Human Frictions in the Transmission of Economic Policy*

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Abstract

Intertemporal substitution is at the heart of modern macroeconomics and finance as well as economic policymaking, but a large fraction of a representative population – those below the top of the distribution by cognitive abilities (IQ) – do not change their consumption propensities with their inflation expectations. Low-IQ men are also less than half as sensitive to interest-rate changes when making borrowing decisions. Low-IQ men account for more than 50% of the individuals and 50% of the labor income in our sample, which includes unique merged administrative data on cognitive abilities, economic expectations, consumption and borrowing plans, as well as total loan amounts from Finland. Heterogeneity in education, income, other expectations, and financial constraints do not explain these results. Limited cognitive abilities are *human frictions* in the transmission and effectiveness of economic policy and inform research on heterogeneous agents in macroeconomics and finance.

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I Introduction

The consumption Euler equation is at the heart of modern dynamic models in macroeconomics and finance. Conventional monetary policy aims to stabilize the economy by changing interest rates, and hence households' consumption expenditure through intertemporal substitution. Intertemporal substitution is also central to the effectiveness of unconventional monetary policy and conventional or unconventional fiscal policies.[1] Standard models and policies assume agents form their expectations rationally and react to changes in expectations. A recent example is forward guidance, which requires households to understand that keeping interest rates low until after the end of a liquidity trap will generate inflation, which should in turn increase current inflation expectations and hence the propensity to consume. Empirically, forward guidance is not as effective as representative-agent models imply (McKay, Nakamura, and Steinsson (2016)). Frictions must thus exist that hinder the transmission of policy through households, and in particular hinder households from increasing their consumption propensity when expecting higher inflation.[2]

In this paper, we document that limited cognitive abilities are *human frictions* to the effectiveness of economic policy. In a representative sample of Finnish men for whom we observe administrative data on cognitive abilities through IQ tests, only men with high cognitive abilities adjust their consumption propensities in response to changes in inflation expectations, even if everybody faces the same nominal interest rates.[3] High-IQ men are also twice as sensitive to changes in interest rates when making borrowing decisions compared to low-IQ men, at times of both increases and decreases of policy rates. Differences in income, education, borrowing constraints, or other expectations such as individual household income expectations cannot explain the heterogeneity in consumption and borrowing responses by IQ.

[1] See Eggertsson and Woodford (2003), Farhi and Werning (2016), and Correia, Farhi, Nicolini, and Teles (2013).

[2] Earlier research found conflicting results on whether households' choice reacts to their changing inflation expectations. For instance, see Bachmann et al. (2015), Armantier et al. (2015), and D'Acunto, Hoang, and Weber (2018a).

[3] In a companion paper, (D'Acunto, Hoang, Paloviita, and Weber (2018)), we show the quality and consistency of economic expectations and economic choices high-cognitive-ability individuals form is substantially higher than those of low-cognitive-ability individuals.

Men with low cognitive abilities are economically relevant because they represent more than 50% of the individuals and 50% of the income in our sample. The non-response to policy changes by these men is thus material to explaining the limited effectiveness of policy interventions implemented under the assumption that unconstrained households react.

We base our analysis on administrative individual-level data from Finland. Around age 20, all Finnish men take a standardized test of cognitive abilities when entering the mandatory military service. We observe the scores of all test takers between 1982 and 2001, which are provided as a standardized variable that follows a stanine distribution (integers from 1 to 9, with 9 being the highest) to allow cross-cohort comparisons. We match these test scores with the individual-level answers to the monthly harmonized European Commission consumer confidence survey (EC survey) from 2001 to 2015. This survey elicits inflation expectations, propensities to consume and borrow, as well as a rich set of demographics such as age, education, marital status, income, household size, and employment status for a set of repeated representative cross sections of Finns. In addition, we observe total debt outstanding at the individual level from tax records.

We build on these unique data and on the fact that cognitive abilities are an important determinant of households' expectations (see D'Acunto, Hoang, Paloviita, and Weber (2018)) to assess the relationship between limited cognitive abilities and households' responsiveness to economic policy. As a first step, we study whether individuals adjust their consumption plans in line with the consumption Euler equation. We thus ask whether IQ levels relate to Finnish men's understanding of intertemporal substitution. We estimate a set of multinomial logit regressions to study the relationship between inflation expectations and willingness to spend on durable goods. The EC survey asks how respondents think consumer prices will evolve in the following 12 months compared to the previous 12 months.[4] When we split the sample into high-IQ and low-IQ respondents, we find high-IQ respondents who think inflation will increase are almost 4% more likely relative to other high-IQ men to state it is a good time to spend. For low-IQ men, instead, we detect a negative and statistically insignificant association between inflation

[4]For ease of interpretation, we follow D'Acunto, Hoang, and Weber (2018a) and create a dummy variable that equals 1 when a household expects inflation to increase.

expectations and their readiness to spend. These results hold conditional on a rich set of demographics including education and income. Because low-IQ men do not react in line with the consumption Euler equation, these results suggest cognitive abilities could be a first-order impediment to the effectiveness of common fiscal and monetary policies that rely on intertemporal substitution.

One might worry 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 real interest rates (see Zeldes (1989)). Conditioning on household income does not affect any of our baseline results, and low-income households are plausibly more likely to be financially constrained than high-income households. We also confirm the baseline patterns when running our analysis separately for men above the median of the distribution by income, a subsample that includes both low- and high-IQ men.

Another potential concern is that expecting higher economic growth and hence higher household income might deliver a spurious positive relationship between the propensity to spend and inflation expectations. We can rule out this concern directly, because we observe individual income expectations elicited at the same time as inflation expectations. We confirm our results when splitting the samples of high-IQ and low-IQ men into those men reporting positive or negative income expectations. These patterns in the data also rule out that individuals act on a subjective Phillips-curve relationship or that indirect effects of monetary policy explain our results (Kaplan, Moll, and Violante (2018)).

After documenting that men with low cognitive abilities do not behave in line with intertemporal substitution, we ask whether they react to changes in nominal interest rates, which are a cornerstone of conventional monetary policy. Central banks commonly lower nominal interest rates to stimulate consumption through household borrowing, and increase rates to avoid overheating. To tackle this question, we move on to test whether the relationship between individuals' propensity to borrow and changes in nominal interest rates varies systematically with individuals' cognitive abilities.[5] An advantage of our setting is our sample period includes two significant policy interventions on nominal interest rates in opposite directions. The European Central Bank (ECB), which has

[5]Note we do *not* argue that reacting to changes in nominal interest rates is optimal for all households.

run monetary policy for Finland and all other Euro-area countries since 1999, lowered its policy rate substantially during and subsequent to the stock-market turmoils of 2001. It kept rates low until 2005, and then increased rates steeply up to January 2007.

Effective transmission of these monetary-policy interventions requires that households increase their demand for loans when nominal rates drop, and decrease their demand for loans when nominal rates increase, ceteris paribus. High-IQ men behave closely in line with this predicted pattern, because their propensity to take out loans increases when rates fall, stays constant while interest rates do not move, and lowers when interest rates rise. To the contrary, low-IQ men appear to be barely sensitive to changes in nominal interest rates when forming their borrowing plans, irrespective of the direction of the rate change. These results hold for the full sample as well if we limit the analysis to households that are unlikely to be financially constrained.

A differential pass-through of policy rates to individual borrowing rates for low- and high-IQ men might explain the differential borrowing sensitivities. A differential pass-through is an unlikely explanation because 95% of all mortages in Finland are adjustable-rate mortgages with a spread on the 12-month EURIBOR, and mortgages represented 74% of all consumer debt at the end of 2014. Alternatively, low-IQ men might be shut-off financial markets which is why they do not care about changes in interest rates. Using registry data, we find individual leverage ratios that are almost constant across the IQ distribution. Finally, so far we have exclusively studied the association between inflation expectations, interest rates, and survey decisions. Even though low IQ men might not adjust their propensities to take out loans to changes in interest rates, it could still be the case high- and low-IQ men might adjust their actual decisions in similar ways. Financial advisor, for example, might call low-IQ men and tell them now is a good time to take out a loan given interest rates are all. Using annual tax data, we find high-IQ men adjust their total outstanding debt balances more to changes in interest rates.

The fact that men with low cognitive abilities are barely sensitive to monetary-policy interventions suggests human frictions might also be an important impediment to the transmission of traditional monetary policy.

