

# IQ, Expectations, and Choice\*

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## Abstract

We use administrative and survey-based micro data to study the relationship between cognitive abilities (IQ), the formation of inflation expectations, and the consumption plans of a representative male population. High-IQ men display 50% lower forecast errors for inflation than other men. High-IQ men, but not others, have consistent inflation expectations and perceptions over time. In terms of choice, only high-IQ men increase their consumption propensity when expecting higher inflation as the consumer Euler equation prescribes. Education levels, income, other expectations, and socio-economic status, although important, do not explain the variation in expectations and choice by IQ. Recent modeling attempts to incorporate boundedly-rational agents into macro models do not fully capture all the facts we document. We discuss which dimensions of expectations formation and choice are important for heterogeneous-agents models of household consumption and for the transmission of fiscal and monetary policy.

**JEL classification:** D12, D84, D91, E21, E31, E32, E52, E65

**Keywords:** Behavioral Macroeconomics, Heterogeneous Beliefs, Limited Cognition, Expectations Formation, Household Finance.

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After the rational-expectations revolution, most macroeconomists lost interest in understanding how individuals form expectations because the models directly imply the expectations of the representative agent. Empirically, though, subjective expectations display large cross-sectional variation and deviate from the rational benchmark (Roth and Wohlfart (2018); Bachmann, Berg, and Sims (2015)).<sup>1</sup> But even theoretically, rational expectations can have implausible implications, especially when the zero lower bound on interest rates binds such as the paradox of toil, extreme fiscal multipliers, the forward guidance puzzle, and the fact that more flexible prices might worsen the effects of recessions.<sup>2</sup>

A recent theoretical literature has tackled these puzzling features of the New Keynesian model by proposing deviations from full information rational expectations (FIRE) in the form of finite planning horizons, bounded rationality, or lack of common knowledge.<sup>3</sup> Most of these models attribute an important role to agents' cognitive abilities in the formation, updating, and mapping of expectations into economic decisions. Inspired by this theoretical literature, in this paper we aim to assess empirically the extent to which cognitive abilities relate to the formation and updating of inflation expectations and how these effects feed into agents' consumption plans. We also aim to assess the channels through which cognitive abilities might relate to expectations formation and consumption decisions to inform the modeling of limited cognition in macroeconomic models and evaluate the extent to which the recently proposed models are consistent with our findings.

Assessing whether and to which extent cognitive abilities are relevant to consumers' expectations and choices faces a major empirical challenge. The econometrician needs to jointly measure the cognitive abilities, macroeconomic and individual subjective expectations, and economic choices of a representative population. To overcome this empirical hurdle, we match at the individual level—for the first time, to the best of our knowledge—administrative data on cognitive-ability tests administered to the

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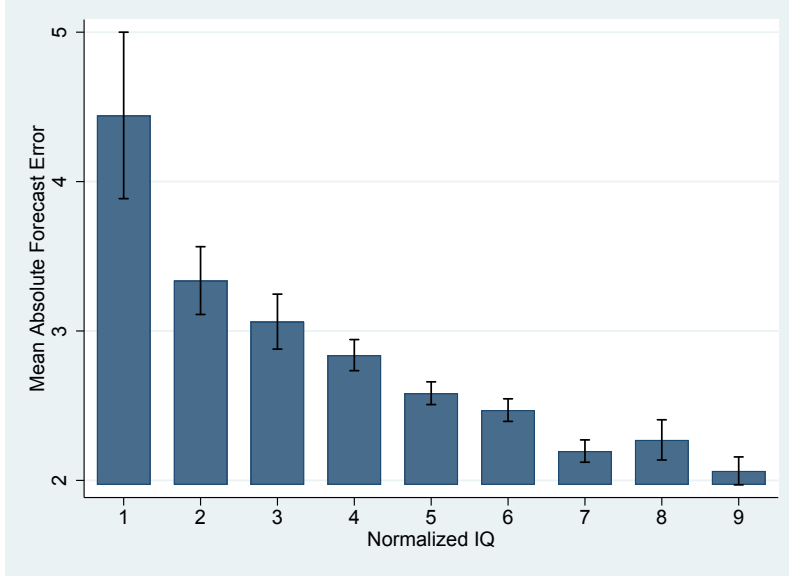
<sup>1</sup>See also Coibion, Gorodnichenko, and Kamdar (2018), Crump, Eusepi, Tambalotti, and Topa (2018), Fuster, Perez-Truglia, Wiederholt, and Zafar (2018), Bordalo, Gennaioli, and Shleifer (2018), Gennaioli, Ma, and Shleifer (2018), Armantier, Bruine de Bruin, Topa, Klaauw, and Zafar (2015), Malmendier and Nagel (2016), D'Acunto, Hoang, and Weber (2021), D'Acunto, Malmendier, Ospina, and Weber (2021), D'Acunto, Malmendier, and Weber (2019), Kamdar (2018), D'Acunto et al. (2020), Andre, Pizzinelli, Roth, and Wohlfart (2019), and Vellekoop and Wiederholt (2017).

<sup>2</sup>See, e.g., Eggertsson and Krugman (2012); Wieland (2019); and Del Negro et al. (2015).

<sup>3</sup>See, e.g., Woodford (2019); Farhi and Werning (2017); García-Schmidt and Woodford (2019); Gabaix (2020); Angeletos and Lian (2018) and Ilut and Valchev (2017).

quasi-universe of a country-level male population with survey-based information on inflation forecasts, as well as on the consumption plans of a representative subset of this population. We also complement the survey-based data with detailed administrative and registry-based micro-data on the demographic characteristics and income of the agents in our sample.

Figure 1: Mean Absolute Forecast Error for 12-Month-Ahead Inflation by IQ



*This figure plots the average absolute forecast error for inflation (in percentage points) across IQ levels. Forecast error is the difference between the numerical forecast for twelve-months-ahead inflation and ex-post realized inflation. Vertical lines represent 95% confidence intervals around the estimated mean for each bin. We use the confidential micro data underlying the official European Commission consumer confidence survey to measure inflation expectations. Statistics Finland asks a representative sample of 1,500 individuals each month. IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. The sample period is from January 2001 to March 2015.*

These data unveil a strong association between the level of cognitive abilities and biases in the formation of economic beliefs. Figure 1 plots the average absolute forecast error for inflation across bins by IQ-test scores. The absolute forecast errors is the absolute value of the difference between an individual’s numerical forecast for twelve-months-ahead inflation and actual inflation measured after twelve months.

We emphasize three facts from Figure 1, which motivate the analysis in the rest of the paper. First, and perhaps not surprisingly, absolute forecast errors decrease monotonically with IQ. The absolute forecast error for agents with the lowest cognitive abilities is 4.3 percentage points, and declines by more than 2 percentage points for individuals in the top IQ bin. Second, the differences in forecast errors are economically and statistically meaningful not only when comparing the extremes of the IQ distribution, but also when

comparing the median individuals in terms of IQ (IQ bin 5) to those with higher and lower levels of cognitive abilities. Comparing 95% confidence intervals across IQ levels, we can statistically and economically reject the null hypothesis of identical forecast error across most adjacent IQ levels. Hence, the role of cognition in the formation of economic expectations is not a binary dimension—low ex-post accuracy is not only a characteristic of agents with low cognitive abilities. Third, the average absolute forecast errors are large across the *whole* IQ distribution relative to the average realized inflation rate of 1.66% during our sample period or the official inflation target of the European Central Bank (ECB) of close to, but below, 2%. Even agents with the highest levels of IQ form inaccurate expectations about macroeconomic variables, on average, and their mean absolute forecast error amounts to more than 100% of the inflation rate the ECB aims to achieve over longer periods of time.

Demographic characteristics that commonly vary across cognitive abilities in the population are unlikely drivers of these baseline facts: We confirm these results when absorbing a rich set of demographics that include age, income, education levels, socio-economic status, marital status, employment status, number of children in the households, and rural versus urban residence, as well as time-varying economy-wide shocks at the monthly level. These demographics represent dimensions that earlier research has related to macroeconomic expectations, as well as potential determinants of households' consumption baskets that shape the inflation expectations of Americans (D'Acunto, Malmendier, Ospina, and Weber (2021)). These observables are also important determinants of expectations and choice in our sample. At the same time, they barely help explain the relationship between IQ and expectations, even for dimensions such as education levels, which the literature often uses as a proxy for unobserved cognitive abilities.

Armed with these novel cross-sectional facts on beliefs and cognitive abilities, we move on to study the formation and updating of inflation expectations within individuals over time by exploiting the panel component of our survey data. Because realized inflation is highly persistent, under rational expectations, we would expect a positive correlation between individuals' recent and current inflation forecasts, on average. Whereas we do detect such positive correlation for men at the top of the IQ distribution (high-IQ men), we fail to detect any correlation for men at the median of the distribution or below (low-IQ men). Moreover, past expectations of future inflation should be correlated with current

perceptions of realized inflation if no major news about inflation occurred between the two interview periods. We find an economically and statistically significant association between past expectations and current perceptions for high-IQ men that is five times larger than the association for low-IQ men. Moreover, the association for high-IQ men is higher across interview periods with stable inflation, whereas it drops across periods of volatile inflation. This result is consistent with the possibility that high-IQ men’s inflation perceptions react to news about inflation. Similar to the other tests, we do not detect any variation in the (low) consistency of inflation perceptions and expectations for low-IQ men.

Despite the economic and statistical significance of the correlations between inflation perceptions and expectations for high-IQ men, the size of the estimated coefficients is rather small, even at times of stable inflation. Paired with the facts that everyone, including high-IQ individuals, make large forecast errors for inflation, this result suggests that the rational-expectations framework is not an adequate description of the decision making process for both low- and high-IQ agents.

Motivated by this observation, we further exploit the richness of our individual-level data to investigate which potential departures from the rational-expectations framework might capture how agents form their macroeconomic expectations. In particular, we consider individuals’ tendency to over- or underreact to macroeconomic news (see Coibion and Gorodnichenko (2012), Coibion and Gorodnichenko (2015), Bordalo, Gennaioli, Ma, and Shleifer (2018)). To this aim, we estimate the relationship between forecast errors and forecast revisions within individuals. We find evidence that high-IQ men overreact to macroeconomic news, whereas the evidence for low-IQ men is noisy and doesn’t conclusively suggest overreaction to news.

Overall, we interpret our evidence as suggesting that high-IQ men overreact to news when forming macroeconomic expectations but update their forecasts in the correct direction. For low-IQ men, instead, we do not find unambiguous evidence in support of any existing framework of expectations-formation. Low-IQ men’s expectations are not adaptive, they are not rational, and are barely consistent with overreaction to macroeconomic news.

In the second part of the paper, we assess whether the heterogeneity of individual expectations by cognitive abilities matters for economic decision-making. Specifically, we assess whether IQ levels relate to Finns’ understanding of intertemporal substitution,

which is a crucial tenet of intertemporal consumption and saving choices. To do so, we follow existing research (Bachmann, Berg, and Sims (2015)) and test whether individuals adjust their durable consumption plans to their inflation expectations, as the consumer Euler equation prescribes, after keeping constant income expectations and other macroeconomic expectations.

Within high-IQ men, respondents who think inflation will increase going forward are about 4% more likely to state it is a good time to purchase larger-ticket items relative to other high-IQ men. Instead, when we consider the subsample of low-IQ men, we detect a small, negative, and statistically insignificant association between inflation expectations and willingness to spend.

One might worry that low-IQ men are more likely to be financially constrained than high-IQ men, which would explain the insensitivity of their consumption plans to changes in perceived real interest rates. Note that income and IQ have a correlation of 0.15 only in our sample, and conditioning on income does not affect any of our results. Moreover, we find that even low-IQ individuals in the top quarter of the population by income are insensitive to their inflation expectations when forming spending plans, which casts doubt on the ability of financial constraints to explain our results.

Another possibility is that expecting higher economic growth and hence higher household income might drive the positive relationship between the propensity to spend and inflation expectations. Because we can observe respondents' income expectations elicited at the same time as their inflation expectations, we can test for this channel directly and we rule it out. Hence, indirect effect of monetary policy that operate through income expectations are not important for the association between IQ, inflation expectations, and consumption plans in our setting (Kaplan, Moll, and Violante (2018)).

In the sample, low-IQ men account for more than 50% of the sample and almost 50% of aggregate income. The insensitivity of their consumption plans to changes in inflation expectations suggests that monetary policy might have to be twice as aggressive in changing interest rates to achieve the same aggregate effects compared to a setting in which the whole population reacted. An important caveat to this statement is of course the fact that we only observe survey-reported propensities to consume and not actual consumption decision but evidence from the US suggests a high correlation between the two (Bachmann et al. (2015)).

In the third part of the paper, we consider how macro models should incorporate

this wealth of new empirical facts on the role of cognition in shaping the formation and updating of subjective beliefs and their impact on choice to the extent they aim to be consistent with our evidence at the micro level. We administered two ad-hoc survey instruments whose questions and information treatments we designed based on recent advances in macroeconomics, behavioral economics, and social psychology.

The first survey instrument aims to assess the extent to which leading attempts to incorporate limited cognitive abilities into standard (New Keynesian) macroeconomic models explain our findings. Most of these models were designed for the specific aim of explaining the forward guidance puzzle, and hence we have no reason to expect that they might explain the whole set of facts we have documented so far. And, of course, the possibility that these modeling approaches might be unable to explain these facts has no implications on their relevance and contribution to the original aim for which they were proposed.

First, we consider level- $k$  thinking (see Farhi and Werning (2017)). We follow Coibion et al. (2018) to elicit the level- $k$  of agents' reasoning in the survey and relate it to their cognitive abilities, which we measure using standard questions in the cognitive psychology literature. The patterns we unveil in terms of levels of reasoning show that high-IQ agents seem to at least understand that level- $k$  thinking is relevant to their decision making, but fail to fully eliminate dominated choices—an attitude that theoretical models typically assign to decision makers with low levels of cognition. Low-IQ agents, instead, demonstrate that they do not understand the concept of level- $k$  thinking and hence barely incorporate it into their decision making.

Second, we consider agents' beliefs and choices under lack of common knowledge about future fundamentals and uncertainty about other agents' reactions to economic shocks (Angeletos and Lian (2018) ). After producing experimental variation in common knowledge about future fundamentals through the survey instrument, we only detect economically small and statistically insignificant effects of common knowledge on agents' inflation expectations, and these effects do not vary with the distribution of cognitive abilities in the population.

Third, we assess behavioral discounting á la Gabaix (2020), due to partial myopia about the distant future. We follow Crump et al. (2018) to estimate the intertemporal elasticity of substitution at the individual level but vary the horizon over which individuals form their inflation expectations. By and large, we fail to detect evidence consistent with

this form of behavioral discounting across agents with different levels of cognitive abilities in our population.

Fourth, we consider agents with finite planning horizon (Woodford (2019)). In his model, agents only form state-contingent plans for a finite number of periods and use experience-based value functions to evaluate the future. We find empirical support for this type of deviation from the standard framework in the sense that high-IQ agents are more likely to report that they typically plan for longer horizons when forming their consumption and saving plans. But we cannot fully disentangle whether an actual longer planning horizon drives this result or the fact that high-IQ agents assume that reporting longer planning horizons is a desirable answer—a classic issue of demand effects in experimental research (De Quidt et al. (2018)).

Because none of the leading models of bounded rationality in macroeconomics seems fully able to account for the novel facts we document in the first parts of the paper, we move on to design a second survey instrument. We aim to further our understanding of how agents with different levels of cognitive abilities think about the concept of inflation, how they differ in their ability to forecast random processes, and how they conceptualize the relationship between economic beliefs and consumption-saving plans. Hence, we move away from the New Keynesian framework and its proposed amendments to the actual beliefs-formation process and choices of agents. We propose a bottom-up approach whereby we provide empirical regularities on expectations-formation and its relationship with choice and planning that could inform future attempts to incorporate bounded rationality in macroeconomic models.

We find that several differences emerge in the ways in which individuals approach the problem of forming inflation expectations based on their cognitive abilities. First, low-IQ individuals have lower knowledge of the concept of inflation, based on their answers to questions about the implications of inflation. Moreover, low-IQ individuals think about inflation differently than others—they think about the prices of concrete goods and services they experience in their daily lives, such as the price of gas or purchases on Amazon. By contrast, high-IQ individuals are more likely to associate inflation with abstract and general economic concepts such as the overall price level or wages.

We also consider agents' ability to forecast any generic mean-reverting processes, such as those of inflation or other macroeconomic variables. As expected, low-IQ individuals make larger errors than high-IQ agents when forecasting these random processes. The



difference in forecasting ability is largest for processes with lower volatility, because high-IQ individuals are also poor in forecasting volatile processes consistent with our field data (Landier et al. (2018)). This result likely reflects a lower ability to think in probabilistic terms by low-IQ individuals (McDowell and Jacobs (2017)), irrespective of their knowledge and understanding of economic concepts.

When we consider agents' ability to map news about inflation into economic decisions in scenario analyses, we find that low-IQ individuals often do not propose meaningful choices, whereas high-IQ individuals are more likely to choose the options that would arise in macro models, such as those the consumer Euler equation prescribes. These results emphasize that high-IQ individuals might be well approximated by theoretical agents who have a clear understanding of the relationships between economic variables and how expectations map into their economic decisions. A realistic description of the economic decision-making of low-IQ individuals, instead, can barely be captured by this approach (e.g., see Ilut and Valchev (2017)).

As a last step, we go back to our field data and assess whether any of the channels we isolated through the survey instruments might explain the link between cognitive abilities and economic decisions in the field in full. First, within the subset of low-IQ men whose perception of recent inflation is correct, we still find that they do not adjust their spending plans to their inflation expectations. The lower average knowledge of low-IQ men of the concept of inflation by itself is hence not enough to fully explain the field results.

Moreover, when we consider low-IQ men who have accurate inflation expectations, we still find that they do not react to their expectations when forming consumption plans. The inability to forecast economic processes by itself is thus also unable to explain our results in full.

Finally, we consider low-IQ agents' inability to map future states of the world into optimal economic choices. Under this framework, even low-IQ agents who have the right information about current inflation and are able to forecast future states of the world accurately would not necessarily adjust their consumption plans based on intertemporal substitution.<sup>4</sup> We find that the differences in choice between high- and low-IQ men drop substantially and almost disappear within the subsample of respondents who have an economics or business degree. In this subsample, the correlation between IQ and forecast errors for inflation almost disappears too. Moreover, in this subsample even

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<sup>4</sup>Note this channel could also explain the excess sensitivity of consumption to predictable income changes (see, e.g., Parker et al. (2013)).

low-IQ individuals who expect higher inflation increase their readiness to spend as the consumer Euler equation predicts.

Taken together, our results attribute a role to cognitive costs in gathering information about current and future inflation, but we also find that cognitive costs are not enough to explain all results. Differences also exist in the ability to forecast random processes. Low- and high-IQ individuals also think differently about inflation and finally, low-cognitive ability individuals have a harder time to map the objective state into the optimal action (Ilut and Valchev (2017)).

