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# Subjective Intertemporal Substitution

Richard K. Crump
Stefano Eusepi
Andrea Tambalotti
Giorgio Topa

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## Abstract

We estimate the elasticity of intertemporal substitution (EIS)—the response of *expected* consumption growth to changes in the real interest rate—using subjective expectations data from the New York Fed's Survey of Consumer Expectations (SCE). This unique data set allows us to estimate the consumption Euler equation with no auxiliary assumptions about the properties of expectations, which are instead necessary when using choice data. We find a subjective EIS of about 0.5, consistent with the results of much of the literature based on microeconomic data and supportive of typical macroeconomic calibrations. We also uncover strong evidence of excess sensitivity of planned consumption growth to expected income changes, even among households that are unlikely to be liquidity constrained.

Key words: subjective expectations, inflation expectations, Euler equation, elasticity of intertemporal substitution

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Crump, Tambalotti, Topa: Federal Reserve Bank of New York (emails: richard.crump@ny.frb.org, andrea.tambalotti@ny.frb.org, giorgio.topa@ny.frb.org). Eusepi: University of Texas at Austin (email: stefano.eusepi@austin.utexas.edu). The authors would like to thank Manuel Arellano, Adrien Auclert, Mark Bils, Stéphane Bonhomme, Chris Carroll, Keshav Dogra, Andrea Ferrero, Andreas Fuster, Giacomo De Giorgi, Simon Gilchrist, Sydney Ludvigson, Alexander Michaelides, Giuseppe Moscarini, Jonathan Parker, Benjamin Pugsley, Ricardo Perez-Truglia, Giorgio Primiceri, Ricardo Reis, Gianluca Violante, and our discussants Dario Caldara and Eric Sims, as well as seminar and conference participants, for helpful comments and suggestions. Zachary Bleemer, Matthew Yeaton, Nima Dahir, and Jiwon Lee provided excellent research assistance. 

# 1 Introduction

Intertemporal substitution, the response of planned consumption growth to changes in the expected rate of return, is at the heart of virtually every modern dynamic model in both macroeconomics and finance. Starting from the pioneering work of Hall (1978, 1988) and Hansen and Singleton (1982, 1983), a large literature has endeavored to quantify this mechanism. However, a clear consensus on the magnitude of the key parameter that governs it—the elasticity of intertemporal substitution (EIS)—remains elusive. For example, a recent meta study by Havranek (2015) based on 2,735 estimates from 169 published papers reports a distribution of estimates that ranges from -5 to 5, with clusters near both 0 and 1. The EIS is difficult to pin down in part because measuring *expected* consumption growth and rates of return, as envisioned in the theory, is challenging. Much of the empirical literature proceeds by substituting expectations with realizations and making auxiliary assumptions on the resulting forecast errors in the context of generalized method of moments (GMM) estimation of the consumption Euler equation.

In this paper, we bypass this challenge entirely by estimating the Euler equation with direct measures of households' *subjective* expectations of both consumption growth and inflation. The latter provide variation in the perceived real interest rate. This approach has two main advantages. First, it does not rely on auxiliary assumptions on the process that generates the expectations. Not having to take a stand on expectation formation is especially valuable because a growing body of evidence has documented many deviations from the simple rational benchmark, but it has not yet resulted in a widely accepted alternative modeling paradigm.[1] On the flip side, the expectations data must of course provide an accurate read on agents' perceptions to be helpful.[2] Second, taking expectations as observable, we can estimate the EIS with ordinary least squares (OLS) rather than GMM, thus avoiding a host of econometric issues related to the choice, validity, and strength of the instruments.

This straightforward yet original empirical strategy is made possible by the unique data collected in the Federal Reserve Bank of New York's Survey of Consumer Expectations (SCE). Unlike other available sources of information on expectations, this nationally representative monthly survey asks a rotating panel of approximately 1,300 U.S. household heads a series of quantitative questions on spending plans and future inflation, as well as on many other macroeconomic developments and household choices and experiences. Some of these

[1] See further below for references and a discussion of this work.

[2] Manski (2004) discusses in depth the value of data on expectations in modeling behavior. He questions the common view among academic economists that "one should believe only what people do, not what they say" and "the broad but unsubstantiated conclusion that all data on expectations are suspect." As we discuss in Section 3, expectations collected in the SCE are informative in the sense that they co-move meaningfully with observed behavior.

questions elicit subjective probabilities of future outcomes, while others focus on point expectations. From the answers, we can derive clean measures of the moments of the subjective distributions of spending growth and inflation at horizons that are suitable for estimating consumption Euler equations at the household level with little or no manipulation of the raw data.[3]

The starting point for our empirical analysis is a first order approximation of the most basic consumption Euler equation, which relates expected consumption growth to the real interest rate and excludes all other variables. Thanks to the wealth of household level data collected by the SCE, though, we can also explore much more general specifications. These extensions of the basic model cover most of the alternatives that have been examined in the literature based on choice data. We take advantage of the probabilistic nature of some of the SCE questions to address misspecification concerns that are hard to avoid with existing data. More specifically, we allow for non separability between consumption and leisure, non isoelastic preferences, life-cycle effects proxied by demographic variables, and the presence of financial constraints. Moreover, some of the regressions include the second moments of the reported probability distributions of the relevant variables to account for possible failures of the first order approximation of the Euler equation. Controlling for these higher moments is especially useful when trying to distinguish among alternative sources of excess sensitivity of planned consumption to expected income growth (e.g., Carroll 2001).

The estimated EIS in the basic specification is between 0.7 and 0.8, at the upper end of the range of the microeconomic estimates based on choice data, as surveyed for instance in Attanasio (1999) and Attanasio and Weber (2010). This estimate is robust to the inclusion of a large set of controls in the regression, which account for many possible extensions of the simplest Euler equation. When we include expected income growth among these controls, however, we uncover statistically strong and consistent evidence of a response of planned consumption to predictable income changes. This excess sensitivity survives even after controlling for many of the potential confounding factors that have been considered in the literature, such as preference non separabilities and liquidity constraints. To account for the latter, we split the sample to focus on households that are unlikely to be financially constrained. We do so based on a range of criteria, some of which depend on the answers to questions that are unique to the SCE and that address the respondents' financial health directly. Even among these households, the evidence in favor of excess sensitivity is statistically significant, and only marginally less strong than for those who are more likely to be

[3] As a comparison, the Michigan Survey of Consumers provides quantitative information on inflation expectations, but only qualitative measures of households' readiness to spend on durable goods. These measures can proxy for current consumption, but they cannot be used to infer planned future consumption growth, as discussed for instance by Bachmann, Berg, and Sims (2015).

constrained.

Once we control for the presence of excess sensitivity, the estimates of the EIS fall to around 0.5. This value is toward the lower end of the range of micro estimates reported in the literature, but a bit above the corrected mean reported in the meta study by Havranek (2015). In the sample of papers that he considers, the mean of the estimates for asset holders is around 0.3-0.4, once corrected for the selective reporting bias associated with discarding negative and insignificant estimates too often. A value of 0.5 is also consistent with standard calibrations in macroeconomic studies (e.g., Hall 2009, 2016) but represents statistical evidence against logarithmic utility in consumption.