In the last part of the paper, we study a set of (non-mutually exclusive) channels

that might explain our results. First, low-IQ men might be less informed about economic fundamentals than high-IQ men, and hence have no idea what current inflation is. We label this potential channel the *costly information-gathering* channel. The cognitive costs of gathering information about macroeconomic variables might be high for low-IQ men, who might thus behave rationally by deciding to not gather such information. This channel might explain why low-IQ men have miscalibrated beliefs about future macroeconomic variables and hence do not react to policy interventions as a standard representative agent model predicts. Although D'Acunto et al. (2018) find evidence that low-IQ men have miscalibrated perceptions of contemporaneous inflation rates, and hence are on average less informed about macroeconomic variables than high-IQ men, we find that even the set of low-IQ men that are correctly informed about inflation does not adjust their consumption plans in response to changing inflation expectations.

The second channel we consider is that low-IQ men might have difficulties in thinking in probabilistic terms about future states of the world. Under this *costly expectations-formation* channel, even well-informed low-IQ men might have miscalibrated expectations about macroeconomic variables, which might in turn explain their non-reaction to changing inflation expectations when forming consumption plans. We find that even those low-IQ men who have accurate inflation expectations, still do not react to changing inflation expectations when forming consumption plans. This result suggests that the costly expectations-formation channel is unlikely to explain our results in full.

Because the tests for the first two channels do not provide us with a complete explanation of our results, we discuss a third channel we think might help explain our results in full, namely, the *lack-of-economic-reasoning* channel. Even low-IQ men who have the relevant information about the current state of the economy as well as accurate expectations for future economic states might still not substitute intertemporally, because they do not grasp the basic economic reasoning to understand intertemporal substitution, that is, how expectations about future inflation should reflect the incentives to consume and save today. The fact that low-IQ men might not understand the logic behind intertemporal optimization might also explain their excess sensitivity of consumption

to predictable income changes (see, e.g., Parker et al. (2013)). This channel is in line with Ilut and Valchev (2017), who model agents with limited cognitive knowledge of the optimal action conditional on the economic state. Similarly, low-IQ men might not grasp the basic economic reasoning for why changing nominal interest rates might affect their incentives to borrow over time, ceteris paribus.

In our setting, low-IQ men represent 50% of the overall income held in our sample, and hence their inaction is material to the effective transmission of fiscal and monetary policy. At the same time, our findings would have relevant policy implications even if the fraction of income accruing to low-IQ men was smaller. In fact, an important implication of our results is a potential redistributive role of monetary policy. Because low-IQ men do not adjust their consumption plans in response to changes in their inflation expectations and to changes in interest rates, common monetary-policy interventions might result in redistribution from men with low cognitive abilities to men with high cognitive abilities. To the extent that cognitive abilities are largely innate or determined by environmental factors individuals can barely control in their early life,[6] this redistribution might be interpreted as a form of unintended yet undue discrimination of economic agents on the part of economic policymaking institutions.

A. Related Literature

Our paper is inspired by a recent literature on the *forward guidance puzzle* (see Del Negro, Giannoni, and Patterson (2015)) – the fact that forward guidance is not as effective empirically as representative-agent models imply. Deviations from the representative-agent framework could possibly explain the limited effectiveness. Borrowing constraints paired with uninsurable income shocks and asset holdings of different liquidity limit the scope of forward guidance and intertemporal substitution more generally (see McKay, Nakamura, and Steinsson (2016), Kaplan, Weidner, and Violante (2014), and Kaplan, Moll, and Violante (2018)). A recent theoretical literature explores deviations from rational expectations in this context. Farhi and Werning (2017) extend the

[6]For a review of the scholarly debate on the origins of cognitive abilities see, among others, Mc Gue et al. (1993) and Plomin and Spinath (2004).

standard New Keynsian model and allow for incomplete markets with uninsurable income shocks and bounded rationality in the form of level-k thinking. These two extensions can limit the power of monetary policy, especially at long horizons. Along similar lines, Woodford (2018) shows decision-makers that only optimize for a limited number of periods ahead can reduce the effectiveness of forward guidance. Gabaix (2018) develops a behavioral New Keynesian model in which a subset of agents is myopic, which mutes the power of forward guidance. Other recent theoretical models with level-k thinking are Garcia-Schmidt and Woodford (2015), who show that interest-rate committments do not need to be deflationary in a liquidity trap, and Iovino and Sergeyev (2018)), who document that balance-sheet policies by central banks might be effective because of level-k thinking. We contribute to this literature by showing empirically that cognitive abilities help explain why large parts of the population might not adjust their consumption plans in response to inflation expectations and their borrowing propensities in response to changes in nominal interest rates.

Our paper also relates to the large literature that emphasizes the stabilization role of inflation expectations. On the monetary-policy side, Krugman (1998), Eggertsson and Woodford (2003), Eggertsson (2006), and Werning (2012) argue that a central bank can stimulate current spending by committing to higher future inflation rates during periods in which the zero lower bound on nominal interest rates binds. On the fiscal policy side, Eggertsson (2011), Christiano, Eichenbaum, and Rebelo (2011), Woodford (2011), and Farhi and Werning (2015) show that inflation expectations can increase fiscal multipliers in standard New Keynesian models in times of a binding zero lower bound on nominal interest rates. We add to this literature showing that cognitive abilities determine whether individuals adjust their consumption plans in response to inflation expectations.

We also contribute to a recent literature that uses micro-level data to study the relationship between inflation expectations and households' readiness to purchase consumption goods. Bachmann et al. (2015) start this literature using survey data from the Michigan Survey of Consumer (MSC). They find an economically small and statistically insignificant association between households' inflation expectations and their readiness to spend on durable consumption goods. Burke and Ozdagli (2014) confirm

these findings using panel survey data from the New York Fed/ RAND-American Life Panel household expectations survey for a period from April 2009 to November 2012. Ichiue and Nishiguchi (2015) find that Japanese households that expect higher inflation plan to decrease their future consumption spending, but have increased their spending in the past, whereas D'Acunto, Hoang, and Weber (2018a) and D'Acunto, Hoang, and Weber (2018b) show households on average behave in line with the predictions from the consumption Euler equation in EU countries. They also use a salient policy, namely, the unexpected announcement of a future VAT increase, as a natural experiment to causally identify the effect. Arioli et al. (2017) confirm these findings for quantitative inflation expectations in Europe. Vellekoop and Wiederholt (2017) find the inflation expectations of Dutch households are systematically related to the composition of households' financial portfolios. Using data from the same survey, Christelis et al. (2016) find trust in the ECB lowers uncertainty about inflation expectations. Coibion, Gorodnichenko, and Kumar (2015) advance this literature using experimental variation to study causally the effect on inflation expectations on economic decisions. Malmendier and Nagel (2009) show that personal experiences determine inflation expectations. D'Acunto, Malmendier, Ospina, and Weber (2017) use unique survey data from the Nielsen homescan sample to show shopping experiences shape inflation expectations and determine the gender bias in inflation expectations.

Our findings stress the importance of cognitive abilities to shape individual economic decision-making. Papers that document the role of IQ in financial decision-making are Grinblatt, Keloharju, and Linnainmaa (2011), who study the effect on stock market participation, Grinblatt, Keloharju, and Linnainmaa (2012), who study the effect on trading behavior, and Grinblatt, Ikäheimo, Keloharju, and Knüpfer (2015), who study mutual fund choice. Agarwal and Mazumder (2013) relate cognitive abilities to suboptimal use of credit cards and home-equity loan applications. More recently, Aghion et al. (2017) use micro-level data on visiospatial IQ to study the effects of cognitive abilities, education, and parental income on inventiveness. Dal Bo, Finan, Folke, Persson, and Rickne (2017) relate IQ to the likelihood individuals enter political careers in Sweden. To the best of our knowledge, D'Acunto et al. (2018) is the first paper that shows cognitive abilities matter

for the formation of economic expectations and choice. This paper is also the first one to interpret cognitive abilities as a potential human friction to the transmission of economic policy.

Increasing the transparency of economic policies and facilitating the public's understanding of policy targets are two key aims of the recent monetary-policy strategy in the United States. The heterogeneity of our findings across cognitive abilities, as well as the non-response of individuals with low cognitive abilities to policy changes, suggests some individuals might not fully understand the aims of policy changes and interventions. Cognitive abilities might therefore result in unintended consequences such as the redistribution of resources from individuals with low IQ to individuals with higher cognitive abilities, which calls for the design of salient policies and more targeted communication strategies (see D'Acunto et al. (2018a) and Coibion, Gorodnichenko, and Weber (2018)).

Our findings also inform the literature on the take-up of economic programs. In the Great Recession, the U.S. administration initiated programs for underwater homeowners to refinance their mortgages, but the take-up rates were surprisingly low. Agarwal et al. (2017) study the effects and take-up rates of the 2009 Home Affordable Modification Program, which provided intermediaries with sizable financial incentives to renegotiate mortgages. They find a take-up rate of just one-third of the overall target population of indebted U.S. households. Moreover, Keys et al. (2016) show 20% of household s that are unlikely to be constraint fail to refinance their mortagages when interest rates decline. Our findings suggest low cognitive abilities might help explain the limited effectiveness of these policies.