**Related Literature.** Our findings stress the importance of cognitive abilities in shaping individual economic decision-making. Papers that document the role of IQ in financial decision-making such as stock market participation, trading behavior, and mutual fund choice are Grinblatt et al. (2011), Grinblatt et al. (2012), and Grinblatt et al. (2016). Agarwal and Mazumder (2013) relate cognitive abilities to suboptimal use of credit cards and home-equity loan applications. Aghion, Akcigit, Hyytinen, and Toivanen (2017) use micro-level data on visuospatial IQ to study the effects of cognitive abilities, education, and parental income on inventiveness. In a study of global preferences, Falk et al. (2018) document the relationship between survey respondents' math skills and their economic preferences and Falk et al. (2019) study the effects of socio-economic status on children's IQ and economic preferences. A large literature has studied the role of cognition as well as the deterioration of cognitive abilities with aging on several features of economic preferences and beliefs about personal outcomes.<sup>5</sup> Our paper contributes to this strand of literature by linking cognitive abilities to macroeconomic expectations and subsequent choices, which allows measuring forecast errors for all individuals based on objective and common realizations. Moreover, we investigate how cognitive abilities relate to consumers' view of the economy and the ways in which they conceptualize economic concepts. The large variation by cognitive abilities we uncover speaks to the relevance of considering subjective models of the macroeconomy both from the research and policy perspectives (Andre, Pizzinelli, Roth, and Wohlfart (2019)).

In our paper, we use a test-based measure of cognitive abilities because such a measure is available for a large population of men in a developed country through administrative

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<sup>5</sup>For instance, see Frederick (2005); Heckman et al. (2006); Chabris et al. (2008); Hanushek and Woessmann (2008); Agarwal, Driscoll, Gabaix, and Laibson (2009); Burks et al. (2009); Dohmen et al. (2010); Benjamin et al. (2013); Agarwal and Mazumder (2013); Choi et al. (2014); Gerardi et al. (2013); Dal Bo et al. (2017); Dohmen et al. (2018).

sources. We do not claim that the measure we use is the best possible measure of cognitive abilities, or that producing one single measure of cognitive abilities is the best way to assess individuals' intelligence and other potentially related traits.<sup>6</sup> In the ideal test, we would have produced a set of measures for several traits related to intelligence and cognition by contacting directly the population of interest and using elicitation methods aligned with the most recent state of the art in this area. Unfortunately, we could produce these measures only for a small population and for a short period of time, but not for a large and representative population over the years, which is the main contribution of our paper in terms of data and measurement.

The first part of our study focuses on how individuals form inflation expectations. Other recent contributions studying the formation and updating of expectations and the relationship with economic behavior are Das et al. (2020), who study the role of socioeconomic status for macroeconomic expectations, Malmendier and Nagel (2016) and Kuchler and Zafar (2018), who study the effect of personal experiences on expectations of aggregate outcomes, and Bailey, Cao, Kuchler, and Stroebel (2018) and Fuster, Perez-Truglia, Wiederholt, and Zafar (2018), who study how agents acquire and process information for national home price expectations. Cavallo, Cruces, and Perez-Truglia (2017) and D'Acunto et al. (2021) show individuals extrapolate from the realized inflation experienced in their shopping bundle to overall inflation expectations. Coibion et al. (2019) study how different forms of monetary-policy communications causally change individuals' inflation expectations. Our result are reminiscent of Rozsypal and Schlafmann (2017) who document an overpersistence bias for income expectations which alters the distribution of marginal propensities to consume and as such makes stimulus policies less effective.

Bachmann et al. (2015) initiate the literature that studies the relationship between inflation expectations and consumption plans at the micro level and Crump et al. (2018), D'Acunto et al. (2021), D'Acunto et al. (2018), and Burke and Ozdagli (2019) are other recent contributions. None of these papers focus on the role of heterogeneous cognitive abilities across agents, which is the main aim of our work.

Finally, our findings add to the growing literature on heterogeneous agents in New Keynesian (HANK) models (Kaplan, Moll, and Violante (2018)). HANK models attribute a relevant role to indirect effects of monetary policy operating through income

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<sup>6</sup>For detailed summaries and for the evolution of this long-standing debate over time, see Weinberg (1989) and Stanovich (2009), among others.

expectations (Slacalek, Tristani, and Violante (2020)). Hagedorn, Luo, Manovskii, and Mitman (2019) shows that HANK models can also successfully solve the forward-guidance puzzle. De Ferra, Mitman, and Romei (2019) extent the HANK model to a small open economy setting to study the transmission of foreign shocks. Auclert, Rognlie, and Straub (2020) estimate a HANK model matching both micro and macro moments and uncover a central role for investment in the transmission of monetary policy. Common to these models is the relevance of the portfolio composition of households, and the correlation of the marginal propensity to consume (MPC) with wealth (Fagereng, Holm, and Natvik (2019) and Fagereng, Holm, Moll, and Natvik (2019)). Our findings open up new exciting avenues to understand both theoretically and empirically how MPC heterogeneity and differences in cognitive abilities interact to shape the aggregate response to policy shocks.

## I Data

Our analysis uses three micro datasets that include individual-level information on macroeconomic expectations, consumption and borrowing plans, and cognitive abilities, as well as administrative information on household-level income.

### A. Data on Cognitive Abilities

Finland has general conscription for men, which means all Finnish men between the ages of 18 and 60 are liable for military or non-military service. The share of men who do non-military service is only about 3% of all men who start military service.<sup>7</sup> Within the first weeks of the mandatory military service, Finnish men typically around the age of 19-20 have to participate in a series of tests. The Finnish Defence Forces (FDF) administer these tests and use the results to select candidates for possible officer training. Because ranking well in the IQ test provides a set of advantages in terms of quality of training and access to elite social networks, men have an incentive to perform as well as possible on the test (Grinblatt et al. (2011)).

The cognitive-ability test consists of 120 questions that focus on three areas – visuospatial, mathematical, and verbal.<sup>8</sup> The FDF aggregates those scores into a composite measure of cognitive abilities, which we label collectively as IQ. The FDF

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<sup>7</sup>Please see <https://puolustusvoimat.fi/en/conscription> for these and additional details.

<sup>8</sup>D’Acunto, Hoang, Paloviita, and Weber (2019) discuss in more detail the different subtests.

standardizes IQ to follow a stanine distribution. Stanine (STAndard NINE) is a method of scaling test scores on a 9-point standard scale with a mean of 5 and a standard deviation of 2, approximating a normal distribution. The respondents with the lowest 4% of test scores are at least 1.75 standard deviations from the mean and are assigned a standardized IQ score of 1, and the 4% with the highest test scores are assigned a standardized IQ score of 9. Hence, most of the observations is around the median bin, whereas the extreme bins account for only a small part of the sample. We have test results for all participants from 1982 until 2001.

Finland is a homogeneous country in terms of cultural background and opportunities. Access to education, including college education, is virtually for free. The country is also racially homogeneous (Grinblatt et al. (2011)). These features make the Finnish setting a desirable laboratory because our measures of IQ are unlikely to proxy for differences in cultural or environmental factors, which individuals could manipulate, but are more likely to reflect differences in innate abilities across individuals.

## **B. Data on Expectations and Spending Plans**

Our main source of information on individual-level macroeconomic expectations and consumption propensities are the confidential micro data underlying the Consumer Survey of Statistics Finland. Statistics Finland conducts the survey on behalf of the Directorate General for Economic and Financial Affairs of the European Commission as part of the harmonized consumer survey program.<sup>9</sup> Every month, it asks a representative repeated cross section of approximately 1,500 Finns questions about general and personal economic conditions, inflation expectations, and willingness to spend on consumption goods.

We obtained access to the micro data underlying the survey for the period starting in January 1996 and ending in March 2015. Until December 1999, Statistics Finland ran the survey using rotating panels, interviewing the same person three times at six-month intervals, replacing each month one-third of the sample. Since January 2001, the survey employs repeated cross sections.<sup>10</sup> The samples are drawn from the total population of 4.4 million individuals and 2.6 million households residing in Finland. The survey is run through phone interviews. In advance of the phone interview, Statistics Finland notifies all target individuals with a letter that contains information about the contents and logistics

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<sup>9</sup>D’Acunto et al. (2021) use the micro data for several European countries and discuss in detail the survey design and data properties.

<sup>10</sup>The data for 2000 are missing, unfortunately.

of the survey. Our analysis employs the purely cross-sectional data starting in 2001, with the exception of Section III, in which we exploit the panel dimension to study variation in expectations within individual over time.

We use the answers to the following two questions in the survey to construct the variables capturing spending plans and inflation expectations in our baseline analysis:

**Question 10** *In view of the general economic situation in Finland, do you think that now it is the right moment for people to buy durable goods such as furniture, home appliances, cars, etc.?*

Respondents can answer, “It’s neither a good nor a bad time,” “No, it’s a bad time,” or “Yes, it’s a good time.”

**Question 7** *By what percentage do you think consumer prices will change over the next 12 months?*

Respondents can answer numbers between -100 and 100 with one decimal point.

In addition, we use qualitative questions regarding expectations about general macroeconomic variables, personal income and unemployment, and a rich set of socio-demographics from Statistics Finland, which include gender, age, marital status, household size, and education levels.

## **C. Data on Income from Tax Returns**

We also have access to administrative income and debt data for all Finnish full-time residents at the end of each calendar year through Statistics Finland. The data contain information on individuals’ labor and business incomes, received and paid income transfers, as well as overall household taxable assets and liabilities. The information is collected from underlying sources across various agencies (Tax Administration, National Institute for Health and Welfare, Statistics Finland, Kela), administrative registers, and statistical repositories.

## D. Descriptive Statistics

Table 1 contains the descriptive statistics for the main variables in our analysis. Mean inflation expectations during our cross-sectional sample are 2.5% with a large cross-sectional dispersion of 3.76%. Mean household income is EUR 22,500 and the average age is 30.7 years. 5.8% are unemployed, 60% are single, and 77.6% have children. In our running sample, 35.6% of men live in urban areas, with 27.8% living in Helsinki, and 34% have a college degree. On average, 51% of respondents say it is a good time to buy durables, 20% say it is a bad time, and the others are indifferent.

Table 2 reports average inflation expectations and standard deviations within each stanine of the distribution by IQ. Both the mean and the cross-sectional dispersion in inflation expectations are higher for low-IQ men than for high-IQ men and decrease monotonically in IQ. Note the number of observations is not symmetric around bin 5, but we observe systematically lower mass in the left tail of the distribution than in the right tail. In some of our analyses, we split our sample between groups 1 to 5 (low-IQ mean) and groups 6-9 (high-IQ men) to obtain subsamples of similar size.

The asymmetry of the distribution of the survey responses by IQ might raise concerns about sample selection,<sup>11</sup> because the underlying distribution of IQ we obtain from the FDF is symmetric around 5. Only after merging the IQ data with the consumer survey do we observe the asymmetry. Conversations with survey experts at Statistics Finland suggest a nonnegligible fraction of Finns who are contacted to complete the survey decline to do so. Low-IQ men might be more likely to decline to participate in the survey relative to high-IQ men. If the low-IQ men who decline are those who have severe cognitive problems or know they have a limited knowledge of their surroundings, we would expect these men would perform even worse, on average, than the surveyed low-IQ men in forecasting inflation and making economic choices. In this case, the empirical effects we estimate in this paper might be a lower bound of the actual effects we would expect if everybody in the population provided expectations and plans.

## II IQ and Expectations across Individuals

In this section, we assess the cross-sectional relationship between subjective beliefs and IQ as well as the role of demographic characteristics other than cognitive abilities.

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<sup>11</sup>We thank Kathrin Schlafmann for emphasizing this point.

## A. Forecast Errors

First, we compute the forecast error for inflation at the individual level as the difference between the numerical forecasts for twelve-months-ahead inflation and ex-post realized inflation. Figure 1 in the Introduction plots the mean of the absolute values of the individual forecast errors within each stanine of normalized IQ. The graph documents a monotonic negative association between forecast errors and cognitive abilities. Men in the lowest IQ stanine have an average absolute forecast error of about 4.4%, whereas men in the highest stanine have an absolute forecast error of about 2%, which is more than 50% smaller. On the one hand, forecast errors decrease by less with increasing cognitive abilities. On the other hand, errors are economically and statistically different across the whole IQ distribution. The role of cognitive abilities is not only confined to differences between a few agents at the bottom of the distribution and all other agents. Panel A of Figure 2 shows that the patterns in Figure 1 are similar if we consider the mean forecast error, that is, we allow for positive and negative deviations from ex-post realized inflation to average out within groups of IQ.

### A.1 Forecast Errors by Income and Education

The univariate association between IQ and forecast errors might proxy for individual-level characteristics other than IQ, such as income or education levels. In our data, IQ and taxable income are positively associated but the correlation is low (0.15).<sup>12</sup> The low correlation stresses the desirability of the Finnish setting which allows us to disentangle variation in cognitive abilities from variation in income.

To assess whether the patterns for forecast errors by IQ are merely proxying for variation in income and education levels, we first repeat the univariate analysis of Panel A of Figure 2 by plotting average forecast errors across income and education groups. Panels B shows that we fail to detect any monotonic association between average forecast errors and income levels. If anything, average errors are higher for the income levels above the median—with the notable exception of the top bin—than for others. The analysis for splitting the sample into six groups based on education levels delivers similar

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<sup>12</sup>D’Acunto et al. (2018) show that average income is monotonically increasing in IQ stanine.



results.<sup>13</sup> Even though the association of education levels with forecast errors is negative, the pattern is not as stark as with IQ, which suggests that differences in IQ levels might capture variation beyond levels of formal education.

We also perform a multivariate analysis in which we regress individual-level forecast errors on a dummy variable that equals 1 if the individual belongs to the top four stanines of the normalized IQ distribution (6 to 9), and 0 otherwise, year-month fixed effects, and a rich set of demographics. Demographics include age, age<sup>2</sup>, a dummy that equals 1 if the respondent is single, logarithm of income, a dummy that equals 1 if the respondent has a college degree, an unemployment dummy, a dummy that equals 1 if the respondent has at least one child, a dummy that equals 1 if the respondent lives in an urban area, and a dummy that equals 1 if the respondent lives in Helsinki. Even after absorbing variation in demographics that might be correlated with IQ, the mean absolute forecast error is 0.24 percentage-points lower for high-IQ men than for low-IQ men (see column (1) of Table 3).<sup>14</sup>

## A.2 Forecast Errors by IQ: Demographic Splits

To further investigate the role of observables in shaping the relationship between IQ and expectations, we perform a multivariate analysis across a set of demographic sample splits in Table 3. One aim is to capture unobserved differences in households' consumption baskets, which are important determinants of inflation expectations (D'Acunto et al. (2021)). To this aim, we compare the size of the association between IQ and absolute forecast errors for inflation separately for single and married respondents (column (2)), respondents below and above age 35 (column (3)), urban and rural respondents (column (4)), and respondents earning more than the median labor income in the sample (column (5)).

Across the board, IQ is economically and statistically negatively associated with forecast errors for inflation within each sample split and we fail to reject the null hypothesis

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<sup>13</sup>We follow the *International Standard Classification of Education* to construct the six groups. The classification includes eight categories, with the first two categories not present in our sample. The categories are: primary education (1), lower secondary education (2), upper secondary education (3), post-secondary non-tertiary education (4), short-cycle tertiary education (5), bachelor (6), master (7), and doctoral (8).

<sup>14</sup>Conditional on demographics, all subcategories of IQ are negatively associated with forecast errors for inflation, see Table A.1 in the Online Appendix. In a horse race across subcategories, we find that arithmetic and verbal IQ remain negatively associated with forecast errors but visuospatial IQ loses its predictive power.

that the point estimates across most splits are equal. A noteworthy exception is age—high IQ relates to larger forecast errors within young respondents. We also observe a stronger effect of IQ on forecast errors within high-income men and men living in rural areas.

The second set of splits aims to proxy for differences in economic sophistication. We estimate the baseline specification for respondents with or without a college degree (column (6)), and respondents with a degree in the areas of economics, business, law, or information, and other respondents (column (7)). The association is about half the size for college-educated respondents and respondents with economic-related degrees than for others. This result suggests that the ability to process numerical information and the grasping of basic economic concepts might in part substitute for cognitive abilities when agents form subjective beliefs. At the same time, IQ is still economically and statistically significantly negatively associated with absolute forecast errors for inflation even for respondents who are more educated or have economics-related degrees. We dig deeper into these results in the channels section of the paper.

A concern with our analysis so far is that IQ and macroeconomic expectations are elicited at different times in our data. IQ is measured for all men at the beginning of the military service—around age 19. Expectations, instead, are elicited at different ages for different men. One might worry that IQ measured at age 19 is not a good proxy for cognitive abilities at different points in one’s life cycle. To address this concern, we split our sample into three groups based on the time between the date men in our sample took the IQ test and the date at which they participated in the survey. Table A.2 in the Online Appendix shows that the size of the association between IQ and forecast errors does not change across groups. Moreover, the results are not different if we interact the high-IQ dummy with respondents’ age, which suggests that agents’ potential deterioration of cognitive abilities over time does not interfere with the explanatory power of our measure of IQ for forecast errors.

### III IQ and Expectations Updating

Our results so far exploited cross-sectional variation in cognitive abilities and inflation expectations for individuals we observe only once. Between 1996 and 1999, though, Statistics Finland administered the survey with a panel component. In this section, we use the panel to study the updating of inflation expectations within individuals by

cognitive abilities.

## A. Are Current and Past Expectations Consistent?

For individuals with well anchored and forward-looking inflation expectations, only news relevant for future inflation should result in forecast revisions. Moreover, realized inflation was highly persistent throughout our sample period with coefficients of auto-correlation well above 0.95. Under rational expectations, we would thus expect a positive correlation between the inflation expectations of individuals across subsequent waves. Columns (1)-(2) of Table 4 estimate the size of this auto-correlation for high- and low-IQ men, after absorbing demographics and year-month fixed effects. An economically and statistically significant correlation of 23% exists for high-IQ men, whereas the association is economically and statistically insignificant for low-IQ men.

Under rational expectations, we would also expect that past inflation expectations are positively correlated with current perceptions of inflation unless major news or shocks realized between elicitation periods. When we regress current inflation perceptions on past inflation expectations (columns (3)-(4) of Table 4), we detect a positive and statistically significant association of 24% for high-IQ men. The association for low-IQ men is statistically significant but an order of magnitude lower (5%) than the association for high-IQ men.

We would expect a muted association instead between past expectations and current perceptions of inflation if shocks to realized inflation occurred between elicitation periods. We thus split our sample into periods in which the difference between the inflation rate at the time of the first and subsequent interview is in the top third of the distribution, and all other periods.<sup>15</sup> Comparing columns (5) and (7) of Table 4, we find that for high-IQ men, the positive association between past inflation forecasts and current perceptions of inflation is higher in periods of stable inflation relative to other periods. Columns (6) and (8) instead document low correlations of similar magnitude for low-IQ men independent of the change in inflation across interviews.