This paper is most directly related to the vast empirical literature that estimates the EIS. Much of this work exploits the moment restrictions embedded in the consumption Euler equation within a GMM framework to estimate preference parameters and to test the theory using either aggregate or, more often, microeconomic data. Attanasio (1999) and Attanasio and Weber (2010) are two recent surveys that put this literature in the broader context of research on consumption. Browning and Lusardi (1996) is an earlier survey focusing on the first wave of this research based on micro data, including seminal contributions by Hall and Mishkin (1982) and Zeldes (1989) using the Panel Study of Income Dynamics (PSID), Meghir and Weber (1996) and Attanasio and Weber (1995) using the Consumer Expenditure Survey (CEX), and Attanasio and Weber (1993) using the Family Expenditure Survey (FES) in the UK. Many other empirical approaches and data sources have also been employed to estimate the EIS. For example, Barsky, Juster, Kimball, and Shapiro (1997) use survey responses to questions about specific hypothetical situations; Gruber (2013) exploits individual variation in capital income tax rates; Engelhardt and Kumar (2009) is based on differences in employer matching rates in 401(k) plans; and Cashin and Unayama (2012) look at an increase in the consumption tax rate in Japan. Alan and Browning (2010) use synthetic residual estimation as an alternative to GMM.

There are a few papers that use survey data in the context of estimating Euler equations. Jappelli and Pistaferri (2000) estimate a standard Euler equation on realized consumption with data from the panel section of the Bank of Italy Survey of Household Income and Wealth with a focus on testing for excess sensitivity of consumption. Christelis, Georgarakos, Jappelli, and van Rooij (2016) estimate the strength of the precautionary saving motive using survey data from the Dutch CentER Internet panel.

Our reliance on expectations data also puts us in contact with the growing literature that studies the properties of the expectations of households, firms, and other agents to refine and test economic theories. A prominent strand of the literature including Mankiw, Reis, and Wolfers (2003), Coibion and Gorodnichenko (2012), Andrade and Le Bihan (2013), Coibion, Gorodnichenko, and Kumar (2018), Coibion and Gorodnichenko (2015), Fuhrer (2015), Malmendier and Nagel (2016), Andrade, Crump, Eusepi, and Moench (2016), and Wiederholt and Vellekoop (2017) focuses on the inflation expectations of households, firms, and professional forecasters. Beyond inflation, there are many papers studying a wide variety of economic and financial variables. For a few examples, Souleles (2004) looks at consumption and sentiment in the Michigan Survey. Greenwood and Shleifer (2014) study investor expectations of stock returns. Gennaioli, Ma, and Shleifer (2015) investigate the relationship between investment and expectations of earnings growth in a survey of CFOs. A common finding among many of these papers is that expectations do not appear to conform to the simple full-information, rational benchmark. This evidence supports our empirical approach which relies on observed expectations rather than on an explicit model of how they are formed.

At the intersection of these two literatures, several recent papers study the connection between consumption and inflation expectations with survey data. Burke and Ozdagli (2013) use responses to a series of survey modules appended to RAND's American Life Panel to estimate the relationship between current realized consumption growth and inflation expectations.[4] Similarly, Bachmann, Berg, and Sims (2015) estimate an ordered probit model of the relationship between "readiness to spend" on durable goods and inflation expectations in the Michigan Survey of Consumers. They also interpret the readiness to spend measure as a proxy for current expenditures. Both these papers find little evidence of a connection between inflation expectations and current consumption. On the contrary, D'Acunto, Hoang, and Weber (2018) and Ichiue and Nishiguchi (2015) find a stronger link in analogous German and Japanese survey data, respectively. The first study carefully exploits a difference-in-difference design to try and isolate the causal effect of changes in inflation expectations on spending and finds it to be large. The second study estimates the reaction of qualitative proxies for both current and future planned spending to changes in inflation expectations. It finds the former to be negative and the latter to be positive, consistent with our results. Due to data limitations, none of these studies can cleanly identify the EIS, since doing so requires data on expected future consumption growth over the same horizon as inflation expectations.[5] Instead, these papers attempt to estimate something more akin to the partial derivative of the consumption function with respect to expected inflation. The

[4]These survey modules were designed by a team of researchers from the New York Fed and various academic institutions. They served as a pilot for the SCE, as discussed in Bruine de Bruin, Manski, Topa, and van der Klaauw (2011).

[5]Among these studies, the regression that is closest to our specification is the one of future planned spending on inflation expectations in Ichiue and Nishiguchi (2015). They still cannot recover an estimate of the EIS because their survey only provides directional information on planned spending.

challenge of this kind of exercise is that this partial derivative is not a structural parameter, like the EIS. Rather, it is a reduced form coefficient whose magnitude and even sign depend on many details of the individual choice problem and of the macroeconomic environment in which that choice takes place (see discussion in Hall 1988). Therefore, it is not too surprising that different studies based on different data in different periods and with different empirical designs might recover different values for that coefficient.

The paper is organized as follows. Section 2 provides the theoretical motivations for our empirical specification. Details of the data set are provided in Section 3. Sections 4 and 5 provide our main results while robustness checks and additional results are reported in Section 6. Section 7 concludes and discusses directions for further work.

# 2 Theoretical Framework

The theoretical underpinning of our estimation exercise is the standard intertemporal Euler equation, which encapsulates the optimal consumption and saving choice of a household that can freely borrow and lend at a known (gross) nominal rate of return $R_t$. In its basic specification with separable isoelastic preferences, this equilibrium condition can be written as

$$1 = E_t^i \left[ \beta \left( \frac{C_{t+1}^i}{C_t^i} \right)^{-\frac{1}{\sigma}} \left( \frac{R_t}{\Pi_{t+1}} \right) \right], \tag{2.1}$$

where $\beta$ is the discount factor and $C_t^i$ is the consumption by household $i$ of a bundle of goods and services, including potentially those from durable goods. The overall level of this consumption can vary across $i$'s—we are not assuming the existence of a representative consumer—but the bundle's composition and hence its relevant price index, denoted by $\Pi_t$, do not. The assumption of a "representative" price index, whose rate of change defines aggregate consumer inflation, is nearly universal in macroeconomics and it forms the basis of inflation measurement. It is also consistent with the SCE survey questions, which have been explicitly developed to elicit expectations of aggregate inflation, rather than of the change in prices that might be more directly salient for the individual respondents.

As suggested by the $i$ superscript on the expectation operator, those expectations are allowed to be heterogeneous across households, as they are in our data. This heterogeneity in inflation expectations is a source of variation in the ex-ante real interest rate perceived by different households over time, for any given level of the nominal interest rate. According to the Euler equation, this variation should be associated with differences in planned consumption. Our estimates of the elasticity of intertemporal substitution, which is denoted by $\sigma$, measure the strength of this association.

We refer to these estimates as *subjective* measures of intertemporal substitution because they reflect the relationship between households' subjective views of future inflation and consumption growth. In this respect, these estimates are much more directly related to individual Euler equations than those derived from observed consumption choices and rates of return, because the latter rely on specific assumptions on the properties of the expectations operator to connect realizations back to the agents' expectations featured in the equation. In contrast, we do not need to take a stand on the nature of the expectation formation process, and in particular on the sources of the observed heterogeneity in expectations, since we observe them directly.[6]

Taking a log-linear approximation of (2.1) yields the familiar relationship

$$E_t^i\left[\Delta c_{t+1}^i\right] = \sigma \log \beta + \sigma r_t - \sigma E_t^i\left[\pi_{t+1}\right] + o_{i,t}, \tag{2.2}$$

where lowercase letters represent logs and $o_{i,t}$ is a remainder collecting second and higher order terms in the approximation. This simple linear equation is the starting point for our regressions. In most specifications, however, we will also include household-level variables available from the SCE that allow us to control for many of the deviations from this basic linear form of the Euler equation that have been explored in the literature. In particular, these variables also include measures of the most relevant terms contained in the approximation remainder, namely the conditional variances and covariances of inflation and consumption growth as perceived by consumers.

