Economic literacy and inflation expectations: evidence from an economic experiment.[1]

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1. Introduction

Consumers' perceptions of past inflation and expectations of future inflation have been found to exhibit an upward bias on average and yet to vary significantly with demographic characteristics. Bryan and Venkatu (2001a) find in a survey of Ohio consumers that women perceive higher rates of recent-past inflation than men do and predict higher future inflation than men, even after controlling for age, education, income, marital status, and race.[2] Studies of consumer survey data in the U.S. (Bryan and Venkatu 2001b; Bruine de Bruin et al. 2010, Pfajfar and Santoro 2008, Souleles 2004), New Zealand (Leung 2009), England (Blanchflower and MacCoille 2009), and Ireland (Duffy and Lunn 2009) have all found that individuals with lower household incomes tend to have higher inflation perceptions and expectations than those with higher incomes, although a study of South African consumers finds the opposite pattern (Kershoff 2000). Higher educational attainment or higher skill levels were also associated with lower inflation expectations in a number of studies (Bryan and Venkatu 2001b, Leung 2009). Monetary policymakers seeking to promote anchored inflation expectations ought to be interested in what demographic variation reveals about how individuals form inflation expectations. In addition, there is concern that biased inflation perceptions may lead to poor financial decision-making on the part of consumers (Duffy and Lunn 2009).

One early explanation of demographic variation posited that consumers who purchase different baskets of goods would have different experiences with inflation and would form different inflation expectations based on such experiences (Jonung 1981). Against this hypothesis, Bryan and Venkatu (2001a) find that gender differences in inflation perceptions hold even for specific goods such as gasoline, and Hobijn et al. (2009) find that demographic differences in experienced inflation are not large enough to explain observed differences in expectations. Pfajfar and Santoro (2008) find that the individual consumption basket influences inflation expectations for some individuals (specifically, those of lower socioeconomic status) but not for others (high SES individuals, who reference aggregate inflation). In a similar vein, Bruine de Bruin et al. (2010) argue that demographic variation in financial literacy contributes to

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[2] The same study reports similar gender differences in inflation expectations based on the nationally-representative University of Michigan consumer survey.

variation in inflation expectations. They find that less financially literate individuals are more likely to refer to their personal financial situation rather than to economic aggregates when forming inflation expectations and are more likely to overestimate inflation. This intriguing finding suggests that additional research is needed concerning the formation of inflation expectations and its relationship to financial and economic literacy.

In this paper, we present new experimental evidence on inflation expectations that sheds light on individual variation in inflation-expectations and their formation. The experiment was designed to elicit subjects' beliefs about which (current and past) economic data are most useful for making inflation forecasts and to observe how they use selected data to form inflation expectations in a simulated economic environment. Subjects also provided demographic information and completed a questionnaire to assess economic and financial literacy (hereafter abbreviated to "economic literacy" or simply "literacy"). Compared to findings from some previous surveys of inflation expectations, we find that fewer demographic factors are associated with systematic variation in inflation expectations, while economic literacy appears to matter a great deal. Our measure of literacy predicts significant differences in subjects' inflation expectations—in terms of the actual values as well as their accuracy—as well as differences in revealed beliefs about the inflation process.[3]

For example, we do not observe robust gender differences in inflation expectations, and income-related differences also appear less stark than in some previous studies. While educational attainment influences inflation expectations to some extent, the influence is not always robust when economic literacy is accounted for. In addition, economic literacy adds explanatory power over and above the general education level and captures heterogeneity in inflation-forecasting behavior that is not accounted for by the observable demographics. We find that more economically literate subjects performed better in forecasting inflation—and in particular were less likely to overestimate inflation—in both the simulated and the real economy and that literacy was associated with (1) differences in knowledge about which economic data are most predictive of inflation and (2) differences in the use of identical information when forming inflation expectations.

Why an experiment?

Survey data offer valuable information by polling consumers about inflation perceptions and expectations in real time. Panel surveys are particularly useful for observing how expectations respond to changes in realized inflation and other macroeconomic conditions, controlling for individual characteristics. Survey methods also have their limitations. First, survey subjects have little incentive to make a good forecast, whereas in the real world there may be economic costs to making a poor forecast. Therefore, forecasts about future inflation may be less carefully considered in a survey than in a real-world situation, although the salience of incentives attached to inflation forecasts is debatable and varies with inflation itself.[4] Second, and more importantly, survey instruments refer to actual

[3] Our measure encompasses aspects of economic literacy (for example, understanding of monetary policy) as well as financial literacy (for example, compound interest) and numeracy. See below for further details.
[4] While consumers are rarely asked to make explicit inflation forecasts in real life, such forecasts are made at least implicitly in the context of many personal financial decisions.

economic conditions and cannot manipulate data in order to access expectations under a wide range of macroeconomic scenarios. For example, the U.S. has experienced relatively low inflation in recent years and the salience of inflation may therefore be low in the current environment. Finally, survey methods are not well-suited to determining how individuals select and process information when forming inflation expectations. For example, survey questions aimed at eliciting the types of information used to form expectations rely on introspection after-the-fact and as such responses may be subject to psychological biases.

Our experiment mitigates these limitations in that (1) subjects were rewarded based on the accuracy of their forecasts and so faced incentives to think carefully, (2) subjects formed inflation expectations under a diverse set of macroeconomic scenarios, and (3) subjects' behavior revealed features of the expectations-formation process that cannot be readily ascertained via survey methods. While this process was of necessity circumscribed by the experimental design, we claim the design reveals important aspects of subjects' beliefs about what drives inflation and therefore something about how they might predict inflation in a real-world context.

Relevant experimental literature

There is a considerable literature in experimental psychology and experimental economics pertaining to the formation of expectations in context-free settings. In such experiments, subjects are typically shown a univariate time-series of a given length and asked to forecast what will happen next in the series. Such experiments were designed to learn about the generic process of data extrapolation, such as the ability to perceive turning points (Becker, Leitner, and Leopold-Wildburger 2009) and the ability to form rational expectations for an autoregressive time series (Hey 1994) or for a random-walk series (Dwyer et al. 1993, Bloomfield and Hales 2002).[5] These studies offer diverse findings and fail to agree strongly on matters such as the rationality of expectation formation and the use of various heuristic devices.

Not surprisingly, perhaps, Lawrence et al. (2006) find that context matters for forecasting—that is, forecasting behavior does not appear to have consistent properties across contexts when individuals have prior experience in the different real-world situations. Therefore, behavior in context-free experimental settings may not apply to the formation of inflation expectations. In addition, we can't be sure *a priori* that subjects in the real world rely on past inflation when forecasting future inflation. Even if they do, they might also refer to factors other than inflation itself. Before applying results from studies of forecasting behavior for generic time series, we first need to understand if univariate extrapolation is even a good representation of the expectations-formation process for inflation.

Only a handful of experiments have focused on inflation expectations in particular. These include Pfajfar and Zakelj (2009), who find that experimental subjects exhibited a diverse set of behaviors—supporting diverse theoretical models—in forming inflation-expectations within the context of a New Keynesian sticky-price model, with variation occurring both between and within subjects. Marimon and Sunder (1995) and Bernasconi and Kirchkamp (2000) both study experimental inflation expectations in the

[5] Additional papers of note in this literature include Bergmann 1988, Blomqvist 1989, Peterson and Reilly 1991, Beckman and Downs 1997, Heit 2000, Bolle 1988a, and Bolle 1988b.

context of overlapping generations models, focusing on the extent to which forecasting behavior follows adaptive learning rules rather than embodying rational expectations. Adam (2007) finds experimental evidence that subjects adopt a "restricted perceptions equilibrium" when forecasting inflation, in the sense that their forecasts depended only on past inflation and not also on other available (and informative) macroeconomic data. Arifovic and Sargent (2003) study the formation of inflation expectations in the context of analyzing the emergence of various macroeconomic equilibria in a laboratory setting.

In each of the aforementioned experiments, the authors were interested primarily in determining whether inflation expectations formed in the laboratory were rational with respect to a particular macroeconomic model or whether they conformed to alternative behavioral models such as adaptive learning. The behavior of experimental subjects (including their inflation expectations) in each case was made to influence subsequent macroeconomic outcomes, giving subjects the opportunity to learn about the model (and, potentially, to learn to play a particular equilibrium of interest) in the course of the experiment. These experimental studies were not primarily interested in identifying the characteristics that predict cross-sectional variation in inflation expectations.

The focus of our experiment is different from those mentioned above in two important respects. First, we wanted to elicit subjects' prior beliefs and habits with respect to the formation of inflation expectations, rather than determine whether subjects can learn about a particular model in the lab. Second, we are primarily interested in the microeconomic variation in inflation expectations and its observable determinants rather than in the extent to which individual and group behavior conforms to the rational expectations hypothesis or some alternative model.[6]

As such, our experimental design differs in several key respects from that of previous experiments which elicited inflation expectations. First, in order to prevent subjects from learning about the model during the course of the exercises, we never informed them of the "correct" inflation forecast in a particular exercise. Second, in our setting, future inflation outcomes are determined by the model and not influenced by subjects' expectations. This design feature is consistent with the notion that, in the real world, people are likely to act as if their individual expectations do not affect future inflation. Third, rather than always showing subjects specific data such as past inflation, in a first set of exercises (completed by all subjects) we offered subjects a choice of data in order to determine what information they deemed relevant to inflation-forecasting. Only in a second series of exercises (also completed by all subjects) did subjects receive preselected, uniform information (which did not always include past inflation). By having each subject complete both sets of exercises—an example of a "within-subject" experimental design—we can exploit multiple data points from each individual to investigate two different channels through which expectations-formation may vary across individuals: (1) the choice of information used to predict inflation and (2) the use of given information.

[6]We focus on the rationality of expectations-formation in our experiments in a forthcoming companion paper.

2. Experimental design

The experiment consisted of 6 components, listed in order: (1) a brief set of questions related to past and future U.S. inflation, (2) a series of 8 inflation-forecasting exercises pertaining to a simulated economy and offering a menu of information sources to choose from, (3) a set of free-response questions about how subjects selected information in the preceding exercises, (4) a series of 9 inflation-forecasting exercises in a simulated economy in which subjects received information of our choosing, (5) a set of 16 multiple-choice questions designed to measure economic and financial literacy, and (6) a demographic questionnaire. We adopted a "within-subject" design, meaning each subject completed each phase of the experiment. The forecasting exercises pertaining to a simulated economy and the economic literacy questions were incentivized, in that subjects received higher dollar rewards the better their performance. Detailed instructions were given prior to each phase of the experiment. In particular, prior to the forecasting exercises, subjects learned how to use the program on a practice interface and took an ungraded quiz that indicated whether they understood the instructions. Answers to the quiz were revealed immediately, just before subjects began the forecasting exercises. We elaborate on each of the experimental components immediately below, and full details are provided in the Appendix, including complete questionnaire contents, instructions, and an example of a simulated-economy forecasting exercise.

Questions about past and future U.S. inflation

After a brief welcome and introductory remarks (in Appendix), the experimental interface was launched. The first question was a multiple choice question seeking a definition of inflation—"Inflation is…" followed by four choices. (The correct answer received a payoff of 20 cents and incorrect answers zero payoff.) Immediately following the question, subjects were shown the correct answer to the question, as follows: "Inflation is the rate of increase in the overall price level of goods and services in an economy." Examples were given of rates of inflation expressed as annual percentage changes in the price level, including both positive and negative example values. Then we posed a question modeled on the University of Michigan's inflation-expectations question to elicit forecasts of inflation in the ensuing 12 months, and another question asking for a forecast of inflation 5 years into the future. (For exact wording of questions, refer to the Appendix materials.)

While not the main focus of this inquiry, we included the questions related to U.S. inflation in order to (1) gauge subjects' knowledge of actual inflation in relation to demographic factors and economic literacy scores and compare the results to previous findings based on survey data, and (2) to relate our subjects' perceptions and predictions of real-world inflation to their behavior in the simulated-economy forecasts.

Inflation-forecasting exercises

The core of our study – the actual experiment – consists of the series of inflation-forecasting exercises for the simulated economy. In each exercise, the objective was to forecast "future" inflation, either 1-year ahead or, in some exercises, 5 years ahead. Instructions stated that all situations were hypothetical and that subjects were not attempting to forecast real-world inflation. However, subjects were

instructed that the data they were shown behaved *as if* they came from a real economy. They were told, correctly, that the situations they face were generated by a model that was calibrated against U.S. historical experience in the late 20th century.

The correct value of the forecast in a given exercise was determined by the model's forecasting equations. That is, subjects' guesses were judged (and payoffs determined) against the value of inflation predicted by the model, rather than by the model's realized future value of inflation. We chose this payoff method in order to avoid the possibility that poor forecasts (from an *ex ante* standpoint) would be rewarded on the basis of good luck in guessing future shocks. Quantitatively, the payoff per exercise was computed as the maximum between zero and the quantity ($45 – $15 × abs(□-□)), where □ denotes the forecast entered by a subject and □ denotes the corresponding prediction of the model.[7] Thus, the maximum payoff a subject could achieve on a given exercise was $45 and the minimum payoff was zero, the latter earned subjects who missed the model's prediction by 3 or more percentage points (in absolute terms).[8] The combined payoff for all forecasting exercises was computed as the average of the payoffs earned in each exercise.[9]

To prevent learning about the accuracy of their forecasts and hence about the model in the course of the experiment, subjects were not informed of the payoff they received (nor of the correct forecast) on any specific forecasting exercise. However, to maintain motivation, subjects were given information about their payoffs at six junctures in the experiment: at four points within the simulated-economy forecasting exercises (after each of the four subsets based on forecasting horizon and endogenous vs. exogenous) they were shown the running cumulative payoff from the exercises that they had completed to that point; following the economic literacy questionnaire they were shown their payoff for that component, and they were shown their final payoff at the end of the experiment, shortly before receiving their cash rewards.

Before making their forecasts, subjects received the opportunity to access information about the current state of the simulated economy. Subjects were told that at least some, though not necessarily all, of the information sources provided were indicative of future inflation. During the course of the experiment, information was presented in two different ways. In the first 8 exercises, which we term "endogenous" henceforth, subjects were not shown any of the data series automatically. Instead, they were shown a menu of 7 items, termed information "sources" within the experiment, and instructed that they could view up to three sources per exercise. In the remaining 9 "exogenous information" exercises, subjects were given pre-selected information. We placed the endogenous exercises prior to the exogenous exercises so that our selection of data sources in the latter would not influence subjects' choice of information in the former.

[7] See Appendix for an image of the screen used in the experiment to explain and illustrate the payoffs.

[8] Despite blunting incentives somewhat, the truncation at zero avoided the problem of negative payoffs. While the minimum payoff based on performance in the forecasting exercises and quizzes was zero dollars, subjects earned a $10 flat fee just for showing up and staying to the end of the experiment.

[9] We chose to provide a high payoff-per-question and average the outcomes rather than giving a low payoff-per-question and adding up the payoffs in order to increase the salience of the per-question payoff.

The point of including the exogenous information exercises (in addition to the endogenous ones) was to identify the treatment effects of information provision. In the endogenous exercises, relationships between data viewed and forecasts are complicated by subjects' selection of information. The exogenous exercises also help us to determine whether variation in forecasting behavior with individual characteristics is reduced when information is controlled. If so, the suggestion would be that variation in inflation expectations owes more to different individuals' accessing different information than to their making different use of the same information.

The model used to generate the simulated economic scenarios is a six-equation, reduced-form model of the U.S. economy that represents a simplified version of the model used by the Federal Reserve Bank of Boston to make macroeconomic forecasts. Dependent variables in the model consisted of the output gap, core CPI inflation, headline CPI inflation, the Federal Funds rate (based on a Taylor rule), real oil price, and the unemployment rate gap. We used the model to generate hypothetical time-series for these variables based on selecting random shocks from the empirical shock distribution estimated for the U.S. over the time period 1984-2007.[10]

From the simulated time series, we selected snapshots (3 or 6 periods, as described below) of contemporaneous data pertaining to headline CPI inflation, the unemployment rate (as a level), the Federal Funds rate (termed "short-term interest rate" in the experiment), and the annual rate of inflation in the price of oil.[11] To the data produced by the model, we appended hypothetical data (3 periods) on annual milk-price inflation and the annual population growth rate. These data were drawn from actual historical time series for the U.S. and chosen so that correlations with model-generated variables were within the normal historical range. Each set of snapshots formed a single macroeconomic scenario that would be used in one of the inflation-forecasting exercises. We selected the set of scenarios with an eye to generating variation in the macroeconomic conditions presented and in the degree of difficulty of making each forecast.