Overall, high-IQ men appear closer to the rational benchmark than low-IQ men, but the magnitudes of the estimated coefficients are small even for high-IQ men, which signal potential departures from the standard rational model also for individuals at the top of

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<sup>15</sup>This test partially hinges on the fact that realized inflation is close to a random walk and hence we can interpret changes as shocks.

the IQ distribution.<sup>16</sup>

## B. Overreaction to Macroeconomic News

Because not only low-IQ men, but also high-IQ men seem to not form expectations in a way that is fully consistent with the rational benchmark, we move on to assess whether other expectations-formation processes proposed in the macroeconomics literature might be consistent with our data.

Mounting evidence suggests that consumers, professional forecasters, and managers form expectations that deviate from the rational benchmark because of underreaction or overreaction to news. We build on the framework in Coibion and Gorodnichenko (2012) and Coibion and Gorodnichenko (2015) to assess if our individuals over- or underreact to news. In this framework, forecast revisions suggest that agents react to (unobservable) news across forecast elicitation periods. We can thus regress the forecast errors of agent  $i$ —the difference between the realized value of a variable,  $x_{t+1}$ , minus the forecast at time  $t$ ,  $x_{i,t+1|t}$ —on the forecast revision,  $FR_{i,t,1} = x_{i,t+1|t} - x_{i,t+1|t-1}$ :

$$x_{t+1} - x_{i,t+1|t} = \alpha + \beta FR_{i,t,1} + \varepsilon_{i,t}. \quad (1)$$

The full-information rational-expectations benchmark implies that  $\hat{\beta} = 0$ . A negative point estimate, instead, implies overreaction to news.<sup>17</sup>

Building on Bordalo et al. (2018), we test in Table 5 for over- and underreaction within high- and low-IQ men by estimating equation (1).<sup>18</sup> The results with and

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<sup>16</sup>Attenuation bias due to measurement error might help explain this low association in part. Note, though, that expectations and perceptions were elicited consistently across survey waves, and the question asks for a precise numerical value, which alleviates concerns about potential measurement error.

<sup>17</sup>To see the intuition, suppose that the agent revised his inflation forecast upwards. A positive coefficient implies the agent, on average, did not update the expectations enough, because the ex-post realized value was above the predicted value. Following a similar intuition, a negative point estimate for  $\beta$  instead implies the agent overreacted to news; that is, he forecasted a value that was too high given the ex-post realization. Bordalo, Gennaioli, Ma, and Shleifer (2018) test this framework on the individual macroeconomic expectations underlying the Survey of Professional Forecasters and find that professional forecasters, on average, overreact to news for most macroeconomic time series, which is in contrast to the results for consensus forecasts in Coibion and Gorodnichenko (2015). They rationalize their findings in a model of diagnostic expectations along the lines of Bordalo et al. (2016), Bordalo et al. (2018), and Bordalo et al. (2017).

<sup>18</sup>Our tests differ slightly from Bordalo et al. (2018), because in our sample, individuals always forecast twelve-months-ahead inflation instead of inflation for a fixed forecast period, such as the year 2020. Because realized inflation is highly persistent and close to a random walk, we can still interpret the coefficients as in Bordalo et al. (2018).

without individual fixed effects are quite similar for high-IQ men. The economically and statistically negative estimates of  $\beta$  imply overreaction to news. For low-IQ men, we also estimate a negative  $\beta$ , but the coefficient is lower than for high-IQ men and becomes statistically insignificant once we absorb time-invariant individual characteristics.

Taken together, our results imply high-IQ men overreact to news when forming inflation expectations, whereas low-IQ men’s expectations do not seem to align either with the rational benchmark or with more recently developed models of expectations formation.

## IV IQ and Choice: Intertemporal Substitution

Our results so far have focused on the formation of subjective beliefs by cognitive abilities. In this section, we move on to assess whether the differences in expectations formation by cognitive abilities are relevant to economic choices, and especially to high-IQ and low-IQ agents’ consumption-saving decisions.

Standard models studying the transmission and effectiveness of fiscal and monetary policy are based on a representative agent with rational expectations who reacts to changes in expectations and economic incentives. For example, the Euler equation predicts a positive association between consumption expenditure and inflation expectations. A natural question is thus whether low-IQ and high-IQ agents differ in the extent to which they update their consumption plans to changing inflation expectations. This analysis is important because households’ understanding of intertemporal substitution is crucial in virtually all macro models including HANK models that rely on the initial intertemporal substitution of unconstrained households.

### A. Intertemporal Substitution

If we correlated numerical values of inflation expectations with consumption decisions, we would be unable to disentangle the case in which low-IQ individuals were unable to articulate their expectations in numerical terms from the case in which they were able to but did not understand intertemporal substitution, because in both cases, we would observe that reported numerical inflation expectations are unrelated to consumption plans (e.g., see Binder (2017) and D’Acunto et al. (2021)).

To address this concern, we follow D’Acunto, Hoang, and Weber (2021) and construct

a measure of inflation expectations based on survey respondents’ *qualitative* expectations. The rationale is that, even if low-IQ households were not able to express their numerical inflation expectations meaningfully, they should be able to report whether they expect inflation to increase, stay the same, or decrease over the following twelve months. If not, they would either not understand the concept of inflation or would hold incorrect beliefs (Duca et al. (2019)).

This measure of inflation expectations derives from a survey question on qualitative inflation expectations and is a dummy variable that equals 1 if the agent expects a higher inflation rate in the following twelve months, relative to the inflation rate over the past twelve months, and 0 otherwise.<sup>19</sup> Following Bachmann et al. (2015), our outcome variable is agents’ readiness to purchase durable goods based on discrete unordered choices in the survey and model the response probabilities in a multinomial-logit setting. We estimate the model via maximum likelihood to obtain the vector of coefficients and compute the marginal effects of changes in the covariates on the probability that individuals choose any of three answers in the survey, and report them in the tables. We cluster standard errors at the quarter level to allow for correlation of unknown form in the residuals across contiguous months. All specifications include the full set of demographic controls we observe, as well as controls for perceived past inflation, see Jonung (1981).

In columns (1) and (2) of Table 6, we report the average marginal effects for whether respondents think it is a good time to purchase durable goods on the dummy that equals 1 if the respondent thinks inflation will be higher over the following twelve months relative to the previous twelve months. High-IQ men who expect inflation to increase are, on average, 3.6% more likely to answer it is a good time to buy durables than are high-IQ men who expect constant or decreasing inflation (column (1)). Instead, column (2) documents no economically or statistically significant association for low-IQ men. If anything, the estimated coefficient is negative, although small in size and not statistically distinguishable from zero. These baseline results are consistent with the possibility that low-IQ men do not understand the concept of intertemporal substitution in full.<sup>20</sup>

In the rest of Table 6, we repeat the analysis across the demographic splits of Table

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<sup>19</sup>D’Acunto, Hoang, and Weber (2021) show that this measure tracks ex-post realized inflation closely. The ability of this qualitative measure to track ex-post realized inflation more closely than quantitative measures might be due to the fact that agents have a good idea of the directional changes of inflation even if they are uninformed about the *level* of inflation (Vellekoop and Wiederholt (2017)).

<sup>20</sup>Table A.3 in the Online Appendix reports marginal effects for all covariates and Table A.4 reports the marginal effects of inflation expectations for different sample splits: low (stanine 1 to 3), medium (stanine 4 to 6), and high IQ (stanine 7 to 9). Marginal effects monotonically increase in size by IQ.

3. For each sample split reported at the top of the columns, we report four marginal effects: for high-IQ and low-IQ men who belong to the reported category (Panel A) and for those who do not belong to the category (Panel B).

We emphasize a set of patterns from these sample splits. First, for most of the splits we consider, high-IQ men who expect higher inflation are systematically more likely to update their spending plans irrespective of whether they belong to the demographic group of interest (see columns (3), (5), (7), (9), (11), and (13)).<sup>21</sup> Second, we fail to reject the null that the marginal effect equals 0 for low-IQ respondents across most demographic splits, irrespective of the sample sizes, both economically and statistically (see columns (4), (6), (8), (10), and (12)).

Moreover, low-IQ men with an economics or business degree are the *only* group of low-IQ men for whom we can detect an economically and statistically positive association between expecting higher inflation and answering it is a good time to purchase durable goods (0.1109, see column (14), Panel A).<sup>22</sup> This result suggests that providing targeted economics knowledge to low-IQ men might be a substitute for cognitive abilities in driving economic choices that conform with standard macroeconomic models (Lusardi and Mitchell (2007)).

## B. Financial Constraints and Income Expectations

Binding financial constraints are a compelling alternative interpretation of our results. If low-IQ men were systematically more likely to be financially constrained than high-IQ men, low-IQ men’s consumption plans would be insensitive to inflation expectations not because they do not understand intertemporal substitution, but because they cannot easily substitute their consumption expenditure intertemporally. To assess the relevance of this alternative interpretation, we repeat our baseline analysis limiting the sample to respondents who are unlikely to be financially constrained—those with high income.<sup>23</sup> Table A.5 in the Online Appendix shows that even the consumption plans of low-IQ men with higher-income are insensitive to changes in inflation expectations.

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<sup>21</sup>We fail to detect statistical significance at conventional levels for the coefficients associated with high-IQ men above 35, high-IQ men below the median of the income distribution, and high-IQ men with an economics or business degree, but even in these cases, the point estimates are positive and large.

<sup>22</sup>The coefficient is also positive for low-IQ men with any college degree (see column (12), Panel A), but we fail to reject the null that this coefficient is 0 statistically. This group also includes men with economics and business degrees which drive the large positive coefficient.

<sup>23</sup>Ideally, we would use more direct measures of financial constraints, such as credit denial or maxed out credit-card limits, but unfortunately these dimensions are unobserved in our data.

Low-IQ men might also have systematically different expectations about *other* dimensions, such as unemployment or income, which might mute their willingness to adjust consumption plans in response to inflation expectations. Kamdar (2018) and Andre et al. (2019) for example show that many individuals associate higher inflation with bad economic times. Columns (1) and (2) of Table A.6 in the Online Appendix replicates our baseline analysis only for agents with positive twelve-months-ahead income expectations. The consumption plans of low-IQ men are insensitive to inflation expectations even within this group. And, we do not detect any reactions for low-IQ men who expect lower income either (column (4)). The association between inflation expectations and spending plans also barely varies with income expectations for high-IQ men which suggests that indirect effects of monetary policy might be less important in our setting (Kaplan et al. (2018)).

## V Implications for Models Incorporating Bounded Rationality

So far, we have studied and documented a set of facts about the relationship between cognitive abilities, subjective beliefs, and economic choices in terms of both cross-sectional and within-individual variation. In the rest of the paper, we ask whether these facts are fully consistent with the current modeling of bounded rationality in macroeconomics and behavioral economics and which dimensions these models should incorporate to be consistent with our results.

### A. Assessing Extant Attempts to Incorporate Bounded Rationality in Macroeconomic Models

A recent theoretical literature in macroeconomics has proposed several ways to incorporate bounded rationality into standard models.<sup>24</sup> Building on this literature, we designed tests that aim to assess whether the proposed modeling approaches help us understand the systematic differences in inflation expectations and choices across agents with different levels of cognitive abilities.

Specifically, we designed an ad-hoc survey instrument, which we fielded on Amazon

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<sup>24</sup>The forward guidance puzzle—the limited empirical effectiveness of guidance about the future path of interest rates relative to the prediction of the standard New Keynesian model—has motivated most of these theoretical endeavors.



Mechanical Turk (mTurk) in February 2021.<sup>25</sup> The survey contained 31 questions and the average response time was 14 minutes and 55 seconds for a population of 1,500 participants. We offered participants standard incentivization schemes—a base payment of \$1.00 as well as the possibility to earn a bonus of up to \$0.35 based on the performance in the cognitive-reasoning questions. The maximal payment respondents could earn was thus \$1.35, and the average payment was \$1.18.

The survey started with five questions about respondents’ preferences and beliefs, which we designed based on Falk et al. (2018). We elicited respondents’ risk tolerance, generalized trust, self-reported mathematical abilities, reciprocity, and willingness to take revenge against peers. In all cases, respondents would use qualitative sliders to scale the extent to which statements about these characteristics described them accurately between 0 and 10.

Second, we proposed the three cognitive-reflection test questions in Frederick (2005).<sup>26</sup> We also added four questions about logical associations and numerical patterns. We presented these questions with the label of “brain teasers” to respondents. We construct our baseline proxy for cognitive abilities as a dummy variable, *High IQ*, which equals 1 if the respondent provided at least five correct answers to the seven questions about cognition, and 0 otherwise. The results are virtually identical if we define this variable by adding or subtracting one correct answer.

We then elicited inflation expectations and proxies for different modeling techniques for bounded rationality which we detail below and we concluded the survey with a set of demographic questions including age, gender, income brackets, education levels, as well as whether the respondent was the main financial decision-maker in his/her household (D’Acunto et al. (2019)) and/or the main grocery shopper for the household (D’Acunto et al. (2019), D’Acunto et al. (2021)).

In terms of recent macroeconomic models, we first consider the relevance of the depths of reasoning. Farhi and Werning (2017) extend the baseline New Keynesian model by introducing bounded rationality in the form of level-k thinking common to all agents. They show that level-k thinking and market incompleteness jointly reduce the power of monetary policy, especially at longer horizon. We follow Coibion et al. (2018) to elicit the

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<sup>25</sup>We report the survey question in Section I of the Online Appendix.

<sup>26</sup>We slightly modified these questions by changing the context as well as the correct answers to ensure that respondents, who could potentially access the internet during the survey, would not be able to obtain the correct answers from any external sources.

level- $k$  of respondents empirically in the survey.

The top left panel of Figure 3 plots the level of reasoning separately for respondents above the median of the IQ distribution (black bars) and other respondents (red bars). In this graph, a value of 0 on the x-axis refers to individuals who respond that they would ask for \$20 dollars from a menu of options between \$11 and \$20 when playing a game in which they or an opponent will receive a \$20 bonus as long as they request one dollar less than the other player. As discussed in Nagel (1995), individuals with deeper levels of reasoning should iteratively eliminate dominated strategies and pick lower values. Hence, we classify individuals as level-0 thinkers if they asked for \$20. The lower the amount requested, the higher is the level  $k$ .

We find that low-IQ individuals are more likely to be level-0 thinkers than others. Moreover, high-IQ respondents are systematically more likely to display lower levels of reasoning than higher levels of reasoning—which seems to be the opposite of what intuition would have suggested. Third, the figure reveals that a large mass of low-IQ respondents picked the midpoint of answer options which might appear surprising if interpreted in terms of depths of reasoning. Instead, this pattern might be due to the fact that many low-IQ individuals do not even understand how the game works and employ a rule of thumb (“pick the midpoint”) to answer this question.

Overall, these results are reminiscent of the updating of inflation expectations within individuals by cognitive abilities we presented above: high-IQ agents seem to at least understand the decision-making setting, even though they employ expectations-formation processes typical of boundedly-rational agents. Low-IQ agents, instead, behave as if they barely understood the concept of beliefs formation and hence do not employ any decision-making rule consistent with extant modeling approaches.

Second, we consider the lack of common knowledge about future policies or fundamentals and the uncertainty about how others would respond to macroeconomic news. Angeletos and Lian (2018) show that relaxing the common-knowledge assumption dampens the general equilibrium effects of news and introduces myopia at the aggregate level that can rationalize the forward guidance puzzle in a New Keynesian model.

We again follow Coibion et al. (2018) to elicit the relevance of this assumption for our findings through an information-provision experiment within the survey (Coibion et al. (2020)). Specifically, we randomly expose respondents to one of three information groups. The control group received information about the fact that the Federal Open

Market Committee (FOMC) sets interest rates in the United States, but no information about the FOMC’s forecast for future inflation. A second group—the common knowledge group—saw the twelve-months-ahead FOMC inflation forecast *and* was told that forecast were publicly disclosed to all agents in the economy. The third group—the limited knowledge group—saw the FOMC forecast and was told that this information was shared by the researchers only with a fraction of survey respondents and hence it might have not been common knowledge. This procedure guarantees variation in the vividness of whether forecasts are common knowledge without incorporating any deception in the survey instrument.

The top right panel of Figure 3 reports the distributions of numerical inflation expectations for respondents exposed to the three alternative information-treatment groups. The evidence in the picture seems inconclusive. On the one hand, making the common-knowledge of the inflation forecast vivid seems to slightly increase the share of survey participants whose subsequent inflation expectations are in the range of the FOMC forecast, relative to respondents in the other groups. On the other hand, though, this effect is economically small and statistically insignificant, irrespective of whether we include the fat tails in the analysis—which make any assessment of the effects of common knowledge noisy—or we exclude them. This small difference in the distribution of inflation expectations does also not vary systematically across high- or low-IQ respondents.

Third, we consider the possibility that agents discount information about the distant future more than information about the imminent future when forming consumption plans (Gabaix (2020)). Gabaix (2020) introduces partial myopia towards distant future events, behavioral discounting, by modeling agents that are not fully rational but shrink the economy towards the steady state when simulating the future. To micro-found the mechanism, he assumes that agents receive noisy signals about the state of the economy.

For this test, we asked randomly half of our respondents for their inflation expectations over the following twelve-months, and the other half for their inflation expectations over the twelve-months period five years later. We then asked all agents to provide a point estimate for their nominal consumption growth over the following twelve months period. We use these answers to estimate agents’ intertemporal elasticity of substitution (IES) following Crump et al. (2018): we regress agents’ expected real consumption growth (nominal growth reported by respondents minus their expected inflation) on their inflation expectations. Under the assumption that nominal interest

rates are common to all agents, the coefficients on inflation expectations allows us to recover the negative IES for each agent.

The bottom left panel of Figure 3 focuses on respondents who provided their inflation expectations for the following twelve months. We find that the average IES below the median of the distribution by IQ is 0.61, which is about three times larger than the IES of high-IQ respondents (0.26). For respondents who reported their one-year inflation expectations in five years from now and expected consumption growth over the following twelve months, the difference between the IES of the two groups disappear because high-IQ respondents have a larger IES in this case.

Overall, the evidence does not provide full support for behavioral-discounting. This mechanism predicts that high-IQ agents have similar levels of the IES irrespective of the horizon over which they formed expectations, but instead low-IQ agents should have displayed a lower IES for the longer elicitation horizon.

Fourth, we consider finite planning horizons. In the standard New Keynesian model, agents form consumption and savings plans over the infinite future. Woodford (2019) instead models decision makers who look ahead only for a finite period. In the model, agents have common planning horizons, but if high- and low-IQ individuals differed in their planning horizons, this model could help explain our findings.

We elicited respondents' planning horizons directly by asking the typical horizon they consider when making their consumption-saving choices. The non-overlapping answer options ranged from the immediate present to 10 years. On average, high-IQ respondents are more likely to report longer planning horizons than low-IQ respondents: 19.5% of high-IQ respondents report horizons above 5 years, whereas only 11.2% of low-IQ respondents do so. A caveat with this specific test is that asking about planning horizons explicitly might capture differences in demand effects. For instance, high-IQ respondents might be more likely to provide longer planning horizons merely because they inferred that this is the "desired" answer, irrespective of the planning horizons they use in their decisions.

Taken together, the leading attempts to incorporate bounded rationality into macroeconomic models do not have a clear empirical mapping in the population we study, despite delivering discounted Euler equations and solving the forward guidance puzzle.