II Data

Our analysis uses three micro data sets that include individual-level information on macroeconomic expectations, consumption and borrowing plans, and 'cognitive abilities, as well as administrative information on household-level income, debt, and interest rates.

A. Expectations, Spending, and Borrowing Plans

Our main source of information on individual-level macroeconomic expectations and consumption and borrowing propensities is the confidential micro data underlying the Consumer Climate 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 European Commissions' harmonized consumer survey program. Every month, they ask a representative repeated cross section of approximately 1,500 Finnish households questions about general and personal economic conditions, inflation expectations, and willingness to spend on consumption goods. Statistics Finland also collects additional information through supplementary questions about households' plans to save and borrow.

We obtained access to the micro data underlying the survey for the period starting in January 2001 and ending in March 2015. Our sample period includes large time variation in macroeconomic fundamentals as well as several policy interventions, which we exploit in the second part of our analysis.

The survey draws repeated cross sections from month to month. 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 of the survey.

We use the answers to the following three questions in the survey to construct the variables capturing spending plans and inflation expectations and perceptions:

Question 6 *By comparison with the past 12 months, how do you expect that consumer prices will develop in the next 12 months?*

Individuals can answer, "Prices will increase more rapidly," "Prices will increase at the same rate," "Prices will increase at a slower rate," "Prices will stay about the same," or "Prices will fall." We create a dummy variable that equals 1 when households answered, "Prices will increase more rapidly," to get a measure of higher expected inflation.[7]

[7]The question corresponds to question 6 in the harmonized EC survey.

Households' inflation expectations are highly correlated with their perception of past inflation (see Jonung (1981)). We also use survey question 4 in our baseline analysis to disentangle the effects of inflation expectations from inflation perceptions:

Question 4 *How do you think that consumer prices have developed over the last 12 months?*

Individuals can answer, "Prices have risen a lot," "Prices have risen moderately," "Prices have risen slightly," "Prices have stayed about the same," or "Prices have fallen."[8]

To study the association between inflation expectations and spending propsensities, we use the answer to the following question:

Question 10 *In view of the general economic situation in Finland, do you think that now it is the right moment for people to make major purchases such as furniture, electrical/ electronic devices, etc.?*

Households can answer, "It is neither the right moment nor the wrong moment," "No, it is not the right moment now," or "Yes, it is the right moment now."[9]

We use the answers to the following question to study the propensity to take out loans in response to changes in nominal interest rates:

Question 22 *In view of the general economic situation in Finland, do you think that at the moment ...*

Households can answer, "It is a very bad time to borrow," "It is a pretty bad time to borrow," "It is a pretty good time to borrow,", or "It is a very good time to borrow."[10]

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

The online appendix contains the original survey questions in Finnish.

[8]The question corresponds to question 5 in the harmonized EC survey.
[9]The question corresponds to question 8 in the harmonized EC survey.
[10]The question is not part of the harmonized EC survey.

B. Cognitive Abilities Data

During the sample period for which we have the data, all Finnish men were required to participate in military service. At the beginning of the mandatory military service, every Finnish man has to participate in a series of psychological tests administered by the Finnish Armed Forces (FAF) around the age of 19-20. The FAF uses the test 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 well.[11]

The test consists of 120 questions that attempt to test cognitive abilities in three areas – logical, mathematical, and verbal cognitive abilities. The FAF aggregates those scores into a composite measure of cognitive abilities, which we label collectively as IQ. The FAF standardizes IQ to follow a stanine distribution year by year. 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. The respondents in the lowest 4% of test scores are at least 1.75 standard deviations from the mean and are assigned a standardized IQ of 1 and the 4% with the highest test scores are assigned a standardized IQ of 9. We have test results for all participants from January 1, 1982 until December 31, 2001.

Finland is a very homogeneous country in terms of cultural background and opportunities. Education opportunities, including college education, are accessible to residents virtually for free. The country is also racially homogeneous, and our sample period does not cover the influxes of migrants that started around 2015 during the Syrian refugee crisis. Our setting is thus an ideal laboratory because our measures of IQ are unlikely to proxy for differences in cultural or environmental factors individuals could manipulate, but are more likely to reflect differences in innate abilities across individuals.

[11] See Grinblatt et al. (2011) for a more detailed discussion. To the extent that individuals attempt to shade their cognitive abilities, all results we report on the differences between low and high cognitive abilities are a lower bound of the true effect.

C. Income and Debt Data from Registries

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 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. The annual administrative data set covers the period between 1988 and 2013.

D. Descriptive Statistics

Table 1 contains the descriptive statistics for the main variables in our analysis. The average inflation expectation is 2.74% with a median of 2%, a standard deviation of 4.84%, and the 1^{st} and 99^{th} percentiles of -4% and 20%. The statistics for the perception of current inflation and forecasts errors are very similar.

The survey sample appears to be balanced between women and men. The median income is EUR 15,500 and the median respondent is 44 years old. About a third of respondents are single, 7% are unemployed, two-thirds have kids, 44% have a college degree, about a third lives in urban areas, and a quarter live in Helsinki. Fourty-eight percent of respondents think it's a good time to buy durables, 23% think it's a bad time, and the remainder think it's neither a good nor a bad time.

Table 2 reports the distribution of normalized IQ in Panel A, the average household leverage ratio by IQ bins in Panel B, and the share of income in total income that accrues to the individual IQ bins in Panel C. Panel B shows little variation in household leverage ratios by IQ. Specifically, low-IQ men have a ratio of total debt to taxable income of 82%, which is slightly higher than the ratio for all bins up to a normalized IQ of 7. High-IQ men, instead, have a minimally higher leverage ratio of 0.93. In the bottom panel, we see the share of income that accrues to the indivual bins. Later in our empirical analysis, we will often split the sample into low and high IQ, with the latter defined as having

a normalized IQ of 6 or higher. Note this implies low-IQ men make up 49.2% of total income and are therefore a large share of aggregate income and the economy.

The overall-cognitive-abilities test consists of three subparts that aim to measure different dimensions of cognitive abilities: a logical part, a verbal part, and an arithmetic part. In addition to the overall normalized IQ score, we also have the subscores from the FAF. Table 3 reports the correlations of these scores with the overall IQ score as well as with income. The overall IQ score has a correlation of around 0.85 with the subscores. More interestingly, we also see that the measure of cognitive abilities we use has only a correlation of 0.15 with income, which is rather low.

III Inflation Expectations, IQ, and Consumption Expenditure

Most existing models studying fiscal and monetary policies assume a representative agent that has all available information, forms expectations rationally, and fully optimizes. The consumption Euler equation is at the core of all modern dynamic models in macro and finance and predicts a positive association between consumption plans and inflation expectations; that is, if the agent expects higher inflation, he should substitute intertemporally and consume more now rather than later. In the textbook New Keynesian model, monetary policy affects real outcomes purely through this intertemporal substitution channel. But unconventional monetary-policy measures, such as forward guidance, as well as unconventional fiscal policies also aim to increase households' inflation expectations and stimulate consumption through intertemporal substitution (see Kaplan et al. (2018) and D'Acunto et al. (2018a)).

Our baseline analysis focuses on this key building block that is instrumental to testing whether limited cognitive abilities hinder the transmission of economic policies. We aim to test whether low-IQ and high-IQ individuals differ in the extent to which they update their consumption plans to changing inflation expectations, the consumption Euler equation. Households' understanding of intertemporal substitution and its implications for consumption plans is crucial for any intertemporal-substitution-based channels to

have any bite in the data. D'Acunto et al. (2018) find individuals with low cognitive abilities display larger forecast errors for inflation than individuals with high cognitive abilities. A crucial question is whether such differences underline any heterogeneity in consumption responses to changing inflation expectations. This step is necessary for cognitive abilities to have a role in individuals' responsiveness to economic and monetary-policy interventions based on intertemporal substitution.

A. Empirical Model

A common concern with survey-based measures of numerical inflation expectations is that households often report implausibly high levels of expected inflation. Moreover, many individuals report expected inflation rates as multiples of 5 or other round values, and a general upward bias exists, which is typically larger for women than for men (e.g., see Binder (2015) and D'Acunto et al. (2017)).

To avoid all the issues arising when using numerical inflation forecasts (see D'Acunto, Hoang, and Weber (2018a) for a detailed discussion), we construct a dummy variable that equals 1 if the respondent expects a higher inflation rate in the following 12 months, compared to the prevailing inflation rate over the past 12 months, and zero otherwise. D'Acunto, Hoang, and Weber (2018a) show this measure tracks closely ex-post realized inflation across several samples in different countries and different time periods. A rationale for why this qualitative-based measure might track ex-post realized inflation more closely than quantitative measures is that respondents might have a clear idea of the directional changes in inflation they perceive and expect, but might be uninformed about the *level* of inflation prevailing at the time they are interviewed.