For a given exercise, we selected three consecutive years of data on each of the six variables. Time was indexed such that the last value in each sequence corresponded to the "current" year, denoted t=0, with earlier years denoted t=-1 ("one year ago"), t=-2 ("two years ago"), and so on. In the case of headline inflation, subjects were shown an additional set of 3 data points, with periods t=-5, t=-4 and t=-3. Thus, for each exercise, we selected a set of seven 3-period time series (in graph form, with data values labeled) indicating recent conditions in the hypothetical economy.

In each endogenous exercise, subjects could access up to three out of the seven information sources. The menu of sources was identical across exercises but the information content was (potentially) different. Each source was labeled with a description of its contents, such as "recent inflation." (See the

[10] Shocks to some variables (headline inflation and Fed Funds rate) were set to zero to avoid extended periods of deflation and/or negative values of the Fed Funds rate. Parametric assumptions were as follows: inflation target set at 2.5 percent, potential growth at 3 percent, equilibrium real Federal Funds rate at 2 percent, and natural rate of unemployment (NAIRU) at 5.25 percent.

[11] The model frequency was quarterly; we converted to annual data by calculating year-over-year changes or (for levels) annual averages.

Appendix for images of the source menu, data samples, and related instructions.) There were no explicit costs of viewing a source other than the time cost, as subjects had a limit of two minutes to complete each forecasting exercise, and the opportunity cost of not viewing another source. Subjects could view only one source at a time in the same window, but were able to toggle back and forth between the selected sources (always limited to three at most) within the time limit. The program kept track of the entire sequence of information viewing, including time spent viewing each source each instance it was viewed. When a given exercise was completed—which occurred when the subject entered a number for the forecast and pressed a "confirm" button—the next exercise appeared and subjects again had the option to select from the menu of sources. The order of information sources was scrambled between subjects so as to prevent order effects, but each individual subject saw the same order in each exercise to prevent confusion. We find no evidence that the order of sources influenced the frequency with which they were chosen.

Endogenous exercises were divided into 1-year horizon forecasting exercises (5 of 8) and 5-year-horizon forecasting exercises (3 of 8). Subjects were prompted when horizons shifted between sets of exercises, to minimize risk that they would confuse the forecast horizon. Also, the horizon was labeled within each exercise. In each of the 1-year-horizon forecasting exercises, the data used in the different exercises were different from each other—that is, taken from non-adjacent time periods of the same simulated time-series or from a separate time-series. However, the data for the 5-year-horizon exercises in each case were identical to the data in one of the 1-year-horizon exercises. The idea was to observe whether forecasts differed with the horizon, controlling for the data. Subjects were not told that data were duplicated and, based on how data were presented, it would have been very difficult to recognize that the data were the same. Once a given exercise was completed, subjects could not go back and revisit it.

In the 9 "exogenous information" exercises, all subjects were shown the same pre-selected information prior to making their forecasts. In all but one exercise, we presented two 3-point data series representing two variables, where one of the sources was recent inflation. In one exercise, we presented only one 3-point data series, which did not show inflation. See the Appendix for an example of an exogenous exercise. Again, exercises were split between 1-year (6 of 9) and 5-year (3 of 9) horizon forecasts, where again each of the 5-year forecasting exercises involved data that duplicated one of the 1-year horizon scenarios.

Within the set of endogenous exercises and, separately, within the exogenous set, subjects were assigned to one of two ordering groups: some subjects saw all the 1-year-horizon exercises within a set first and then all the 5-year-horizon exercises (to avoid going back and forth between horizons), and a second group received the 5-year exercises first, followed by the 1-year exercises. Randomization into groups was conducted separately for the endogenous set and the exogenous set. Therefore, a given subject received the 17 inflation-forecasting exercises in one of four possible unique sequences.

Free response questions

Immediately following completion of the endogenous forecasting exercises, and prior to completing the exogenous exercises, subjects were asked two open-ended questions about their behavior in the

endogenous exercises. These questions were as follows, in order: "Other than the available sources, what additional information would have been helpful to you in making your forecasts?" and "Considering the average number of information sources you chose, tell us why you chose this many sources." We posed these questions in order to identify the information sources our subjects might refer to when forming inflation expectations in the real world and to gain additional insight into their thought processes in carrying out the endogenous exercises.

Economic literacy questions and demographics questionnaire

The questionnaire on economic and financial literacy consisted of 16 multiple-choice questions (including the question on the definition of inflation mentioned above and asked prior to the forecasting exercises) covering both knowledge of monetary policy and basic concepts of personal finance. The items covering monetary policy were intended to assess subjects' knowledge of the goals and tools of monetary policy and understanding of macroeconomic interdependencies. The set of financial literacy questions covered concepts such as the time value of money, compound interest, properties of alternative investment products, the distinction between nominal and real values, and general numeracy. Many of our financial literacy questions or slight variations thereof have been used and tested in previous studies, including van Rooij, Lusardi, and Alessie (2007) and the Jump$tart High School Survey of Financial Literacy.[12] Each question was followed by a menu of four answers, and subjects were asked to mark the single answer they deemed correct. Each correct response received a payoff of $0.20, while incorrect answers and unanswered questions received a payoff of $0. The total payoff for the literacy quiz was the sum of payoffs per question. The full set of economic literacy questions is provided in the Appendix.

The information we requested in the demographics questionnaire included age, sex, ethnicity, household income, current employment situation, and both own and mother's educational attainment. In addition, subjects were also asked whether or not they had ever taken a class in economics or personal finance, to what extent they were interested in politics or economics, and to what extent they had experience with investing in financial markets. Racial categories subjects could select from included white, African-American or black, Hispanic, Asian, Native American, and other. Subjects could list more than one race, and those who did are placed in a separate "multiracial" category for purposes of empirical analysis. Income choices consisted of 7 discrete ranges, which were collapsed into four groups in the empirical analysis. For educational attainment (both own and mother's), subjects selected from the choices "high-school diploma or less," "some college but no degree," "associate's degree," "bachelor's degree," and "advanced degree," where examples of the latter (Ph.D., M.D., Master's) were given. In the empirical analysis we combine the "associate's degree" responses (actually just a single response) and "some college" responses to form the category "some college." The complete demographic questionnaire is included in the Appendix.

[12] Jump$tart Coalition Survey of Personal Financial Literacy Among Students, 2008. http://www.jumpstart.org/survey.html

3. Description of Subject Pool

We conducted 5 separate sessions of the experiment, following pre-testing conducted at the Boston Fed. The first session was a test run that took place in a computer lab at Roxbury Community College (in mid-November 2009) in Boston and consisted of 13 subjects, all students at the college. The remaining four sessions, which took place a few weeks after the initial session (in early December 2009), were conducted at the Harvard Decision Sciences Laboratory on the campus of Harvard University and consisted of a total of 137 subjects, including both Harvard students and non-students. During the test run, we determined that a number of subjects believed that they were supposed to forecast the future value for whichever data series they had chosen to look at (such as milk price inflation). Following this experience, we improved the instructions for the simulated-economy forecasting exercises and added the instructions quiz. In the analysis that follows, therefore, we refer only to data generated by the 137 subjects from the Harvard sessions.

Demographics

Descriptive statistics for the sample subjects are shown in Table 1. Mean age was 29, reflecting the presence of non-students in addition to students; 61 percent of subjects were female and 82 percent were born in the United States. The racial/ethnic shares were 60 percent white, 11 percent black, 14 percent Asian, 2 percent Hispanic (representing only 3 subjects),[13] 9 percent multiracial and 4 percent other. Income responses fell into four categories: 45 percent had household incomes below $40,000 per year, 19 percent between $40,000 and $79,999, 19 percent between $80,000 and $149,999, and 15 percent $150,000 or greater. (See Figure 1 for details of income, age, and educational attainment in the sample.) Regarding own educational attainment, 7 percent of subjects had only a high school diploma or less, 39 percent held an associate's degree, 39 percent a bachelor's degree, and 15 percent an advanced degree. Regarding mother's education, 15 percent reported attainment of high school or less, 44 percent an associate's degree, 34 percent a bachelor's degree, and 34 percent an advanced degree.

4a. Results: Economic literacy and real-world inflation

Economic literacy and its determinants

Table 2 describes the economic-and-financial literacy scores. Potential scores on the quiz ranged from zero to 100 percent. As seen in Table 2, the mean score was 66 percent, with a range from 13 percent to 100 percent, and the standard deviation was 19 percentage points. Common factor analysis reveals that there is only one underlying latent factor that drives the common variance among the 16 items of the economic literacy questionnaire. We are inclined to interpret this single common factor as reflecting economic and financial literacy.[14] Cronbach's alpha for the questionnaire was 0.74, above the widely-used threshold of 0.70 for acceptable reliability.

[13]The small number of Hispanic subjects means we will not emphasize this factor in the ensuing analysis, even when results are statistically significant.

[14] We followed the common rule of retaining only factors with eigenvalues greater than one. Specifically, the first factor had an eigenvalue of 3.03 and accounted for 80% of the common variance among items, while the second

In posing the question of whether variation in economic literacy might account for demographic variation in inflation perceptions and expectations, it is useful first to describe the relationship between demographic factors and our literacy measure. We examine these relationships using an OLS regression of literacy scores against demographic and socioeconomic characteristics. Results are shown in Table 3, (136 subjects; 1 subject was dropped due to non-response). The model includes the indicator ("economic education") for whether subjects had taken an economics or finance course. Robust results (significant at the 5 percent level or better) include the following: women had lower scores than men, by about 6.5 percentage points on average; blacks had lower scores than whites by about 10.5 percentage points; and educational attainment beyond high school raised scores significantly—an associate's degree and a bachelor's degree had roughly equal effects while an advanced degree had a stronger effect (raising the score by roughly 24 percentage points). "Economic education" raised the score significantly even controlling for general educational attainment. Neither income nor mother's education influenced the literacy score. The race and gender differences are noteworthy given the numerous controls for other factors in the model.

Perceptions and expectations of U.S. inflation

Figure 2 shows the mean and median values of subjects' perceptions of average U.S. inflation during the past 5 years, as well as mean and median values of their forecasts of U.S. inflation, including 1-year-ahead (next twelve months) and 5-year-ahead forecasts.[15] For comparison, the figure shows the same statistics for inflation forecasts (made at nearby dates) made by Michigan survey subjects (for 1-year-ahead inflation and for inflation "5 to 10 years ahead") and forecasts made by professional forecasters Global Insight and Macroeconomic Advisers (1-year ahead and 5-years ahead for each). Figures A1 through A3 (in the Appendix) show histograms of the respective distributions of our subjects' perceptions (past 5 years) and forecasts (1-year-ahead and 5-years-ahead) of U.S. inflation.[16]

The mean estimate by our subjects of average U.S. inflation during the 5 years preceding the experiment (December 2004-December 2009) was 4.4 and the median estimate was 3.5 (all figures rounded to nearest tenth of a point), while the actual value (based on the headline CPI) was 2.5 The mean and median forecasts by our subjects (recorded in December 2009) of U.S. inflation 1-year- ahead were 2.4 and 1.5, respectively, values which were significantly lower than the corresponding values from the Michigan survey (4.8 and 3.0, respectively). The median value of our subjects' forecasts matched the point forecasts made by the firms Global Insight and Macroeconomic Advisers.[17] The latest inflation data show that headline CPI increased by 1.1 percent between September 2009 and September 2010. Inflation forecasts for 5-years-ahead by our subjects displayed a mean value of 6.8 and median of 4.4,

factor had an eigenvalue of only 0.69, accounting for 18% of common variation. More details on the results of factor analysis are available from the authors on request.

[15] In all reports of inflation perceptions and forecasts, whether pertaining to the U.S. economy or in the simulated-economy exercises, we eliminate observations in which inflation values were either below -10 percent or above 50 percent.

[16] These figures depict the truncated distributions.

[17] Source for professional forecasts is Haver.

values considerably higher than the corresponding figures from Michigan and from the professional forecasters. The larger values for 5-year-ahead inflation may reflect misunderstanding of the question as referring to cumulative inflation. Only later in the experiment, in the instructions for the simulated-economy forecasting exercises, did we explain the concept of annual inflation 5 years in the future.

Table 4 shows mean inflation perceptions and forecasts among our subjects, broken down by demographic category. Variation in perceptions of past inflation agree broadly with results from previous surveys: women perceived higher inflation than men, non-whites perceived higher inflation than whites (averaging across non-white groups), and perceptions appear to decrease (though not systematically) with income and educational attainment. However, patterns in the inflation forecasts are much harder to read (especially in the case of 1-year-ahead forecasts) and appear inconsistent in most dimensions with the past-inflation-perceptions data.

In multivariate analysis (Table 5), we find that few of the factors considered in Table 4 have significant effects on inflation estimates and that our measure of economic literacy can account for the effects of some factors. In the first model (Table 5, column 1), estimates of average U.S. inflation during the past 5 years are regressed against all of the observed individual factors except for the "economic education" indicator (a binary variable for whether subjects had ever taken a course in economics) and the economic literacy score, using OLS.[18] Hispanics[19] while subjects whose mother had a bachelor's degree gave significantly lower estimates (-2.8 percentage points) than those whose mother had a high-school diploma or less. Women gave higher estimates than men, by 1.7 points on average, but the effect is significant only at the 10 percent level (p value .056). When economic education and economic literacy are added (column 2), the gender effect becomes insignificant, while the "mother's bachelor's degree" effect is robust. Economic literacy itself exerts a significant negative effect on the inflation estimate—each 10 percentage point increase in the score lowers the inflation estimate by roughly .55 percentage point. When both literacy and economic education are included, economic education is not significant.[20]

The pattern of results is basically the same when we analyze the absolute errors on the inflation estimates rather than the levels (Table 5, column 3). This means that individuals who give higher inflation estimates tend to give less accurate estimates, consistent with the average tendency to overestimate inflation. Women display significantly higher absolute errors than men when economic literacy is not accounted for (significance at 5 percent level, results now shown), but the difference becomes insignificant when the literacy score is included (column 3). Having a mother with a bachelor's degree reduces the absolute error on the inflation estimate, however, and the effect is not explained by our literacy measure. The literacy score itself lowers the absolute error by about the same margin as it lowers the inflation estimate itself, implying that more literate subjects give more accurate estimates of

[18] Tests for heteroscedasticity did not reject the null of homoscedasticity.

[19] Hispanics gave significantly higher estimates than whites by roughly 2.4 percentage points. However, since there are only 3 Hispanic subjects in our sample, we are reluctant to make much of these effects (nor of any other effects) of Hispanic race on outcomes.

[20] Our literacy measure appears to trump the effect of the economic education dummy, which is significant when literacy is excluded from the model but not when both are included.

inflation because they are less likely to overestimate it. The economic education indicator is only significant when economic literacy is not also included in the model (results not shown).

To further test for gender differences in inflation expectations, which have been observed in a number of previous studies (Bryan and Venkatu 2001a, Pfajfar and Santoro 2008, for example), we divide the sample into two groups: individuals 24 years of age and older and individuals under age 24 (the median age in our sample) and estimate the models described above (results not shown). Within either age group, we find no significant differences between men and women in either the tendency to overestimate inflation or in the average accuracy (absolute error) of inflation forecasts once economic literacy is controlled for. Therefore the lack of robust gender differences does not appear to be driven by the relatively young mean age in our sample.

Regarding forecasts of U.S. inflation over the next twelve months (Table 5, column 4), none of the demographic or socioeconomic factors matter, regardless of whether economic education and/or economic literacy are included in the model (results shown are for the most-inclusive regression). Economic literacy exerts a significant negative effect on the forecast, but the regression is not jointly significant (F-statistic=1.01).[21]

Looking at the 5-year-ahead forecasts (Table 5, column 5), Hispanics and multiracial individuals give significantly higher values, even when economic literacy is accounted for. Higher literacy scores are again associated with significantly lower forecasts in this case—each 10 percentage point increase in the score reduces the 5-year-ahead forecast by 0.87 percentage point.

4b. Results: Inflation-expectations in the simulated-economy setting

Recall that subjects completed a series of inflation-forecasting exercises, each of which involved different fictional economic scenarios. (Some data were duplicated between 1-year-horizon and 5-year-horizon forecasting exercises.) In each case, the subject was asked to provide a forecast of future inflation in the fictional economy, either 1-year ahead or 5-years ahead depending on the exercise, using either information they selected from a menu (endogenous cases) or information which we provided to them (exogenous cases). Subjects were instructed to express forecasts as a percent, using up to two digits after the decimal point.