## **B. Which Dimensions Should Models Include?**

To inform future theoretical advances incorporating bounded rationality in macroeconomic models, we move on to assess more directly how agents with different levels of cognitive abilities differ in the ways they conceptualize inflation and its relationship with economic decisions and in the formation and updating of expectations over time.

To this aim, we designed a second ad-hoc survey instrument. We fielded two sessions of this survey on mTurk in August 2019. The survey contained 69 questions and the average response time in the first session was 28 minutes and 39 seconds, and 28 minutes and 21 seconds in the second session. In each session, we recruited 500 respondents, for a total of 1,000 respondents. We offered participants a base payment of \$1.50 as well as the possibility to earn a bonus of up to \$5.65. The maximal payment respondents could earn was thus \$7.15, and the average payment was \$3.41. Below, we only highlight the parts of this survey that differ from the survey we discussed above.

To understand how agents conceptualize inflation, we asked respondents to assess whether a set of six statements about inflation in Leiser and Drori (2005) were true or false. Respondents earned a bonus payment of \$0.05 for each correct answer. Moreover, respondents faced a task to forecast two zero mean, mean-reverting random processes.<sup>27</sup> Third, we proposed an “association game” based on Leiser and Drori (2005), which we discuss in detail below.

### **B.1 Conceptualizing Inflation by Cognitive Abilities**

High- and low-IQ men might understand the concept of inflation differently. For instance, Leiser and Drori (2005) conducted detailed one-on-one surveys with a sample of Israelis employed in different jobs (psychology students, high-school students, grocers, and school teachers), and found systematic differences in their knowledge of inflation as well as in the extent to which they thought inflation related to other macroeconomic variables. In our application, low-IQ individuals might have a worse understanding of the concept of inflation and hence have a harder time providing plausible inflation forecasts.

To assess this potential explanation, we consider respondents’ answers to the six true-false statements about inflation. Figure 4 reports univariate results for sample averages and 95% confidence intervals around the sample mean for the number of correct answers across respondents with different levels of IQ. Consistent with the conjecture that low-IQ

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<sup>27</sup>We followed Landier, Ma, and Thesmar (2018) to incentivize this task and provide details below.

respondents are less familiar with the concept of inflation, they on average answer 4.05 questions correctly, whereas high-IQ respondents provide about 5 correct answers, on average.

Low-IQ respondents might be worse at answering questions about inflation for two reasons. On the one hand, they might lack a formal and theoretical understanding of the concept of inflation and the relationship between inflation and other economic variables. On the other hand, low-IQ respondents might possess an intuitive understanding of inflation. Even if they did not know the formal definition, they might be able to grasp the concept in concrete hypothetical scenarios that mimic daily situations. Our results are inconsistent with the latter possibility. Figure A.3 in the Online Appendix show that low-IQ respondents are less likely than high-IQ respondents to answer questions about inflation correctly even when considering daily-life scenarios about the consequences and implications of inflation for spending and saving.

Overall, we find that low-IQ respondents have a worse understanding of the concept of inflation relative to others, both in terms of theoretical and practical understanding. At the same time, despite the statistical significance of the differences across IQ levels, the economic magnitude of these differences is not large. On average, high-IQ men provide 0.77 more correct answers from a list of six questions. The fact that low-IQ men seem to know less about inflation, but not by a large amount, suggests that other channels might also be relevant to explain the differences in inflation forecasts by cognitive abilities.

## **B.2 Forecasting Mean-Reverting Processes by Cognitive Abilities**

A second channel we consider is agents' ability to think in probabilistic terms and hence to produce plausible forecasts for future values of generic stochastic processes. Providing plausible forecasts for inflation requires not only familiarity with the economic concept, but also the ability to assess potential realizations and probabilities.

To assess this channel, we analyze the forecasting task in our survey, which asks individuals to forecast two alternative mean-reverting processes.<sup>28</sup> We first explain to survey participants that they will see a random process that partially relies on the last realization and partially on randomness. We show individuals the first 40 realizations of the process and then ask them to forecast the process for 15 periods.

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<sup>28</sup>Note we do not aim to assess whether agents extrapolate from observed realizations, which creates a difference between our test and the one in Landier et al. (2018).

After each forecast, individuals see the realization before they make the subsequent forecast. The data-generating process follows a zero-mean AR(1) process with a coefficient of autocorrelation of 0.9. Individuals forecast two processes with error-term standard deviations of 5 and 20.<sup>29</sup> We randomize the order of the two processes, but conditional on the process, each survey participant sees the same realizations.

The incentive payment is a decreasing function of the absolute forecast error ( $\Delta$ ) and the error-term volatility ( $\sigma$ ):

$$S = 100 \times \max(0, 1 - |\Delta|/\sigma). \quad (2)$$

We convert the overall score into dollar payments using a conversion factor of 600.<sup>30</sup>

Figure 5 reports the univariate results for comparing the average within-individual mean absolute forecast error for low- and high-IQ respondents.<sup>31</sup> Two patterns emerge, which are consistent with our results in the field discussed in the first part of the paper. First, for both the mean and the absolute forecast errors, high-IQ men display lower forecast errors than low-IQ men in terms of both economic and statistical significance. Second, the difference in average forecast errors is larger when respondents assess the more stable process, but this difference drops substantially for the more volatile process. Hence, high-IQ individuals possess a better ability to forecast generic random processes but only to the extent that they are not too volatile.

### B.3 Mapping Information about Inflation into Planned Choices

Because individuals think about the concept of inflation differently, high- and low-IQ individuals might also display a differential ability to map news about inflation into their optimal consumption and savings decisions (Ilut and Valchev (2017)).

To study this third channel, we designed an “association game” based on Leiser and Drori (2005). In this game, respondents had to choose three words out of seven they thought were most related to the term “Inflation.” For each word, they had to explain briefly in their own words why the association had come to their mind. Three of the words were abstract concepts (prices, wages, and savings), three were concrete

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<sup>29</sup>The latter specification follows Landier et al. (2018) and the former is closer to the actual process of inflation.

<sup>30</sup>Landier et al. (2018) discuss that under the loss function in equation (2), a rational agent would choose the rational-expectations forecast.

<sup>31</sup>Results are similar for mean forecast errors which we report in Figure A.4 in the Online Appendix.

concepts (gas, Amazon, and stocks), and one was not immediately related to inflation (elections). Asking for respondents’ motivations in their own words was important not only to assess whether the associations were meaningful, but also to identify potential bots or inattentive respondents (D’Acunto (2015)). We evaluated all answers by giving a score of 1 to a generally correct answer, 0.5 to potentially correct but incomplete answers, and 0 to wrong answers. Two of the authors rated the answers independently, and we used the average of the two ratings to create a final score at the respondent level.

We first compare the frequencies with which low- and high-IQ respondents reported each of the six words among the three words they associate most with inflation. Panel A of Figure 6 reports these frequencies for each word across the two groups defined above—concrete words (left figure) and abstract words (right figure).

The panel delivers two consistent patterns. On the one hand, low-IQ individuals are more likely than high-IQ individuals to pick concrete concepts in the association game, and this likelihood holds both economically and statistically for each of the three concrete concepts. By contrast, high-IQ individuals are more likely than low-IQ individuals to pick abstract concepts.

Panel A of Figure A.5 in the Online Appendix reports the univariate results for comparing the average ratings for the proposed explanations in the association game across respondents with low and high IQ levels. High-IQ respondents are more likely than low-IQ individuals to report meaningful explanations for the associations. As was the case for the questions about inflation, though, the difference is not economically large—the average rating equals 0.62 for low-IQ respondents and 0.74 for high-IQ respondents.

Finally, we consider three specific questions that relate directly to the consequences of higher unexpected inflation for other macroeconomic variables. The first question asks whether, after news of future higher inflation, a household should save more. The consumer Euler equation motivated the question, based on which news of higher future inflation in times of stable nominal interest rates should reduce perceived real rates and on average decrease households’ propensity to save absent countervailing factors such as income effects or binding constraints. Panel B of Figure A.5 in the Online Appendix shows that high-IQ respondents are less likely than low-IQ respondents to state that households should save more when news about higher future inflation intervenes. An anecdotal assessment of the reported motivations in the association game suggests that low-IQ respondents are more likely than high-IQ respondents to associate higher inflation



with bad economic states, which might trigger increased savings (Andre et al. (2019)).

In Panel B of Figure 6, we consider two other questions—whether inflation mainly benefits savers, and whether a condition of persistent deflation is desirable for the economy. In both cases, low-IQ respondents are more likely to provide answers that differ from the most plausible answers based on macro theory and policy.

Overall, the answers of low-IQ survey participants seem to portray an understanding of the consequences of inflation on other macroeconomic variables that does not conform with standard macroeconomic models.

#### **B.4 From Plans to Actual Choices**

To conclude our analysis, we ask to what extent the channels we have isolated in a controlled environment might be relevant for economic choices in the field. To this aim, we move back to analyze our Finnish observational data.

We first focus on the subsamples of high- and low-IQ men with perception errors for inflation below the median and below the 25<sup>th</sup> percentile. These men are likely informed about the prevailing inflation rate, irrespective of whether their IQ is high or low.<sup>32</sup> If a lack of knowledge about inflation explained our baseline results in full, we would expect to find little variation in the Euler equation estimates across high- and low-IQ men in the subset of respondents that are well informed about inflation.

In Panel A of Table 7, we regress consumption propensities on inflation expectations for men with low perception errors, across levels of IQ. In column (1), we find high-IQ men within the group of men with low perception errors display a large, positive, and statistically significant association between their inflation expectations and consumption propensities. The size of this association is higher than the size of the baseline association we detected in Table 6. In column (2) of Table 7, the point estimate for low-IQ men is positive and economically non-negligible, but we fail to detect a significant association between inflation expectations and consumption propensities for low-IQ men with low perception errors. The results are similar if we restrict the samples even more and only consider men whose perception error is below the 25<sup>th</sup> percentile (columns (3)-(4)). Even

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<sup>32</sup>A concern is low-IQ men provide values at random and they end up being close to realized inflation by chance. Panel A of Figure A.1 in the Online Appendix suggests this concern is not material, because it shows that even if low-IQ men on average have less accurate inflation perceptions than high-IQ men, still a large fraction answers values close to ex-post realized inflation. If low-IQ men merely provided values at random, the distribution of perceived inflation should be closer to a uniform distribution instead of displaying a mode close to realized inflation.

in this case, low-IQ men whose perceptions about inflation are quite accurate do not display a significant positive association between inflation expectations and consumption propensity.

The fact that low-IQ men do not behave in line with the consumer Euler equation even when they seem well informed about the prevailing inflation rate might suggest that informing consumers about the level of current inflation might not be sufficient to affect the economic plans or choices of low-IQ men.

The second channel states that low-IQ men might be unable to think in probabilistic terms and about future states of the world (McDowell and Jacobs (2017)). This channel could explain the non-response in the Euler equations only if low-IQ men were sophisticated about their bias; that is, they knew that they should not rely on their faulty expectations when making consumption and saving plans.

Here, we focus on the subsample of men with forecast errors for inflation below the median and below the 25<sup>th</sup> percentile. Because the distribution of both low-IQ and high-IQ men has a mode at plausible values for inflation forecasts (see Panel B of Figure A.1 in the Online Appendix), the two subsamples are likely to include individuals who are able to think probabilistically and to come up with plausible forecasts of inflation, irrespective of their IQ levels.

Panel B of Table 7 shows that high-IQ men increase their spending propensities when they expect higher inflation and their inflation forecasts are accurate (columns (1) and (3)). Low-IQ men, instead, are still unresponsive, both economically and statistically, even if their inflation expectations are close to the ex-post realizations.

These results suggest that merely providing the broader population with plausible forecasts of future inflation might not be enough to align their consumption and saving plans to what the consumer Euler equation predicts.

Third, low-IQ agents in the controlled mTurk environment were less likely to map information about future inflation into their consumption-savings decisions in a way consistent with the Euler equation. We propose suggestive evidence for this channel in the field data by focusing on two subsamples. First, we consider only high- and low-IQ men with a college degree in economics and business. Intuitively, both of these two groups should understand intertemporal substitution and should know how inflation expectations map into optimal action, because they should have been trained on these concepts extensively during their college studies. Columns (1)-(2) of Panel C of Table

7 estimate the marginal effect of expecting higher inflation on the propensity to spend for this subsample. Within the group of men with an economics or business degree, *both* high- and low-IQ men increase their propensity to consume when expecting higher inflation, which is consistent with the consumer Euler equation.

To further assess whether the split by degrees in business or economics is likely to capture knowledge of basic economic concepts as opposed to the effects of a quantitative college degree, in columns (3)-(4) of Panel C of Table 7, we consider the subsample of high- and low-IQ men with a college degree in engineering. Men trained in engineering obtained college education, irrespective of their IQ levels, and if anything were trained more in quantitative skills than men who earned an economics or business degree. At the same time, these men were not trained specifically in economic concepts such as intertemporal substitution. We see that for this group, low-IQ men do not display a positive association between expecting higher inflation and willingness to purchase durable goods. If anything, the estimated coefficient is large and negative, although statistically insignificant.<sup>33</sup>

Overall, we interpret the results in Panel C of Table 7 as broadly consistent with the possibility that low-IQ men do not understand basic economic concepts and hence cannot map their macroeconomic expectations into optimal choice consistent with Ilut and Valchev (2017).

## VI Conclusion

We show that cognitive abilities play a central role in the formation and updating of subjective macroeconomic expectations as well as in their mapping into households' consumption-saving decisions. These effects are important in both unique observational micro-level data for a large, representative population, as well as in controlled environments that allow us to assess the channels through which cognitive abilities shape expectations and choice.

Our results support recent theoretical attempts that aim to resolve puzzling features of the standard New Keynesian model, such as the paradox of toil, implausibly large fiscal multipliers, the forward guidance puzzle, and the possibility that more flexible prices make recessions worse (Eggertsson and Krugman (2012); Wieland (2019); and Del Negro et al. (2015)). Models in which agents have finite planning horizons (Woodford (2019)) or are

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<sup>33</sup>Note that for this group, high-IQ men display no association between inflation expectations and willingness to consume, which emphasizes that education per se does not explain our results.

subject to bounded rationality (Farhi and Werning (2017); García-Schmidt and Woodford (2019); and Gabaix (2020)) differ in their micro foundation but all attribute a relevant role to cognitive abilities in the formation, updating, and mapping of expectations into economic decisions.

Future research in economics, finance, and cognitive science should build on our results to investigate both empirically and theoretically the specific mechanisms that transmit the role of cognitive abilities into subjective beliefs and choice. For instance, do cognitive abilities matter for the gathering of information, the processing of information, and the mapping of processed values into economic decisions (Ilut and Valchev (2017))? Or, are they only driving choices through a subset of these channels? Distinguishing between these mechanisms is crucial not only to inform the development of new heterogeneous-agent models across fields of economics, but also to inform policymakers on the interventions that might help low-IQ individuals make optimal decisions based on the incentives policies create (e.g., see D’Acunto et al. (2021)) as well as to inform private interventions to manage households’ beliefs and choice, such as robo-advising and FinTech applications (e.g., see D’Acunto and Rossi (2020), D’Acunto and Rossi (2021), and D’Acunto et al. (2019)).

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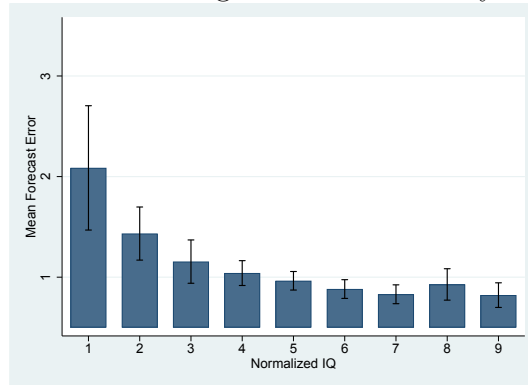
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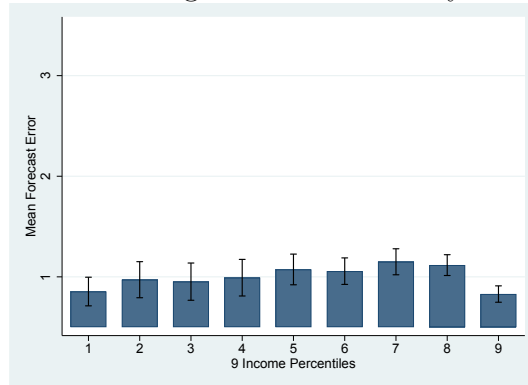