Our first outcome variable of interest, households' readiness to purchase durable goods, derives from discrete, non-ordered choices in a survey. We therefore model the response probabilities in a multinomial-logit setting.

We assume the answer to the question on the readiness to spend is a random variable representing the underlying population. The random variable may take three values, $y \in \{0, 1, 2\}$: 0 denotes it is neither a good nor a bad time to purchase durable goods, 1 denotes it is a bad time to purchase durable goods, and 2 denotes it is a good time to

purchase durable goods.

We define the response probabilities as $P(y = t|X)$, where $t = 0, 1, 2$, and X is an $N \times K$ vector where N is the number of survey participants. The first element of X is a unit vector, and the other $K - 1$ columns represent a rich set of household-level observables, including demographics and expectations.

We assume the distribution of the response probabilities is

$$P(y = t|X) = \frac{e^{X\beta_t}}{1 + \sum_{z=1,2} e^{X\beta_z}} \tag{1}$$

for $t = 1, 2$, and β_t is a $K \times 1$ vector of coefficients. The response probability for the case $y = 0$ is determined, because the three probabilities must sum to unity.

We estimate the model via maximum likelihood to obtain the vector β_t of coefficients for $t = 1, 2$, and set the category $y = 0$ as the baseline response. We compute the marginal effects of changes in the covariates on the probability that households choose any of three answers in the survey, and report them in the tables.

B. Empirical Results: Baseline

To corroborate the accuracy of our data, we first estimate the relationship between inflation expectations and readiness to purchase durable goods in the overall sample, which includes both men and women. If the Euler-equation logic holds, we should observe a positive association between households' inflation expectations and their readiness to purchase durable goods. Table 4 reports the average marginal effects computed from the multinomial logit regressions of whether it's a good time to purchase durable goods on the dummy that equals 1 if the respondent thinks inflation will be higher in the following 12 months than it was in the previous 12 months. We cluster standard errors at the quarter level to allow for correlation of unknown form in the residuals across contiguous months. In all columns, we report the marginal effect of the inflation-increase dummy on the likelihood that individuals respond that it is a good time to buy durables. We always condition on perceptions of past inflation because they shape households' expectations

about future inflation (Jonung (1981)).[12] We see in column (1) that individuals who expect inflation to increase are on average 2.1% more likely to answer it is a good time to buy durables compared to individuals who expect constant or decreasing inflation.

Of course, large differences exist in households' purchasing propensities, which vary systematically by demographic characteristics (see, e.g., Attanasio and Weber (1993)). Household characteristics that determine both purchasing propensities and inflation expectations might be systematically related, and hence controlling for the observed heterogeneity across households is important to verify the associations we documented so far are not spurious. In column (2) of Table 4, we add a rich set of demographics including age, age^2, sex, marital status, log of income, employment status, number of kids, urban versus rural classification, college dummy, and a dummy that equals 1 if the respondent lives in Helsinki as covariates in the baseline specification. The baseline positive association between inflation expectations and readiness to purchase durable goods is unchanged.

Having established that the baseline positive association between inflation expectations and readiness to consume holds for the average individual in the full sample of men and women, we move on to consider the subset of male respondents for whom we observe cognitive abilities. This subsample amounts to about 17% of the overall sample. When we repeat the specification of column (2) within this restricted subsample, we find a positive marginal effect of inflation expectations on consumption propensities, which is not statistically significant.

This nonresult between inflation expectations and purchasing propensities might camouglage large cross-sectional differences. To understand whether cognitive abilities might be relevant to explaining if households' consumption propensities react to changes in inflation expectations, we split the whole sample into men with an IQ above 5 and other men. In columns (4) and (5) of Table 4, we repeat the analysis of column (3) separately for each of the two groups. Column (4) shows that in the subsample with high cognitive abilities, men are 3.6% more likely than over men with high IQ to say it is a good time to purchase durables when they expect inflation to increase. This result is consistent with

[12] All results are qualitatively and quantitatively similar without conditioning on past inflation.

the conjecture that high-IQ men understand intertemporal substitution as well as the consumption-Euler-equation logic, and hence their consumption plans react to inflation expectations. When we move on to consider men with lower IQs (column (5)), we do find a negative but statistically insignificant marginal effect of inflation expectations on consumption propensities. Note that a statistical-power issue can barely explain this lack of reaction of the consumption plans of low-IQ men to inflation expectations, because the size of the samples in column (4) and column (5) are almost identical.

Overall, the results in Table 4 suggest that men with high cognitive abilities, but not other men, adjust their consumption plans in response to inflation expectations in line with the consumption Euler equation.

C. Financial Constraints and Individual-level Shocks

Binding financial constraints are a compelling alternative interpretation of our results. If low-IQ men are systematically more likely to be financially constrained than high-IQ men, low-IQ men's consumption plans might 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. To proxy for the lack of financial constraints, we consider subsamples of respondents whose income is in the upper part of the income distribution. The rationale for this test is that financially-unconstrained respondents can substitute intertemporally if they realize doing so is convenient.

Table 5 reports the marginal effects of expecting higher inflation on the willingness to purchase durable goods for respondents whose income is above the median income of men with IQ data (columns (2) and (3)) and whose income is above the 25^{th} percentile (columns (4) and (5)). In both cases, we replicate the baseline positive association between inflation expectations and readiness to spend on durable goods for high-IQ men. To the contrary, the consumption plans of low-IQ men appear to be insensitive to changes in inflation expectations even for those men who are unlikely to be financially constrained.

A second relevant concern is that income expectations might explain our baseline

results, which could happen for several reasons. First, low-IQ men might have more negative expectations regarding *other* dimensions of their future personal outlook and/ or macroeconomic variables, which might mute their willingness to adjust future consumption plans in response to inflation expectations (Das, Kuhnen, and Nagel (2018)). For instance, low-IQ men who expect higher inflation might also be more likely than high-IQ men to expect a job loss over the following 12 months. In this case, a negative expected income shock might counteract the effect of higher inflation expectations on consumption plans. Second, high-IQ men might adjust their consumption plans according to their inflation expectations not because they have a Euler equation in mind, but because they also expect higher income following an individual Phillips-curve logic. Third, Kaplan et al. (2018) show in heterogeneous-agent models with uninsurable income shocks and assets of different liquidity that conventional monetary policy affects consumption decisions mainly through changes in income, because of indirect effects on labor demand.

To assess the relevance of these channels different from intertemporal substitution, we exploit the richness of our expectations data. The survey asks about individuals' expectations regarding any changes in their income over the following 12 months, which should capture any potential household-level or macro-level shocks that are likely to produce income effects at the household level.

Table 6 replicates our baseline analysis using individual income expectations. In columns (2)-(3) of Table 6, we focus only on respondents who expect their household income to increase over the following 12 months. Within this group, the consumption plans of high-IQ men react to inflation expectations, whereas the consumption plans of low-IQ men are insensitive to inflation expectations – if anything, the statistically insignificant association is negative. This result is direct evidence that even low-IQ men who do not expect any negative income shocks do not adjust their consumption plans in response to inflation expectations. In columns (4)-(5) of Table 6, we move on to consider only respondents who expect their household income to stay the same or decrease over the following 12 months. Again, we detect the same patterns as in the baseline analysis, whereby high-IQ men adjust their consumption plans in response to inflation expectations, whereas the consumption plans of low-IQ men are insensitive to inflation expectations.

The results for high-IQ men suggest the consumer Euler equation plausibly explains our baseline results, wheres income effects based on a Phillips-curve logic or indirect effects of monetary policy are an unlikely explanation.

IV Interest-Rate Transmission to Loans

We saw in the previous section men with low cognitive abilities do not adjust their consumption plans in line with the predictions of a consumption Euler equation, which suggests conventional and unconventional monetary- and fiscal-policy measures might be less effective than a representative-agent model might predict. We now study the propensity to take out loans over time in response to changes in nominal interest rates by cognitive abilities. Conventional monetary policy uses short-term interest rates in an attempt to stabilize investment and consumption through credit or bank-lending channels.

Our data allow us to perform this test. From the survey, we observe respondents' propensity to borrow through bank loans. Moreover, the time period our survey covers includes several instances of large changes in short-term nominal interest rates by the ECB, which has run the monetary policy of Finland since the country's entry into the Eurozone in 1999. Central banks often lower nominal interest rates during crises to stimulate consumption through loans. At the same time, central banks might increase nominal interest rates at times of sustained growth and inflationary pressure to avoid overheating, again through lower credit.