Figure 3 shows the distribution of inflation forecasts across all subjects and all forecasting exercises. We observe clustering of forecasts at whole number values (5 percent was the most frequent forecast, followed by 2 percent and 4 percent) and values ending in .5 (of which 2.5 was most frequent, followed by 0.5 and 5.5). The average forecast was 3.1 and the median was 2.5. The aggregate distribution reflects both within-subject variation (across exercises) and between-subject variation in forecasts (for a given exercise). Therefore the multi-modality and non-normality of the distribution are not surprising.[22]

[21] In this regression, we excluded an observation in which the forecast was equal to 50 percent because inclusion of this outlier distorted regression results significantly. The next-highest forecast value after 50 was 15.

[22] In the regression analysis we will typically be dealing with the distribution of mean (within-subject) forecasting errors and other summary statistics on within-subject behavior, which conform more closely to normal

The distribution of individual inflation-forecasting errors across all exercises (see histogram in Figure 4) exhibits a positive bias on average (mean value 0.76), a rightward skew (2.11) and high kurtosis (60.5). Figure 5 shows kernel density plots of the (signed) error distributions for two separate sets of exercises: the set of all six 5-year-ahead forecasting exercises and the set of six 1-year-ahead forecasting exercises that involved the same hypothetical macroeconomic scenarios. Among this set, we find that the forecast horizon has no significant effect on the average error per exercise.

Demographics, economic literacy, and forecasting performance

Here we investigate whether demographic factors and/or economic literacy scores predict variation in prediction errors in our simulated-economy forecasting exercises. To judge inflation-bias, we compute the average (signed) forecasting error by subject across all exercises and examine its relationship to demographic factors and our economic literacy measure. Results are in Table 6. Column 1 shows results of an OLS model that includes just the demographic factors: age, gender, U.S.-born status, racial identity, household income, own educational attainment, and mother's educational attainment. In this model, the only demographic factors that have significant effects (p value .05 or lower) on mean inflation bias are black race, which increases the mean forecast error by 1.65 percentage points, and holding an advanced degree, which lowers the mean error by 1.75 percentage points or about one-half of a standard deviation (3.52 percentage points). When economic literacy is added to the model (column 2), the black racial effect remains significant and the point estimate is slightly lower (1.47), but within the confidence interval of the original estimate. The significance of the advanced-degree effect falls (p-value .072) and so does the absolute value of the point estimate (-1.35). Economic literacy reduce the mean error significantly, where the point estimate implies a 0.16 percentage point decrease in the mean error for every 10 percentage-point increase in the literacy score.

Having a higher mean error does not necessarily imply that a subject overestimated inflation in a greater number of exercises than subjects with lower mean errors, because a single large positive error might be driving the mean error estimate. To better assess the tendency to overestimate inflation (rather than the average extent of overestimation), we construct a variable that measures the percentage of exercises (by subject) in which inflation was overestimated in a categorical sense. An "overestimate" was defined as an error greater than 2 units, as in Duffy and Lunn (2009). Results are in Table 6, columns 3 and 4. While blacks had higher mean forecasting errors, the regression indicates that they were only marginally more likely to overestimate inflation than whites in the categorical sense (p-value .07 when literacy excluded, column 3). When the economic literacy score is included (column 4), the black racial effect becomes insignificant. Therefore, the higher mean error observed for blacks in the previous analysis was likely driven by large errors on a few exercises rather than by a consistent pattern of overestimation. Economic literacy significantly reduces the tendency to overestimate inflation, by an estimated 2.3 percentage points per 10-percentage-point increase in the literacy score.

To judge the accuracy of forecasts, we computed the average absolute forecasting error by subject across exercises. Table 6 (column 6) shows results of an OLS model in which the dependent variable is

distributions. When working with forecast levels, we will condition on shifters such as exercise fixed effects or subject effects (or characteristics) to control for multimodality.

the mean absolute error and explanatory variables are as in the previous models, including economic literacy. Results indicate that black subjects had significantly larger average absolute errors than whites, by 1.36 percentage points. Some factors that appear significant when literacy is excluded from the model (same table, column 5), such as age (older subjects had higher mean absolute errors) and having "some college" education (lower errors), become only marginally significant (in the case of age) or lose significance (some college) when the literacy score is included. Literacy again has significant effects, reducing the mean absolute error by 2.7 percentage points per 10-point increase in the literacy score.

We also constructed a variable that measures the percent of exercises (by subject) in which the subject's forecast was accurate in the categorical sense (results not shown), defined as an error in the closed interval [-1,2].[23] In this specification, blacks were not found to have a significantly lower share of accurate forecasts than whites. Again, the implication is that the higher average absolute errors found for blacks were driven by large deviations on a small number of exercises rather than by a consistent pattern of gross inaccuracy. However, economic literacy increased the percentage of accurate forecasts significantly, as did being in the highest-income category.

Formation of inflation expectations: selection of information in endogenous exercises

Figure 6 summarizes subjects' choice of information sources in the endogenous exercises. For each individual and each information source (such as "current and recent inflation," consisting of the 3 most-recent values of inflation), we computed the share of exercises in which the subject picked the given source, computing the shares separately for 1-year-ahead forecasting exercises and 5-year-ahead exercises. The average choice rates across individuals (by forecast horizon) are shown in Figure 6. For each forecasting horizon, the choice rates across sources sum to 3 (rather than 1) because each subject could select up to 3 sources per exercise. Because subjects had the option to select fewer than 3 sources per exercise, we also show the residual category of "missed choice opportunities," which refers to the average rate at which subjects chose not to select an additional source when the option was available.[24]

The most frequently-selected source, by far, was "current and recent inflation," selected by the average subject in 84 percent of the 1-year-horizon exercises and in 82 percent of the 5-year-horizon exercises. While these rates are high, as we might expect, they nonetheless indicate that the average subject chose not to view recent inflation in 16 percent of (1-year-horizon) exercises. There was considerable variation between subjects in the inflation-choice rate, however, as the standard deviation of the choice rate for "current and recent inflation" was 26 percentage points. This variation is in keeping with survey evidence that some subjects report not referring to economic aggregates such as inflation when forming inflation-expectations in an open-ended setting.

[23] The asymmetric definition of accuracy is based on Duffy and Lunn's (2009) specification. They argue that accuracy should be defined asymmetrically to reflect the skewness of the historical inflation distribution. Although their inflation data pertain to Ireland, a similar argument applies to U.S. inflation data. All results reported here pertaining to economic literacy are robust to defining accuracy symmetrically using the interval [-2,2].

[24] The maximum potential value of this "missed opportunity" rate per individual is 3 (or 300 percent), which would apply to a subject who chose zero sources in every exercise. For actual sources (such as "oil price inflation") the maximum potential choice rate is 1 (100 percent), which would apply to an individual who chose the given source in every exercise.

"Earlier inflation" was the second-most-popular source, at both forecasting horizons, and was more frequently selected during the 5-year-horizon exercises (average choice rate 57 percent) than the 1-year-horizon exercises (42 percent). The remaining sources were ranked in the following order for the 1-year exercises, not including missed opportunities: milk-price change (38 percent), oil-price change (37 percent), short-term interest rate (32 percent), unemployment rate (27 percent), and population growth rate (8 percent). In the 5-year-horizon exercises, the unemployment rate and short-term interest rate traded places in the rankings and the choice rate for population growth was greater (at 14 percent) than in the 1-year-horizon exercises. The "missed opportunities" rates imply that the average subject selected about 2.7 sources per exercise on average (for either forecasting horizon), which means that most subjects chose the maximum 3 sources in all or most exercises.

We have seen that economic literacy predicts variation in both the values and the accuracy of inflation forecasts in the simulated-economy exercises. One possible explanation for this association is that more literate subjects were more likely to choose relevant information sources. Within the context of the macroeconomic model used to generate the data in the forecasting exercises, the single data source (each source encompassing 3 data points) with the greatest predictive power for 1-year-ahead inflation is recent inflation, followed by the unemployment rate, oil-price inflation, the Fed Funds rate, and earlier inflation.[25] To investigate this possibility, we analyze the cross-sectional variation in the selection of information in the endogenous exercises.

First, we consider the determinants of the individual choice rate (defined above) for "current and recent inflation," which we will term simply "inflation" in the text that follows. Results are shown in Table 7. When we include only demographic and socioeconomic factors (omitting economic literacy—see column 1), we observe that both Hispanics and blacks chose inflation at lower rates than whites (by 47 percentage points and 14 percentage points, respectively) and that age also reduced the inflation-choice rate. Those with incomes between $40,000 and $79,999 chose inflation at a higher rate than the lowest-income group (by 12 percentage points); the same marginal effect is observed for those in the highest income category ($150,000 per year or greater). Individuals with a bachelor's degree chose inflation at a higher rate (by 19 percentage points) than those with only a high school diploma or less, and an advanced degree raised the inflation-choice rate by 31 percentage points over the rate among the least-educated group.

When the economic literacy score is added to the model (Table 7, column 2), the coefficients on the black racial dummy and on bachelor's degree become insignificant and the effect of an advanced degree becomes significant only at the 10 percent level. The effects of age, Hispanic race, and income (for both income groups mentioned above) are robust, however. In addition, a 10 percentage-point increase in the literacy score predicts a 5.1 percentage-point increase in the inflation-choice rate (significant at 1 percent level). Economic literacy therefore may explain some of the demographic variation in inflation-

[25] Due to model lags in the transmission of monetary policy, the correlation between the (current) Fed Funds rate and 1-year-ahead inflation is positive. All other correlations follow expected macroeonomic relationships (for example, the current unemployment rate is negatively correlated with 1-year-ahead inflation).

choice rates, such as the difference between blacks and whites and the effects of education to some extent, but does not account for the differences between income groups, for example.

R-squared values from the two preceding regressions (0.50 and 0.39, respectively, for models with and without economic literacy, with corresponding adjusted R-squared values of 0.42 and 0.30) indicate that the included individual characteristics capture a significant portion of the variation in the rate at which individuals selected recent inflation in the endogenous exercises. For the same sets of regressors, explanatory power is considerably weaker when we examine choice rates for the other information sources, including the unemployment rate, earlier inflation values, milk-price change, oil-price change, short-term interest rate, and population growth rate. Overall, we find few significant effects of the demographic and socioeconomic factors on the selection rates of these sources, while economic literacy is in some cases a significant factor (results not shown).

Having a higher literacy score raised the choice-rate for the unemployment rate (2.8 percentage points per 10-point increase in literacy) and for the oil-price change (3.2 percentage points per 10-point increase in literacy), and exerted a marginally significant positive effect on selection of the short-term interest rate (2.7 percentage points, p-value 0.057). Those not born in the U.S. had a greater tendency to select the unemployment rate than U.S.-born individuals, regardless of economic literacy. Older individuals were less likely to select "earlier inflation," even controlling for economic literacy. Asians chose to view the oil-price change at a higher rate than whites by about 17 percentage points, an effect that does not depend on whether economic literacy is included. Hispanics and blacks were both more likely to select population growth than whites, again regardless of economic literacy. Surprisingly, having either some college education or holding a bachelor's degree increased the tendency to select the population growth rate (by 15 percentage points and 12 percentage points, respectively).

Selecting the milk-price change might be thought of as a proxy for a tendency to refer to one's personal consumption basket to form inflation-expectations, assuming the individual purchases milk on a regular basis. However, we find no significant demographic variation (at the 5 percent significance level) in the tendency to select the milk-price change, nor do we observe that economic literacy has a significant impact on this tendency. Selection of the oil-price change might also proxy for referring to the personal consumption basket, although again we observe little systematic variation in this tendency with socioeconomic factors and, as stated above, more literate subjects were more likely to select oil price change then less literate subjects. Taken together, these findings not offer strong support to the findings of Pfajfar and Santoro (2008) that individuals of lower socioeconomic status are more likely to refer to their personal consumption basket (rather than aggregate inflation) when forming inflation expectations. However, consistent with the latter finding, we did observe (above) that individuals in the lowest-income group are less likely to select general inflation than individuals in some of the higher-income groups.

More literate subjects chose a significantly greater number of sources on average per exercise than less literate subjects and spent significantly more time deliberating on each exercise (within the two-minute limit), controlling for other demographic and socioeconomic factors (results not shown). Individuals with

an advanced degree also selected a greater number of sources, controlling for economic literacy and other factors, but did not spend more time deliberating than less-educated individuals.

How literacy matters: selection of information vs. use of given information

Thus far, results indicate that more economically literate subjects (1) are more likely to view recent inflation in the endogenous forecasting exercises and (2) have lower absolute errors (and higher proportion of categorically "accurate" forecasts) on average across all exercises (endogenous and exogenous combined). In the endogenous exercises, economic literacy might have contributed to more accurate inflation expectations both through its influence on information selection (more literate subjects chose more-relevant information) and through its influence on the use of information once selected. In the exogenous exercises, economic literacy could have influenced performance only through its effects on the use of given information. Comparing the influence of economic literacy between the two types of exercises (endogenous vs. exogenous) may therefore tell us something about the significance of each of these two mechanisms.

Results are shown in Table 8. First consider the average absolute errors in the set of exogenous forecasting exercises only (column 1). Adopting the same regression specification as in Table 5, column 6, (described above), but restricted to the exogenous exercises, the estimated marginal effect of the economic literacy score is approximately -2 (significant at 1 percent level), which means that a 10-percentage point increase in the literacy score reduces the mean absolute error (across the 9 exogenous exercises) by 0.2 percentage point. In the endogenous exercises, the analogous marginal effect is -3.4 (also highly significant, see column 2).[26]

While economic literacy contributed significantly to better average performance in the exogenous exercises, its impact was greater (in absolute terms) in the endogenous exercises. Economic literacy also exerted a stronger impact in the endogenous exercises than the exogenous ones in terms of the percent of exercises estimated accurately in the categorical sense.[27] Given our experimental design, these results indicate that more economically literate subjects were both more capable of exploiting given information (exogenous exercises) and more likely to choose relevant information (endogenous exercises). Further, the results indicate that the ability to select relevant information conferred an additional advantage on subjects' performance, over and above the ability to make use of given information.

Other factors also mattered more in the endogenous exercises than in the exogenous exercises, even conditioning on economic literacy. For example, the effect of black race is stronger and own educational

[26]While the latter effect is larger in absolute terms, the variance of the mean absolute error distribution is also considerably higher among the endogenous exercises than the exogenous exercises. Considered as fractions of the respective standard deviations of the dependent variable, the effect of literacy in the exogenous exercises amounts to one-fifth of a standard deviation and in the endogenous exercises the fraction is just 0.15.

[27] This comparison is based on simple inspection of the respective coefficient estimates on economic literacy in regressions of "percent of exercises accurately estimated" for the two different types of exercise. These coefficient values are 0.41 and 0.25, respectively. The values are not within one standard error of each other (based on the standard error of either estimate), but the 95 percent confidence intervals overlap.

attainment becomes significant (with negative signs) at each education level in excess of high school (Table 8, column 2). Perhaps even more striking, the variance of the mean absolute errors is more than five times as great in the endogenous exercises as in the exogenous exercises (although the respective means are roughly equal), indicating that differential selection of information—whether predicted by demographic factors or economic literacy—induces large variations in forecasting performance. These findings also imply that variation in inflation-forecasting behavior in experiments that provide all subjects with the same information set (rather than offering a choice of information) is likely to be significantly diminished relative to real-world variation in such behavior.

Analysis of free response questions

In response to the open-ended question asking what additional information they would have liked to help make their inflation forecasts, the most popular type of response (we collapsed open-ended answers into twenty categories) involved a request for information (recent data or "trends") about the prices of specific goods, such as houses, various food items, cars, gold, electricity, and various others. In the second-most-frequent response, subjects expressed a desire for "more background knowledge" about "how inflation works" and more general economics knowledge. The third-most-popular response category asked for more data about inflation itself, such as a longer historical time series or near-term projections of inflation. Tied for fourth place were a group who requested future values or forecasts of specific variables (other than inflation) such as unemployment, and a group who requested recent data on either "GNP," "GDP," or "economic growth." The fifth-ranked response indicated that the subject needed no additional information or could not think of anything else they would have needed. Other requested data included information on taxes and the fiscal situation, the political situation, and the exchange rate, among others.

Considering these responses, more than a third either requested data similar to our included choices (such as specific prices and more about inflation) or requested no additional information. These responses indicate that our menu of choices included at least some of the types of information people refer to when forming inflation-expectations in a free-thinking context. The request for "more background knowledge" rather than specific other information suggests that subjects believed the given information was relevant but they did not know how to best use it to make an inflation forecast. In addition, the overall seriousness of the responses indicates subjects took the experiment itself seriously.