Figure 2: **Average Forecast Error by IQ, Income, and Education Levels**

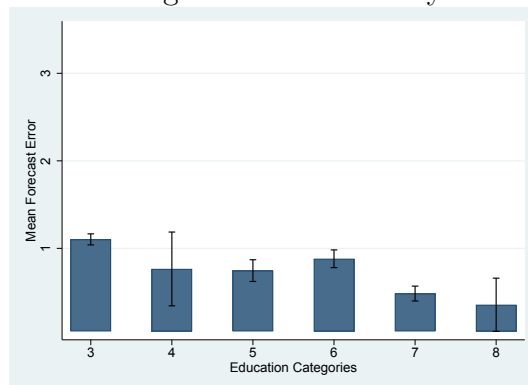
Panel A. Average Forecast Error by IQ



Panel B. Average Forecast Error by Income

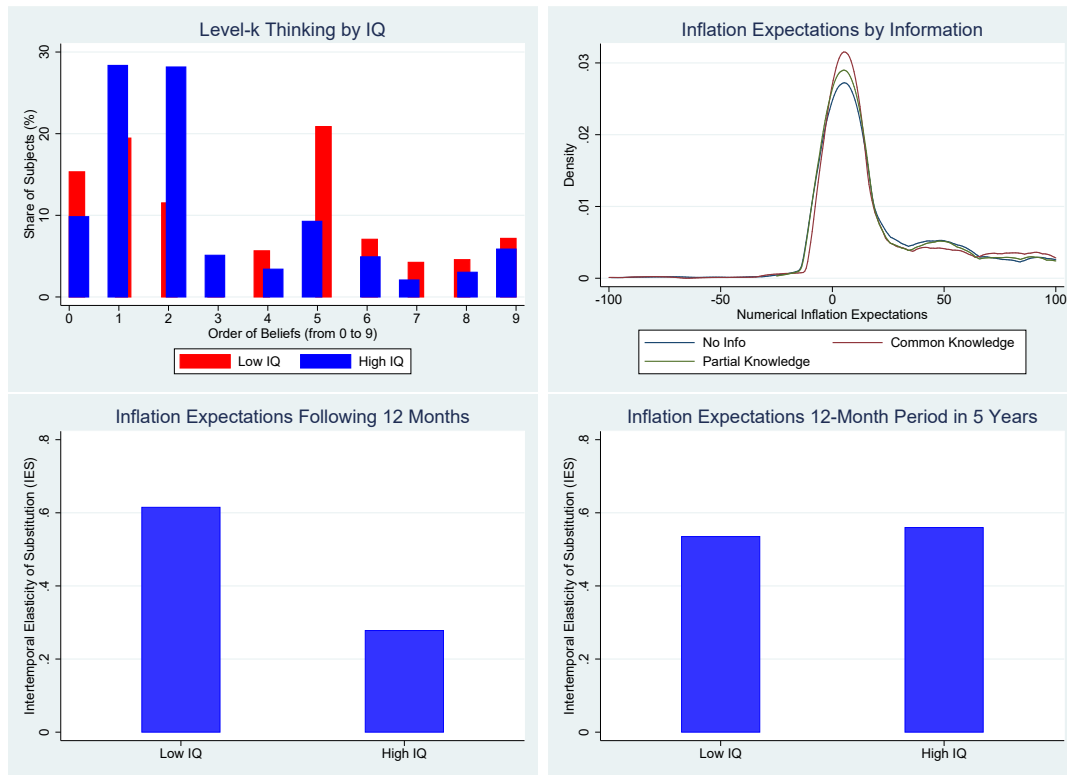


Panel C. Average Forecast Error by Education



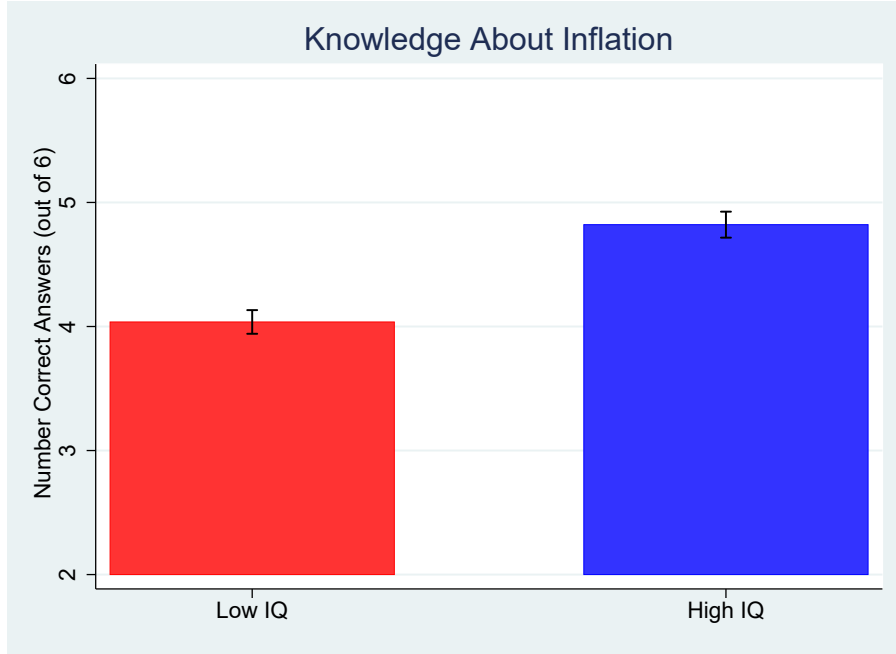
Panel A of this figure plots the average forecast error for inflation (in percentage points) across IQ levels. Panel B plots the average forecast error for inflation across 9 income percentiles. Panel C plots the average forecast error for inflation across 6 education categories. Forecast error is the difference between the numerical forecast for twelve-months-ahead inflation and ex-post realized inflation. Vertical lines represent 95% confidence intervals around the estimated mean for each bin. We use the confidential micro data underlying the official European Commission consumer confidence survey to measure inflation expectations. Statistics Finland asks a representative sample of 1,500 individuals each month. IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. Education levels are based on the International Standard Classification of Education. The sample period is from January 2001 to March 2015.

Figure 3: Assessing Leading Behavioral Macro Models



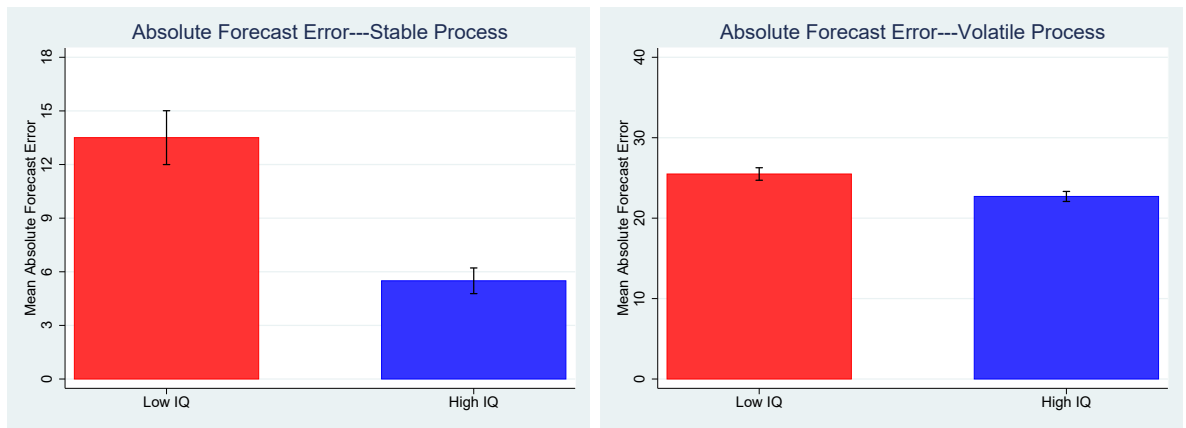
This picture reports evidence to assess the recent attempts to incorporate bounded rationality in standard macro models. The top left panel plots the distribution of level- $k$  of thinking of respondents by low and high IQ. High-IQ respondents scored above the median in a cognitive reflection test in the survey. The top right panel plots the distribution of numerical inflation expectations for respondents that were randomly assigned to three information treatments—(i) no information on inflation forecasts; (ii) information on inflation forecasts paired with information that the forecast is common knowledge; and (iii) information on inflation forecasts paired with information that the forecast might not be known by all agents in the economy. The bottom panels report the estimated intertemporal elasticity of substitution of respondents when respondents are asked to form inflation expectations for the following twelve months (left panel) or the twelve-months period 5 years ahead (right panel). The questions were part of a survey on mTurk we fielded in February 2021 with 1,500 respondents.

Figure 4: Knowledge about Inflation by IQ



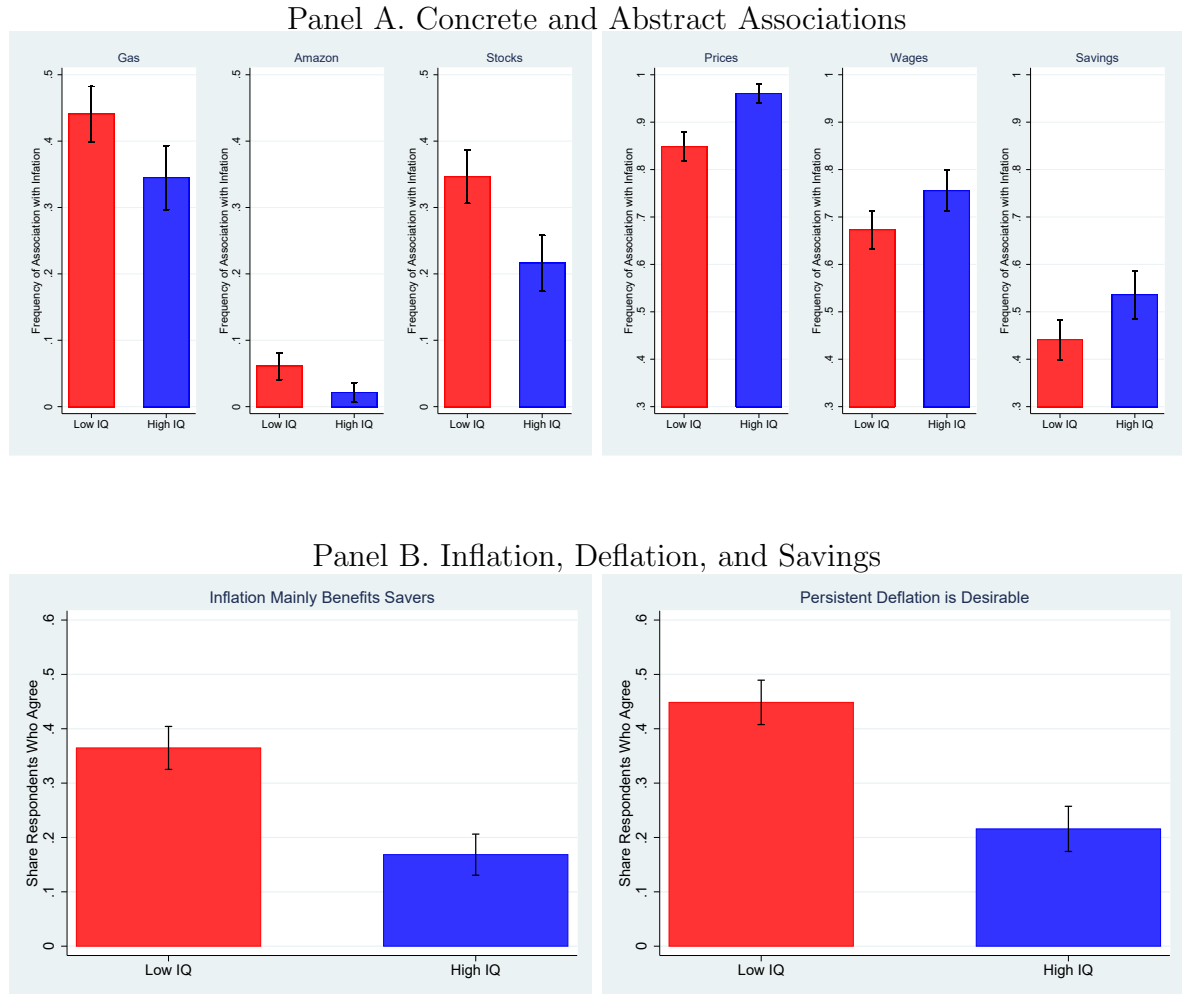
This figure plots the number of correct answers about the concept of inflation to six questions by low and high IQ. High-IQ respondents scored above the median in a cognitive reflection test in the survey. The questions were part of a survey on mTurk we fielded in August 2019 with 1,000 respondents.

Figure 5: Absolute Forecast Errors of Random Process by IQ



This figure plots the average mean absolute forecast error across two groups of individuals based on cognitive abilities. High-IQ respondents scored above the median in a cognitive reflection test in the survey. We produced these data through a forecasting task inspired by Landier et al. (2018). We asked respondents to forecast two zero-mean  $AR(1)$  processes for 15 periods with coefficients of mean reversion of 0.9. The left figures plot the statistics for a process with a volatility of 5 and the right figures plot the statistics for a process with a volatility of 20. The forecasting tasks was part of a survey on mTurk we fielded in August 2019 with 1,000 respondents.

Figure 6: Inflation Associations and Economic Reasoning by IQ



Panel A plots the frequency with which individuals associate each of 6 pre-specified words with inflation. Survey participants had to pick 3 words from the list they thought were most related to the concept of “inflation.” Frequencies are reported as average shares of respondents mentioning each word across two groups. We produced these results through an association game task á la Leiser and Drori (2005). Panel B reports the share of respondents who agree with statements about the association of inflation with saving and the desirability of deflation. High-IQ respondents scored above the median in a cognitive reflection test in the survey. The questions were part of a survey on mTurk we fielded in August 2019 with 1,000 respondents.

Table 1: **Descriptive Statistics**

This table reports descriptive statistics for the variables we use in the paper. We use the confidential micro data underlying the official European Commission consumer confidence survey to construct these variables. Statistics Finland asks a representative sample of 1,500 individuals each month. IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. The sample period is January 2001 to March 2015.

Statistic	Inflation Perception	Inflation Expectation	Total Debt [EUR]	IQ Dummy	Age	Income [EUR]
Nobs	27,184	27,568	27,540	27,568	27,568	27,568
Mean	3.00	2.47	38,591	0.50	30.70	22,541
Std	4.63	3.76	53,806	0.50	6.94	14,301
p1	-5.00	-5.00	0	0	19	900
p10	0.00	0.00	0	0	21	6,700
p25	0.00	0.00	0	0	25	13,100
p50	2.00	2.00	14,400	1	30	21,000
p75	5.00	3.50	62,300	1	36	28,900
p90	7.00	5.00	102,200	1	40	38,300
p99	20.00	15.00	242,400	1	46	74,400
Single	no	38.93%	Urban		no	64.41%
	yes	61.07%			yes	35.59%
Unemployed	no	94.17%	Helsinki		no	72.19%
	yes	5.83%			yes	27.81%
Kids	no	22.41%	College		no	65.67%
	yes	77.59%			yes	34.33%
Durables	Good time	50.94%				
	Neutral	28.67%				
	Bad time	20.40%				

Table 2: **Numerical Inflation Expectations by IQ**

This table reports the average and standard deviation of inflation expectation by normalized IQ. We use the confidential micro data underlying the official European Commission consumer confidence survey to measure inflation expectations. Statistics Finland asks a representative sample of 1,500 individuals each month. IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. The sample period is from January 2001 to March 2015.

IQ	Low-IQ Men					High-IQ Men			
	1	2	3	4	5	6	7	8	9
Mean	3.46	2.80	2.58	2.42	2.40	2.36	2.28	2.30	2.26
Std	8.70	5.93	5.52	4.66	4.66	4.16	3.47	4.13	3.31
Nobs	928	2,221	2,860	7,011	9,528	8,099	6,030	3,213	2,688

Table 3: Absolute Forecast Errors and IQ: Splits by Demographic Groups

This table reports the coefficient estimates from a linear regression of absolute forecast errors for inflation on normalized IQ and individual demographics. For each demographic category listed above a column, we perform the analysis separately for respondents who belong to the category (Panel A) and respondents who do not belong to the category (Panel B). We define forecast errors as differences between inflation expectations over the following twelve months and ex-post realized inflation. We use the confidential micro data underlying the official European Commission consumer confidence survey to measure inflation expectations. Statistics Finland asks a representative sample of 1,500 individuals each month. IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. High IQ is a dummy that equals 1 if normalized IQ is larger than 5. Demographics controls are age, age<sup>2</sup>, sex, marital status, log of income, employment status, number of children, urban versus rural classification, college dummy, and a dummy that equals 1 if the respondent lives in Helsinki. Standard errors are clustered at the quarter level. The sample period is January 2001 to March 2015.

	Full Sample (1)	Single (2)	Below 35 (3)	Urban (4)	Top 50% Income (5)	College Degree (6)	Econ/Business Degree (7)
<b>Panel A. Respondent within Category</b>							
High IQ	-0.2388 *** (0.0472)	-0.2451 *** (0.0534)	-0.2728 *** (0.0704)	-0.1837 *** (0.0597)	-0.2586 *** (0.0688)	-0.1243 *** (0.0508)	-0.1530 * (0.0884)
Demographics	X	X	X	X	X	X	X
Year-Month FE	X	X	X		X	X	X
Adj. R <sup>2</sup>	0.0608	0.0509	0.0457	0.0467	0.0446	0.0758	0.0093
Nobs	27,568	16,837	11,231	9,812	10,713	9,463	2,949
<b>Panel B. Respondent outside Category</b>							
High IQ	-0.2100 *** (0.0618)	-0.1915 *** (0.0481)	-0.2745 *** (0.0537)	-0.1760 *** (0.0500)	-0.2830 *** (0.0552)	-0.2563 *** (0.0441)	
Demographics	X	X	X	X	X	X	X
Year-Month FE	X	X			X	X	X
Adj. R <sup>2</sup>	0.0663	0.0682	0.0566	0.0626	0.0447	0.0528	
Nobs	10,731	16,337	17,756	16,855	18,105	24,619	

Standard errors in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Table 4: Current Perceptions and Expectations and Past Inflation Expectations by IQ

This table reports the coefficient estimates from a linear regression of inflation expectations (columns (1)–(2)) and inflation perceptions (columns (3)–(8)) on inflation expectations 6 months ago for men with high and low IQs. Columns (5) to (8) split the sample into periods in which the difference between the inflation rate at the time of the first and subsequent interview is in the top third of the distribution (changing inflation), and all other periods (stable inflation). We use the confidential micro data underlying the official European Commission consumer confidence survey to measure inflation expectations. Statistics Finland surveys the same individual up to three times with a gap of six months in between interviews. IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. We define High IQ as the sample of men with normalized IQ larger than 5. The sample period is January 1996 to December 1999.

	Inflation Expectations		Inflation Perceptions					
	(1) High IQ	(2) Low IQ	All Periods (3)		Periods of Stable Inflation (5)		Periods of Changing Inflation (7)	
			High IQ	Low IQ	High IQ	Low IQ	High IQ	Low IQ
Past expectations	0.231*** (0.0661)	0.025 (0.0476)	0.243*** (0.047)	0.053*** (0.021)	0.300*** (0.054)	0.047* (0.028)	0.141 (0.090)	0.061*** (0.024)
Demographics	X	X	X	X	X	X	X	X
Year-Month FE	X	X	X	X	X	X	X	X
Adj. R <sup>2</sup>	0.03	0.02	0.03	0.02	0.04	0.02	0.03	0.04
Nobs	1,082	774	1,367	1,185	922	782	445	403

Standard errors in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$



Table 5: **Forecast Errors on Forecast Revisions by IQ**

This table reports the coefficient estimates from the following linear specification separately for high- and low-IQ men:

$$x_{t+1} - x_{i,t+1|t} = \alpha^{IQ} + \beta FR_{i,t,1}^{IQ} + \varepsilon_{i,t},$$

where the forecast errors of agent  $i$  is the difference between the realized value of a variable,  $x_{t+1}$ , minus the forecast at time  $t$ ,  $x_{i,t+1|t}$ . The forecast revision is given by  $FR_{i,t,1} = x_{i,t+1|t} - x_{i,t+1|t-1}$ . We use the confidential micro data underlying the official European Commission consumer confidence survey to measure inflation expectations. Statistics Finland surveys the same individual up to three times with a gap of six months in between interviews. IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. We define High IQ as the sample of men with normalized IQ larger than 5. The sample period is March 1995 to December 1999.

	(1) High IQ	(2) Low IQ	(3) High IQ	(4) Low IQ	(5) High IQ	(6) Low IQ	(7) High IQ	(8) Low IQ
Forecast revision	-0.7612*** (0.0979)	-0.5235*** (0.1516)	-0.7771*** (0.0910)	-0.5257*** (0.1519)	-0.8533*** (0.0634)	-0.6333*** (0.1653)	-0.8739*** (0.1114)	-0.5191 (0.4191)
Year-Month FE			X	X	X	X	X	X
Demographics					X	X	X	X
Individual FE							X	X
Pseudo R <sup>2</sup>	0.6545	0.4817	0.7284	0.5207	0.8193	0.6362	0.9581	0.9426
Nobs	1,377	1,203	1,377	1,203	1,082	774	1,082	774

Standard errors in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Table 6: Inflation Expectations and Readiness to Spend: Splits by Demographic Groups

This table reports the average marginal effects of multinomial logit regressions. Households' readiness to purchase durables is the dependent variable. Inflation increase is a dummy variable that equals 1 when a survey participant replies that inflation will increase. For each demographic category listed above a column, we perform the analysis separately for respondents who belong to the category (Panel A) and respondents who do not belong to the category (Panel B). We use the confidential micro data underlying the official European Commission consumer confidence survey to construct these variables. Statistics Finland asks a representative sample of 1,500 individuals each month whether it is a good time to purchase durables given the current economic conditions. Individuals can reply that it is a good time, it is a bad time, or it is neither a good time nor a bad time. In this table, we study the "it is a good time" outcome. IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. We define High IQ as the sample of men with normalized IQ larger than 5. Demographics controls are age, age<sup>2</sup>, sex, marital status, log of income, employment status, number of children, urban versus rural classification, college dummy, and a dummy that equals 1 if the respondent lives in Helsinki. Standard errors are clustered at the quarter level. The sample period is January 2001 to March 2015.