As we show in Panel A of Figure 1, our sample period includes variation in ECB policy rates in both directions.[13] On May 31, 2001, the ECB lowered its deposit facility rate from 3.75% to 3.50% (right y-axis) and continued lowering the rate until it reached a trough of 1.00% on June 30, 2003. Recessionary pressures in France and Germany mainly drove the cuts in nominal rates. In times of low interest rates, financing conditions become more favorable and individuals have an incentive to borrow more. In our setting, we can control directly for individual expectations regarding future income and employment status, which absorbs the effects of potentially concurrent recessionary pressures on Finnish households'

[13]The figure plots the beginning of quarter deposit facility rate. Other short-term policy rates such as the rate on the main refinancing operations move in parallel to the deposit facility rate.

willingness to borrow. Panel A of Figure 1 further documents that the ECB kept the deposit facility rate stable from June 30, 2003, until June 30, 2005, when the ECB started to tighten monetary policy and increased rates throughout 2006.

Before moving on to the multivariate analysis, we document the average propensity to borrow over time by high-IQ men and low-IQ men in response to changes in interest rates in the raw data. Individuals can answer that now is a "very good time to borrow" (4), a "pretty good time to borrow" (3), a "pretty bad time to borrow" (2), or a "really bad time to borrow" (1) to the question "If you think about the general economic situation in Finland, then do you think that at this time it is ..." Comparing Panels B and C of Figure 1, we see that the average propensity to take out loans is about 2.5 for both groups of men at the beginning of the period. During the period 2001-2003, while the ECB substantially decreases short-term rates, high-IQ men increase their propensity to borrow, with a peak at 3.1 exactly when the facility rate reaches its lowest point for the 6-year period we consider. During the same period, low-IQ men's propensity to borrow increases only slightly, peaking at 2.8 in January 2003. Overall, the increase in the propensity of high-IQ men to borrow (0.6) is 100% higher than the increase in the propensity of low-IQ men to take out loans (0.3).

Men with low cognitive abilities might not increase their propensity to borrow, because of financial constraints instead of a lack of forward-looking behavior. The increase in the deposit facility rate starting on June 30, 2005, allows us to rule out financial constraints, because financial constrains only matter when rates decrease and not when they increase. We see in Panel C of Figure 1 that high-IQ men reduce their propensity to borrow from 3.1 at the end of June 2005 to 2.6 in the third quarter of 2006. By contrast, low-IQ men do not change their propensity to borrow over the same period, despite the substantially higher nominal interest rates. These results point to a difference in the sensitivity of the propensity to borrow to changes in nominal interest rates across men with different levels of cognitive abilities, with high-IQ men reacting to changes in nominal interest rates and low-IQ men being insensitive to changes. Measures of monetary policy aimed at affecting the real economy through household borrowing might thus be less effective than representative-agent models predict, because a significant fraction of

individuals – those with lower cognitive abilities – might not react to changing incentives and might not understand intertemporal substitution.

To control for systematic heterogeneity across low-IQ and high-IQ men other than cognitive abilities, as well as to assess the statistical significance of the differences in the reaction to changing nominal interest rates, we perform the analysis in a multivariate setting. We report the marginal effects for estimating specifications of the following type

$$Loan_{i,t} = \alpha + \beta IQ_{i,t} \times Post_t + \gamma Post_t + \zeta IQ_{i,t} + X'_{i.t}\delta + \eta_t + \epsilon_{i,t}, \tag{2}$$

where $Loan_{i,t}$ is a dummy variable that equals 1 if respondent i in month t says it was a very good or pretty good time to take out a loan, and zero otherwise; $IQ_{i,t}$ is a dummy variable that equals 1 when the standardized IQ score of individual i is 6 or above; $Post_t$ is a dummy variable that equals 1 in the months after the ECB decreased or increased the facility rate, and zero in the months before the changes; and X is a vector of individual level controls including age, age^2, gender, marital status, log of income, employment status, kids, urban versus rural classification, and a dummy for Helsinki. We estimate this specification with a linear probability model (OLS) as well as using non-linear estimators.

Panel A of Table 7 reports the results for estimating equation (2) for the period of January 2001 to June 2003, during which the ECB cut the deposit facility rate. Whether we study the raw data across all estimation methods (columns (1)-(3)) or absorb demographic characteristics (columns (4)-(6)), we find that (i) on average, all respondents are more likely to think it is a good time to borrow after the cut in interest rates, but (ii) the propensity to borrow increases substantially more for high-IQ men than for low-IQ men. High-IQ men increase their propensity to take out loans by 100% and up to 150% more than low-IQ men, as can be seen by comparing the estimated coefficients $\hat{\beta}$ to the estimated coefficients $\hat{\gamma}$ across all specifications.

Panel B of Table 7 reports the results for estimating equation (2) for the period July 2003 to December 2006, during which the ECB increased the facility rate. Consistent with the conjecture that high-IQ men react more to changes in policy rates, the estimated coefficients $\hat{\beta}$ are negative and statistically different from zero; that is, high-IQ men are

substantially less likely than low-IQ men to claim it is a good time to take out a loan once nominal interest rates increase. Once we control for demographic heterogeneity, high-IQ men are about 3 times less likely to claim it is a good time to take out a loan compared to low-IQ men and compared to the period before the interest-rate increase.

The differential sensitivity in the propensity to take out loans to changes in nominal interest rates for men with high and low cognitive abilities both when interest rates decrease and when interest rates increase makes financial constraints an unlikely driver of these results. Alternatively, low-IQ men might be shut off from financial markets and do not care about changes in interest rates. But Panel B of Table 2 shows total debt to taxable income is almost constant across the IQ distribution. Note also that the survey question asks respondents whether it is a good time to take out a loan in general, and not whether it is a good time for their own households. Nevertheless, in the online appendix, we address these concerns directly by estimating equation (2) separately for men in the top fraction of the distribution by income, which includes households that are less likely to face financial constraints. The results of this robustness test, which we report in Table A.1 of the Online Appendix, corroborate the view that differences in the reaction to policy changes across levels of cognitive abilities might be driven by a different ability to understand economic incentives and intertemporal substitution between high-IQ men and low-IQ men.

Moreover, a differential pass-through of policy rates to individual borrowing rates for low- and high-IQ men might explain our findings. For example, banks might systematically change interest rates more slowly for men with low cognitive abilities than for men with high cognitive abilities in response to changes in policy rates. This differential pass-through is an unlikely explanation because 95% of all mortages in Finland are adjustable-rate mortgages with a spread on the 12-month EURIBOR, and mortgages represented 74% of all consumer debt at the end of 2014.

Finally, so far we have studied exclusively the association between inflation expectations, interest rates, and survey decisions. Even though low IQ men might not adjust their propensities to take out loans to changes in interest rates, it could still be the case high and low IQ men might adjust their actual decisions in similar ways for

several reasons: (i) they might learn from family, neighbours, co-workers, or friends; (ii) supply-side forces might tell low-IQ men to adjust their decisions; for example, mortgage bankers might call these men and tell them now is a good time to take out loans given rates are low; (iii) they might be aware of their inability to optimize and rely on advice in general. To test whether we observe differences in the behavior between low- and high-IQ men also in actual choices, we use registry data from Statistics Finland. We observe for each individual at an annual frequency the amount of total debt outstanding for tax purposes. We then calculate the annual change in total debt and regress it on the change in the deposit facility rate estimating the following specification

$$\Delta debt_{i,t} = \alpha + \beta IQ_{i,t} \times \Delta rates_t + \zeta IQ_{i,t} + X'_{i.t}\delta + \eta_t + \epsilon_{i,t},$$

where $\Delta debt_{i,t}$ is the annual change in total debt of respondent i; $\Delta rates_t$ is the annual change in the ECB deposit facility rate; $IQ_{i,t}$ is a dummy variable that equals 1 when the standardized IQ score of individual i is 6 or above; and X is a vector of individual level controls including age, age^2, gender, marital status, log of income, employment status, kids, urban versus rural classification, and a dummy for Helsinki. IQ dummy equals one if normalized IQ is larger than 5. The sample period is 2001 to 2011.

Table 8 reports the results. Columns (1) and (2) reports the results for the sample from 2001 until 2011 when the change in the deposit facility rate reached 0. We see the estimate for the interaction term is negative and marginally statitically significant when we average out demographic controls. An increase in the deposit facility rate of 1% reduces the amount of total debt by 57 Euros more for men with IQ above 5 which is about 3% of the average change during our sample.

Of course, the recent Great Recession and European Sovereign Debt Crisis are major macroeconomic events during this sample period and might affect the changes in debt. Columns (3) and (4) report results for a sample ending in 2007. Again, we see high-IQ men reduce their total debt more than low-IQ men. The estimate in column (4) when we partial out demographics equals around 4% of the average change in our sample.

The results in Table 8 are reassuring. Even in settings in which we only observe

annual data, crude measures, and decisions subject to possibly countervailing forces, we still see differences in the actual behavior between high- and low-IQ men.