Responses to the question asking why subjects chose the number of sources that they did were dominated overwhelmingly by the response that "more information is better" or some variant of this response, as most subjects chose the maximum number of sources available in most questions. Some subjects indicated that they chose only two sources because they did not know how to make use of the additional data. Again the responses indicate that subjects tried to do their best on the exercises rather than behaving randomly.

5. Summary and discussion

In data from a new experiment designed to elicit subjects' prior tendencies and beliefs with respect to the formation of inflation expectations, we find strong associations between our measure of economic-

and-financial literacy and the behaviors of interest. In data on perceptions of past U.S. inflation, greater economic literacy was associated with inflation estimates that were lower (in levels) and more accurate compared to the correct value. Greater economic literacy also predicted significantly lower expectations of U.S. inflation, whether 1-year-ahead or 5-years-ahead. In the simulated-economy forecasting exercises, more literate subjects displayed lower (signed) errors on average as well as lower absolute errors; they also overestimated inflation (defined categorically) less frequently and gave accurate estimates more frequently. All of these effects are highly significant and are observed even when conditioning on an extensive list of demographic and socioeconomic factors, including general educational attainment—both own and mother's—as well as on household income, age, gender, and race. Therefore, we can be fairly certain that the associations between economic literacy and inflation expectations do not arise spuriously.

Economic literacy contributed to greater forecasting accuracy in our experiment through two different channels: as illustrated by their greater success in the endogenous exercises, more literate subjects were more likely to select "recent inflation" than less literate subjects, where recent inflation was the most reliable predictor of future inflation among the menu of sources offered. As illustrated by their greater success in the exogenous exercises, more literate subjects were also better able to make use of given data (such as data on recent inflation and unemployment) to come up with a reasonable forecast. Both selection and use of information could have influenced success in the endogenous exercises, and consistent with this fact we find that economic literacy exerted greater marginal effects on performance (measured by mean absolute errors within-subject) in the endogenous exercises than in the exogenous set.

Demographic and socioeconomic factors influenced behavior in some dimensions, although by less than we might have expected based on results of previous surveys, and many effects were not robust. For example, while women gave higher estimates of past U.S. inflation, the difference can be accounted for by gender differences in economic literacy. Women did not give systematically higher forecasts than men of future inflation, either in real-world forecasts or in forecasts for the simulated economy. African-Americans had higher mean errors in forecasting inflation in the simulated environment (but not when estimating past U.S. inflation), indicating stronger positive inflation bias, and higher absolute errors as well, although in categorical terms blacks were not significantly more likely to overestimate inflation than whites controlling for economic literacy. Higher educational attainment (such as holding a bachelor's degree or advanced degree) predicted lower absolute forecasting errors even after controlling for economic literacy, although higher education did not significantly reduce the categorical tendency to overestimate inflation. Greater household income was not associated with any significant effects on inflation forecasts or accuracy, either in the real-world questions or the simulated-economy exercises, although higher income did predict a greater tendency to select inflation in the endogenous exercises.

Considering forecasting performance (measured by within-subject means of absolute errors), the significant demographic effects that we do observe, such as the negative effect of black race and the positive effects of higher educational attainment, appear to be driven primarily by performance in the endogenous exercises. This finding suggests that demographic variation in the formation of inflation

expectations (among similarly economically literate subjects) derives from demographic variation in information selection—reflecting different beliefs about what drives future inflation—more so than demographic variation in the use of given information.

In the exogenous exercises, information-provision leveled the playing field considerably, resulting in a significant reduction in the variance of performance across subjects compared to the endogenous exercises. This finding—together with other comparisons between the two groups of exercises—suggest that economic education can improve inflation forecasting simply by teaching people to focus on aggregate inflation (and other macroeconomic indicators) rather than specific prices, although this presumes that subjects understand the concept of aggregate inflation and know how to access information on recent movements in the CPI.

References

Adam, K. (2007). Experimental Evidence on the Persistence of Output and Inflation. *Economic Journal* 117: 603-636.

Arifovic, J., and Sargent, T.J. (2003). Laboratory Experiments with an Expectational Phillips Curve, in D. E. Altig and B. D. Smith (eds.), *Evolution and Procedures in Central Banking*. Cambridge University Press, Cambridge.

Becker, O., Leitner, J., and Leopold-Wildburger, U. (2009). Expectation Formation and Regime Switches. *Experimental Economics* 12: 350-364.

Beckman, S. R., and Downs, D. (1997). Forecasters as Imperfect Information Processors: Experimental and Survey Evidence. *Journal of Economic Behavior & Organization* 32: 89-100.

Bergmann, B. (1988). An experiment on the formation of expectations. *Journal of Economic Behavior and Organization* 9: 137-151.

Bernasconi, M., and Kirchkamp, O. (2000). Why do monetary policies matter? An experimental study of saving and inflation in an overlapping generations model. *Journal of Monetary Economics* 46(2): 315-343.

Blanchflower, D. G. and MacCoille, C. (2009). The formation of inflation expectations: an empirical analysis for the UK. NBER working paper w15388.

Blomqvist, H. C. (1989). The 'Rationality' of Expectations: an Experimental Approach. *Journal of Economic Psychology* 10: 275-299.

Bloomfield, R., and Hales, J. (2002). Predicting the Next Step of a Random Walk: Experimental Evidence of Regime-Shifting Beliefs. *Journal of Financial Economics* 65: 397-414.

Bolle, F. (1988a). Testing for rational expectations in experimental predictions, in *Applied Behavioural Economics*, vol. 1 (ed. S. Maital). New York: New York University Press.

Bolle, F. (1988b). Learning to make good predictions in time series, in *Bounded Rational Behavior in Experimental Games and Markets* (R Tietz, W. Albers and R. Selten, eds.). Berlin: Springer-Verlag.

Bruine de Bruin, W., Vanderklaauw, W., Downs, J.S., Fischhoff, B., Topa, G., and Armantier, O. (2010). Expectations of inflation: The role of financial literacy and demographic variables. *Journal of Consumer Affairs* 44: 381-402.

Bryan, M. F., and Venkatu, G. (2001a). The curiously different inflation perspectives of men and women. *Economic Commentary*, Federal Reserve Bank of Cleveland, November 2001.

Bryan, M. F., and Venkatu, G. (2001b). The demographics of inflation opinion surveys. *Economic Commentary*, Federal Reserve Bank of Cleveland, October 2001.

Duffy, D., and Lunn, P.D. (2009). The misperception of inflation by Irish consumers. *The Economic and Social Review* 40 (2): 139–163.

Dwyer, G. P., Williams, A. W., Battalio, R. C., and Mason, T. I. (1993). Tests of Rational Expectations in a Stark Setting. *The Economic Journal 103* (418): 586-601.

Heit, E. (2000). Properties of Inductive Reasoning. *Psychonomic Bulletin & Review* 7(4): 569-592.

Hey, J. D. (1994). Expectations formation: Rational or adaptive or …? *Journal of Economic Behavior and Organization* 25: 329—349.

Hobijn, B., Topa, G., Mayer, K., and Stennis, C. (2008). Whose Inflation Is It? Household Level vs. Aggregate Measures of Inflation. Manuscript. Federal Reserve Bank of New York.

Jonung, L.. (1981). Perceived and Expected rates of Inflation in Sweden. *The American Economic Review* 71 (5): 961-968.

Kershoff, G. (2000). Conducting inflation expectation surveys in South Africa. Bureau for Economic Research.

Lawrence, M. Goodwin, P., O'Conner, M, and Onkal, D. (2006), "Judgemental Forecasting: A review of progress over the last 25 years," *International Journal of Forecasting* 22: 493-518.

Leung, C. (2009). The demographics of household inflation perceptions and expectations. Reserve Bank of New Zealand: Bulletin, Vol. 72, No. 2, June 2009.

Marimon, R., and Sunder, S. (1995). Does a constant money growth rule help stabilize inflation? Experimental evidence, *Carnegie-Rochester Conference Series on Public Policy* 43(1): 111-156.

Peterson, S. P., and Reilly, R. J. (1991). The Rationality of Expectations: The Blomqvist Experiment Reconsidered. *Journal of Economic Psychology* 12: 527-533.

Pfajfar, D., and Santoro, E. (2008). Asymmetries in Inflation Expectation Formation Across Demographic Groups. Cambridge Working Papers in Economics 0824, Faculty of Economics, University of Cambridge.

Pfajfar, D., and Zakelj, B., (2009). Experimental Evidence on Inflation Expectation Formation. Discussion paper 2009-07, Tilburg University, Center for Economic Research.

Souleles, N. S. (2004). Expectations, Heterogeneous Forecast Errors, and Consumption: Micro Evidence from the Michigan Consumer Sentiment Surveys. *Journal of Money, Credit and Banking* 36(1): 39-72.

Van Rooij, M., Lusardi, A., and Alessie, R. (2007). Financial Literacy and Stock Market Participation. NBER working paper 13565.

Table 1: Sample Characteristics (N=137)

Age	28.533
Female	0.610
White	0.599
Black	0.109
Hispanic	0.022
Asian	0.139
Other Race	0.044
Multiracial	0.088
Not US-Born	0.175
Economics Course	0.533
Income $\leq$ \$39,999	0.453
Income \$40,000 – \$79,999	0.190
Income \$80,000 – \$149,999	0.190
Income $\geq$ \$150,000	0.153
HS Diploma	0.066
Some College	0.394
Bachelor's Deg.	0.387
Advanced Deg.	0.153
Mother HS Diploma	0.153
Mother Some College	0.080
Mother Bachelor's Deg.	0.343
Mother Advanced Deg.	0.336

Table 2: Literacy Score Statistics

Mean	0.663
Std. Deviation	0.188
Median	0.690
Minimum	0.130
Maximum	1.000
Cronbach's α	0.740

Table 3: Literacy Scores (N=136)

Female	-0.078**	-0.065**
	(0.033)	(0.031)
Age	-0.002	-0.002
	(0.002)	(0.002)
Black	-0.106**	-0.105**
	(0.051)	(0.048)
Hispanic	-0.008	0.074
	(0.108)	(0.102)
Asian	0.005	-0.006
	(0.054)	(0.050)
Multiracial	0.008	-0.007
	(0.056)	(0.053)
Other Race	-0.155*	-0.117
	(0.079)	(0.074)
Not US-Born	0.060	0.061
	(0.047)	(0.043)
Some College	0.141**	0.138**
	(0.070)	(0.065)
Bachelor's	0.172**	0.137**
	(0.069)	(0.065)
Advanced Degree	0.262***	0.238***
	(0.082)	(0.077)
Mother Some College	0.041	0.083
	(0.062)	(0.059)
Mother Bachelor's	0.028	0.018
	(0.045)	(0.042)
Mother Advanced Degree	0.058	0.049
	(0.048)	(0.045)
Income $40,000–$79,999	0.019	-0.005
	(0.043)	(0.040)
Income $80,000–$149,999	0.013	-0.015
	(0.045)	(0.043)
Income $\geq$ $150,000	0.021	0.010
	(0.047)	(0.044)
Economics Course		0.139***
		(0.031)
Constant	0.572***	0.505***
	(0.087)	(0.082)

Table 4: Mean US Inflation Forecast by Demographic Group

	Past 5 Years	1 Year Ahead	5 Years Ahead
Male	3.575	2.169	6.022
Female	4.857	2.481	7.983
White	3.949	1.864	6.270
Black	5.623	1.310	7.667
Hispanic	6.500	3.583	13.667
Asian	3.895	4.327	5.107
Multiracial	5.371	4.063	14.458
Other Race	5.917	1.917	8.708
Not US-Born	4.013	2.364	6.362
US-Born	4.473	2.363	6.842
Income $\leq$ \$39,999	4.712	2.860	6.135
Income \$40,000–\$79,999	3.440	2.519	7.085
Income \$80,000–\$149,999	5.233	1.331	8.480
Income $\geq$ \$150,000	3.824	1.991	6.121
HS Diploma	5.233	0.559	8.15
Some College	4.899	2.545	9.075
Bachelor's Deg.	3.983	1.823	4.945
Advanced Deg.	3.762	4.006	4.729

Table 5: Inflation Forecast Levels on Demographic Characteristics

	Past 5 Years	Past 5 Years	Past 5 Years (Abs. Error)	1-Year Ahead	5-Years Ahead
Female	1.667*	1.131	1.047	-0.557	1.384
	(0.865)	(0.791)	(0.634)	(0.626)	(1.437)
Age	-0.039	-0.056	-0.020	-0.021	0.070
	(0.043)	(0.039)	(0.034)	(0.037)	(0.062)
Black	1.612	1.018	0.302	-1.207	1.487
	(1.453)	(1.364)	(1.178)	(1.065)	(1.826)
Hispanic	2.434**	1.737*	0.849	1.761	9.855**
	(1.150)	(0.915)	(0.795)	(1.111)	(4.668)
Asian	-1.303	-1.195	-1.402*	0.232	-0.887
	(1.095)	(1.050)	(0.837)	(0.970)	(2.016)
Multiracial	1.186	1.355	0.628	1.643	8.874**
	(1.551)	(1.541)	(1.353)	(1.511)	(4.150)
Other Race	1.400	0.246	-0.302	-0.286	0.758
	(1.944)	(1.973)	(1.845)	(1.569)	(4.391)
Not US-Born	-0.104	0.215	0.064	0.496	0.607
	(0.881)	(0.824)	(0.660)	(0.775)	(2.102)
Some College	-0.340	0.466	1.232	3.392*	1.038
	(2.141)	(2.026)	(1.770)	(1.910)	(3.940)
Bachelor's Deg.	-0.590	0.633	0.962	2.612	-2.314
	(2.092)	(1.934)	(1.702)	(1.811)	(3.745)
Advanced Deg.	-0.408	1.226	0.979	3.379	-3.151
	(2.350)	(2.233)	(1.934)	(2.116)	(4.078)
Mother Some Coll.	-1.281	-1.385	-1.742	-0.216	-0.925
	(1.819)	(1.684)	(1.535)	(1.297)	(3.724)
Mother Bach. Deg.	-2.756**	-2.506**	-2.610**	-1.097	-0.530
	(1.268)	(1.215)	(1.032)	(1.092)	(2.545)
Mother Adv. Deg.	-1.668	-1.264	-1.495	-1.060	-0.859
	(1.436)	(1.369)	(1.185)	(1.002)	(2.702)
Income $40,000–$79,999	-1.390	-1.090	-0.343	0.448	0.728
	(1.142)	(1.030)	(0.841)	(0.965)	(1.816)
Income $80,000–$149,999	1.342	1.637	1.035	-0.918	3.455
	(1.244)	(1.242)	(1.064)	(0.886)	(2.617)
Income $\geq$ $150,000	-0.857	-0.650	-0.881	0.065	-0.387
	(0.998)	(0.921)	(0.722)	(0.866)	(1.336)
Literacy Score		-5.540**	-5.370***	-4.584**	-8.707**
		(2.464)	(1.815)	(2.250)	(4.369)
Economics Course		-1.106	-0.595	0.643	0.503
		(0.736)	(0.562)	(0.734)	(1.515)
Constant	6.433***	10.132***	7.485***	3.461	8.997*
	(2.239)	(2.785)	(2.284)	(2.177)	(4.971)
N	135	135	135	134	133