Equation (2.2) is ubiquitous in macroeconomics, starting from the pioneering work of Hall (1978). Most of this vast literature uses either aggregate time-series, or cross-sectional data on *realized* consumption and rates of return to estimate

$$\Delta c_{t+1}^i = c + \sigma rr_{t+1} + \varepsilon_{i,t+1},$$

where $rr_{t+1}$ is a real interest rate, and the error term $\varepsilon_{i,t+1}$ now also includes agents' consumption forecast errors. In general, these forecast errors will be correlated with $rr_{t+1}$, requiring the use of instruments to estimate the EIS. This need for instruments to construct the forecasts that feature so prominently in the Euler equation generates a host of econometric problems that have proven challenging to address in full. Partly as a result of these

[6] A recent paper by Kaplan and Schulhofer-Wohl (2017) points to one possible source of this heterogeneity. They find a significant amount of variation in household level inflation using scanner data that covers about 1/3 of expenditures. The main source of this heterogeneity are differences in prices paid, rather than in the bundle being consumed. Investigating the extent to which different households pay different prices for a broader set of goods and services and how this heterogeneity affects their inflation expectations is an interesting avenue for future research.

problems and of the many attempts to address them, as well as of the limitations in the available consumption data, the estimates of this important parameter range from close to 0 to well above 1, as nicely illustrated in the meta study of Havranek (2015).

In contrast, our approach relies on direct measures of US households' expectations of both inflation and their consumption growth from the New York Fed's Survery of Consumer Expectations. With these data we can estimate equation (2.2) directly, hence bypassing many of the problems that have plagued the literature based on realizations of consumption and of ex-post rates of return. To our knowledge, this is the first study to combine high quality survey data on both consumption growth and inflation expectations to estimate an Euler equation, and in particular the elasticity of intertemporal substitution.

# 3 Data

The empirical analysis uses data from the NY Fed's Survey of Consumer Expectations (SCE). The SCE is a nationally representative, internet-based survey of a rotating panel of about 1,300 household heads. The survey has been conducted at a monthly frequency since June 2013. New respondents are drawn each month to match various demographic targets from the American Community Survey (ACS), and stay on the panel for up to twelve months.[7] The SCE has high response rates: first-time respondents have a response rate between 50% and 60%; for repeat respondents the average response rate is about 75%. The SCE sample is highly representative of the U.S. population of household heads.[8] In addition, in all our analyses we also employ survey weights to match population characteristics.

The survey contains a core monthly module on expectations about various macroeconomic and household level variables. Respondents are asked for their expectations of the "rate of inflation" "over the next 12 months". They are also asked for their expectations regarding total income growth (before taxes and deductions) and total spending growth for all members of their household (including themselves), "over the next 12 months". These questions form the basis of our baseline estimation. The survey also contains information about expected earnings growth for employed respondents (conditional on remaining in the same job at the same conditions) over the next 12 months; expectations about access to credit and about their household's financial situation; expectations about the state of the economy more broadly.

[7] The survey is conducted on behalf of the NY Fed by the Demand Institute, a non-profit organization jointly operated by The Conference Board and Nielsen.

[8] The SCE sample is based on a pool of potential participants from the Consumer Confidence Survey run by The Conference Board, and is drawn via a stratified sampling procedure that aims to match various demographic targets from the American Community Survey. For more details on the survey see Armantier, Topa, van der Klaauw, and Zafar (2017).

In addition, the survey contains detailed demographic information about the respondents and their household, labor force status and labor market transitions.[9]

As stressed in Manski (2004), different survey designs can have a substantial impact on the quality of the elicited expectations. The SCE contains several important distinguishing features relative to existing household surveys of inflation expectations. First, the rotating panel aspect enables us to observe changes in expectations (and behavior) of the same individuals over time. This is an important advantage over surveys that are based on repeated cross-sections with a different set of respondents in each wave. Second, the survey asks quantitative questions on *both* inflation *and* spending growth expectations. We believe this is a unique feature of our data that enables us to estimate the consumption Euler equation directly. Third, for several key questions (including inflation and earnings growth expectations) the core survey elicits density forecasts in addition to point predictions. This allows us to include measures of second order moments of the subjective distributions expressed by respondents in our extensions and robustness exercises (see Section 6).

The launch of the SCE was preceded by an intense testing and experimentation phase aimed at evaluating the feasibility of eliciting high quality expectations data and at testing various design features of the survey questions.[10] This work led to the adoption of a question wording for inflation expectations that asks explicitly about "the rate of inflation" as opposed to changes in "prices in general" (as in the University of Michigan Survey of Consumers) or other potential wordings. As Bruine de Bruin, van der Klaauw, Downs, Fischhoff, Topa, and Armantier (2012) and van der Klaauw, Bruine de Bruin, Topa, Potter, and Bryan (2008) show, the "rate of inflation" wording adopted in the SCE elicits more homogeneous interpretations and is the most likely to lead respondents to think about the general U.S. rate of inflation or changes in the U.S. cost of living, and the least likely to evoke thoughts of prices respondents pay as well as of specific prices.[11] Furthermore, additional work conducted both in the experimentation phase and in the early stages of the SCE shows that the vast majority of consumers have a good understanding of the concept of inflation and are able to express it in quantitative terms.[12]

In order to elicit a density forecast for inflation, respondents are asked to assign probabil-

[9] The precise wording of the questions used in our analysis is reported in the Appendix.

[10] For some preliminary findings from this testing phase, see van der Klaauw, Bruine de Bruin, Topa, Potter, and Bryan (2008).

[11] These findings are based on an experimental survey fielded on RAND's American Life Panel that tested (in a randomized setting) responses to three alternative wordings of the inflation expectations questions: one that asked about the "rate of inflation over the next 12 months"; one that asked for the expected change in "prices in general during the next 12 months"; and one that asked about the expected change in "prices you pay for things you usually spend money on during the next 12 months".

[12] See Armantier, Topa, van der Klaauw, and Zafar (2017, p. 55).

ities to various possible inflation outcomes.[13] Specifically, they are asked to state the percent chance that, over the next 12 months, the "rate of inflation" would fall within the following intervals: -12% or less, [-12%,-8%], [-8%,-4%], [-4%,-2%], [-2%,0%], [0%,2%], [2%,4%], [4%,8%], [8%,12%], 12% or more.[14] We then follow Engelberg, Manski, and Williams (2009) to fit a generalized beta distribution to each respondent's stated histogram.[15] This enables us to compute various statistics for each individual, including measures of central tendency (typically the density mean) and forecast uncertainty (the interquartile range or the variance).

We exploit the fact that we have two different measures of inflation expectations and drop survey responses where the point forecast of inflation and the density forecast are not consistent with each other in a weak sense. Specifically, we eliminate those responses where the point forecast lies outside the range between the 1st and 99th percentile of their fitted forecast density. We also drop observations where the density-implied variance is very high as in this case measures of central tendency are not very informative. In our main results we trim the top 5 percent of density-implied variances.[16] In our trimmed sample the correlation coefficient between point forecasts of inflation and the forecast-density-implied means is 0.8. We also investigated other variants of this rule and found that our results are highly robust to alternative approaches. We also use the two measures of inflation expectations to address potential measurement error issues: in particular, we run IV specifications in our various regressions, using the point forecast as an instrument for the density mean resulting from each respondent's density forecast.

