 2 × Risk aversion, switches	-0.0441	0.0444	-0.0057
	(0.0506)	(0.0417)	(0.0116)
Treatment, Control × Loss aversion, coin tosses	0.0009	-0.0013	0.0017
	(0.0350)	(0.0289)	(0.0080)
Treatment, Intervention 1 × Loss aversion, coin tosses	0.0213	-0.0119	0.0047
	(0.0358)	(0.0295)	(0.0082)
Treatment, Intervention 2 × Loss aversion, coin tosses	-0.0086	-0.0039	0.0041
	(0.0457)	(0.0377)	(0.0105)
Treatment, Control × Loss aversion, switches	0.0371	-0.0795	0.0426***
	(0.0643)	(0.0531)	(0.0147)
Treatment, Intervention 1 × Loss aversion, switches	0.0753	-0.0086	-0.0436**
	(0.0927)	(0.0765)	(0.0212)
Treatment, Intervention 2 × Loss aversion, switches	0.0359	0.0083	-0.0097
	(0.0938)	(0.0774)	(0.0215)
Treatment, Control × Time preferences, smaller-sooner choices	-0.0231*	0.0165	-0.0004
	(0.0135)	(0.0112)	(0.0031)
Treatment, Intervention 1 × Time preferences, smaller-sooner choices	0.0407***	-0.0197*	-0.0079**
	(0.0142)	(0.0118)	(0.0033)
Treatment, Intervention 2 × Time preferences, smaller-sooner choices	-0.0069	0.0035	0.0019
	(0.0105)	(0.0087)	(0.0024)
Treatment, Control × Time preferences, switches	-0.0352	0.0869	-0.0138
	(0.1511)	(0.1247)	(0.0346)
Treatment, Intervention 1 × Time preferences, switches	0.0077	-0.0027	-0.0005
	(0.0316)	(0.0261)	(0.0072)
Treatment, Intervention 2 × Time preferences, switches	0.0292	-0.0321	-0.0039
	(0.0538)	(0.0444)	(0.0123)
R-squared	0.3064	0.3109	0.3185
R-squared Adj.	0.0930	0.0989	0.1088

Standard errors in parentheses.

* p<.1, ** p<.05, *** p<.01

Appendix G: Mediation analysis results

Table 31 - Mediation analysis of control

Path	Coefficient	STE	p value
Change in average qualitative perceptions ~ Control	-0.02	0.02	0.31
Change in average qualitative expectations ~ Control	0.02	0.02	0.45
Change in average expectation uncertainty ~ Control	0.03	0.03	0.39
Change in perception sensitivity ~ Control	0.03	0.04	0.44
Change in perception bias ~ Control	0.08	1.10	0.95
Change in expectation sensitivity ~ Control	-0.06	0.05	0.22
Change in expectation bias ~ Control	-0.06	1.12	0.96
Change in final savings ~ Change in average qualitative perceptions	0.07	0.12	0.56
Change in final savings ~ Change in average qualitative expectations	-0.02	0.12	0.86
Change in final savings ~ Change in average expectation uncertainty	-0.30	0.08	0.00
Change in final savings ~ Change in perception sensitivity	0.07	0.07	0.32
Change in final savings ~ Change in perception bias	-0.00	0.00	0.69
Change in final savings ~ Change in expectation sensitivity	0.07	0.05	0.14
Change in final savings ~ Change in expectation bias	0.00	0.00	0.38
Total	-0.28	0.04	0.00
Direct	-0.27	0.04	0.00
Indirect Change in average qualitative perceptions	-0.00	0.00	0.94
Indirect Change in average qualitative expectations	0.00	0.00	0.94
Indirect Change in average uncertainty	-0.01	0.01	0.43
Indirect Change in perception sensitivity	0.00	0.01	0.54
Indirect Change in perception bias	-0.00	0.00	0.98
Indirect Change in expectation sensitivity	-0.00	0.00	0.46
Indirect Change in expectation bias	-0.00	0.00	0.85

Table 32 - Mediation analysis of Intervention 1

Path	Coefficient	STE	p value
Change in average qualitative perceptions ~ Intervention 1	0.03	0.02	0.12
Change in average qualitative expectations ~ Intervention 1	-0.01	0.02	0.71
Change in average expectation uncertainty ~ Intervention 1	-0.08	0.03	0.02
Change in perception sensitivity ~ Intervention 1	-0.04	0.04	0.27
Change in perception bias ~ Intervention 1	-1.65	1.12	0.14
Change in expectation sensitivity ~ Intervention 1	0.17	0.05	0.00
Change in expectation bias ~ Intervention 1	-0.84	1.14	0.46
Change in final savings ~ Change in average qualitative perceptions	0.07	0.12	0.56
Change in final savings ~ Change in average qualitative expectations	-0.02	0.12	0.86
Change in final savings ~ Change in average expectation uncertainty	-0.30	0.08	0.00
Change in final savings ~ Change in perception sensitivity	0.07	0.07	0.32
Change in final savings ~ Change in perception bias	-0.00	0.00	0.69
Change in final savings ~ Change in expectation sensitivity	0.07	0.05	0.14
Change in final savings ~ Change in expectation bias	0.00	0.00	0.38
Total	0.10	0.04	0.03
Direct	0.07	0.05	0.14
Indirect Change in average qualitative perceptions	0.00	0.01	0.82
Indirect Change in average qualitative expectations	0.00	0.00	0.98
Indirect Change in average uncertainty	0.02	0.01	0.02
Indirect Change in perception sensitivity	-0.00	0.00	0.46
Indirect Change in perception bias	0.00	0.01	0.77
Indirect Change in expectation sensitivity	0.01	0.01	0.22
Indirect Change in expectation bias	-0.00	0.01	0.64

Table 33 - Mediation analysis of Intervention 2

Path	Coefficient	STE	p value
Change in average qualitative perceptions ~ Intervention 2	-0.01	0.02	0.62
Change in average qualitative expectations ~ Intervention 2	-0.01	0.02	0.71
Change in average expectation uncertainty ~ Intervention 2	0.05	0.03	0.16
Change in perception sensitivity ~ Intervention 2	0.01	0.04	0.77
Change in perception bias ~ Intervention 2	1.41	1.06	0.18
Change in expectation sensitivity ~ Intervention 2	-0.09	0.05	0.06
Change in expectation bias ~ Intervention 2	0.81	1.08	0.46
Change in final savings ~ Change in average qualitative perceptions	0.07	0.12	0.56
Change in final savings ~ Change in average qualitative expectations	-0.02	0.12	0.86
Change in final savings ~ Change in average expectation uncertainty	-0.30	0.08	0.00
Change in final savings ~ Change in perception sensitivity	0.07	0.07	0.32
Change in final savings ~ Change in perception bias	-0.00	0.00	0.69
Change in final savings ~ Change in expectation sensitivity	0.07	0.05	0.14
Change in final savings ~ Change in expectation bias	0.00	0.00	0.38
Total	0.17	0.04	0.00
Direct	0.20	0.04	0.00
Indirect Change in average qualitative perceptions	-0.00	0.00	0.84
Indirect Change in average qualitative expectations	0.00	0.00	0.94
Indirect Change in average uncertainty	-0.01	0.01	0.16
Indirect Change in perception sensitivity	0.00	0.00	0.91
Indirect Change in perception bias	-0.00	0.01	0.48
Indirect Change in expectation sensitivity	-0.01	0.01	0.12