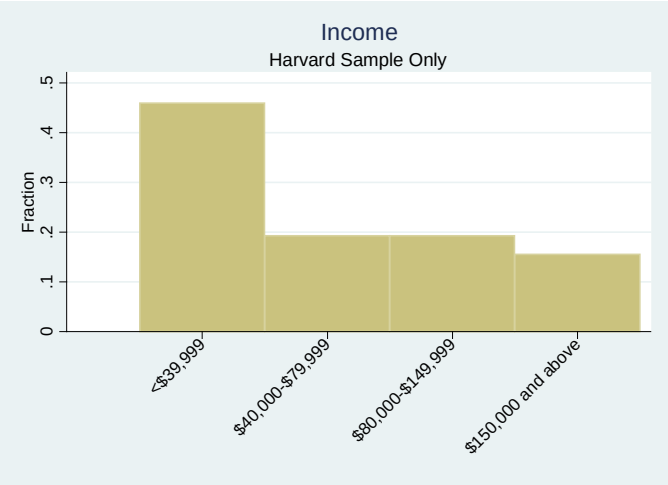


Figure 1A

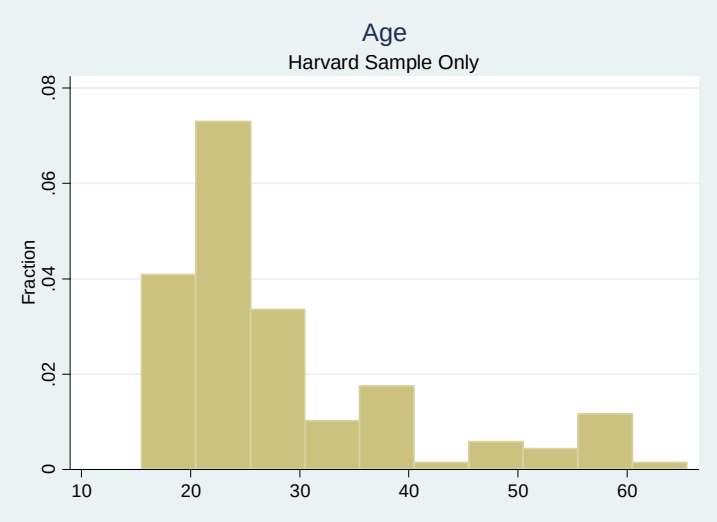


Figure 1B

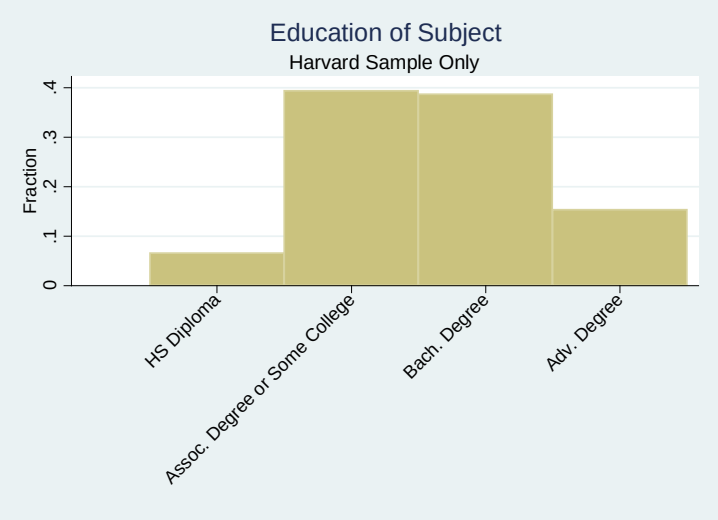
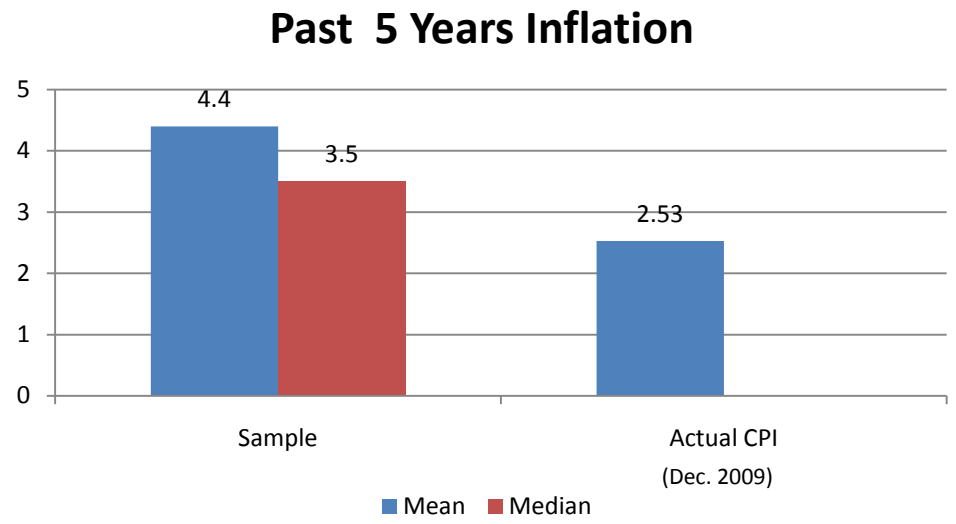
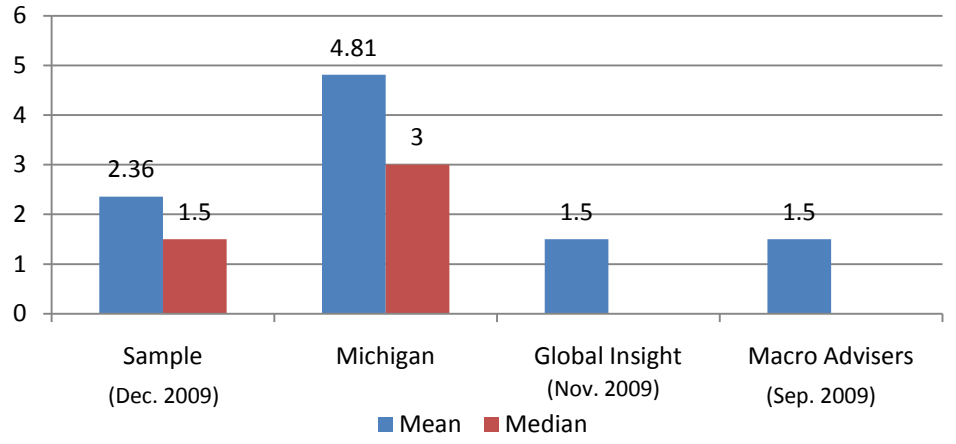

Education of Subject
Harvard Sample Only
Fraction
0
.1
.2
.3
.4
HS Diploma
Assoc. Degree or Some College
Bach. Degree
Adv. Degree

Figure 1C


Past 5 Years Inflation
5
4
3
2
1
0
4.4
3.5
2.53
Sample
Actual CPI
(Dec. 2009)
Mean
Median


1-Year Ahead Inflation
6
5
4
3
2
1
0
2.36
1.5
4.81
3
1.5
1.5
Sample
(Dec. 2009)
Michigan
Global Insight
(Nov. 2009)
Macro Advisers
(Sep. 2009)
Mean
Median

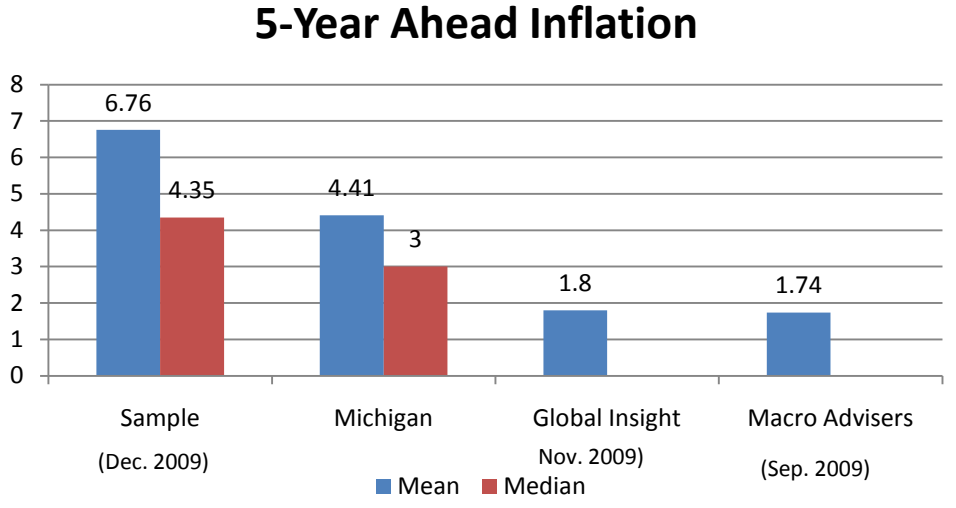

5-Year Ahead Inflation
8
7
6
5
4
3
2
1
0
6.76
4.35
4.41
3
1.8
1.74
Sample
(Dec. 2009)
Michigan
Global Insight
Nov. 2009)
Macro Advisers
(Sep. 2009)
Mean
Median

Figure 2

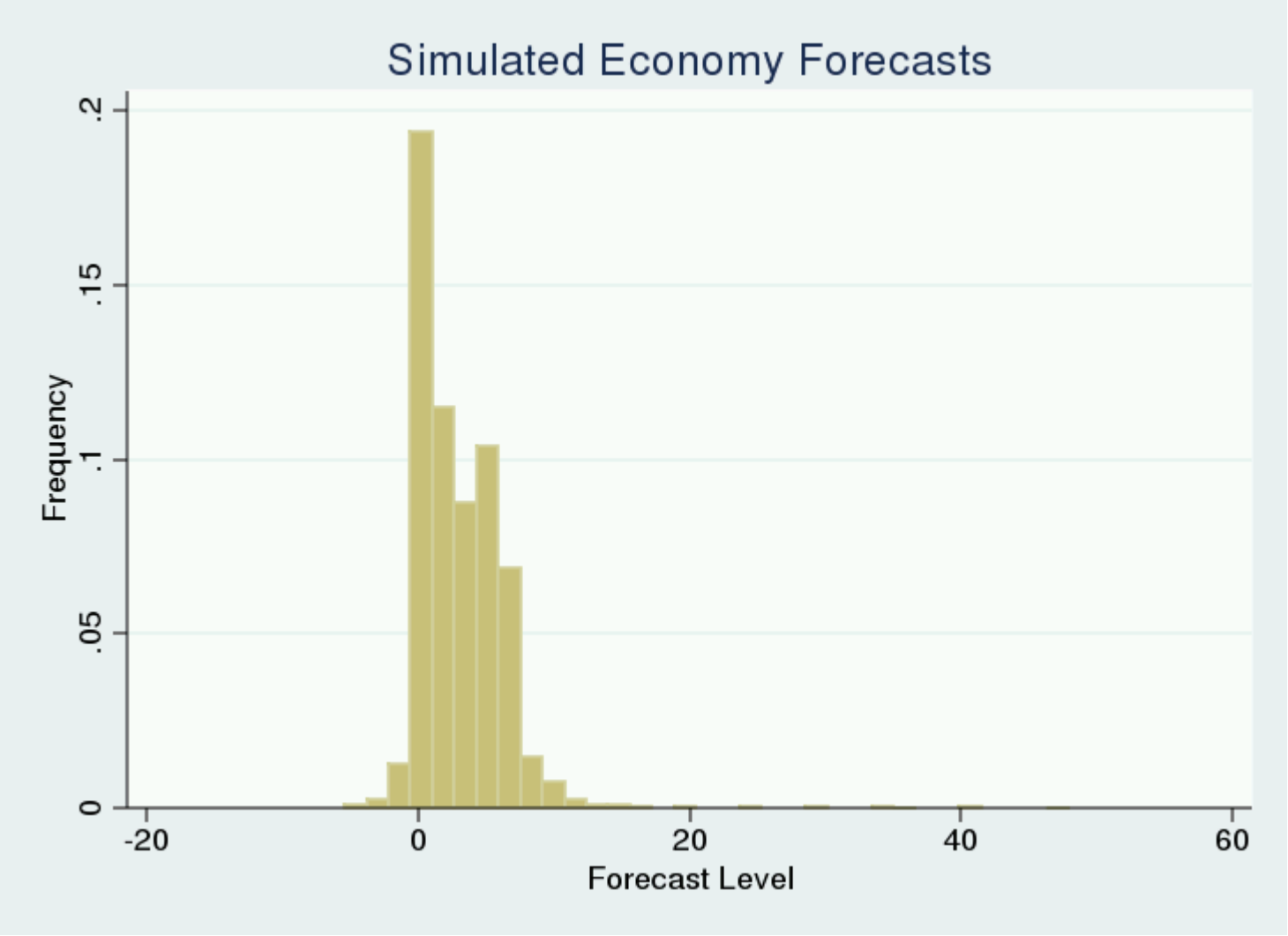

Simulated Economy Forecasts
Frequency
0
.05
.1
.15
.2
-20
0
20
40
60
Forecast Level

Figure 3

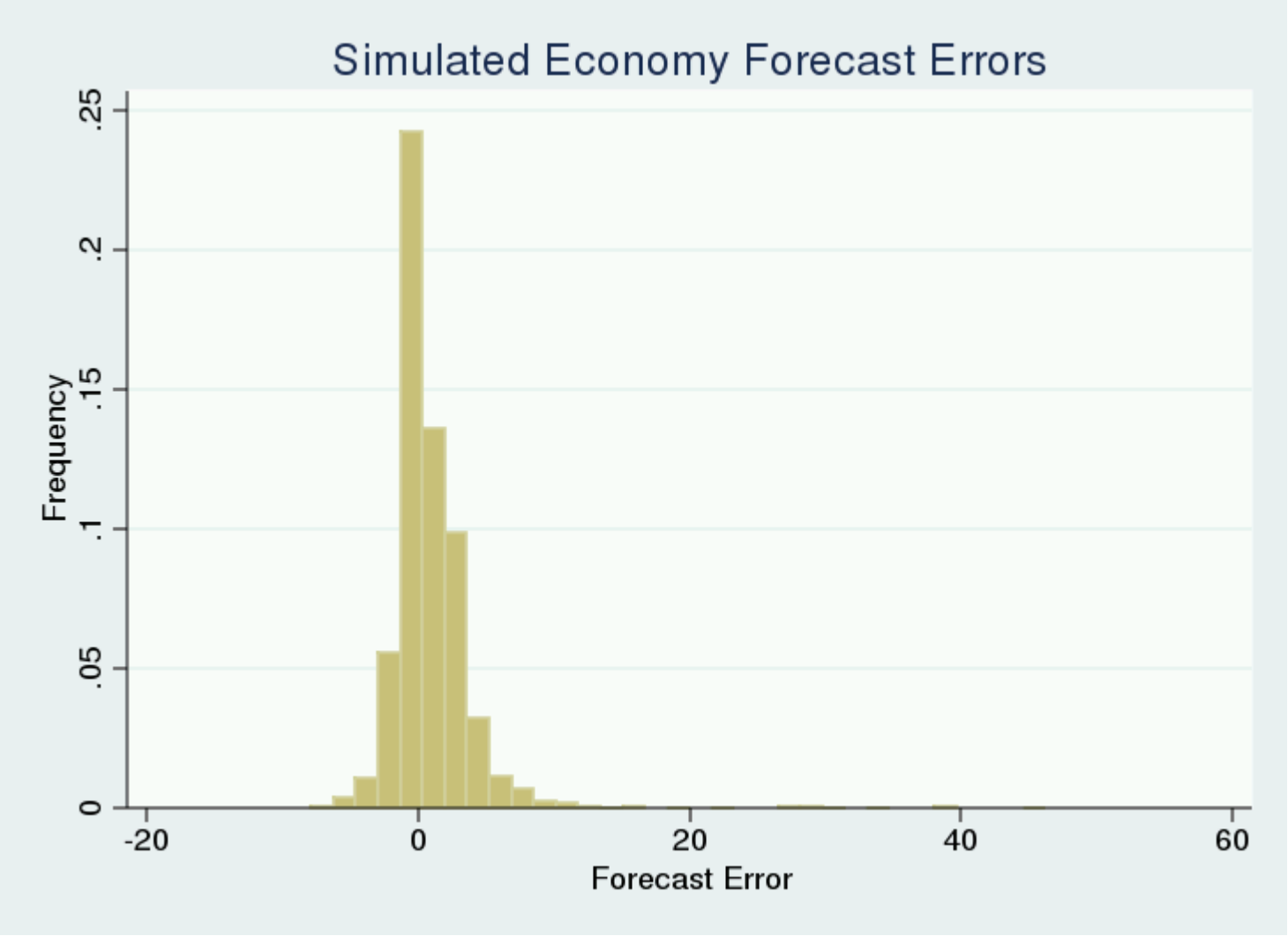

Simulated Economy Forecast Errors
Frequency
0
.05
.1
.15
.2
.25
-20
0
20
40
60
Forecast Error