V Channels

In the previous sections, we provided arguments for why channels such as households' financial constraints or expectations about future economic conditions are unlikely to explain our findings. In this section, we further investigate a set of channels that could help explain why low-IQ men might be less responsive than high-IQ men to policy changes.

First, low-IQ men might be less informed than high-IQ men about economic fundamentals including the current state, potentially because gathering information about macroeconomic variables is more cognitively costly to them (*costly information-gathering* channel). In this case, because low-IQ men would have heavily miscalibrated perceptions about current inflation, they would also have miscalibrated beliefs about future macroeconomic variables and would be unlikely to adjust their consumption plans in response to changing economic conditions in line with the aims of policy interventions.

To assess this channel directly, we exploit a unique feature of our survey – the fact that the survey asks households directly about their perception of current inflation on top of their expectations about future inflation. Based on this question, we compute an inflation-perception error at the individual level as the difference between the numerical response for perceived inflation and the actual current rate of inflation. Consistent with the costly information-gathering channel, D'Acunto et al. (2018) show low-IQ men have higher perception errors for contemporaneous inflation than high-IQ men, but also show variation in income levels or education levels across men with different levels of IQ do not drive the baseline pattern.

To dig deeper into the costly information-gathering channel, we focus on a sample of men with perception errors below the median within each month. These men represent individuals who are likely to be informed about the prevailing inflation rate at the time of the interview, and due to the large sample size, they are unlikely to be individuals who merely guessed the prevailing inflation rates while providing values at random.

In column (1) of Table 9, we find that high-IQ men within the group of men with low perception errors for contemporaneous inflation display a large positive and 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 4. In column (2) of Table 9, instead, we fail to detect any significant association between inflation expectations and consumption propensities for low-IQ men with low perception errors for contemporaneous inflation. This non-result suggests that even low-IQ men who are likely to be informed about macroeconomic variables do not display a behavior consistent with the Euler equation. These results might have important normative implications; that is, a mere policy of educating consumers about the level of current inflation might not be sufficient to increase the effectiveness of policy interventions.

The second channel we consider to explain why low-IQ men display no reaction to changing economic incentives is that they might be unable to think in probabilistic terms and about future states of the world. In this case, they might form miscalibrated expectations and have forecast errors that are too large. To assess the relevance of this channel, we focus on a subsample of men with forecast errors below the median forecast errors for inflation. We define forecast error as the difference between the expected numerical inflation rate over the next 12 months of individual i in months t and the ex-post realized inflation in 12 months. Intuitively, these men should be more able than others to think probabilistically and to come up with plausible assessments of plausible future macroeconomic conditions.

Columns (3) and (4) of Table 9 show only high-IQ men increase their spending propensities when their inflation expectations increase. Low-IQ men are still unresponsive, even if their expectations about future inflation are close to the ex-post realization. These results also have normative implications. Educating the population only about expected inflation rates in the future – for example, by stating the central bank follows a specific inflation target – is likely insufficient to obtain a reaction to policy interventions by the whole population, because low-IQ consumers are still unlikely to react.

D'Acunto et al. (2018) find low-IQ men have on average larger perception errors for current inflation and forecast errors for future inflation, but here we find no correlation

between inflation expectations and consumption propensities even among samples of low-IQ men with accurate perceptions and expectations of inflation. Low-IQ men thus might not understand basic economic concepts such as intertemporal optimization, which might also explain the excess sensitivity of consumption to predictable income changes (see, e.g., Parker et al. (2013)). This latter channel, which we label the *lack-of-economic-reasoning* channel, is in line with Ilut and Valchev (2017), who model agents with limited cognitive knowledge of the optimal action conditional on the economic state.

A last point to consider is the fact that many economists discard data on household inflation expectations because such data are noisy and sometimes extreme observations occur, which economists take as a sign that those data are unreliable. We agree with the notion that household-level inflation expectations are quite noisy, but disagree with the prescription that because of this noise, economists and policymakers should discard data on household expectations when conducting academic research or designing policies. The very fact that many policies rely on households reacting to higher inflation expectations by increasing their consumption propensities makes understanding which households have plausible inflation expectations and which households understand the theoretical link between inflation expectations and consumption propensities crucial for the effectiveness of economic policies.

The results in this paper show that many households might ignore fundamental assumptions of macroeconomic models and policymaking. Thus, policymakers should design policies in a way that is salient and easy to understand for the whole population if they want to promote policy effectiveness. Moreover, only by designing salient policies that guarantee everybody reacts as expected can policymakers avoid unintended consequences of policies, such as the unintended redistribution of financial resources from low-IQ men to high-IQ men due to the fact the former group does not react. An example of such a salient type of policy is unconventional fiscal policies, such as the pre-announcement of future value-added tax increases (e.g., see D'Acunto, Hoang, and Weber (2018a)).

VI Conclusion

We document a *human friction* to the transmission of economic policies – households' limited cognitive abilities. In a representative sample of Finnish men, we find that only men with high cognitive abilities change consumption plans in line with the consumption Euler equation. High-IQ men are also twice as responsive as low-IQ men in their propensity to borrow to interest rate changes and their total debt balances from tax data are also more sensitive to changes in interest rates. Short-term interest rates are the conventional monetary-policy tool of central banks, and consumer credit is a central propagation mechanism of interest rates to the real economy. Our findings suggest that cognitive abilities are indeed a *human friction* that can limit central banks' ability to stabilize demand both in recessions and expansions. This human friction might inform future theoretical and empirical advances in the recent literature on heterogeneous agents in economics and finance.

The consumption Euler equation is at the core of all dynamic models in macroeconomics and finance. In representative-agent New Keynesian models, conventional and unconventional fiscal, as well as monetary policy, typically operates through changes in inflation expectations on households' consumption decisions. The results in this paper show many households might ignore these fundamental assumptions of macroeconomic models and policymaking. Thus, policymakers should design policies in a way that is salient and easy to understand for the whole population. An example of such a salient type of policy is unconventional fiscal policy, such as the pre-announcement of future value-added tax increases (e.g., see D'Acunto, Hoang, and Weber (2018a)). Our results also provide empirical support for recent theoretical advances that deviate from the rational-expectations paradigm, such as Farhi and Werning (2017), Gabaix (2018), Woodford (2018), Garcia-Schmidt and Woodford (2015), and Iovino and Sergeyev (2018).

Our findings also show that the common practice of focusing on financial markets in monetary-policy communication might not be enough. Even if central banks are successful in changing long-term rates by guiding financial markets regarding the future path of short-term interest rates, if a substantial fraction of the population does not react to

these changes in rates, the policy might be ineffective. Future research should also study which type of communication tools policymakers can use to reach the overall population instead of only a small fraction of it. Coibion, Gorodnichenko, and Weber (2018) show solely relying on newpspapers and the media might not be sufficient in this respect and that policymakers have to consider novel strategies to communicate with the public.

More broadly, combining economic policies with limited cognitive abilities is likely to result in large redistributive effects from low-IQ individuals to high-IQ individuals, because only high-IQ individuals adjust their behavior in response to changing economic fundamentals. This redistribution could be interpreted as a form of undue discrimination of low-IQ individuals on the part of policymakers to the extent that cognitive abilities are an innate individual characteristic or are largely determined by early-life environmental factors individuals can barely control. Future empirical and theoretical research should delve into the unintended redistributive effects of economic policies based on individuals' cognitive abilities.

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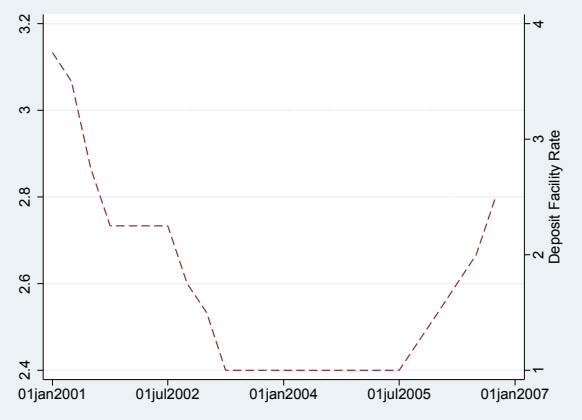
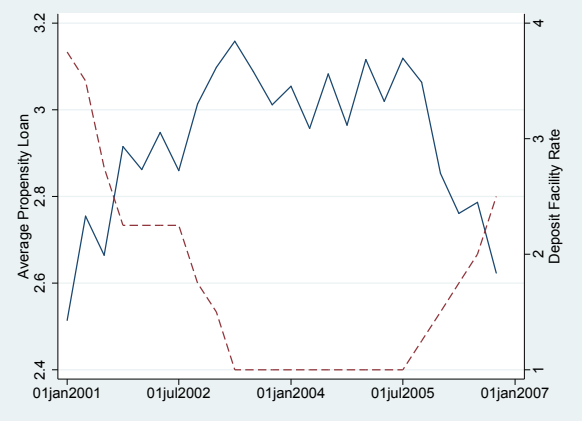
Figure 1: **ECB Deposit Facility Rate and Propensity to Borrow by IQ**