	Full Sample		Single		Below 35		Urban		Top 50% Income		College Degree		Econ/Business Degree	
	High IQ (1)	Low IQ (2)	High IQ (3)	Low IQ (4)	High IQ (5)	Low IQ (6)	High IQ (7)	Low IQ (8)	High IQ (9)	Low IQ (10)	High IQ (11)	Low IQ (12)	High IQ (13)	Low IQ (14)
<b>Panel A. Respondent within Category</b>														
Expects Higher Inflation	0.0358*** (0.0119)	-0.0096 (0.0138)	0.0377** (0.0167)	-0.0183 (0.0177)	0.0614*** (0.0221)	-0.004 (0.0201)	0.0391** (0.0192)	-0.0131 (0.0239)	0.0723*** (0.0207)	-0.0288 (0.0233)	0.0390** (0.0174)	0.0254 (0.0260)	0.0459 (0.0309)	0.1109** (0.0458)
Demographics	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Year-Month FE	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pseudo R <sup>2</sup>	0.0108	0.0091	0.0098	0.0069	0.0097	0.0054	0.0109	0.0109	0.0094	0.0064	0.0131	0.0156	0.0148	0.0276
Nobs	16,606	16,256	10,109	11,107	6,499	7,469	7,070	4,644	6,593	6,703	7,512	3,051	2,024	1,398
<b>Panel B. Respondent outside Category</b>														
Expects Higher Inflation			0.0356** (0.0163)	0.0067 (0.0211)	0.0211 (0.0158)	-0.0152 (0.0187)	0.0333** (0.0169)	-0.0061 (0.0168)	0.0121 (0.0150)	0.0016 (0.0178)	0.0354** (0.0173)	-0.0200 (0.0152)	0.0341*** (0.0129)	-0.0225* (0.0135)
Demographics			X	X	X	X	X	X	X	X	X	X	X	X
Year-Month FE			X	X	X	X	X	X	X	X	X	X	X	X
Pseudo R <sup>2</sup>			0.0145	0.0171	0.0131	0.0127	0.0107	0.0092	0.0146	0.0122	0.0097	0.008	0.0111	0.0085
Nobs			6,497	5,149	10,107	8,787	9,536	11,612	10,013	9,553	9,094	13,205	14,582	14,858

Standard errors in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Table 7: Inflation Expectations and Readiness to Spend: Channels

This table reports the average marginal effects of multinomial logit regressions. Individuals' readiness to purchase durables is the dependent variable. Inflation expectation is a dummy variable which equals 1 when a household replies that inflation will increase. We use the confidential micro data underlying the official European Commission consumer confidence survey to construct these variables. The surveys ask representative samples of individuals on a monthly basis whether it is a good time to purchase durables given the current economic conditions. Individuals can reply that it is a good time, it is a bad time, or it is neither a good time nor a bad time. In this table we study the "it is a good time" outcome. We measure normalized IQ using data from the official military entrance exam in Finland. Demographics controls are age, age<sup>2</sup>, sex, marital status, log of income, employment status, number of children, urban versus rural classification, college dummy, and a dummy that equals 1 if the respondent lives in Helsinki. We cluster standard errors at the quarter level. The sample period is from January 2001 to March 2015.

	(1)	(2)	(3)	(4)
<b>Panel A</b>	<b>Abs Perception Error <math>\leq Q50_t</math></b>		<b>Abs Perception Error <math>\leq Q25_t</math></b>	
	High IQ	Low IQ	High IQ	Low IQ
Expects Higher Inflation	0.0472*** (0.0153)	0.0209 (0.0165)	0.0587** (0.0239)	0.0149 (0.0250)
Demographics	X	X	X	X
Year-Month FE	X	X	X	X
Nobs	10,115	8,984	4,800	4,007
<b>Panel B</b>	<b>Abs Forecast Error <math>\leq Q50_t</math></b>		<b>Abs Forecast Error <math>\leq Q25_t</math></b>	
	High IQ	Low IQ	High IQ	Low IQ
Expects Higher Inflation	0.0401** (0.0184)	0.0069 (0.0243)	0.0409 (0.0254)	0.0112 (0.0298)
Demographics	X	X	X	X
Year-Month FE	X	X	X	X
Nobs	9,699	8,694	5,869	5,262
<b>Panel C</b>	<b>Economics Major</b>		<b>Engineering Major</b>	
	High IQ	Low IQ	High IQ	Low IQ
Expects Higher Inflation	0.0619* (0.0330)	0.1059** (0.0475)	-0.0220 (0.0964)	-0.2886 (0.2782)
Demographics	X	X	X	X
Year-Month FE	X	X	X	X
Nobs	1,751	1,228	273	52

Standard errors in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Online Appendix:

# IQ, Expectations, and Choice

Francesco D'Acunto, Daniel Hoang, Maritta Paloviita, and Michael Weber

*Not for Publication*

# I Survey Questions February 2021 Wave

## WELCOME TO THE SURVEY “PLAY GAMES AND TELL US YOUR VIEW OF THE ECONOMY”

In this survey, we will have you play a few games and we will also ask for your opinions and ideas about the economy. We hope you will have fun while completing our survey!

Some sections of the survey will allow you to earn bonus payments. Each section that provides a bonus will state so clearly in the instructions and will give you precise instructions about how the bonus will be computed.

Some other sections ask your opinions about the economy. In those sections, there is no right or wrong answer and hence you will not earn bonus payments.

**Please do COPY THE CONFIRMATION CODE at the end of the survey and paste it back on the mTurk HIT. If you do not, we will NOT be able to link your answers to your Worker ID and will NOT be able to pay you!**

GOOD LUCK AND HAVE FUN!

Box: I'm now ready to start the survey

In this screen, we want to hear more about your personality. Please refer to the statements on top of each slider. For each slider below:

- 0 means “does not describe me at all”
- 10 means “describes me perfectly”

Please move each slider based on the extent to which you think the statement describes you as a person.

**Question 1** *In general, I am very willing to take risks*

**Question 2** *When someone does me a favor, I am willing to return it*

**Question 3** *If I am treated very unjustly, I will take revenge at the first occasion, even if there is a cost to do so*

**Question 4** *I am good at math*

**Question 5** *I assume that people normally have the best intentions when they interact with me*

In the next screens, we will present you with seven brain teasers, which we hope you will find interesting and fun! Your answers to the brain teasers will contribute to the final bonus payment. For each correct answer, you will earn a 5-cent bonus. You cannot lose any money in this game.

Box: I understand the rules. Let's start this game.

**Question 6** *A coke and a candy cost \$2.10 in total. The coke costs \$2.00 more than the candy. How many \$-cents does the candy cost?*

**Question 7** *If it takes 10 machines 10 minutes to make 10 pens, how many minutes would it take 100 machines to make 100 pens?*

**Question 8** *A family of rabbits lives in the city of Rabbit-ville. The population of rabbits doubles in size every two years. This year, the rabbit family has 1 million members. How many years ago did the rabbit family have 250,000 members?*

**Question 9** *What is the average of the following numbers? 1, 2, 6*

**Question 10** *Assume that the first two statements are true:*

*All restaurants in Japan serve beverages.*

*Fanta is a popular soda in Japan.*

*Do Japanese restaurants in the US serve Fanta?*

- Yes
- Not certain
- No

**Question 11** *From the following two statements, which conclusions are absolutely true?*

*None of the gardeners are tennis players.*

*All writers are gardeners.*

- Some gardeners are tennis players
- Writers are not tennis players
- Writers are tennis players
- Some writers are not gardeners

**Question 12** *What is the missing number in this series? 1, 16, 81, ... , 625, 1296*

In the next screen, we want to ask your opinion about the state of the economy. There is no right or wrong answer here and we genuinely want to know what YOU think. It would be very important to us that you give us your own opinion, without consulting others or the internet.

Please make an effort to provide your best guess even in case you feel you do not have a strong expertise on the topic we bring up. Again, having your honest opinion is very important to us.

We would like to ask you some questions about the overall economy and in particular about the rate of inflation/deflation (Note: inflation is the percentage rise in overall prices in the economy, most commonly measured by the Consumer Price Index and deflation corresponds to when prices are falling).

**Question 13** *Over the LAST twelve month, what do you think the overall rate of inflation/ deflation HAS BEEN in the economy in %?*  
*Please enter a number between -100% and 100%*

Please randomize: 50% of the sample see Q14. and Q15. 50% of the sample see Q16. and Q17.

**Question 14** *Over the NEXT twelve month, what do you think the overall rate of inflation/ deflation WILL BE in the economy in %?*  
*Please enter a number between -100% and 100%*

**Question 15** *Now think about your total household spending, including groceries, clothing, personal care, housing (such as rent, mortgage payments, utilities, maintenance, home improvements), medical expenses (including health insurance), transportation, recreation and entertainment, education, and any large items (such as home appliances, electronics, furniture, or car payments).*

*By about what percent do you expect your total household spending to [increase/decrease]? Please give your best guess.*

*Over the NEXT 12 months, I expect my total household spending to [increase/decrease] by % [please enter a negative number if you expect your household spending to decrease].*

**Question 16** *Over the twelve month period from February 2025 to February 2026, what do you think the overall rate of inflation/ deflation WILL BE in the economy in %?*  
*Please enter a number between -100% and 100%*

**Question 17** *Now think about your total household spending, including groceries, clothing, personal care, housing (such as rent, mortgage payments, utilities, maintenance, home improvements), medical expenses (including health insurance), transportation, recreation and entertainment, education, and any large items (such as home appliances, electronics, furniture, or car payments).*

*By about what percent do you expect your total household spending to [increase/decrease]? Please give your best guess.*

*Over the NEXT 12 months, I expect my total household spending to [increase/decrease] by % [please enter a negative number if you expect your household spending to decrease].*

**Question 18** *When making decisions about spending versus saving money, how far in the future do you typically plan?*

- I just plan for the moment

- 1-3 months
- More than 3 months but less than 1 year
- 1 to 2 years
- 2 to 5 years
- 5 to 10 years
- More than 10 years

**Question 19** *Please consider the following situation. You and another person are playing a game in which each person requests an amount of money. The amount must be (a whole dollar amount) between 11 and 20 dollars. Each person will receive the amount he/she requests. One of the two will also receive an additional amount of 20 dollars if he/she asks for exactly one dollar less than the other.*

*What amount of money would you request?*

DROPDOWN MENU: \$11, \$12, \$13, ..., \$20

We would like to ask you a few more questions. Before we proceed, we would like you to know that the Federal Reserve meets eight times a year and is responsible for setting basic interest rate levels in the US.

Randomly split sample into three groups.

**Question 20** *Control group: No info*

*Treatment group 1: Also, in a public release which is available to all Americans at no charge, the Federal Reserve recently reported that consumer prices in the US in 2021 will increase by 1.8%.*

*Treatment group 2: Also, we would like to share the following information only with you and a few other households. The vast majority of Americans do not know this information yet. The Federal Reserve recently reported that consumer prices in the US in 2021 will increase by 1.8%.*

**Question 21** *What percentage of Americans (aged 18 and older) do you think knows this information?*

% RANGE: -100 to 100, ONE DECIMAL

If you think there was inflation, please enter a positive number. If you think there was deflation, please enter a negative number. If you think there was neither inflation nor deflation, please enter zero.



**Question 22** *Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After one year, how much would you be able to buy with the money in this account?*

- More than today
- Same as today
- Less than today
- I don't know

**Question 23** *If you have \$100 in a savings account and the interest rate is 10% per year and you never withdraw or deposit money, how much will you have in the account after:*

Please enter a whole dollar amount at each.

- One year:      RANGE: 0-999
- Two years:      RANGE: 0-999

**Question 24** *If the chance of getting a disease is 5 percent, how many people out of 1,000 would be expected to get the disease?*

- people RANGE: 0-1000
- Don't know

**Question 25** *Suppose you have a choice between receiving with certainty \$100 today or with certainty \$X in a week. What would be the minimum value of \$X that you would need before accepting to receive money in a week? Please choose an option below that best describes your preference.*

- \$100 today or \$101 in 1 week
- \$100 today or \$103 in 1 week
- \$100 today or \$108 in 1 week
- \$100 today or \$117 in 1 week
- \$100 today or \$125 in 1 week
- \$100 today or \$133 in 1 week
- \$100 today or \$150 in 1 week

**Question 26** *Suppose you have a choice to receive with certainty \$100 or to play a lottery. If you choose the lottery, with a 50% chance you will win a payoff, and with a 50% chance you won't win anything. We will propose you different lotteries in which the payoffs differ. For each option in the lines below, would you prefer to take the \$100 or to participate in the proposed lottery?*

- \$100 guaranteed vs. 50% chance to win \$300, \$0 otherwise
- \$100 guaranteed vs. 50% chance to win \$280, \$0 otherwise
- \$100 guaranteed vs. 50% chance to win \$260, \$0 otherwise
- \$100 guaranteed vs. 50% chance to win \$240, \$0 otherwise
- \$100 guaranteed vs. 50% chance to win \$220, \$0 otherwise

- \$100 guaranteed vs. 50% chance to win \$200, \$0 otherwise
- \$100 guaranteed vs. 50% chance to win \$180, \$0 otherwise
- \$100 guaranteed vs. 50% chance to win \$160, \$0 otherwise
- \$100 guaranteed vs. 50% chance to win \$140, \$0 otherwise
- \$100 guaranteed vs. 50% chance to win \$120, \$0 otherwise
- \$100 guaranteed vs. 50% chance to win \$100, \$0 otherwise

In the last screen, we would like you to fill a short form about your demographics. This information is very helpful for us for statistical purposes, and it will be kept completely private and anonymous.

**Question 27** *What is your age?*

**Question 28** *What is your gender?*

- Male
- Female
- Non-binary/ third gender
- Prefer not to answer

**Question 29** *Which category reflect your gross annual income?*

- Between \$0 and \$9,999
- Between \$10,000 and \$19,999
- Between \$20,000 and \$34,999
- Between \$35,000 and \$49,999
- Between \$50,000 and \$69,999
- Between \$70,000 and \$99,999
- Between \$100,000 and \$149,999
- More than \$150,000

**Question 30** *What is your highest level of education?*

- Did not complete High School
- High School, but no College
- Some College education but no degree
- Graduated from College
- Graduated from past-graduate degree (e.g., Masters, JD, MD, PhD)

**Question 31** *Do you or someone else make most financial decisions in your household?*

- I make most financial decisions
- Someone else in my household makes most financial decisions

**Question 32** *Are you or someone else the main grocery shopper in your household?*

- I'm the main grocery shopper
- Someone else is the main grocery shopper

**Question 33** *Finally, do you have any comments for us? Feel free to write anything you want or to leave this field blank.*

Thank you very much for participating in our survey! Your answers are very important to us, and we greatly appreciate that you took the time to work on our survey.

Below you find the CONFIRMATION CODE you need to enter in the HIT on MTurk for the payment. Reporting this code is crucial to link your answers in this survey to your Worker ID on MTurk.

Please also check below and click on the arrow to the right to complete the questionnaire.

## II Survey Questions August 2019 Wave

### WELCOME TO THE SURVEY “PLAY GAMES AND TELL US YOUR VIEW OF THE ECONOMY”

In this survey, we will have you play a few games and we will also ask for your opinions and ideas about the economy. We hope you will have fun while completing our survey!

Some sections of the survey will allow you to earn bonus payments. Each section that provides a bonus will state so clearly in the instructions and will give you precise instructions about how the bonus will be computed.

Some other sections ask your opinions about the economy. In those sections, there is no right or wrong answer and hence you will not earn bonus payments.

**Please do COPY THE CONFIRMATION CODE at the end of the survey and paste it back on the mTurk HIT. If you do not, we will NOT be able to link your answers to your Worker ID and will NOT be able to pay you!**

GOOD LUCK AND HAVE FUN!

Box: I’m now ready to start the survey

In this screen, we want to hear more about your personality. Please refer to the statements on top of each slider. For each slider below:

- 0 means “does not describe me at all”
- 10 means “describes me perfectly”

Please move each slider based on the extent to which you think the statement describes you as a person.

**Question 1** *In general, I am very willing to take risks*

**Question 2** *When someone does me a favor, I am willing to return it*

**Question 3** *If I am treated very unjustly, I will take revenge at the first occasion, even if there is a cost to do so*

**Question 4** *I am good at math*

**Question 5** *I assume that people normally have the best intentions when they interact with me*

In the next screens, we will present you with seven brain teasers, which we hope you will find interesting and fun! Your answers to the brain teasers will contribute to the final bonus payment. For each correct answer, you will earn a 5-cent bonus. You cannot lose any money in this game.

Box: I understand the rules. Let's start this game.

**Question 6** *A coke and a candy cost \$2.10 in total. The coke costs \$2.00 more than the candy. How many \$-cents does the candy cost?*

**Question 7** *If it takes 10 machines 10 minutes to make 10 pens, how many minutes would it take 100 machines to make 100 pens?*

**Question 8** *A family of rabbits lives in the city of Rabbit-ville. The population of rabbits doubles in size every two years. This year, the rabbit family has 1 million members. How many years ago did the rabbit family have 250,000 members?*

**Question 9** *What is the average of the following numbers? 1, 2, 6*

**Question 10** *Assume that the first two statements are true:*

*All restaurants in Japan serve beverages.*

*Fanta is a popular soda in Japan.*

*Do Japanese restaurants in the US serve Fanta?*

- Yes
- Not certain
- No

**Question 11** *From the following two statements, which conclusions are absolutely true?*

*None of the gardeners are tennis players.*

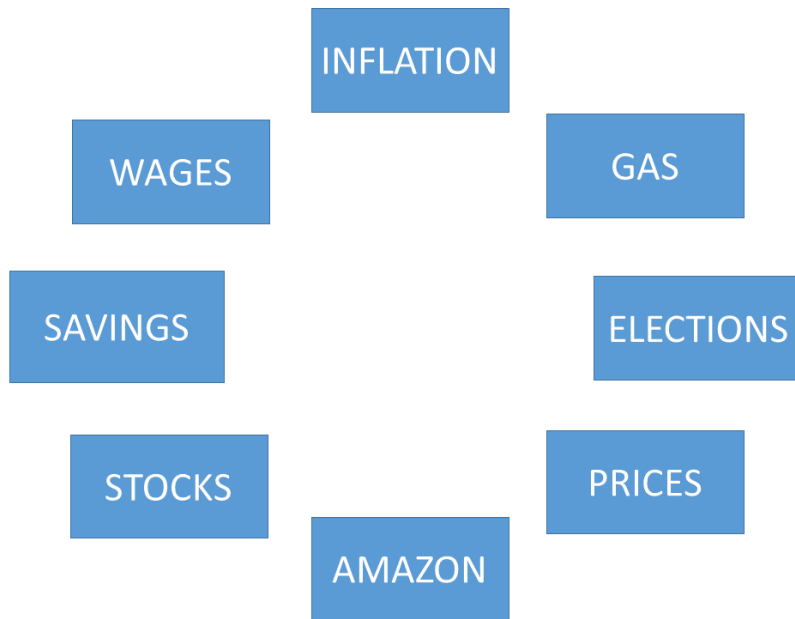
*All writers are gardeners.*

- Some gardeners are tennis players
- Writers are not tennis players
- Writers are tennis players
- Some writers are not gardeners

**Question 12** *What is the missing number in this series? 1, 16, 81, ... , 625, 1296*

**Question 13** *Please list the first 5 words (separated by comas) that come to your mind when thinking about POLITICS.*

**Question 14** *Please list the first 5 words (separated by comas) that come to your mind when thinking about INFLATION.*



In the next screen, we will play the **Association Game**.