Figure 4

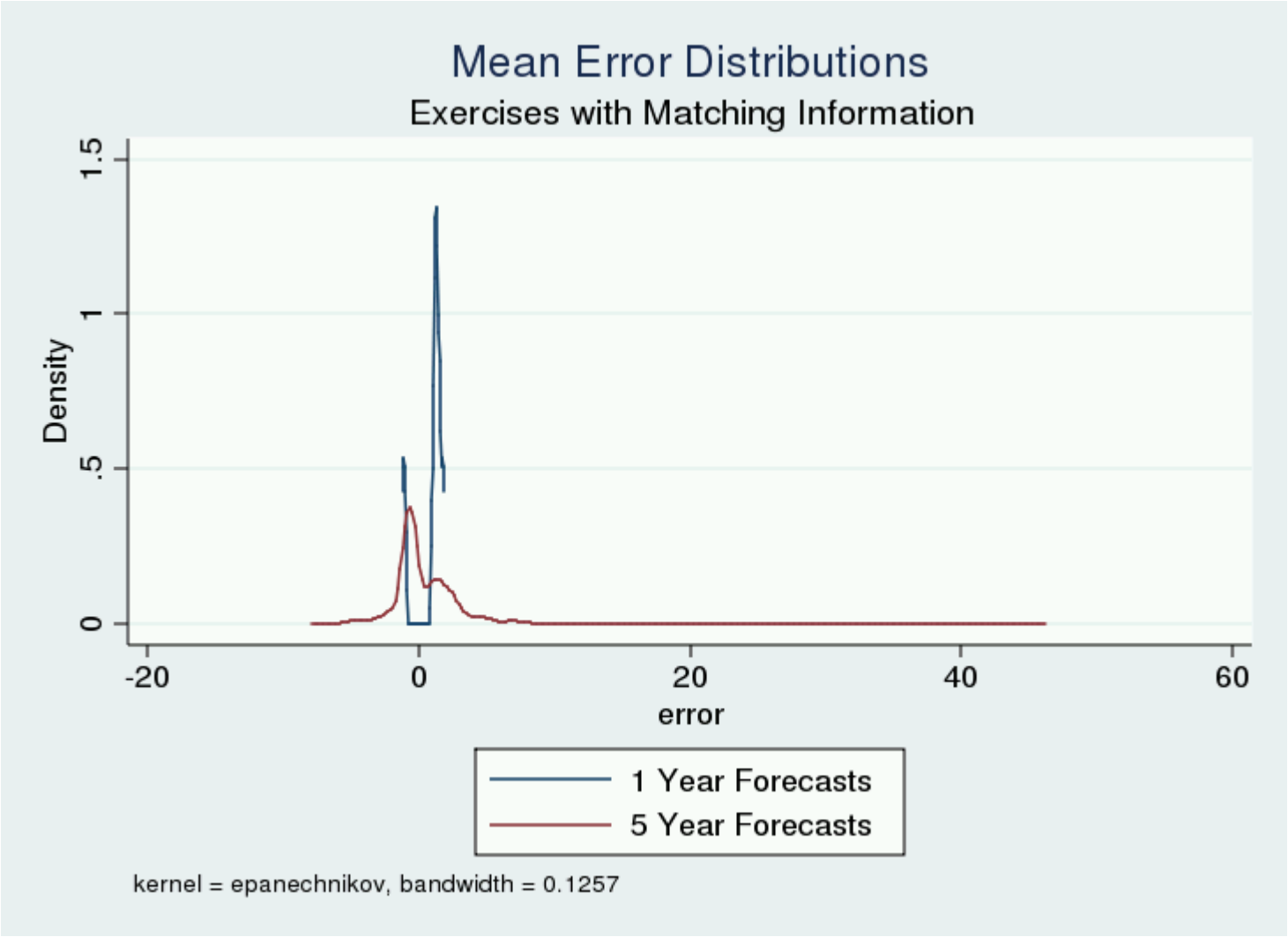

Mean Error Distributions
Exercises with Matching Information
Density
0
.5
1
1.5
-20
0
20
40
60
error
1 Year Forecasts
5 Year Forecasts
kernel = epanechnikov, bandwidth = 0.1257

Figure 5

Table 6

	Mean Error	Mean Error	% Overestimated	% Overestimated	Mean Abs. Error	Mean Abs. Error
Age	0.024	0.021	0.002*	0.002	0.026**	0.022*
	(0.015)	(0.015)	(0.001)	(0.001)	(0.013)	(0.012)
Female	0.390	0.271	0.015	-0.002	0.352	0.197
	(0.293)	(0.296)	(0.026)	(0.025)	(0.246)	(0.243)
Not US-Born	0.440	0.543	0.007	0.022	0.189	0.324
	(0.414)	(0.413)	(0.036)	(0.035)	(0.348)	(0.339)
Hispanic	1.300	1.283	0.147*	0.145*	2.156***	2.133***
	(0.954)	(0.943)	(0.084)	(0.080)	(0.800)	(0.773)
Black	1.650***	1.473***	0.074*	0.048	1.427***	1.195***
	(0.455)	(0.460)	(0.040)	(0.039)	(0.382)	(0.377)
Asian	-0.083	-0.076	0.066	0.067*	-0.050	-0.041
	(0.472)	(0.467)	(0.041)	(0.040)	(0.396)	(0.383)
Other Race	0.135	-0.091	0.099	0.066	-0.120	-0.416
	(0.702)	(0.704)	(0.062)	(0.060)	(0.589)	(0.577)
Multiracial	0.071	0.090	0.016	0.019	0.035	0.060
	(0.499)	(0.494)	(0.044)	(0.042)	(0.419)	(0.405)
Income $40,000–$79,999	-0.181	-0.154	0.012	0.016	-0.442	-0.406
	(0.379)	(0.375)	(0.033)	(0.032)	(0.318)	(0.308)
Income $80,000–$149,999	0.074	0.094	-0.005	-0.002	-0.082	-0.055
	(0.401)	(0.397)	(0.035)	(0.034)	(0.337)	(0.325)
Income $\geq$ $150,000	-0.422	-0.386	-0.036	-0.031	-0.663*	-0.615*
	(0.420)	(0.416)	(0.037)	(0.035)	(0.352)	(0.341)
Some College	-1.196*	-0.984	0.032	0.064	-1.388***	-1.108**
	(0.614)	(0.617)	(0.054)	(0.052)	(0.515)	(0.506)
Bachelor's Deg.	-0.724	-0.651	0.082	0.093	-1.031	-0.934
	(0.912)	(0.903)	(0.080)	(0.077)	(0.765)	(0.740)
Advanced Deg.	-1.749**	-1.355*	-0.004	0.055	-2.041***	-1.523**
	(0.726)	(0.747)	(0.064)	(0.063)	(0.609)	(0.612)
Mother Some Coll.	-0.749	-0.548	-0.068	-0.038	-0.824	-0.559
	(0.677)	(0.677)	(0.059)	(0.058)	(0.568)	(0.555)
Mother Bach. Deg.	0.112	0.177	-0.003	0.007	-0.189	-0.104
	(0.397)	(0.394)	(0.035)	(0.033)	(0.333)	(0.323)
Mother Adv. Deg.	-0.007	0.105	-0.040	-0.023	-0.328	-0.181
	(0.414)	(0.414)	(0.036)	(0.035)	(0.348)	(0.339)
Literacy Score		-1.567*		-0.235***		-2.060***
		(0.813)		(0.069)		(0.666)
Constant	1.008	1.876**	0.160**	0.290***	2.720***	3.861***
	(0.772)	(0.886)	(0.068)	(0.075)	(0.648)	(0.726)
N	136	136	136	136	136	136

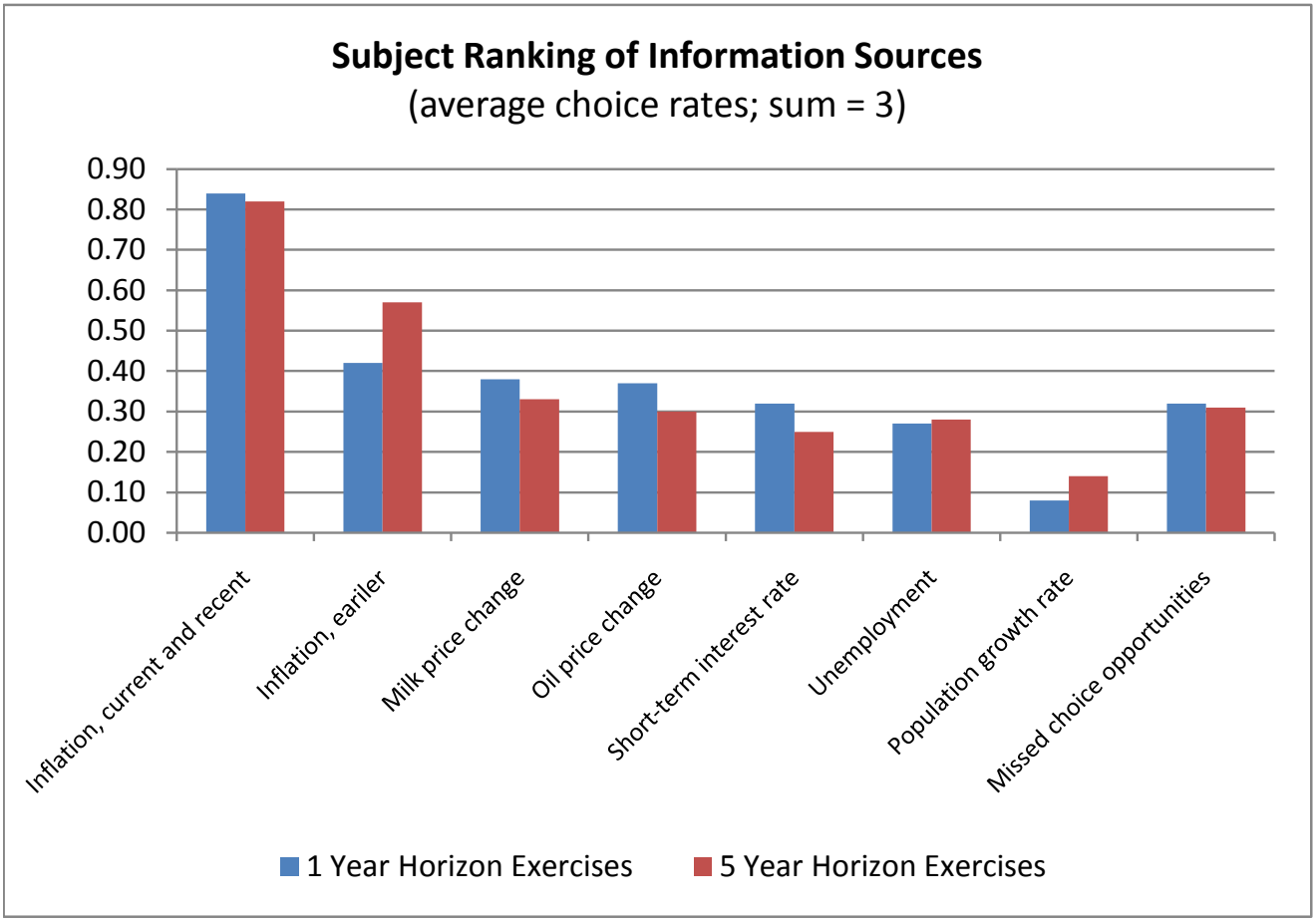

Subject Ranking of Information Sources
(average choice rates; sum = 3)
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Inflation, current and recent
Inflation, eariler
Milk price change
Oil price change
Short-term interest rate
Unemployment
Population growth rate
Missed choice opportunities
1 Year Horizon Exercises
5 Year Horizon Exercises

Figure 6

Table 7: Picking Inflation

Age	-0.010***	-0.009***
	(0.002)	(0.002)
Female	-0.060	-0.020
	(0.042)	(0.039)
Not US-Born	-0.022	-0.049
	(0.057)	(0.053)
Hispanic	-0.504***	-0.437***
	(0.106)	(0.097)
Black	-0.180***	-0.122**
	(0.062)	(0.057)
Asian	-0.077	-0.084
	(0.069)	(0.063)
Multiracial	-0.094	-0.060
	(0.067)	(0.061)
Other Race	-0.158	-0.089
	(0.098)	(0.091)
Income $40,000–$79,999	0.157***	0.151***
	(0.053)	(0.048)
Income $80,000–$149,999	0.052	0.049
	(0.058)	(0.053)
Income $\geq$ $150,000	0.156**	0.136**
	(0.060)	(0.055)
Some College	0.123	0.036
	(0.075)	(0.071)
Bachelor's Deg.	0.237***	0.126*
	(0.077)	(0.074)
Advanced Deg.	0.348***	0.194**
	(0.097)	(0.093)
Mother Some Coll.	0.053	0.018
	(0.076)	(0.069)
Mother Bachelor's Deg.	0.049	0.029
	(0.057)	(0.052)
Mother Adv. Deg.	0.090	0.051
	(0.059)	(0.054)
Literacy Score		0.534***
		(0.102)
Constant	0.929***	0.651***
	(0.102)	(0.107)
N	148	148

Table 8: Mean Absolute Errors

	Exogenous Exercises	Endogenous Exercises
Female	0.196	0.114
	(0.162)	(0.417)
Age	0.020**	0.031
	(0.008)	(0.022)
Black	0.580**	2.241***
	(0.250)	(0.644)
Hispanic	1.553***	2.756**
	(0.516)	(1.329)
Asian	0.099	0.120
	(0.257)	(0.661)
Multiracial	0.085	0.035
	(0.270)	(0.696)
Other Race	-0.435	-0.483
	(0.386)	(0.995)
Not US-Born	0.317	0.618
	(0.226)	(0.581)
Some College	0.023	-1.840**
	(0.339)	(0.872)
Bachelor's Deg.	-0.420	-2.024**
	(0.339)	(0.873)
Advanced Deg.	-0.450	-2.293**
	(0.410)	(1.056)
Mother Some Coll.	-0.049	-0.481
	(0.300)	(0.771)
Mother Bach. Deg.	-0.124	0.021
	(0.218)	(0.561)
Mother Adv. Deg.	-0.110	-0.272
	(0.231)	(0.594)
Income \$40,000–\$79,999	-0.384*	-0.352
	(0.205)	(0.529)
Income \$80,000–\$149,999	-0.176	-0.004
	(0.218)	(0.560)
Income $\geq$ \$150,000	-0.421*	-0.941
	(0.227)	(0.585)
Literacy Score	-2.048***	-3.425***
	(0.440)	(1.134)
Constant	2.952***	5.063***
	(0.487)	(1.254)
N	136	136

Appendix

Contents:

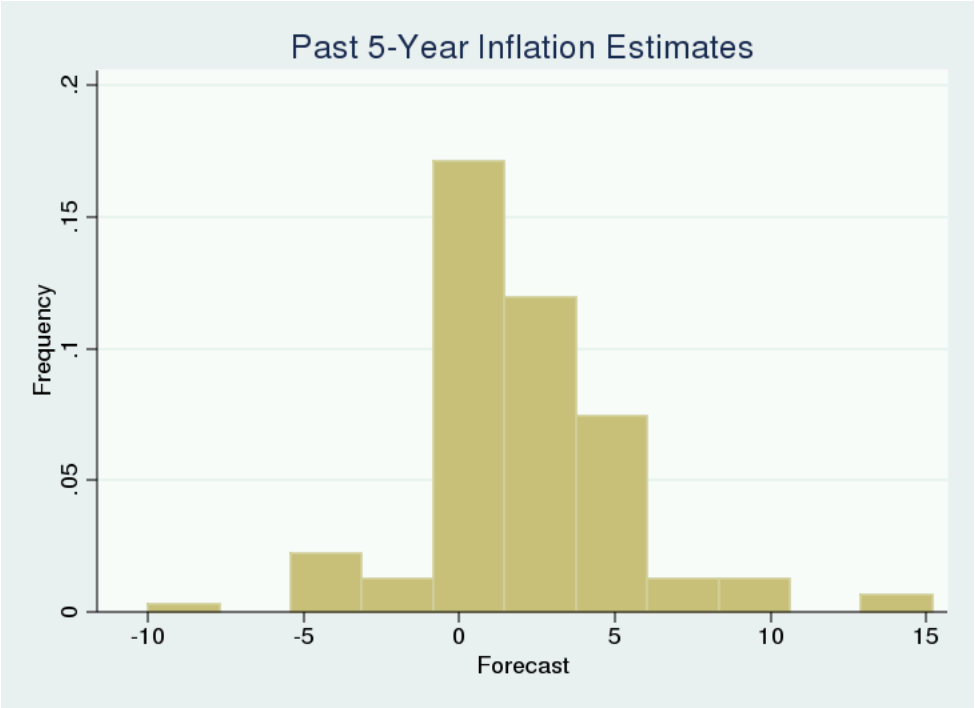

Past 5-Year Inflation Estimates
Frequency
0
.05
.1
.15
.2
-10
-5
0
5
10
15
Forecast