In addition to the core monthly module, the SCE also contains various supplementary modules on specific topics, which are rotated every month. Our analysis mostly focuses on

[13] A large and growing literature shows that this sort of probabilistic questions are feasible and provide meaningful information. Bruine de Bruin, Manski, Topa, and van der Klaauw (2011), in a precursor survey to the SCE, show that respondents are willing and able to answer these questions, with high item response rates, reasonable ratings on clarity and difficulty, and sensible correlations with responses that denote uncertainty about future outcomes. Mueller, Spinnewijn, and Topa (2018) show that probabilistic expectations about future labor market transitions are strongly predictive of actual transitions, specifically from unemployed to employed. Delavande, Giné, and McKenzie (2011) provide a survey of the literature in development economics and show that respondents understand probabilistic questions, and the elicited density forecasts are useful predictors of future behavior and outcomes.

[14] Respondents see the sum of their stated probabilities to make sure that they add up to 100. The item response rates to these density questions is close to 100%.

[15] As in Engelberg, Manski, and Williams (2009), in the case where a respondent assigns all probability to a single interval we fit a uniform distribution, and if the respondent assigns probabilities to only two intervals we fit a triangular distribution.

[16] In practice, we first trim the top 5% based on density-implied variance and then drop any additional observations based on the 1–99 consistency rule. We also trim the top and bottom 2.5% of household expectations of spending growth and income growth over the next 12 months. These combined trimming rules result in a loss of 17,643 observations out of the initial sample of 64,583.

data from the monthly core modules, but also uses data from a special module on spending plans and expectations that is fielded every four months (in April, August and December). This module contains a density forecast version of the spending growth expectations question, which we exploit in various robustness exercises (see Section 6). In addition, respondents are asked about how their current monthly household spending compares (in terms of a percentage change) to that of twelve months ago. We use this question below in Section 6.2 in our discussion of habit formation. In April 2015 the special module posed the spending growth expectations question using a different wording than in the core module. Specifically, it asked respondents to think of "all spending categories combined" and to provide the expected change in "overall monthly household spending 12 months from now, compared to [their] current monthly spending".[17] We use responses to this question in one of our robustness exercises (see, again, Section 6), to ensure that our estimated EIS is robust to alternative wordings of the spending growth expectations question.

Finally, it is worth noting that the SCE inflation expectations have been shown to be informative, in the sense that they co-move in a meaningful way with investment choices in a financially incentivized field experiment (Armantier, Bruine de Bruin, Topa, van der Klaauw, and Zafar 2015). Moreover survey respondents update their inflation expectations sensibly, upon receiving relevant information (Armantier, Nelson, Topa, van der Klaauw, and Zafar 2016).

# 4 Estimating the EIS

Our empirical strategy is based on equation (2.2), which corresponds to the following baseline regression model:

$$\text{ExpCG}^i_{t,t+12} = -\sigma \cdot \text{Exp}^i\text{Infl}_{t,t+12} + \delta'\kappa_{g_{it}} + \theta' x_{it} + \epsilon_{it}, \tag{4.1}$$

where $\text{ExpCG}^i_{t,t+12}$ is expected real consumption growth over the following year calculated as,

$$\text{ExpCG}^i_{t,t+12} \equiv \text{ExpSG}^i_{t,t+12} - \text{Exp}^i\text{Infl}_{t,t+12}.$$

In this expression, $\text{ExpSG}^i_{t,t+12}$ is the point expectation of nominal household spending

[17]The spending categories are defined immediately before this question and represent: Housing (including mortgage, rent, maintenance and home owner/renter insurance); Utilities (including water, sewer, electricity, gas, heating oil); Food (including groceries, dining out, and beverages); Clothing, footwear and personal care; Transportation (including gasoline, public transportation fares, and car maintenance); Medical care (including health insurance, medical bills, prescription drugs); Recreation and entertainment; Education and child care.

growth over the following twelve months (see Question Q26 in the Appendix). That question asks respondents to

> "...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)."

This wording provides a clear definition of "spending" as pertaining to a comprehensive basket of goods and services, including those provided by durables such as housing and cars as measured by rent or car payments. This definition of spending provides a measure of (nominal) consumption on a basket of goods and services that is fairly close to that captured for instance by the CPI. Using such a comprehensive definition of spending as the relevant match to the concept of nominal consumption that enters utility and the Euler equation has the advantage of avoiding issues with the non separability between durable and non durable consumption in utility, since the latter is already included in the form of its service flow. On the contrary, this separability issue is usually a challenge for estimation strategies based on micro consumption data, which usually only include measures of non durable consumption.[18]

$\text{Exp}^i\text{Infl}_{t,t+12}$ is the density-implied mean of the distribution of expected inflation over the following twelve months, from Question Q9.[19] The $i$ superscript is on "Exp", and not on "Infl", as a reminder that we interpret the heterogeneity in the responses to this question as reflecting differences across households in their expectations of aggregate inflation, rather than in the price index to which those expectations refer. Isolating the former source of variation is one of the main objectives of the question wording in the SCE, as highlighted in Section 3. The variable $\text{Exp}^i\text{Infl}_{t,t+12}$ appears in both the dependent and independent variable in equation (4.1). However, this poses no problems as we could equivalently recover $\sigma$ as $1 - \zeta$ where $\zeta$ is the coefficient from the transformed model where $\text{ExpSG}^i_{t,t+12}$ is the dependent variable.

To capture variation over time in the level of the nominal interest rate faced by respondents, we include different forms of time effects. In the simplest setting, we set $\delta = 1$ and $\kappa_{g_{it}} = \tilde{\kappa}_t \; \forall i$, where $\tilde{\kappa}_t$ denotes month dummies. This corresponds to the assumption that

[18] The expenditures on some of the large items mentioned at the end of Question 26, such as appliances, are the main caveat against our identification of spending as measured in the SCE with the notion of flow consumption that enters the Euler equation. In practice, though, the measurement error induced by including the total cost of an appliance or piece of furniture into a flow measure of consumption—assuming that this is how respondents actually interpret the question—is hopefully small.

[19] This mean is computed from a generalized beta distribution fitted to the individual responses, as discussed in Section 3.

this interest rate is common to all households and observed at time $t$ as in equation (2.2). We also allow for cross-sectional and time series variation in the level of interest rates faced by households with different demographic and other characteristics as captured by the group membership identifier, $g_{it}$. For example, we interact labor force status with month dummies to generate part of $\kappa_{g_{it}}$. Since the household labor force status may change in our sample period, we allow for time-variation in the group identifier. A complete list of these and all control variables including full details of their construction are provided in the Appendix.

Many of our regressions also include a vector $x_{it}$ of controls. The elements of this vector can vary across specifications, as detailed when discussing the results below. From a theoretical perspective, these richer specifications address the possibility that the restrictions underlying equation (2.2) might not hold in the data. Many such deviations from the most basic form of the Euler equation have found support in the literature. Examples include the presence of shifters of the marginal utility of consumption connected to changes in family composition and other life-cycle factors, to non separabilities between consumption and leisure and, more generally, to non-isoelastic preferences. Another class of violations of equation (2.2) is associated with potential sources of excess income sensitivity, such as the presence of liquidity or credit constraints that prevent individuals from borrowing and lending freely at the aggregate interest rate. In all these cases, a first order approximation of the Euler equation continues to relate expected consumption growth to expected returns with a slope coefficient $\sigma$. However, that approximation features more terms than just the interest rate, such as those capturing the (first order) effects on marginal utility of leisure, demographics, income, or the multiplier on financial constraints. Throughout our discussion of the empirical results we detail how our household-level controls allow us to address most of the potential deviations from the baseline Euler equation which have found empirical support in the literature.[20]

## 4.1 Baseline Results

We estimate equation (4.1) using monthly waves of the SCE from June 2013 through July 2017 and all regression results are based on the sampling weights discussed in Section 3. Table 1 presents baseline results. Column (1) reports the regression coefficient on expected inflation, $-\sigma$, in a simple specification without any controls. Columns (2) and (3) add an increasingly rich set of controls, starting from demographic and labor supply variables in column (2). Columns (4) to (6) repeat the same regressions using the point forecasts of inflation as an instrument for the mean of the density forecast. Results for all of these

[20] Attanasio (1999) provides a comprehensive and lucid survey of the theoretical foundations and empirical performance of these more general specifications.

specifications are discussed below and full details of each specification are provided in the Appendix.