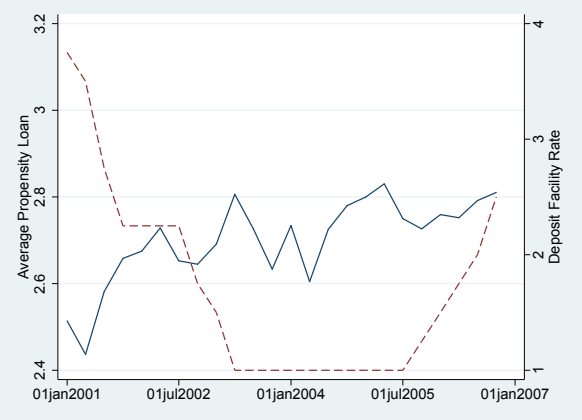
Panel A. ECB deposit facility rate (2001-2007)



Panel B. Borrowing: High-IQ Men



Panel C. Borrowing: Low-IQ



Panel A of this figure plots the beginning of quarter European Central Bank Deposit Facility Rate from quarter 1 2001 to quarter 4 of 2006. Panel B and Panel C of this figure plot the cross-sectional mean of whether individuals think it's a good time to take out a loan in Finland by IQ levels. Individuals can answer that now is a "very good time to borrow" (4), a "pretty good time to borrow" (3), a "pretty bad time to borrow" (2), or a "really bad time to borrow" (1) to the question "If you think about the general economic situation in Finland, then do you think that at this time it is ..." High-IQ men are all men with the highest 3 scores of the 9-point distribution. Low-IQ men are all men with the lowest 3 scores of the 9-point distribution. We use the confidential micro data underlying the official European Commission consumer confidence survey to measure the propensity to take out a loan. 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. The sample period is January 2001 to December 2006.

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 measure inflation expectations. 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. Income comes from the registry of Statistics Finland. The sample period for the monthly survey data is January 2001 to March 2015.

Statistics Statistics	Inflation Perception	Inflation Expectation	Forecast Error	Perception Error	Abs Forecast Error	Abs Perception Error	Expectation - Perception	IQ	IQ_{visio}	IQ_{verbal}	IQ_{arith}	Income	Age
Nobs	286,053	287,340	287,340	286,053	287,340	286,053	269,464	47,069	46,606	46,606	46,606	344,210	346,283
Mean	3.09	2.74	1.19	1.55	2.68	2.94	-0.45	5.37	5.41	5.12	5.32	17,454	43.92
Std	5.61	4.85	4.99	5.55	4.38	4.96	4.81	1.89	1.91	1.88	1.96	12,812	16.80
p1	-5.00	-4.00	-5.20	-5.74	0.04	0.04	-15.00	1	1	1	1	0	15
p10	0.00	0.00	-2.41	-2.06	0.32	0.31	-4.00	3	3	3	3	4,000	20
p25	0.00	0.00	-1.10	-1.06	0.79	0.81	-1.00	4	4	4	4	9,500	30
p50	2.00	2.00	0.37	0.50	1.59	1.61	0.00	5	5	5	5	15,500	44
p75	5.00	4.00	2.32	2.64	3.12	3.23	0.00	7	7	6	7	22,800	57
p90	8.00	5.50	5.04	6.09	5.31	6.53	2.00	8	8	8	8	31,300	66
p99	22.00	20.00	18.71	20.69	18.94	21.46	10.00	9	9	9	9	67,000	77
Gender	male	170,256		College		no	112,593		Durables		Bad time	55,905	
	female	176,125				yes	89,398				Good time	119,009	
Single	no	222,687		Urban		no	240,885				Neither	72,306	
	yes	123,596				yes	105,052						
Unemployed	no	322,043		Helsinki		no	258,538						
	yes	24,240				yes	87,366						
Kids	no	108,658											
	yes	237,723											

Table 2: **IQ, Income, and Total Debt**

This table reports the distribution of IQ in Panel A, the household leverage ratio in Panel B, and the share of income in total income in Panel C. 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. Income and debt data come from the registry of Statistics Finland. The sample period is January 2001 to March 2015.

	Low IQ	2	3	4	5	6	7	8	High IQ
					Panel A. Distribution of Normalized IQ				
Nobs	1,785	3,921	4,701	10,907	13,797	11,162	7,849	4,043	3,298
					Panel B. Total Debt / Taxable Income by IQ				
	0.82	0.77	0.76	0.75	0.78	0.80	0.81	0.87	0.93
					Panel C. Income Share by IQ				
	1.86%	4.52%	6.28%	15.38%	21.16%	17.79%	16.11%	8.83%	8.07%

Table 3: **Correlation between IQ and Income**

This table reports the correlation between income and overall IQ and the different subcomponents. IQ is the standardized test score from the military entrance exam test for all men in Finland. IQ_{logic}, IQ_{verbal}, IQ_{arith} are subscores for the logical, verbal, and arithmetic parts of the test. IQ and the subcategories obtain integer values between 1 and 9 with 9 being the highest score. Income data come from the registry of Statistics Finland. The sample period is January 2001 to March 2015.

	IQ	IQ_{logic}	IQ_{verbal}	IQ_{arith}
IQ	1			
IQ_{ogic}	0.83	1		
IQ_{verbal}	0.85	0.56	1	
IQ_{arith}	0.88	0.62	0.66	1
Income	0.15	0.10	0.11	0.15

Table 4: **Inflation Expectations and Readiness to Spend: Baseline**

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^2, sex, marital status, log of income, employment status, number of kids, 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 January 2001 to March 2015.

			Men with IQ data	Men high IQ	Men low IQ
	(1)	(2)	(3)	(4)	(5)
Inflation expectation	0.0214***	0.0172***	0.0147	0.0358***	−0.0096
	(0.0047)	(0.0055)	(0.0100)	(0.0119)	(0.0138)
Demographics		X	X	X	X
Pseudo R^2	0.0067	0.0132	0.0107	0.0108	0.0091
Nobs	310,852	187,084	32,862	16,606	16,256

Standard errors in parentheses

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

Table 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^2, sex, marital status, log of income, employment status, number of kids, 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 25th percentile of income in the cross section. The sample period is January 2001 to March 2015.

		Income $>$ 50th percentile$_t$		**Income $>$ 25th percentile$_t$**	
	Men with IQ data	Men high IQ	Men low IQ	Men high IQ	Men low IQ
	(1)	(2)	(3)	(4)	(5)
Inflation expectation	0.0147	0.0306**	0.0022	0.0343***	−0.011
	(0.0100)	(0.0154)	(0.0195)	(0.0130)	(0.0130)
Demographics	X	X	X	X	X
Pseudo R^2	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 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^2, sex, marital status, log of income, employment status, number of kids, 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	0.0294$*$	-0.0166	0.0371$**$	-0.0046
	(0.0100)	(0.0165)	(0.0190)	(0.0158)	(0.0176)
Demographics	X	X	X	X	X
Pseudo R^2	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
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 7: **Change in the Propensity to Borrow around Interest Rate Changes**

This table reports the coefficient estimates from the following specification:

$$Loan_{i,t} = \alpha + \beta IQDummy_i \times Post_t + \gamma Post_t + \zeta IQDummy_i + X'_{i.t}\delta + \epsilon_{i,t},$$

where $Loan_{i,t}$ is a dummy variable that equals 1 if the respond answers it is a good time to take out a loan, and zero otherwise; and $Post_t$ is a dummy variable that equals 1 in the months in which the ECB changes the deposit facility rate, and zero in the months before the change. We estimate this specification with a linear probability model (OLS) as well as using non-linear estimators. We use the confidential micro data underlying the official European Commission consumer confidence survey to construct these variables. We measure normalized IQ using data from the official military entrance exam in Finland. 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. IQ dummy equals one if normalized IQ is larger than 5. Demographic controls are age, age^2, sex, marital status, log of income, employment status, number of kids, urban versus rural classification, college dummy, and a dummy that equals 1 if the respondent lives in Helsinki. The sample period is January 2001 to December 2006.