Figure A1

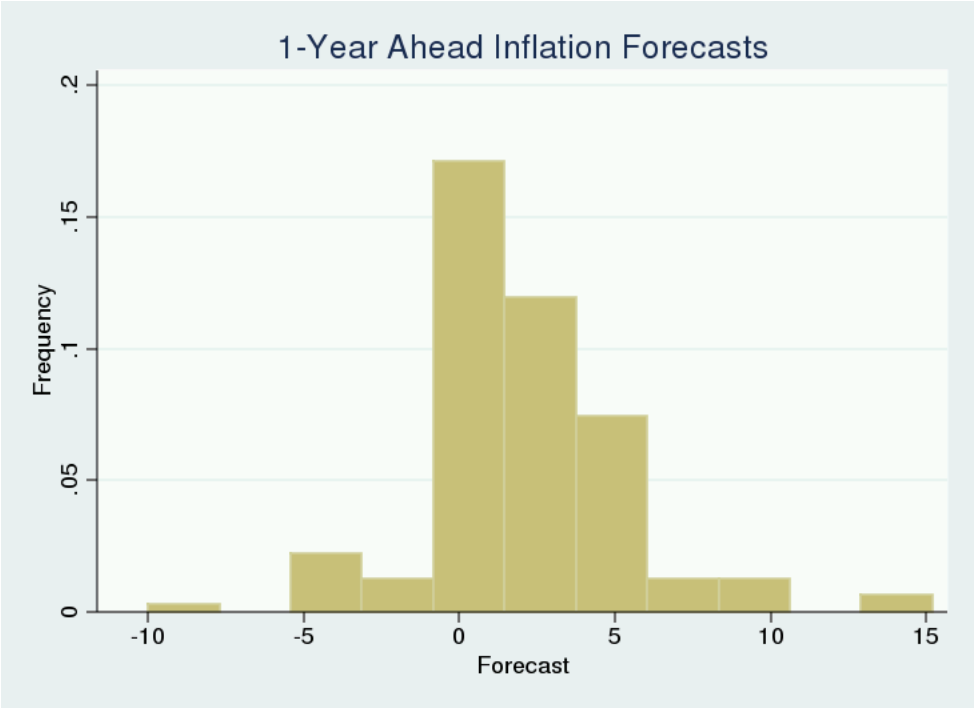

1-Year Ahead Inflation Forecasts
Frequency
0
.05
.1
.15
.2
-10
-5
0
5
10
15
Forecast

Figure A2

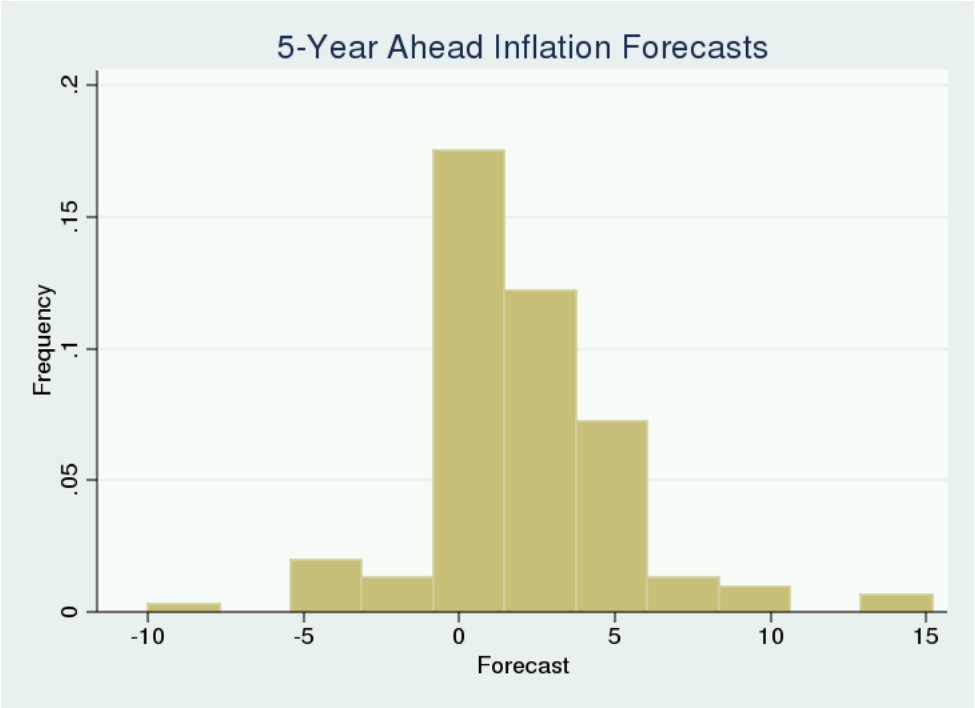

5-Year Ahead Inflation Forecasts
Frequency
0
.05
.1
.15
.2
-10
-5
0
5
10
15
Forecast

Figure A3

Part 1: Questions related to past and future US Inflation

Screen 1

Thank you for participating in our research study.

Your main task will be **to make forecasts (predictions) of inflation**. Before we explain what inflation is, please answer the multiple choice question on the next page.

The correct answer receives a payoff of 20 cents ($0.20). If you select an incorrect answer or do not answer, you will receive $0. You have 1 minute to answer the question. Press "Continue" to view it.

Screen 2

(see question #1 of the economic literacy questionnaire)

Screen 3

Here is the correct answer:

"Inflation is the **rate of increase in the overall price level of goods and services** in an economy."

From now on, **inflation** will be **expressed as an annual percentage rate**:

- Example 1: Suppose the annual U.S. inflation rate was 10% for a particular year. This means that the overall price level of consumer goods and services went up by 10 percent compared to the previous year.
- Example 2: If the annual U.S. inflation rate were -4.50%, prices in general would go down by 4 and one half percent per year.

Now we will ask you to make some guesses about inflation in the U.S. There are no cash rewards for these answers. Time limits will be shown on the top of each screen.

Screen 4a

During the next 12 months, do you think that prices in general (in the U.S.) will go up, go down, or stay where they are now?

- Go up.
- Go down.
- Stay where they are now.

Select the single response you think is best. Then press "Confirm."

Screen 5b (if "go up" or "go down" was selected)

By about what percent do you expect prices to go up [alt: down] on average, during the next 12 months? (Please enter the number of percent, which can have up to 2 digits after the decimal point).

Screen 5

On average over the past 5 years, what has been the annual rate of inflation in the U.S.? (Please enter annual inflation rate in percent. The number can have up to 2 digits after the decimal point.)

What is your best guess (forecast) of what inflation in the U.S. will be in the year 2015? (Please enter annual inflation rate in percent. The number can have up to 2 digits after the decimal point.)

Part 2: "Endogenous" exercises pertaining to simulated economy

Screen 6

Now we switch to a fictional economy. In this part, there will be 8 forecasting exercises.

Your task: In each exercise, you will **predict future inflation in a fictional economy**.

Objective: Your forecast should be **as close as possible to future inflation** in the fictional economy. What "future" means will be specified later.

Assistance: You will have the option to look at **information that may help you** in forecasting inflation.

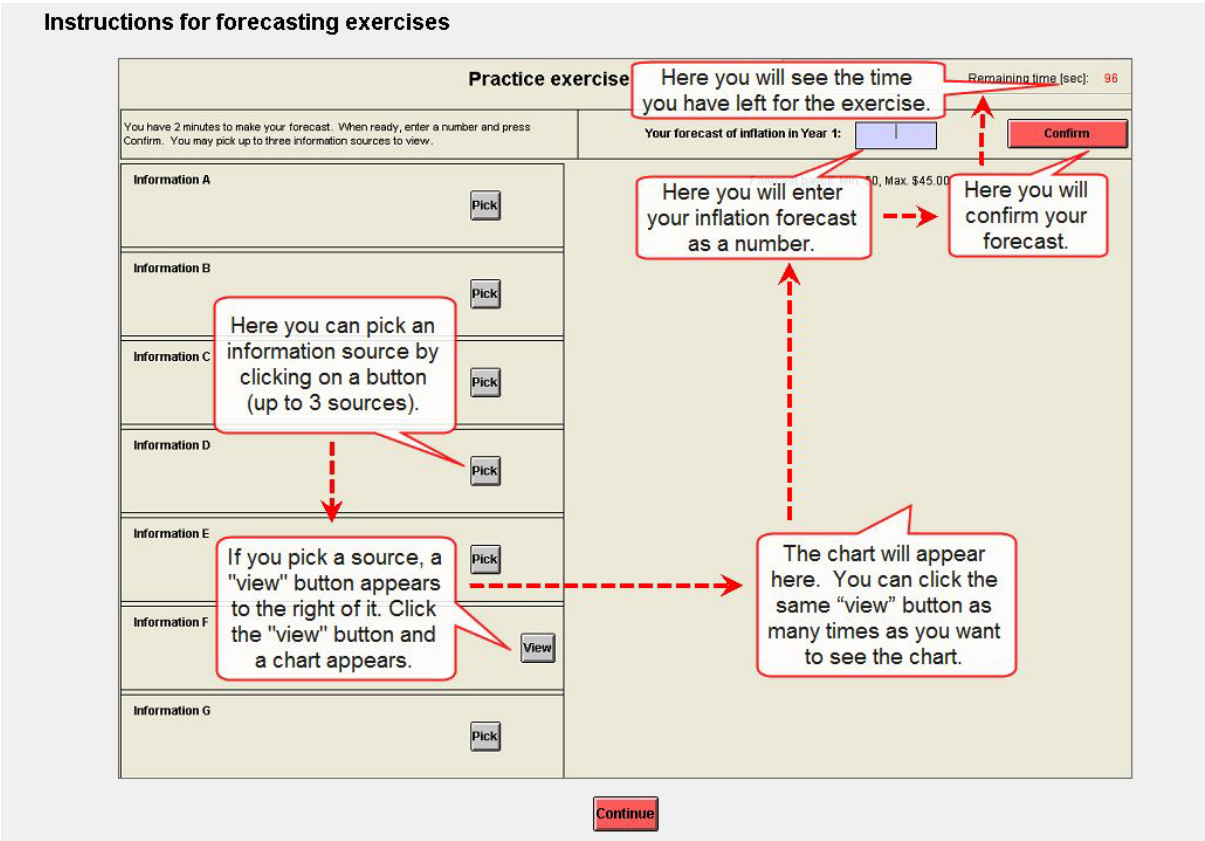
Where the data come from: All data in the fictional economy are generated by a mathematical model based on economic research. The model **captures real-world relationships between inflation and other aspects** of the economy. The data in the fictional economy behave similarly to historical data from the U.S. over the last 25 years.

Screen 7

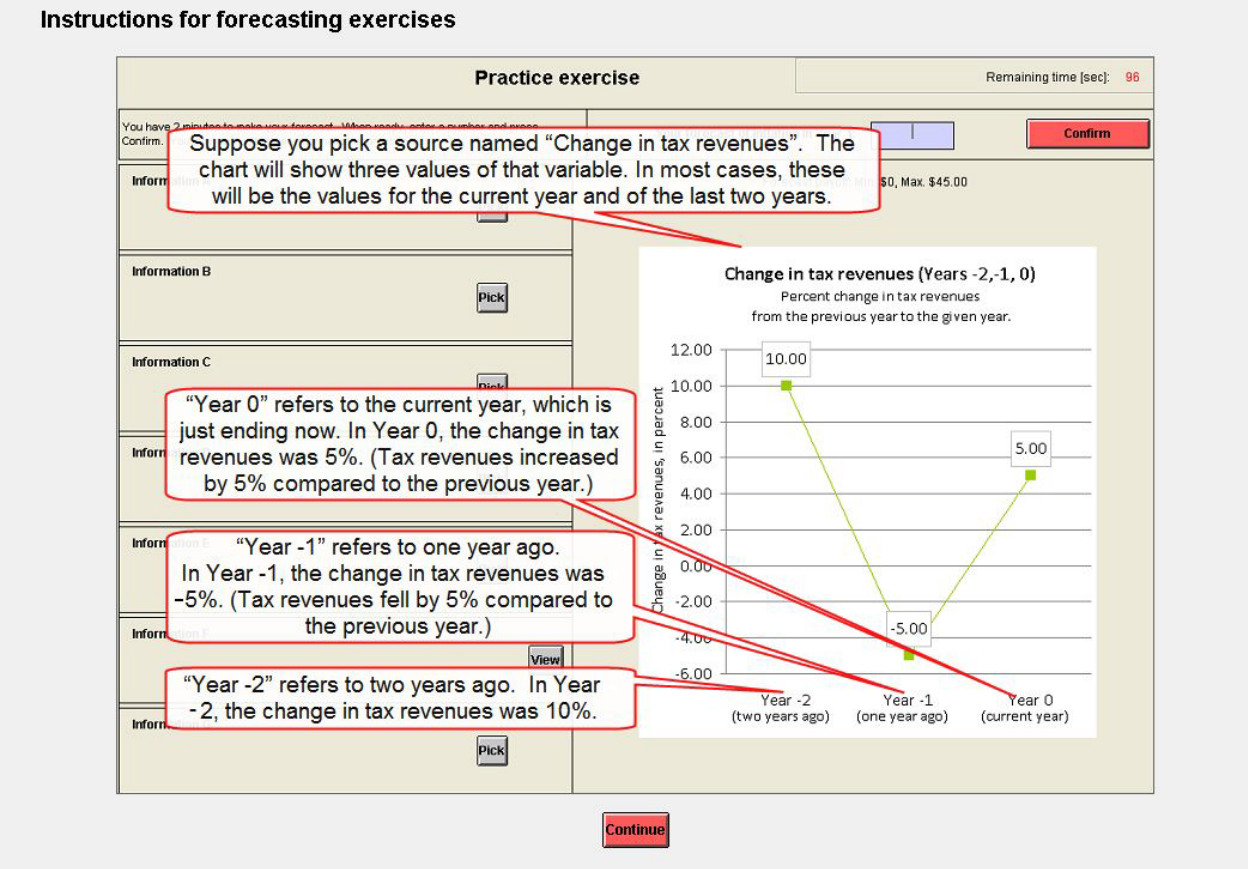
Information sources: Before making your inflation forecast, you will have the option to access information about the fictional economy. At least **some of the information sources are useful,** since they show data that may be indicative of future inflation. However, **some of the information may be irrelevant** to the forecast.

There will be **seven sources to choose from**. You can **access up to three sources** per exercise. You will now see a sample screen.

Screen 8



Screen 9



Screen 10

Test run: The following exercise is a test run and will have no impact on your payoffs. You are simply learning where to click.

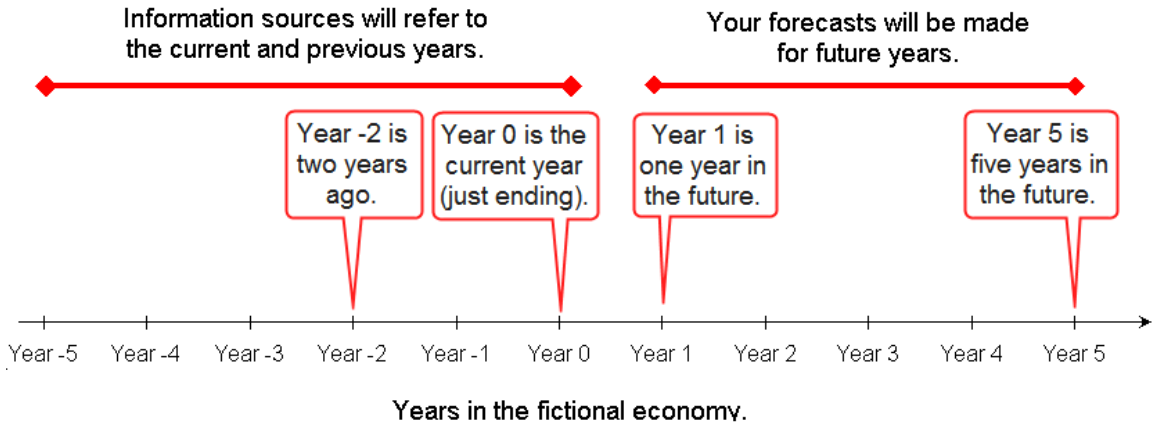
Please pick at least at one information source and view it. Then enter any number in the forecast box and press "Confirm".

Screen 11

(same interface as in "real" exercises, but with abstract information sources "Information source 1" etc.)

Screen 12

Forecast horizon: In **some exercises**, you will make a forecast of (that is, predict) what inflation will be **in "Year 1"** in the fictional economy. In **other exercises** you will forecast inflation **in "Year 5."** The chart below explains the timing. We will remind you of the forecast date within each exercise.



Screen 13

Payoffs per exercise: Your payoff per exercise will be between $0 and $45. **The closer your forecast is to future inflation in the fictional economy** (determined by the model), **the more you will earn**.

Keep in mind:

- If your forecast is exactly right, you get $45 for that exercise.
- If your forecast is 3 or more percentage points too high or too low, your payoff is $0.
- In between, you earn 15 cents ($0.15) more for every 0.01 percentage points you get closer to the correct forecast.