Across specifications, we observe a remarkably consistent finding: the elasticity of intertemporal substitution implied by the estimates of $\sigma$ is between 0.7 and 0.8, and is precisely estimated. These values are at the upper end of the range recovered by state of the art studies based on micro data on observed consumption choices, as recently surveyed by Attanasio and Weber (2010) for instance.[21] Furthermore, we explain around 20% of the variation in expected real spending growth over our sample period, even in the simplest specification.

The estimates reported in Table 1 are all significantly different from 0 as well as 1, which are both economically significant hypotheses. The fact that we can strongly reject an EIS of 0 indicates that households' expectations are consistent with a strong intertemporal substitution motive. In contrast, estimates of the EIS close to 0 are common in studies based on aggregate data (e.g., Hall 1988, Campbell and Mankiw 1989) calling into question the empirical relevance of one of the key mechanisms at the heart of dynamic macroeconomics. Bachmann, Berg, and Sims (2015) reach a similarly negative conclusion on the relevance of intertemporal substitution, and in particular on the responsiveness of spending readiness to inflation expectations, using data from the Michigan survey of consumers.

As we discussed earlier, $\sigma = 1$ corresponds to a $\zeta$ coefficient of zero in the transformed regression of expected *nominal* spending growth on expected inflation. Failing to reject this outcome would have been consistent with the absence of any economic relationship between expected spending growth and inflation–the two variables from which we derive our measure of real consumption growth. This, in turn, would have cast doubt over the informativeness of our survey data to estimate the EIS. On the contrary, we strongly reject $\sigma = 1$ which is reassuring on this count.

On a similar note, the rejection of $\sigma = 0$ also rules out a mechanical "model" of nominal spending growth expectations formed by simply adding inflation expectations to an exogenous value of real expected consumption growth. A priori, such a model seems implausible, since it features some sophistication in distinguishing between real and nominal spending, but at the same time extreme naiveté in ignoring the connection between inflation expectations and consumption. Nevertheless, it is reassuring that we can soundly reject this hypothesis based on our results.

[21] See, in particular, the estimates discussed on Attanasio and Weber (2010, p. 710).

## 4.2 Accommodating Deviations from the Basic Euler Equation

The literature that estimates Euler equations using micro data has demonstrated that this relationship is unlikely to hold in its textbook form only involving expected consumption growth and rates of return. At the household level, many factors aside from consumption can shift marginal utility, such as the arrival of a child, or the decision of family members to work in the market or at home. Moreover, consumption and leisure might not be separable in utility. The literature has addressed these and related considerations by including in Euler equation regressions a varied set of demographic and labor supply variables, as nicely summarized in Attanasio (1999, Section 3.6) and Browning and Lusardi (1996, Table 5.1).

In Column (2) of Table 1 we follow a similar approach by exploiting the comprehensive set of questions on household composition, the marital and labor market status of its members, their education, age and other demographic traits available in the SCE (see Appendix for details). These responses essentially span the entire set of "demographic" controls traditionally used in the literature. In contrast, the prior literature was often limited to specific subsets of these controls depending on availability in the data set of interest. Moreover, the level of detail included in the SCE questions allows us to accommodate a wide range of outcomes for their relevant categories. For example, household labor status for both the head of household and their spouse can be reported into 10 different categories such as working part-time as opposed to full-time or, not working, but would like to work as opposed to retired or permanently disabled. We exploit this detailed information in our controls. For example, we include categorical variables for characteristics such as marital status, race, gender and education but also interaction terms to capture different household compositions and labor force status at a granular level. Furthermore, these household characteristics may exhibit variation over time, as the SCE captures, for example, changes in household composition, marital and labor market status, homeownership status over the respondent's participation in the panel. The inclusion of these controls has little effect on our estimate of the EIS; however, we do observe an increase in $R^2$ to about 22%.

The regression results discussed so far are based on the assumption (maintained in equation (2.2)) that all households can freely borrow and lend at the same given interest rate $R_t$. We account for possible time variation in this aggregate interest rate by including time effects. In practice, the interest rate faced by different households is likely to vary not just over time but also as a function of their characteristics. Column (3) allows for this possibility in a flexible manner through group-specific time effects based on demographic characteristics, numeracy, homeownership status, and labor force status. This specification is therefore consistent with different groups of households facing an entirely different path of interest rates over time.

Finally, Columns (4)–(6) repeat the sequence of regression specifications from Columns (1)–(3) based on a simple IV strategy. We instrument for expected inflation, measured as the mean of the density forecast, using point forecasts. This should ameliorate the effects of any measurement error on our preferred measure of inflation expectations. Across these three IV specifications, estimates of the EIS are similar but they are somewhat attenuated as compared to the OLS estimates. This shifts the estimates of the EIS from a bit below 0.8 to closer to 0.7. Moreover, just as in Columns (1)–(3) we can strongly reject the null hypotheses that $\sigma = 0$ or $\sigma = 1$.

# 5 Excess Sensitivity

One of the most extensively documented failures of the basic life cycle model as encapsulated in the Euler equation (2.2) is the so-called "excess sensitivity" of consumption to anticipated income changes. This refers to the very common finding that measures of expected income growth have a statistically significant coefficient when included in regressions of consumption growth on returns (see Jappelli and Pistaferri 2010 for a recent survey of this literature). The simple intuition for why this is puzzling is that predictable changes in resources should already be incorporated in one's life cycle plan, and hence have no effect on subsequent consumption growth. This section investigates the extent to which excess sensitivity is also a feature of the SCE data–it is indeed a pervasive feature–and explores some of its potential drivers, such as the presence of borrowing constraints.

The literature has interpreted the abundant evidence in favor of excess sensitivity as reflecting one of three main departures from the assumptions underlying the basic Euler equation. First, it might be due to non separabilities in utility, for instance between consumption and hours of work, with income entering the regression as a proxy for the latter. We addressed the issue of non separability in Section 4.2. There, we showed that our estimates of the subjective EIS are robust to the inclusion of a long list of controls in the regressions, which are designed to capture most of the potential shifters of the marginal utility of consumption that have been considered in the literature, including those connected with non separable utility (see Table 1). We include these same controls in our excess sensitivity regressions, so as to rule out the possibility that a significant coefficient on expected income might in fact be due to non separable preferences.

Second, excess sensitivity might reflect binding liquidity constraints on some households, which prevent them from adjusting their consumption in advance of receiving more resources, even if this change is predictable. Third, excess sensitivity might reflect more general failures of the Euler equation and its underlying assumptions, such as lack of planning, attention, or sophistication, at least among some individuals. We explore these possibilities in the remainder of the section.

We start our exploration of the connection between expected consumption and income growth by simply adding a measure of the latter to our baseline regression specification. In the SCE, expected household income growth over the following twelve months (Question 25) is the most comprehensive measure available. As with spending growth we deflate this nominal variable by subtracting the density-implied mean of expected inflation over the same period. Table 2 reports the results from this specification. The first set of columns ((1)–(3)) report OLS estimates with expanding sets of controls whereas the second set of columns ((4)–(6)) reports IV estimation results as in Table 1.