	OLS (1)	Probit (2)	Logit (3)	OLS (4)	Probit (5)	Logit (6)
	Panel A. Rate Cut: Jan 2001 – June 2003					
IQ Dummy	−0.0278	−0.0241	−0.0248	−0.0482	−0.0445	−0.0448
	(0.0293)	(0.0274)	(0.0282)	(0.0325)	(0.0295)	(0.0308)
Post	0.0618***	0.0590***	0.0597***	0.0648***	0.0597**	0.0619**
	(0.0218)	(0.0222)	(0.0225)	(0.0251)	(0.0258)	(0.0263)
Post × IQ Dummy	0.0945***	0.0913***	0.0919***	0.0884**	0.0875***	0.0883***
	(0.0319)	(0.0287)	(0.0297)	(0.0352)	(0.0313)	(0.0326)
Demographics				X	X	X
R^2	0.0121	0.0101	0.0101	0.0509	0.0463	0.0464
Nobs	5,850	5,850	5,850	4,070	4,070	4,070
	Panel B. Rate Increase: July 2003 – December 2006					
IQ Dummy	0.0789***	0.0811***	0.0806***	0.0358***	0.0411***	0.0407***
	(0.0108)	(0.0109)	(0.0108)	(0.0124)	(0.0127)	(0.0128)
Post	0.005	0.00464	0.00471	−0.0328**	−0.0308**	−0.0337**
	(0.0136)	(0.0130)	(0.0132)	(0.0155)	(0.0154)	(0.0157)
Post × IQ Dummy	−0.0753***	−0.0855***	−0.0833***	−0.0823***	−0.0939***	−0.0948***
	(0.0202)	(0.0233)	(0.0226)	(0.0218)	(0.0262)	(0.0256)
Demographics				X	X	X
R^2	0.007	0.0067	0.0067	0.0442	0.0465	0.0475
Nobs	8,601	8,601	8,601	5,937	5,937	5,937

Standard errors in parentheses

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

Table 8: **Change in Total Outstanding Debt to Interest Rate Changes**

This table reports the coefficient estimates from the following specification:

$$\Delta debt_{i,t} = \alpha + \beta IQDummy_{i,t} \times \Delta rates_t + \zeta IQDummy_{i,t} + X'_{i.t}\delta + \eta_t + \epsilon_{i,t},$$

where $\Delta debt_{i,t}$ is the annual change in total debt of respondent i; $\Delta rates_t$ is the annual change in the ECB deposit facility rate; and X is a vector of individual level controls including age, age^2, sex, marital status, log of income, employment status, number of kids, urban versus rural classification, college dummy, and a dummy that equals 1 if the respondent lives in Helsinki. We use registry data from Statistics Finland to construct these variables. We measure normalized IQ using data from the official military entrance exam in Finland. 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. IQ dummy equals one if normalized IQ is larger than 5. The sample period is 2001 to 2011.

	2001-2011		2001-2007	
	(1)	(2)	(3)	(4)
IQ Dummy × Δ rates	−51.41	−56.84∗	−121.73 ∗ ∗∗	−89.10 ∗ ∗
	(33.23)	(33.29)	(41.58)	(41.80)
IQ Dummy	13.78	78.40	45.74	59.21
	(29.90)	(31.32)	(33.10)	(35.83)
Demographics		X		X
Year FE	X	X	X	X
R^2	0.002	0.008	0.002	0.009
Nobs	271,787	267,988	154,175	152,100

Standard errors in parentheses
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 9: **Inflation Expectations and Readiness to Spend: by Perception and Forecast error**

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 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^2, sex, marital status, log of income, employment status, number of kids, 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 (1) and (2) condition on having an absolute perception error of current inflation below the median perception error, and columns (3) and (4) condition on having an absolute forecast error of future inflation below the median forecast error. The sample period is January 2001 to March 2015 for a total of 21 years.

	Abs Perception Error <= Median$_t$		**Abs Forecast Error <= Median$_t$**	
	Men high IQ	Men low IQ	Men high IQ	Men low IQ
	(1)	(2)	(3)	(4)
Inflation expectation	0.0472***	0.0209	0.0401**	0.0069
	(0.0153)	(0.0165)	(0.0184)	(0.0243)
Demographics	X	X	X	X
Pseudo R^2	0.0104	0.0061	0.0101	0.0083
Nobs	10,115	8,984	9,699	8,694

Standard errors in parentheses

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

Online Appendix: Human Frictions to the Transmission of Economic Policy

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

Not for Publication

I Survey Questions

Below we report the original survey questions we use in the analysis with answer choices in Finnish.

Question 4 *Millä tasolla arvioitte kuluttajahintojen olevan Suomessa tällä hetkellä verrattuna hintoihin 12 kuukautta sitten. Ovatko ne mielestänne:*

- 1 paljon korkeammat
- 2 melko paljon korkeammat
- 3 hieman korkeammat
- 4 samalla tasolla
- 5 alemmat?
- 6 eos

Question 6 *Miten arvioitte kuluttajahintojen muuttuvan Suomessa seuraavien 12 kuukauden aikana. Arveletteko, että hinnat:*

- 1 nousevat nopeammin kuin tällä hetkellä
- 2 nousevat samaa vauhtia kuin tällä hetkellä
- 3 nousevat hitaammin kuin tällä hetkellä
- 4 pysyvät nykyisellä tasolla
- 5 laskevat nykyisestä tasosta?
- 6 eos

Question 10 *Jos ajattelette ensin yleistä taloudellista tilannetta Suomessa, niin onko mielestänne nyt edullinen aika ostaa kestokulutustavaroita, kuten huonekaluja, kodintekniikkaa, auto tms.?*

- 1 on edullinen aika
- 2 ei ole edullinen aika
- 3 ei kumpikaan
- 4 eos

Question 22 *Jos ajattelette taas yleistä taloudellista tilannetta Suomessa, niin onko tällä hetkellä mielestänne:*

- 1 erittäin hyvä aika ottaa lainaa
- 2 melko hyvä aika ottaa lainaa
- 3 melko huono aika ottaa lainaa
- 4 vai erittäin huono aika ottaa lainaa?
- 5 eos

Table A.1: **Change in the Propensity to Take out Loan to Rate changes: unconstrained**

This table reports the coefficient estimates from the following specification:

$$Loan_{i,t} = \alpha + \beta IQDummy_i \times Post_t + \gamma Post_t + \zeta IQDummy_i + X'_{i.t}\delta + \epsilon_{i,t},$$

where $Loan_{i,t}$ is a dummy variable that equals 1 if the respond answers it is a good time to take out a loan, and zero otherwise; and $Post_t$ is a dummy variable that equals 1 in the months in which the ECB changes the deposit facility rate, and zero in the months before the change. We estimate this specification with a linear probability model (OLS) as well as using non-linear estimators. We use the confidential micro data underlying the official European Commission consumer confidence survey to construct these variables. We measure normalized IQ using data from the official military entrance exam in Finland. 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. IQ dummy equals one if normalized IQ is larger than 5. Demographic controls are age, age^2, sex, marital status, log of income, employment status, number of kids, urban versus rural classification, college dummy, and a dummy that equals 1 if the respondent lives in Helsinki. The sample period is January 2001 to December 2006.

	OLS (1)	Probit (2)	Logit (3)	OLS (4)	Probit (5)	Logit (6)
	Panel A. Rate Cut: Jan 2001 – June 2003					
IQ Dummy	0.0005	0.0004	0.0004	−0.0361	−0.0339	−0.0342
	(0.0319)	(0.0284)	(0.0299)	(0.0335)	(0.0299)	(0.0315)
Post	0.1002***	0.0936***	0.0951***	0.0753***	0.0685***	0.0708***
	(0.0238)	(0.0250)	(0.0253)	(0.0257)	(0.0265)	(0.0271)
Post × IQ Dummy	0.0663*	0.0693**	0.0688**	0.0789**	0.0805**	0.0808**
	(0.0348)	(0.0305)	(0.0319)	(0.0361)	(0.0317)	(0.0333)
Demographics				X	X	X
R^2	0.0179	0.0158	0.0158	0.0468	0.0439	0.0437
Nobs	4,422	4,422	4,422	3,804	3,804	3,804
	Panel B. Rate Increase: July 2003 – December 2006					
IQ Dummy	0.0676***	0.0731***	0.0720***	0.0363***	0.0427***	0.0415***
	(0.0116)	(0.0119)	(0.0117)	(0.0125)	(0.0129)	(0.0129)
Post	−0.0269*	−0.0247*	−0.0252*	−0.0396**	−0.0369**	−0.0398**
	(0.0147)	(0.0144)	(0.0147)	(0.0157)	(0.0156)	(0.0160)
Post × IQ Dummy	−0.0847***	−0.0997***	−0.0963***	−0.0858***	−0.0987***	−0.0986***
	(0.0216)	(0.0259)	(0.0250)	(0.0221)	(0.0268)	(0.0261)
Demographics				X	X	X
R^2	0.011	0.0115	0.0115	0.0433	0.0451	0.0459
Nobs	6,548	6,548	6,548	5,650	5,650	5,650

Statistics in parentheses

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