The table below shows some examples..

Difference between your forecast and actual future inflation (in percentage points)	Your payoff
0.00	$45.00
+1.00 or -1.00	$30.00
+1.50 or -1.50	$22.50
+2.00 or -2.00	$15.00
+2.50 or -2.50	$7.50
+3.00 or -3.00	$0.00
+10.00 or -10.00	$0.00

Screen 14

Combined payoffs: Your combined payoff for all forecasting exercises (in the entire session) will be the **average of the payoffs** earned in each individual exercise, **not the sum.**

For example, if your payoff is $40 on half of the exercises and $0 on the other half of the exercises, your *combined payoff* will be $20.

You will earn an additional $10 just for your participation, regardless of your actions in the exercises.

Screen 15

Some final remarks:

- **Time limit:** You will have **2 minutes** to complete each exercise.
- **Units:** Inflation is expressed as an annual percentage rate. Your forecasts may contain up to two digits after the decimal point.
- **Don't forget to confirm your forecast:** If you don't enter a forecast and press the "confirm" button before time runs, you will get a payoff of $0.
- **Each exercise is a new situation:** The situation of the fictional economy (described by the information sources) may be different across exercises. As a result, the future inflation you are trying to forecast is potentially different in each exercise.

Screen 16

Please answer the following multiple-choice questions to make sure you have understood the instructions:

What variable will you forecast in each of the following exercises?

- Future inflation
- Different variables (depending on the exercise)

How many information sources can you pick and view in each exercise?

- Only one source
- Up to three sources

Suppose you are asked to forecast inflation in Year 5. This is the change in the price level between…

- Year 4 and Year 5.
- Year 0 (the current year) and Year 5.

Screen 17

The correct answers to the questions you just completed are shown below **in bold**:

What variable will you forecast in each of the following exercises?

- **Future inflation**
- Different variables (depending on the exercise)

How many information sources can you pick and view in each exercise?

- Only one source
- **Up to three sources**

Suppose you are asked to forecast inflation in Year 5. This is the change in the price level between…

- **Year 4 and Year 5.**
- Year 0 (the current year) and Year 5.

Screen 18

Preview of information sources: You now have a chance to familiarize yourself with the seven information sources that will appear in the exercises.

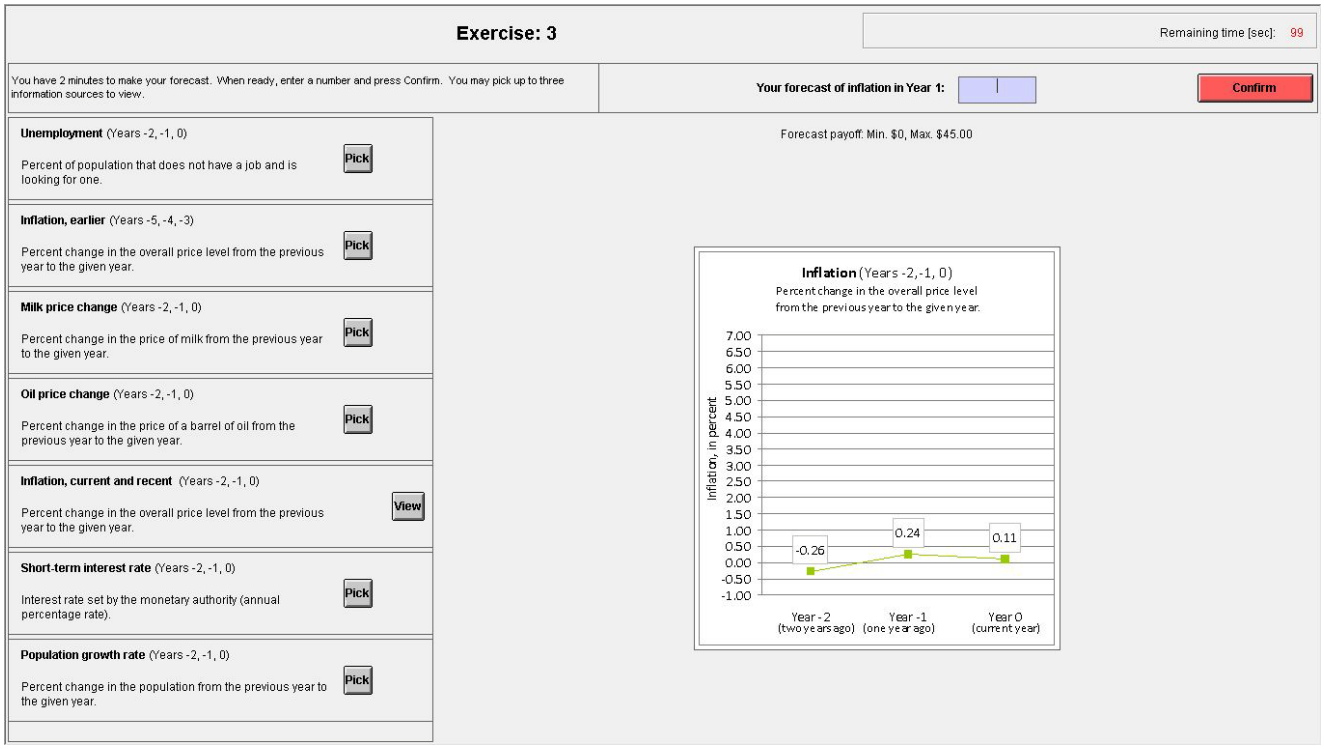
Some of these sources may help you in forecasting future inflation. Please take two minutes to study the definitions carefully.

Screen 19

Forecast horizon for first series of exercises: Recall that the current year is always Year 0. In the following 5 [alt: 3] exercises, you will forecast inflation for **Year 1** [alt: Year 5]. This is **one year in the future** [alt: five years in the future]. Inflation in Year 1 is the change in the price level between Year 0 and Year 1. [Alt: Inflation in Year 5 is the change in the price level between Year 4 and Year 5.]

Now you are ready to begin the exercises. Press "Continue" to start.

Screen 20a,b,c… (3 or 5 exercises)



Screen 21

Thank you for your forecasts. Your combined (average) payoff from the first 5 [alt: 3] exercises is: $ …

Second series of exercises, with new forecasting horizon: Here are 3 [alt 5] new exercises. Again, you will be making forecasts of inflation in the fictional economy. However, now you are making a forecast of **inflation in Year 5** [alt, year 1]. This is **5 years in the future** [alt: 1 year in the future]. Inflation in Year 5 is the change in the price level between Year 4 and Year 5. [Alt: Inflation in Year 1 is the change in the price level between Year 0 and Year 1.]

Screen 22a,b,c… (another 3 or 5 exercises)

Screen 23

Thank you for your forecasts. Your combined (average) payoff from the first 8 exercises is: $ …

You now have to wait until all subjects have completed their forecasts.

Part 3: Free response questions

Screen 24

Now we would like to learn some things about how you made your forecasts. You have 4 minutes for answering the following 2 questions. There are no right or wrong answers.

Other than the available sources, what additional information would have been helpful to you in making your forecasts?

free text entry

Considering the average number of information sources you chose, tell us why you chose this many sources.

free text entry

Part 4: "Exogenous" exercises pertaining to a simulated economy

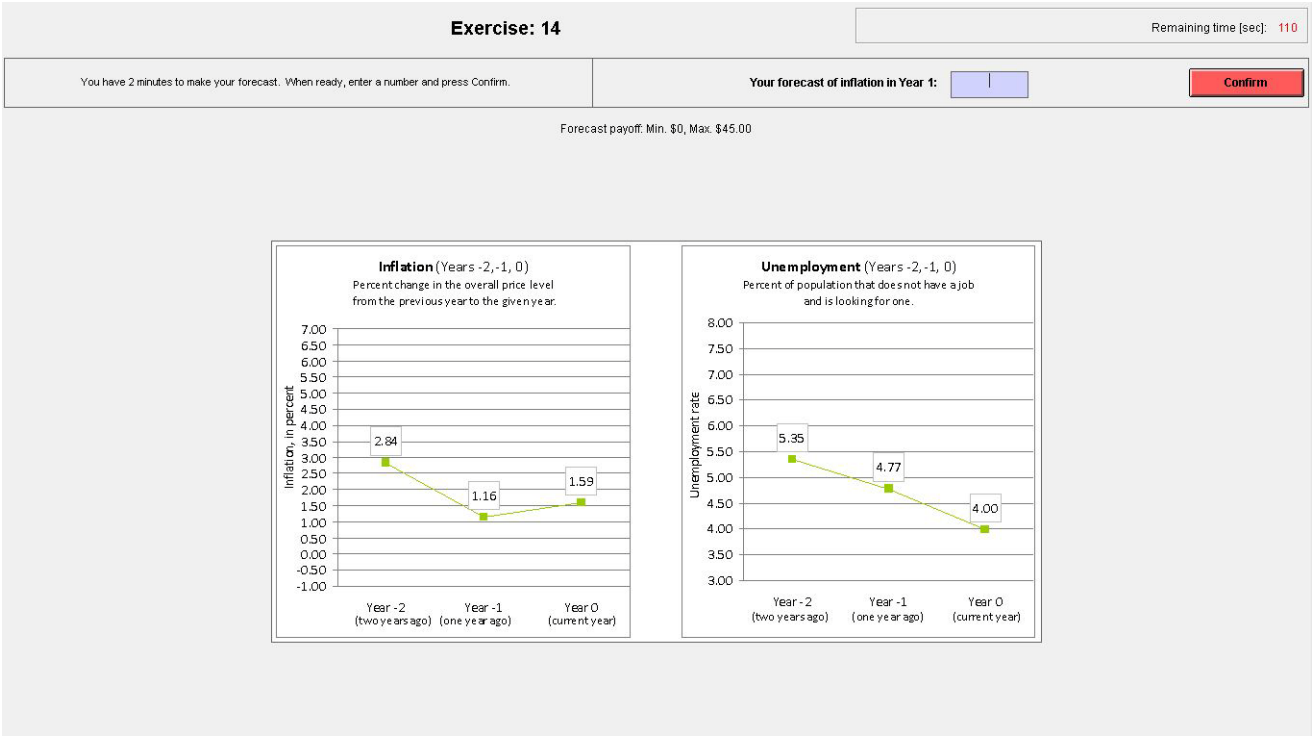
Screen 24

Third series of exercises: Here is another series of forecasting exercises. Again, you will be making forecasts of inflation. However, now you do not have to click to view information sources. The screen will show either one or two charts containing information about the fictional economy. The information may or may not be relevant to the future inflation you are forecasting.

Payoffs: The payoff structure is exactly the same as in the previous exercises. When we calculate your combined payoff, the payoffs from these exercises will be averaged in with the payoffs from the previous exercises.

Forecast horizon: In the following 6 [alt: 3] exercises, you will forecast inflation for **Year 1** [alt: Year 5]. This is **one year** [alt: five years] **in the future.** Inflation in Year 1 is the change in the price level between Year 0 and Year 1. **[**alt: Inflation in Year 5 is the change in the price level between Year 4 and Year 5.]

Screen 25a,b,c… (3 or 6 exercises)



Screen 26

Thank you for your forecasts. Your combined (average) payoff from the first 11 [alt 13] exercises is: …

Fourth series of exercises, new forecasting horizon: Here are 3 [alt 6] new exercises. Again, you will make forecasts of inflation. Again, you will see one or two charts with information about the fictional economy. However, you will now make a **forecast for inflation in Year 5.** [alt: year 1] This is **5 years** [alt 1 year] **in the future**. Inflation in Year 5 is the change in the price level between Year 4 and Year 5. [Alt: Inflation in Year 1 is the change in the price level between Year 0 and Year 1.]

Screen 27a,b,c… (another 3 or 6 exercises)

Screen 28

Thank you for your forecasts. Your combined (average) payoff from the 16 exercises is: …

You now have to wait until all subjects have completed their forecasts.

Part 5: Economic literacy questionnaire

Screen 29

In this part, you are asked to answer **15 multiple choice questions** (4 pages). For each one, select the single response you think is best.

Each **correct answer receives a payoff of 20 cents** ($0.20). Incorrect answers and unanswered questions receive a payoff of $0. The combined payoff for all questions is the sum of the payoffs for each question. This payoff will be added to the payoffs you have already earned up to this point.

You will have 25 minutes to complete all 15 questions. You cannot go back to previous pages. Please press “Continue” to start answering the questions.

Screen 30a,b,c,d

(see questions #2 - #16 of the economic literacy questionnaire)

Screen 31

Your combined payoff from the multiple choice questions is $ …

You now have to wait until all subjects have completed the questions.

Part 6: Questionnaire on demographics

Screen 31

To complete the session, we ask you to provide some information about your background. Remember that all information will remain confidential.

Screen 32a,b,c

(set of questions on demographic background)

Screen 33

Thank you. Your final payoff amount is $ …

Please stay seated until we call you to receive your payoff.

Questionnaire on economic and financial literacy

Question	% correct
1. The rate of inflation in an economy is best described as the rate of increase in the ☐ **overall price level of goods and services.** ☐ overall level of money wages. ☐ the long term interest rate. ☐ value of money.	65.7%
2. Who carries out monetary policy in the United States? ☐ The US Treasury. ☐ US Congress. ☐ **The Federal Reserve.** ☐ The Office of the Comptroller of the Currency.	74.5%
3. A primary purpose of monetary policy today is to ☐ **Stabilize the price level of goods and services.** ☐ Stabilize the price of corporate stocks. ☐ Keep interest rates low and steady. ☐ Reduce national debt.	84.7%
4. Which of the following is a tool of monetary policy? ☐ Raising and lowering income taxes. ☐ Increasing and decreasing unemployment benefits. ☐ **Buying and selling government securities.** ☐ Increasing and decreasing government spending.	51.8%
5. A change in which of the following prices tends to have the largest impact on overall inflation? ☐ The price of milk. ☐ **The price of a barrel of oil.** ☐ The price of gold. ☐ The price of corporate stocks.	59.1%
6. Which of the following measures is most likely to lead to lower inflation? ☐ **Raising the short-term interest rate.** ☐ Lowering the short-term interest rate. ☐ Lowering income taxes. ☐ Raising the level of government spending.	39.4%
7. Which of the following circumstances is most likely to contribute to higher inflation? ☐ **Low unemployment.** ☐ High unemployment. ☐ Low government debt. ☐ High immigration.	48.2%
8. Imagine you have $100 in a bank account. Your money earns 10% interest per year. How many dollars are in your account after two years? ☐ Exactly $110. ☐ Exactly $120. ☐ Exactly $200. ☐ **Slightly more than $120.**	81.8%

9. Which of the following groups would most likely be hurt financially by unexpected inflation? ☐ People who are borrowing money at fixed rates of interest ☐ Purchasers of land who are speculating on price increases ☐ **Retirees who are living on a fixed income** ☐ Workers with a cost-of-living adjustment clause in their contracts	83.9%
10. Suppose Jose can choose whether to receive $10,000 today or to receive $10,000 three years from now. Which option is worth more? ☐ $**10,000 today.** ☐ $10,000 three years from now. ☐ It does not matter. They are of equal value. ☐ It cannot be determined from the information given.	38.0%
11. The chance of getting a viral infection is .0005. Out of 10,000 people, about how many of them are expected to get infected? ☐ **5** ☐ 20 ☐ 50 ☐ 500	85.4%
12. Suppose that in the year 2012, your net income (after taxes) has doubled and the prices of all goods have doubled as well. In 2012, how much will you be able to buy with your income? ☐ More than you can buy today. ☐ **The same as you can buy today.** ☐ Less than you can buy today. ☐ It cannot be determined from the information given.	83.9%
13. Which of the following tends to have the highest growth over periods of time as long as 20 years? ☐ A checking account. ☐ **Stocks.** ☐ U.S. Government savings bonds. ☐ A savings account.	48.2%
14. Which of the following investments would best keep its value (purchasing power) in the event of a sudden increase in inflation? ☐ A 10-year bond issued by a corporation. ☐ A certificate of deposit at a bank. ☐ A twenty-five year corporate bond. ☐ **A house financed with a fixed-rate mortgage.**	51.8%
15. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account? ☐ More than you can buy today. ☐ Exactly the same as you can buy today. ☐ **Less than you can buy today.** ☐ It cannot be determined from the information given.	88.3%
16. In the ACME sweepstakes, the chance of winning a car is 1 in 1,000. What percent of tickets of ACME sweepstakes win a car? ☐ 0.01% ☐ **0.1%** ☐ 1% ☐ 10%	73.7%