The table shows strong evidence of excess sensitivity. Across all six specifications the coefficient associated with expected real income growth is highly statistically significant. Our estimates point to an elasticity of expected consumption growth to predictable income changes of around 0.2. This is a pretty typical finding in studies based on microeconomic data, as surveyed for instance in Browning and Lusardi (1996).[22]

In terms of economic significance, a simple back of the envelope calculation suggests that an average household spends roughly 16 cents out of an anticipated extra dollar of income.[23] By way of comparison, this inferred marginal propensity to consume is towards the bottom of the range found in the literature that uses household level data and quasi experiments to identify the effects on consumption of predictable changes in income induced by tax policy. For instance, Parker, Souleles, Johnson, and McClelland (2013) and Souleles, Parker, and Johnson (2006) find that on average treated households in their quasi experimental design spent about 12 to 30 percent of the payments connected with the Economic Stimulus Act of 2008 and 20 to 40 percent of the tax rebates generated by the Economic Growth and Tax Relief Reconciliation Act of 2001 on non durable consumption in the three-month period in which the payments were received. After reviewing this literature, and conducting some original empirical analysis, Kaplan and Violante (2014) take 0.25 as their preferred estimate for what they call the rebate coefficient. However, they also point out that this coefficient is in fact a mixture of the marginal propensities to consume of different groups of rebate recipients. In their structural model, which produces a rebate coefficient of 0.15, the average marginal propensity to consume out of an anticipated income change is only 0.06.

Another key finding in Table 2 is that the inclusion of real income growth shifts the estimated EIS down by roughly 0.2 from a range of 0.7–0.8 in Table 1 to about 0.5–0.6. In

[22] Their Table 5.1 summarizes the findings of more than twenty studies that find elasticities anywhere between zero (or even slightly negative) and 0.6, with most estimates clustered in the 0.1 to 0.4 range.

[23] This is based on an elasticity of about 0.2 from Table 2 multiplied by 0.8, the average ratio of consumption expenditures to personal income from the National Income and Product Accounts over our sample period.

light of the strong explanatory power of expected real income growth in this specification, this is our preferred estimate. These values of the elasticity are toward the lower end of the range of estimates based on micro data, as surveyed for instance in Attanasio and Weber (2010), but they are consistent with standard calibrations in macroeconomic studies (e.g., Hall 2009, 2016.) This represents statistical evidence against logarithmic utility in consumption, which is arguably the most common specification in macroeconomics.

One common explanation for the evidence in favor of excess sensitivity is that it might reflect the presence of liquidity constraints. To distinguish this hypothesis from other failures of the basic Euler equation, Zeldes (1989) first suggested splitting the sample between households who are more or less likely to be constrained. Using the level of wealth as a proxy for this likelihood, he finds that consumption growth among poor households is more sensitive to income than among richer ones. We follow a similar approach, but use survey questions directly related to the availability of liquid funds and to credit access as our proxy for the presence of constraints.[24] This strategy is related to the one pursued by Jappelli, Pischke, and Souleles (1998). They use direct questions on liquidity constraints and on credit cards and credit lines in the Survey of Consumer Finances (SCF) as their source of information to identify potentially constrained households, in the context of a switching regression model run on consumption data from the Panel Study of Income Dynamics (PSID). An important advantage of our data with respect to that used by Jappelli, Pischke, and Souleles (1998) is that they all come from answers provided by the same households within the same survey, rather than from two separate sources.

Table 3 presents results from a sample-split based on the responses to the following question:

> What do you think is the percent chance that you could come up with \$2,000 if an unexpected need arose within the next month?

In most circumstances, households with easy access to \$2,000 of liquid wealth should be able to smooth consumption over time. Therefore, this question provides a clean way of isolating households who are most likely to be on the Euler equation from those that are not.[25] Furthermore, we define as unconstrained those households who report a 100% chance to raise \$2,000 in every month they are in the survey. This high threshold produces a

[24] An alternative and complementary approach taken in Dogra and Gorbachev (2016) is to include directly in the Euler equation a proxy for the Lagrange multiplier on the liquidity or borrowing constraint as a fitted value from an auxiliary regression. In our case, a proxy of this sort would likely be spanned by our set of control variables.

[25] This question is very similar to one from the 2009 TNS Global Economic Crisis survey that Lusardi, Schneider, and Tufano (2011) use to define "financially fragile" households.

conservative classification rule that should minimize the risk of including households who are unable to smooth consumption among the unconstrained group. For instance, the "wealthy hand to mouth" of Kaplan and Violante (2014) and Kaplan, Violante, and Weidner (2014), although rich in total wealth, may have difficulty raising liquid funds to smooth unexpected shocks.

Panels A and B of Table 3 report results for unconstrained and constrained households, with the latter comprising about 60% of our sample. This fraction is fairly close to the 50% of "financially fragile" households in the SCF found by Kaplan, Violante, and Weidner (2014).[26] It is also within the range found in Zeldes (1989), who places anywhere between 1/3 and 3/4 of the population in his constrained group, depending on the definition of wealth that he uses for the split. Even among this conservatively defined 40% of unconstrained households, we find strong statistical evidence of excess income sensitivity. Across the six regression specifications in Panel A, the estimated coefficient associated with expected real income growth ranges between 0.16 and 0.21, only modestly below the estimates based on the full sample from Table 2. In comparison, the estimates in Panel B range between 0.19 and 0.23 uniformly above the corresponding coefficients reported in Panel A. Furthermore, the estimated subjective EIS is essentially the same as that of Table 2 across both panels. These results strongly suggest that the findings of excess sensitivity in the full sample are not driven by the presence of constrained households.

As an alternative proxy for the presence of constraints we use responses to the following question:

> What do you think is the percent chance that, over the next 3 months, you will NOT be able to make one of your debt payments...?

In this case, we define as constrained those households who report a positive probability of missing a payment at any time during their participation in the panel. Given the high cost of delaying payments to most consumer debt instruments, a nonzero probability is a strong indication of the presence of constraints. We acknowledge that reporting a zero probability is no guarantee of consistent access to means for smoothing consumption which is why querying households on their ability to raise \$2,000 is our preferred discriminant. However, only about a quarter of households consistently report a zero probability in our sample suggesting that, in practice, this is a high bar to clear. The results obtained using this sample-split presented in Table 4 are very similar to those shown in Table 3. In particular, the unconstrained households exhibit the same degree of excess sensitivity as those identified in Table 3.

[26]Following Lusardi, Schneider, and Tufano (2011), Kaplan, Violante, and Weidner (2014) designate as "financially fragile" those households who are less than \$2,000 away from the liquid wealth threshold that defines hand to mouth households.

The results of this section point to excess sensitivity as a pervasive feature of these survey data. The extensive set of controls that are included in our regressions should accommodate a wide variety of non-separable utility specifications ruling this out as the source of excess sensitivity. In addition, the evidence in Tables 3–4 indicates that excess sensitivity is unlikely to reflect the presence of liquidity constraints. This leaves open the possibility that consumption growth responds to predictable changes in income for reasons other than those currently emphasized in the literature.

# 6 Extensions and Robustness

In this section we examine several extensions of our baseline specification, to account for additional potential departures from the canonical Euler equation representation. We also perform various robustness exercises regarding the wording of our spending growth expectations question and the use of density versus point forecasts to elicit spending growth expectations.