We will show you 8 words in a circle. The word on top of the circle is INFLATION. You should pick 3 of the other words in the circle that you associate with the concept of “Inflation” and tell us in a few words why this association comes to your mind.

Here, answers are not necessarily true or false, and you will not be paid based on the answers you give. We want to understand your opinions so feel free to tell us what you think!

Box: I understand the rules. Let’s play the Association Game!

**Question 15** *What is the FIRST word you want to associate with Inflation?*

**Question 16** *Why?*

**Question 17** *What is the SECOND word you want to associate with Inflation?*

**Question 18** *Why?*

**Question 19** *What is the THIRD word you want to associate with Inflation?*

**Question 20** *Why?*

In the next screen, we will show you six statements about the economic concept of INFLATION. For each statement, you should tell us if you think that the statement is True or False.

For each correct answer, you will earn a 5-cent bonus. You cannot lose any money in this game.

Box: I understand the rules. Let's play the Association Game!

**Question 21** *There is inflation in the economy when the prices of goods increase steadily*

- True
- False

**Question 22** *A persistent deflation (opposite of inflation) is desirable*

- True
- False

**Question 23** *When lots of money is printed, it loses its value*

- True
- False

**Question 24** *You can choose if investing your retirement savings in stocks or bonds. You think there is a risk of unexpectedly higher inflation relative to what experts predict today over the next 20 years. Based on this, you should invest in stocks.*

- True
- False

**Question 25** *High inflation benefits savers, on average*

- True
- False

**Question 26** *If your income doubles over the next 10 years and the prices of all goods also double, then you will be able to buy fewer goods in 10 years relatively to today.*

- True
- False

In the next screen, we will play the **Forecasting Game**.

We will show you two “random processes,” one after the other. A random process is a line that moves up and down over time. At each point in time, the next value depends partly on randomness and partly on the last value of the line.

As an example, you can think about the pictures of the values of the stock market over time. The processes we will show you, though, are produced by a random number

generator and are not replications of real world processes, such as stock market prices over time. For each random process, we will show you the process path until now. Then, we will ask you to guess the next value of the process for 15 times. Each time, after you make your guess, you will see the actual random value the random process generator produced.

Your performance in this game, which depends on both skill and luck, will contribute to your bonus payment. To compute the bonus, we will compute the distance (absolute value) between your forecast and the actual random value in each period (“forecast error”).

Because one process is noisier and hence harder to forecast relative to the other, to help you we will adjust your forecast error based on how difficult it is to forecast the process.

Box: I understand the rules. Let’s start this game.

In the next 15 screens, you will work with the same random process.

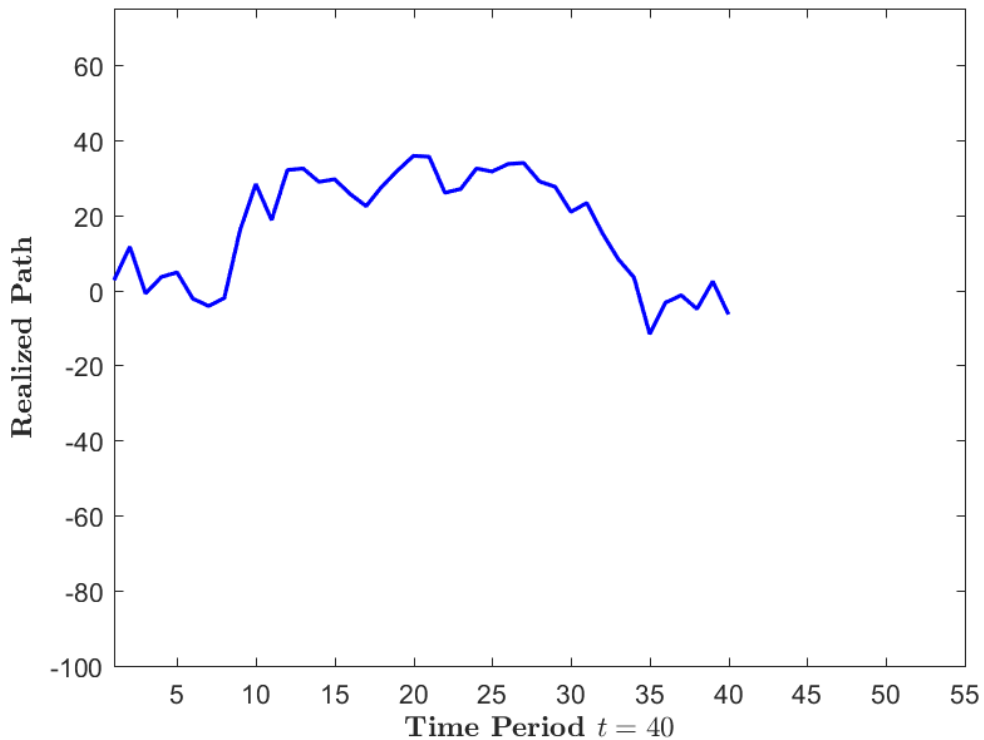
On top of graph, you will see the “Realized Value”, which is the value of the process now. Your job is to guess the next value of the process.

After each guess, a random number generator will produce the value. You will then be asked to guess the following value again. You will guess values for 15 times.

Have fun and good luck!



**Realized Value = -6.41**



**Question 27** *The value of the random process plotted above now (period  $t = 40$ ) is -6.41.*

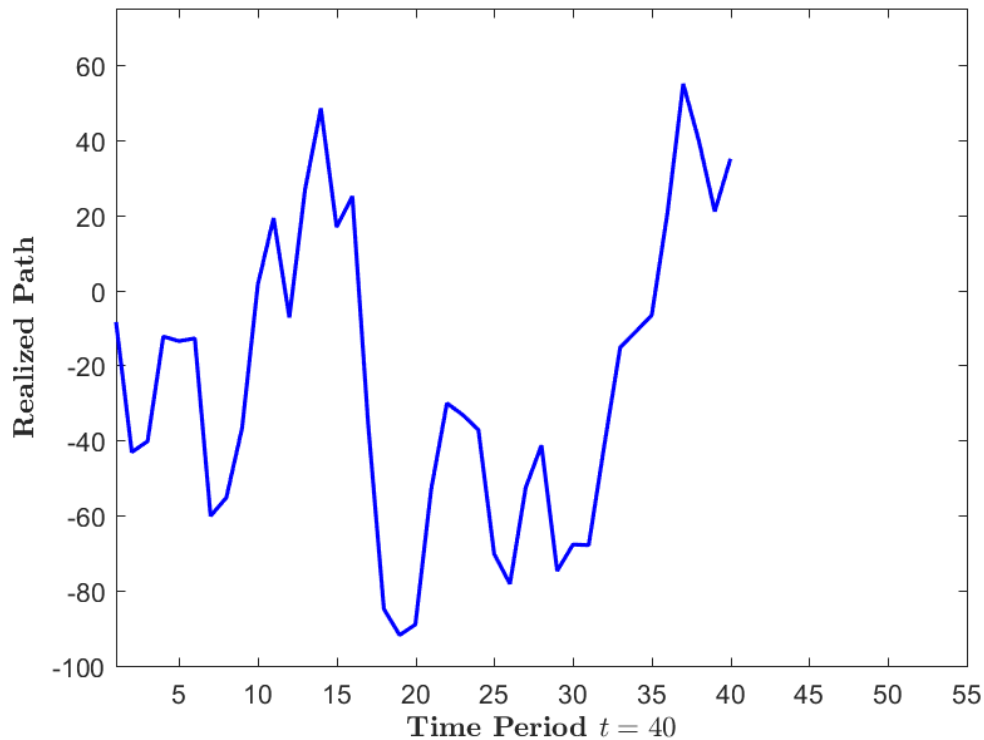
*What is your guess for the value of the process next period,  $t = 41$ ?  
Please provide a value between -100 and 80, using at most 2 decimal points.*

In the next 15 screens, you will work with the same random process.

On top of graph, you will see the “Realized Value”, which is the value of the process now. Your job is to guess the next value of the process.

After each guess, a random number generator will produce the value. You will then be asked to guess the following value again. You will guess values for 15 times.

**Realized Value = 35.03**



**Question 28** *The value of the random process plotted above now (period  $t = 40$ ) is 35.03.*

*What is your guess for the value of the process next period,  $t = 41$ ?  
Please provide a value between -100 and 80, using at most 2 decimal points.*

In the next screen, we want to ask your opinion about the state of the economy. There is no right or wrong answer here and we genuinely want to know what YOU think. It would be very important to us that you give us your own opinion, without consulting others or the internet.

Please make an effort to provide your best guess even in case you feel you do not have a strong expertise on the topic we bring up. Again, having your honest opinion is very important to us.

**Question 29** *Over the LAST twelve month, what do you think the overall rate of inflation/ deflation HAS BEEN in the economy in %?  
Please enter a number between -100% and 100%*

**Question 30** *Over the NEXT twelve month, what do you think the overall rate of inflation/ deflation WILL BE in the economy in %?  
Please enter a number between -100% and 100%*

**Question 31** *Now imagine that, unexpectedly, experts say inflation will double over the next 12 months, but everything else, including real economic growth, unemployment, and interest rates on savings accounts, will not change. Your own economic situation will not change either.*

*What would you do today?*

- Consume more and spend more
- Save more in your retirement account
- Save more in your retirement account
- Keep more money in your checking account
- Invest more in stocks
- Do nothing different from before

**Question 32** *Why did you choose this option?*

In the last screen, we would like you to fill a short form about your demographics. This information is very helpful for us for statistical purposes, and it will be kept completely private and anonymous.

**Question 33** *What is your age?*

**Question 34** *What is your gender?*

- Male
- Female
- Non-binary/ third gender
- Prefer not to answer

**Question 35** *Which category reflect your gross annual income?*

- Between \$0 and \$9,999
- Between \$10,000 and \$19,999
- Between \$20,000 and \$34,999
- Between \$35,000 and \$49,999
- Between \$50,000 and \$69,999
- Between \$70,000 and \$99,999
- Between \$100,000 and \$149,999
- More than \$150,000

**Question 36** *What is your highest level of education?*

- Did not complete High School
- High School, but no College
- Some College education but no degree
- Graduated from College
- Graduated from past-graduate degree (e.g., Masters, JD, MD, PhD)

**Question 37** *Do you or someone else make most financial decisions in your household?*

- I make most financial decisions
- Someone else in my household makes most financial decisions

**Question 38** *Are you or someone else the main grocery shopper in your household?*

- I'm the main grocery shopper
- Someone else is the main grocery shopper

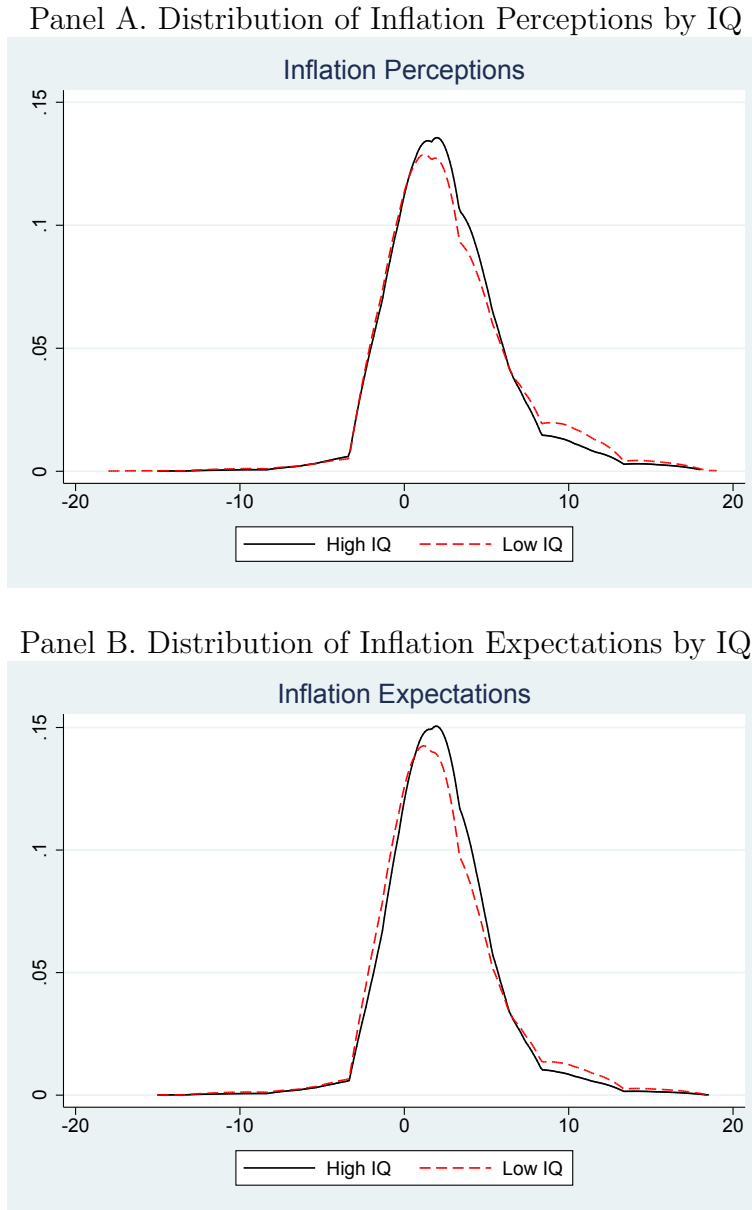
**Question 39** *Finally, do you have any comments for us? Feel free to write anything you want or to leave this field blank.*

Thank you very much for participating in our survey! Your answers are very important to us, and we greatly appreciate that you took the time to work on our survey.

Below you find the CONFIRMATION CODE you need to enter in the HIT on MTurk for the payment. Reporting this code is crucial to link your answers in this survey to your Worker ID on MTurk.

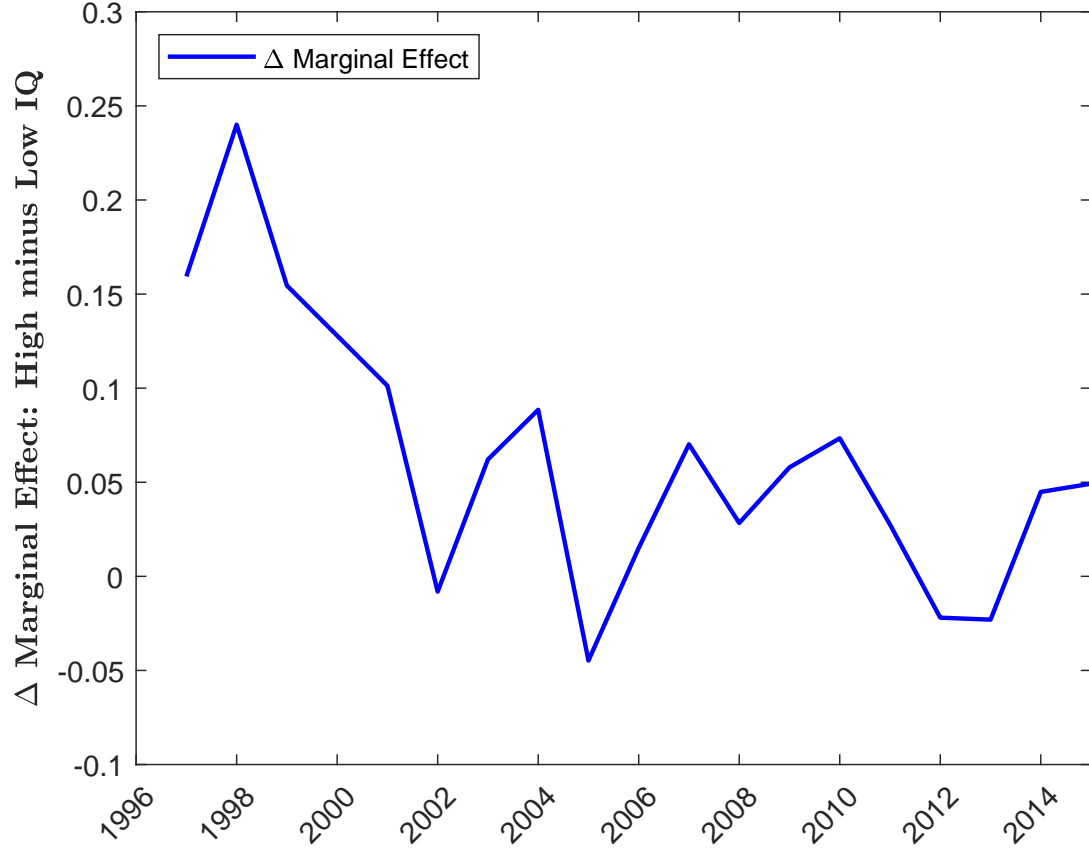
Please also check below and click on the arrow to the right to complete the questionnaire.