## 6.1 Higher-Order Terms

In equation (2.2), the term $o_{i,t}$ represents the approximation error induced by the linearization of equation (2.1). Extending the approximation to second order produces

$$
\begin{aligned}
E_t^i\left[\Delta c_{t+1}^i\right] \;\approx\;& \sigma\log\beta + \sigma r_t - \sigma E_t^i\left[\pi_{t+1}\right] \\
&+\frac{1}{2}\sigma Var_t^i\left(\pi_{t+1}\right) + \frac{1}{2}\frac{1}{\sigma}Var_t^i\left(\Delta c_{t+1}^i\right) + Cov_t^i\left(\pi_{t+1},\Delta c_{t+1}^i\right), \qquad (6.1)
\end{aligned}
$$

which highlights that the approximation error contains the conditional variances and covariances of the variables of interest. More generally, $o_{i,t}$ includes the conditional higher-order moments of the subjective joint distribution of consumption growth and returns (e.g., Jappelli and Pistaferri 2000, Carroll 2001, Ludvigson and Paxson 2001).

Higher-order expansions do not affect the first order terms in the approximation, which therefore continue to provide useful variation to identify the EIS. In fact, this remains true for specifications of utility that are more general than the isoelastic form assumed in equation (2.1), as discussed in the next subsection. From an econometric point of view, however, the concern is that the higher order terms may be correlated with expected inflation. If this were the case, estimates of the EIS based on the linearized equation would be biased. A related concern, raised by Carroll (1997), is that omitting the second order terms could produce spurious evidence in favor of excess sensitivity if the first and second moments of the forecast distribution are correlated across individuals.

If the subjective joint distributions are homoskedastic, as usually assumed in the literature, this bias would only emerge through a cross-sectional correlation between expected inflation and the second-order moments of the subjective distribution.[27] In all of our regressions, we control for this potential correlation by including a rich set of individual specific controls that should capture most of the potential drivers of the correlation.

If the higher order moments of the subjective distributions are not constant, the residuals of the first order approximation will vary with both $i$ and $t$ in ways that might be harder to control for. We address this possibility in two ways. First, in some of the baseline regressions (columns (3) and (6) in the tables), we allow for time effects that vary by household characteristics which will accommodate group-specific changes in higher-order moments over time. Second, we can use the second moments of the subjective distributions elicited by the SCE as further controls in our regressions.[28]

The results of this exercise are reported in Table 5 where we include the variance of the subjective forecast distribution of inflation along with that for earnings growth. We use earnings growth risk as a proxy for consumption growth uncertainty here because the SCE does not include information on the subjective distribution of the latter in its core monthly module.[29] This restricts the sample to those heads of household who are currently employed, reducing the number of observations by about 30%.[30] The parameter estimates for the EIS and the excess sensitivity of income, reported in Columns (1)–(3) and (5)–(7), are roughly unchanged across the various specifications with these additional controls.

[27] Indeed, Bruine de Bruin, Manski, Topa, and van der Klaauw (2011) show that in a precursor to the SCE the Inter-Quartile Range of individual subjective distributions is correlated at the individual level with both point forecasts and density mean forecasts of inflation.

[28] Jappelli and Pistaferri (2000) use the subjective variance of the growth rate of earnings from the Bank of Italy Survey of Household Income and Wealth to control for this possible bias. See also Ludvigson and Paxson (2001) for a broader discussion of the problems associated with the estimation of linearized Euler equations.

[29] Jappelli and Pistaferri (2000) also use the subjective variance of earnings growth as a proxy for consumption risk in their study of precautionary saving and excess sensitivity based on the 1989 to 1993 waves of the panel survey of Italian households. Although their overall empirical design is fairly similar to ours, they do not report estimates of the EIS due to results that they deemed "implausible," as detailed in their footnote 14. More recently, Christelis, Georgarakos, Jappelli, and van Rooij (2016) use information on the second moments of expectations of consumption growth from a Dutch survey to estimate prudence. We do not pursue this line of inquiry here because we are focusing on estimates of the EIS, but the SCE data could, in principle, be used in this context as well.

[30] For consistency, we also replace the expected household income growth variable with expected earnings growth for the respondent. In the Supplementary Appendix (Table A.2) we report a version of Table 2 (on excess sensitivity) in which we simply replace expected household income growth with expected earnings growth: the resulting estimates are robust to this change and to the related reduction in sample size. Furthermore, we also report the same specifications as in Tables 1–4 for the sample of respondents who are currently employed and using real expected earnings growth in place of real household income growth for reference (Tables A.1–A.4).

The variance of the subjective distribution of inflation has an estimated coefficient which is positive and statistically significant although with a small overall magnitude. The estimated coefficient associated with the subjective variance of future earnings growth is positive but not statistically significant in any of our specifications.

## 6.2 More General Utility Specifications

The literature in both macroeconomics and finance has explored many alternatives to the separable isoelastic utility specification considered in equation (2.1). The recursive preferences popularized by Epstein and Zin (1989, 1991) are probably the most popular among these alternatives, together with utility functions that allow for the presence of habits in consumption (e.g. Dynan 2000). In both of these cases, the elasticity of expected consumption growth to expected inflation continues to identify (the negative of) the EIS. The difference from the CRRA case is that other variables aside from expected returns might now enter the first and/or higher order approximations of the Euler equation. As in the case of the second order moments discussed in the previous section, then, the concern is that these new terms might be correlated with individual inflation expectations, biasing our estimates.

For instance, Vissing-Jørgensen and Attanasio (2003) show that under joint log-normality of consumption growth and returns, the standard log-linear approximation of the Euler equation obtains even under recursive preferences (see their equation (4)). In this approximation, the EIS corresponds to the elasticity of expected consumption with respect to the expected return of any financial asset for which consumers are not at a corner, as in equation (2.2). The coefficient of relative risk aversion, which under these preferences is not the reciprocal of the EIS, is part of the composite coefficients on the second moments of consumption growth and of the returns of both financial assets and total wealth inclusive of human capital, as first shown by Attanasio and Weber (1989). While the presence of these terms, and in particular of the unobservable return on wealth, makes the estimation of risk aversion challenging in this context (Vissing-Jørgensen and Attanasio 2003, Chen, Favilukis, and Ludvigson 2013), the EIS can be estimated with standard methods and data.

In this utility specification, along with the higher-order terms discussed in the previous section, we require that the variation in expected inflation on the right-hand side of the regression is orthogonal to the second moments of the return on total wealth. This orthogonality holds in the time series under joint log-normality, which makes the second moments constant over time, but it might fail under more general distributional assumptions, as well as quite plausibly in the cross section. In columns (4) and (8) of Table 5 we include a set of "macro" controls built from survey responses regarding the future evolution of economy-wide variables such as the unemployment rate and the stock market. These additional controls should help capture the variation in the second-order moments of the return on total wealth if the state of the business cycle is the primary driver of their movements. The estimated EIS and degree of excess sensitivity are essentially unchanged with the addition of these controls.

Habit formation is another popular source of time non separability in preferences. With this type of utility, a habit stock that depends on past consumption affects current marginal utility, and hence intertemporal substitution. Even in this case, though, the EIS corresponds to the slope of a first order approximation of the Euler equation (e.g. equation (8) in Dynan 2000). In addition, this approximation also includes lags (and potentially leads) of the habit stock, depending on the details of the specification. In our empirical context, then, the concern is again the possibility that these extra linear terms might be correlated with expected inflation.