Figure A.1: **Distribution of Inflation Perceptions and Expectations by IQ**



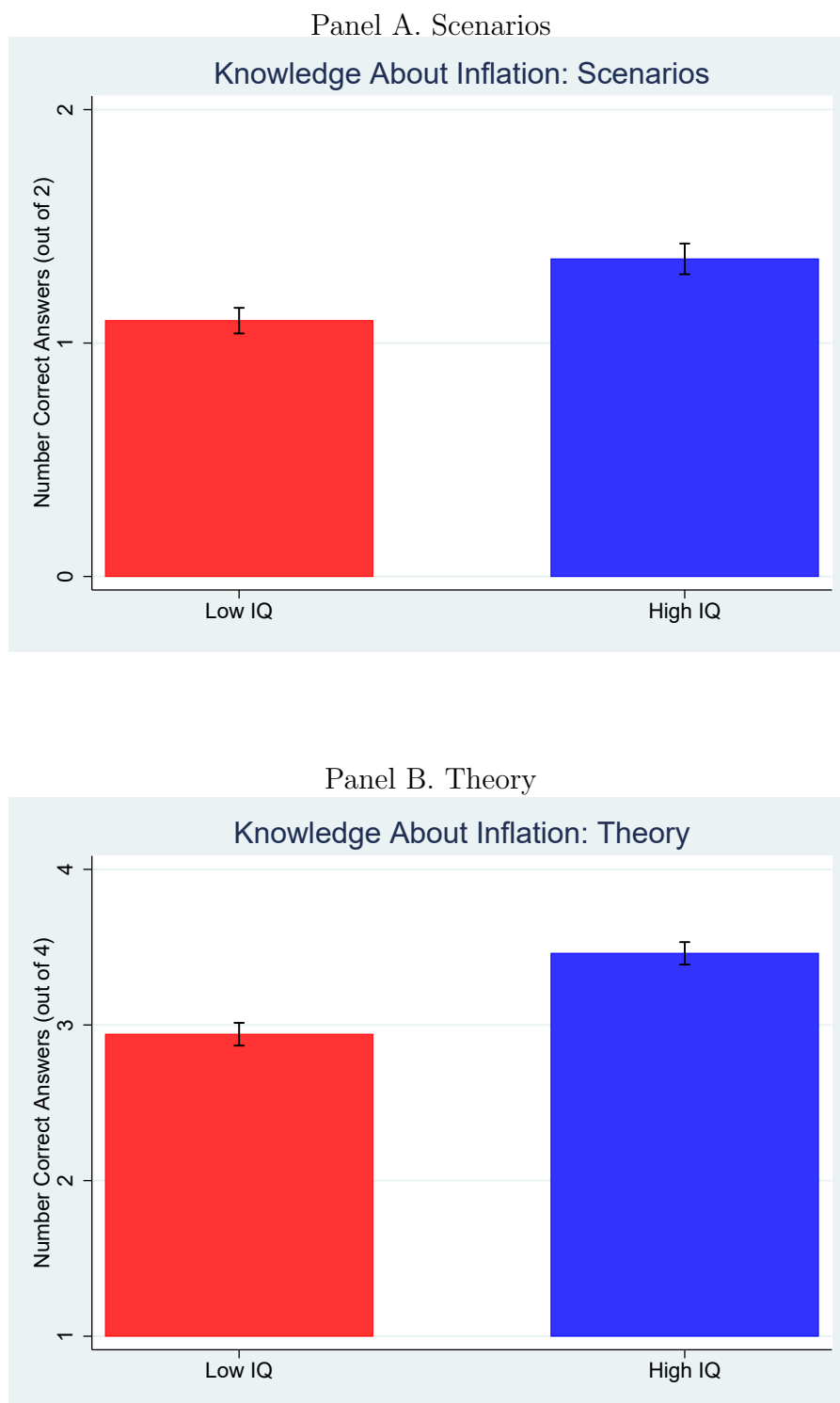
*This figure plots the density of numerical inflation perceptions (Panel A) and numerical inflation expectations (Panel B) across men with IQ levels between 1 and 5 (“Low IQ”) and between 6 and 9 (“High IQ”). IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. To measure numerical inflation perceptions and expectations, we use the confidential micro data underlying the official European Commission consumer confidence survey. Statistics Finland asks a representative sample of 1,500 individuals each month. The sample period is from January 2001 to March 2015. The densities are estimated using an Epanechnikov kernel with a bandwidth of 1.5 in both Panels.*

Figure A.2: **Difference in Marginal Effects over Time**



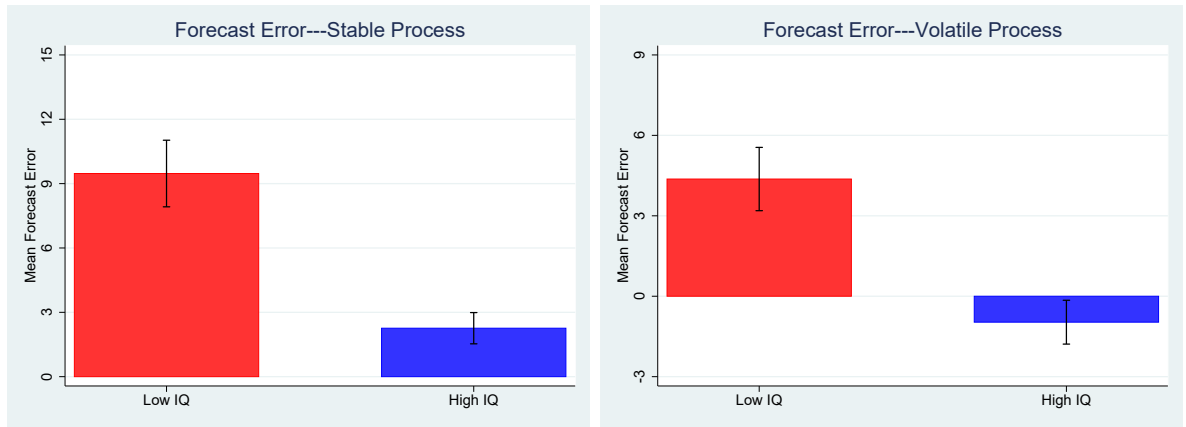
*This figure reports the difference in average marginal effects between high and low IQ of a multinomial logit regression over time. Households' readiness to purchase durables is the dependent variable. Inflation increase is a dummy variable that equals 1 when a survey participant replies that inflation will increase. We use the confidential micro data underlying the official European Commission consumer confidence survey to construct these variables. Statistics Finland asks a representative sample of 1,500 individuals each month whether it is a good time to purchase durables given the current economic conditions. Individuals can reply that it is a good time, it is a bad time, or it is neither a good time nor a bad time. In this table, we study the "it is a good time" outcome. IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. We define High IQ as the sample of men with normalized IQ larger than 5. Standard errors are clustered at the quarter level. The sample period is January 1996 to March 2015.*

Figure A.3: **Knowledge about Inflation by IQ: Scenarios versus Theory**



*This figure plots the number of correct answers about the concept of inflation to six questions by low and high IQ. Panel A reports the share of correct answers to four scenario questions and Panel B reports the share of correct answers to two theory questions. Low-IQ respondents scored 4 or less in our cognitive ability measure, whereas high-IQ respondents scored between 5 and 7 in the test. We fielded the survey on MTurk in August 2019. The survey consisted of two sessions with 500 respondents each.*

Figure A.4: Mean Forecast Errors of Random Process by IQ

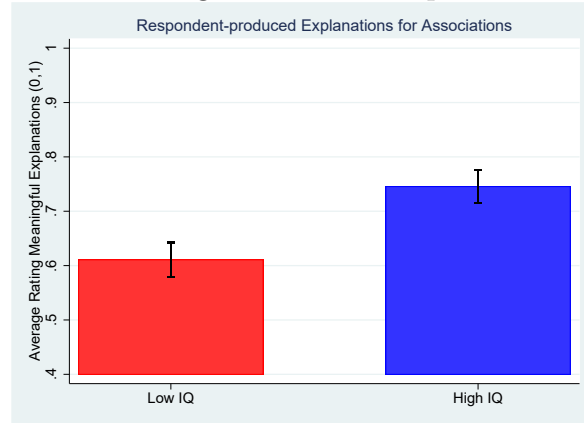


This figure plots the average mean forecast error across two groups of individuals based on cognitive abilities. Low-IQ respondents scored 4 or less in our cognitive ability measure, whereas high-IQ respondents scored between 5 and 7 in the test. We produced these data through a forecasting task inspired by Landier et al. (2018). We asked respondents to forecast two zero-mean  $AR(1)$  processes for 15 periods with coefficients of mean reversion of 0.9. The left figures plot the statistics for a process with a volatility of 5 and the right figures plot the statistics for a process with a volatility of 20. The forecasting tasks were part of a survey on MTurk we fielded in August 2019. The survey consisted of two sessions with 500 respondents each.

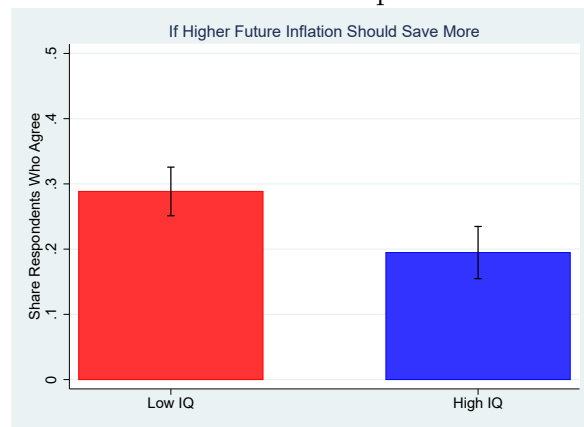


Figure A.5: **Economic Reasoning by IQ**

Panel A. Rating of Provided Explanation and



Panel B. Euler Equation



Panel A plots the ratings for the explanations respondents proposed for the words they associated with inflation across two groups—low-IQ respondents, who score 4 or less in our cognitive ability measure, and high-IQ respondents, who score between 5 and 7 in the test. A generally correct answer received a score of 1, potentially correct but incomplete answers received a score of 0.5, and a wrong answers received a score of 0. Two of the authors rated the answers independently, and we used the average of the two ratings to create a final score at the respondent level. Panel B plots the share of respondents who agree with the statement that one should save more if news about higher future inflation arrives. These questions were part of a survey on mTurk we fielded in August 2019. The survey consisted of two sessions with 500 respondents each.

Table A.1: **Absolute Forecast Errors and IQ: Subcategories**

This table reports the coefficient estimates from a linear regression of absolute forecast errors on normalized IQ. We report results for the three subcategories of the overall IQ measure: visuospatial, mathematical, and verbal. We use the confidential micro data underlying the official European Commission consumer confidence survey to measure inflation expectations. Statistics Finland asks a representative sample of 1,500 individuals each month. IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. The sample period is from January 2001 to March 2015. High IQ is a dummy that equals 1 if normalized IQ in the respective category is larger than 5. Standard errors are clustered at the quarter level. The sample period is January 2001 to March 2015.

	(1)	(2)	(3)	(4)
High IQ <sub>visuospatial</sub>	-0.1510*** (0.0391)			-0.0393 (0.0434)
High IQ <sub>verbal</sub>		-0.2228*** (0.0400)		-0.1385*** (0.0447)
High IQ <sub>arithmetic</sub>			-0.2473*** (0.0401)	-0.1743*** (0.0462)
Demographics	X	X	X	X
Year-Month FE	X	X	X	X
Adj. R <sup>2</sup>	0.0549	0.0555	0.0557	0.0561
Nobs	27,484	27,484	27,484	27,484

Standard errors in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Table A.2: **Absolute Forecast Errors and IQ: Time Since Test**

This table reports the coefficient estimates from a linear regression of absolute forecast errors on normalized IQ and several interaction terms of IQ with dummy variables and age.  $\mathbb{1}_{long\ ago}$  equals 1 for individuals that are in the top third of the distribution of the time gap between when they took the IQ test and the survey on inflation expectations,  $\mathbb{1}_{medium\ ago}$  equals 1 for individuals that are in the middle third, and  $\mathbb{1}_{pre\ test}$  equals 1 for individuals that answered the survey on inflation expectations before the IQ test. We use the confidential micro data underlying the official European Commission consumer confidence survey to measure inflation expectations. Statistics Finland asks a representative sample of 1,500 individuals each month. IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. The sample period is from January 2001 to March 2015. High IQ is a dummy that equals 1 if normalized IQ is larger than 5. Standard errors are clustered at the quarter level. The sample period is January 2001 to March 2015.

	(1)	(2)	(3)	(4)
High IQ	−0.2467*** (0.0503)	−0.2969*** (0.0852)	−0.2467*** (0.0406)	−0.3644** (0.1754)
High IQ $\times \mathbb{1}_{long\ ago}$	0.0022 (0.0787)	0.0528 (0.1059)		
High IQ $\times \mathbb{1}_{medium\ ago}$		0.0721 (0.1045)		
High IQ $\times \mathbb{1}_{pre\ test}$			0.0785 (0.4126)	
High IQ $\times$ age				0.0039 (0.0056)
Demographics	X	X	X	X
Year-Month FE	X	X	X	X
Pseudo R <sup>2</sup>	0.0556	0.0558	0.0557	0.0556
Nobs	27,568	27,568	27,568	27,568

Standard errors in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Table A.3: **Inflation Expectations and Readiness to Spend**

This table reports the average marginal effects of a multinomial logit regression. Households' readiness to purchase durables is the dependent variable. Inflation increase is a dummy variable that equals 1 when a survey participant replies that inflation will increase. We use the confidential micro data underlying the official European Commission consumer confidence survey to construct these variables. Statistics Finland asks a representative sample of 1,500 individuals each month whether it is a good time to purchase durables given the current economic conditions. Individuals can reply that it is a good time, it is a bad time, or it is neither a good time nor a bad time. In this table, we study the "it is a good time" outcome. IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. We define High IQ as the sample of men with normalized IQ larger than 5. Standard errors are clustered at the quarter level. The sample period is January 2001 to March 2015.

	High IQ (1)	Low IQ (2)
Inflation expectations	0.0358*** (0.0119)	-0.0096 (0.0138)
Inflation perception	-0.0737*** (0.0074)	-0.0629*** (0.0058)
Age	-0.0047 (0.0063)	-0.0105* (0.0062)
Age <sup>2</sup>	0.0000 (0.0001)	0.0001 (0.0001)
Single	-0.0098 (0.0079)	-0.0046 (0.0084)
Log of Income	0.0115* (0.0063)	-0.0031 (0.0073)
Unemployed	-0.0338* (0.0183)	-0.0102 (0.0146)
Kids	-0.0285*** (0.0095)	-0.0100 (0.0105)
Urban	0.0078 (0.0086)	-0.0086 (0.0084)
Helsinki	-0.0378*** (0.0090)	-0.0009 (0.0122)
College	0.0023 (0.0093)	0.0097 (0.0112)
Demographics	X	X
Year-Month FE	X	X
Pseudo R <sup>2</sup>	0.0108	0.0091
Nobs	16,606	16,256

Standard errors in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Table A.4: **Inflation Expectations and Readiness to Spend (Alternative Cut-Offs)**

This table reports the average marginal effects of a multinomial logit regression. Households' readiness to purchase durables is the dependent variable. Inflation increase is a dummy variable that equals 1 when a survey participant replies that inflation will increase. We use the confidential micro data underlying the official European Commission consumer confidence survey to construct these variables. Statistics Finland asks a representative sample of 1,500 individuals each month whether it is a good time to purchase durables given the current economic conditions. Individuals can reply that it is a good time, it is a bad time, or it is neither a good time nor a bad time. In this table, we study the "it is a good time" outcome. IQ is the standardized test score from the Finnish Defence Forces. IQ obtains integer values between 1 and 9. We define High IQ as the sample of men with normalized IQ larger than 6. We define Low IQ as the sample of men with normalized IQ smaller than 4. And we define Medium IQ as the sample of men with normalized IQ between 4 and 6. Standard errors are clustered at the quarter level. The sample period is January 2001 to March 2015.

	High IQ (1)	Medium IQ (2)	Low IQ (3)
Expects Higher Inflation	0.0508*** (0.0154)	0.0011 (0.0146)	-0.0291 (0.0252)
Demographics	X		X
Year-Month FE	X		X
Pseudo R <sup>2</sup>	0.0113	0.0089	0.0128
Nobs	10,344	18,629	3,889

Standard errors in parentheses

\* $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\* $p < 0.01$

Table A.5: Inflation Expectations and Readiness to Spend: Unconstrained

*This table reports the average marginal effects of a multinomial logit regression. Individuals' readiness to purchase durables is the dependent variable. Inflation expectation is a dummy variable which equals 1 when an individual replies that inflation will increase. We use the confidential micro data underlying the official European Commission consumer confidence survey to construct these variables. The surveys ask representative samples of individuals on a monthly basis whether it is a good time to purchase durables given the current economic conditions. Individuals can reply that it is a good time, it is a bad time, or it is neither a good time nor a bad time. In this table we study the "it is a good time" outcome. IQ is the standardized test score from the military entrance exam test for all men in Finland. IQ obtains integer values between 1 and 9 with 9 being the highest score. High-IQ men are all men with the IQ scores above 5. Demographic controls are age, age<sup>2</sup>, sex, marital status, log of income, employment status, number of children, urban versus rural classification, college dummy, and a dummy that equals 1 if the respondent lives in Helsinki. We cluster standard errors at the quarter level. Columns (2) and (3) condition on having taxable income above the median income in the cross section and columns (4) and (5) condition on having taxable income above the 25<sup>th</sup> percentile of income in the cross section. The sample period is January 2001 to March 2015.*

	Men with IQ data (1)	Income > 50 <sup>th</sup> percentile <sub>t</sub> (2)		Income > 25 <sup>th</sup> percentile <sub>t</sub> (4)	
		Men high IQ	Men low IQ	Men high IQ	Men low IQ
Inflation expectation	0.0147 (0.0100)	0.0306** (0.0154)	0.0022 (0.0195)	0.0343*** (0.0130)	-0.011 (0.0130)
Demographics	X	X	X	X	X
Pseudo R <sup>2</sup>	0.0107	0.0127	0.0121	0.0112	0.0096
Nobs	32,862	10,723	9,514	14,852	14,383

Standard errors in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Table A.6: Inflation Expectations and Readiness to Spend: by Financial Outlook

*This table reports the average marginal effects of a multinomial logit regression. Individuals' readiness to purchase durables is the dependent variable. Inflation expectation is a dummy variable which equals 1 when an individual replies that inflation will increase. We use the confidential micro data underlying the official European Commission consumer confidence survey to construct these variables. The surveys ask representative samples of individuals on a monthly basis whether it is a good time to purchase durables given the current economic conditions. Individuals can reply that it is a good time, it is a bad time, or it is neither a good time nor a bad time. In this table we study the "it is a good time" outcome. IQ is the standardized test score from the military entrance exam test for all men in Finland. IQ obtains integer values between 1 and 9 with 9 being the highest score. High-IQ men are all men with the IQ scores above 5. Demographic controls are age, age<sup>2</sup>, sex, marital status, log of income, employment status, number of children, urban versus rural classification, college dummy, and a dummy that equals 1 if the respondent lives in Helsinki. We cluster standard errors at the quarter level. Columns (2) and (3) condition on having a positive outlook regarding household income, and columns (4) and (5) condition on having a negative outlook regarding household income. The sample period is January 2001 to March 2015.*

	High Income Expectations		Low Income Expectations		
	Men high IQ	Men low IQ	Men high IQ	Men low IQ	
(1)	(2)	(3)	(4)	(5)	
Inflation expectation	0.0147 (0.0100)	0.0294* (0.0165)	-0.0166 (0.0190)	0.0371** (0.0158)	-0.0046 (0.0176)
Demographics	X	X	X	X	X
Pseudo R <sup>2</sup>	0.0107	0.0115	0.0083	0.0106	0.0104
Nobs	32,862	7,337	6,409	9,269	9,847
Standard errors in parentheses					
* $p < 0.10$ , ** $p < 0.05$ , *** $p < 0.01$					