In addition to the rich set of controls we have already discussed, every four months, as part of the special module on spending expectations, respondents are asked about how their household spending compares to that of twelve months ago. Table 6 reports the results of a regression in which we add each respondent's reported change in household spending over the past twelve months to the specification reported in Table 2. The results are robust to the inclusion of this measure of past consumption growth, both in terms of the estimated EIS and with regard to the estimated excess sensitivity to expected income growth.[31]

## 6.3 Additional Robustness Checks

### 6.3.1 Density Forecast Version of Spending Growth Expectations

As discussed in Section 3, the SCE fields a special module on spending plans and expectations every four months, which includes a density forecast version of the spending growth expectations question. The format of the question is similar to that used to elicit a subjective distribution over future inflation (as well as earnings growth) outcomes in the core monthly module, asking respondents to assign probabilities to several pre-determined bins. We use responses to this question in a couple of robustness exercises.

[31] Huang, Liu, and Zhu (2015) derive a linear approximation of the temptation preferences of Gul and Pesendorfer (2001). In this case, the log of the consumption-wealth ratio becomes another argument of the linearized Euler equation. To assess the robustness of our results to this setting, we estimated the specifications in Table 1 and 2 supplemented with additional variables. We include measures of log earnings (available three times per year in the Labor Market Ad Hoc Module) and log wealth (available once per year in the August Quarterly Household Finance module) as proxies for wealth and consumption, respectively. This reduces our sample size to about 2,200 observations but our main results are robust to including these variables.

First, in Table 7 we report results for a version of our baseline Tables 1 and 2 in which we replace the standard measure of household spending growth expectations (from the monthly core module) with the forecast-density implied mean of respondents' expectations about household spending growth, from the special module. The results are robust to this alternative specification, with the estimated EIS and excess sensitivity parameter remaining similar to the baseline estimates. Next, we add the second moment of the subjective distribution for spending growth in the specification with higher order moments described in Table 5. The results of this specification are reported in Table A.5 (in the Supplementary Appendix). The parameter estimates for the EIS and the excess sensitivity of income are very similar to those in Table 5.[32]

#### 6.3.2 Alternative Wording of Spending Growth Expectations

As a one-time robustness exercise, the SCE fielded an alternative wording of the question on expected household spending growth in the special spending module of April 2015 (see Appendix for the precise wording). This variant was introduced to assess whether responses are sensitive to different formats of the question. First, the alternative question is given to respondents immediately after a series of questions about each individual component of their monthly household spending, so respondents are more likely to consider all possible spending categories when expressing their spending growth expectations. Second, the description of the time horizon over which expected spending growth is expressed is worded differently.

Table 8 displays the regression results with two alternative wordings of the spending question used as dependent variables. Time effects are not included since this regression uses data solely from the April 2015 survey. Consequently, the resulting estimate of the EIS is not directly comparable to those in Tables 1 and 2. Panel A contains results for the standard wording of the question used in all waves of the SCE whereas Panel B contains results for the special variant of the question used only in April 2015. The results show that the estimates of the EIS are very similar across the two wordings of the spending growth expectations question.

# 7 Conclusion

The elasticity of intertemporal substitution is the key parameter behind households' intertemporal choices, regulating their planned responses to changes in future rates of return.

[32]Note that in this table we revert to using the point forecast of expected spending growth as the dependent variable so as to avoid any mechanical relationship between it and the second moment of the expected spending growth distribution.

In this paper, we levered the unique features of the New York Fed's Survey of Consumer Expectations (SCE) to estimate a subjective version of the EIS within a standard consumption Euler equation framework. We refer to these estimates as subjective because they are based on households' reported views regarding their future spending growth and inflation, rather than on their observed choices. The main advantage of our empirical approach is that we can estimate the EIS with no auxiliary assumptions on the properties of expectations. In particular, we do not need to take a stand on the information set on which they are based, and to which expectation errors are therefore orthogonal, as in the studies based on choice data and GMM techniques. Instead, we take subjective expectations as given and estimate the subjective EIS with simple OLS regressions.

Although they are based on an entirely different source of variation, these estimates of the EIS are directly comparable, and closely in line, with those obtained by the vast literature that estimates Euler equations with micro choice data. In particular, we find values of the EIS around 0.5, comfortably away from zero, but also from one. We also uncover pervasive evidence of excess sensitivity of planned consumption growth to expected income changes, even among households that are least likely to be liquidity constrained according to a set of criteria based on their answers to questions directly related to their financial health.

The main drawback of our approach, as of all Euler equation estimations, is that knowing the EIS is not sufficient to deduce the response of *current* consumption to changes in expected returns. The fact that households plan a flatter consumption profile going forward when they expect higher inflation, as the positive EIS that we find implies, does not mean that they will increase their consumption today to adjust to that plan. Yet, that is the response that policymakers would like to know about when trying to gauge the response of consumers to interventions such as forward guidance, one of whose intended effects is indeed to increase inflation expectations, especially at the zero lower bound (e.g., Del Negro, Giannoni, and Patterson 2012, Eggertsson and Woodford 2003, Werning 2011). Using expectations data to inform the debate on the effects of such policies more directly is an important avenue for future research, even though decades of research on consumption functions suggest that progress on this question will be especially challenging.

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## Table 1: Baseline Specification

This table presents estimation results from our baseline specification in equation (4.1). The dependent variable is the respondent's point forecast of expected household spending growth over the next 12 months. We use the respondent's forecast-density implied mean for inflation over the next 12 months as the measure of subjective expected inflation. The right panel reports results based on an IV estimator using the respondent's point forecast for inflation as the instrument. Columns (1) and (4) report results with no additional control variables; columns (2) and (5) report results using demographic and labor supply variables as controls; columns (3) and (6) further allow for group-based heterogeneity of borrowing rates based on respondent characteristics. A list of all control variables is provided in the Appendix. Robust standard errors, clustered at the individual level, are reported in parentheses. The sample period is 2013:06 – 2017:07.

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.778*** | -0.786*** | -0.775*** | -0.725*** | -0.731*** | -0.722*** |
| | (0.022) | (0.022) | (0.023) | (0.021) | (0.022) | (0.022) |
| Observations | 46923 | 46741 | 46719 | 46923 | 46741 | 46719 |
| Adjusted $R^2$ | 0.180 | 0.223 | 0.240 | 0.179 | 0.222 | 0.240 |
| Demos | | ✓ | ✓ | | ✓ | ✓ |
| Het Int. Rate | | | ✓ | | | ✓ |

## Table 2: Excess Income Sensitivity

This table presents estimation results from the specification in equation (4.1). The dependent variable is the respondent's point forecast of expected household spending growth over the next 12 months. We use the respondent's forecast-density implied mean for inflation over the next 12 months as the measure of subjective expected inflation and include the respondent's expected real household income growth over the next 12 months as a control variable. Real household income growth is constructed as the respondent's point forecast of household income growth less their forecast-density implied mean for inflation. The right panel reports results based on an IV estimator using the respondent's point forecast for inflation as the instrument. Columns (1) and (4) report results with no additional control variables; columns (2) and (5) report results using demographic and labor supply variables as controls; columns (3) and (6) further allow for group-based heterogeneity of borrowing rates based on respondent characteristics. A list of all control variables is provided in the Appendix. Robust standard errors, clustered at the individual level, are reported in parentheses. The sample period is 2013:06 – 2017:07.

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.581*** | -0.581*** | -0.564*** | -0.516*** | -0.515*** | -0.500*** |
| | (0.024) | (0.025) | (0.024) | (0.025) | (0.026) | (0.025) |
| Real Exp. Inc. Growth | 0.188*** | 0.202*** | 0.210*** | 0.203*** | 0.218*** | 0.225*** |
| | (0.011) | (0.010) | (0.010) | (0.009) | (0.009) | (0.009) |
| Observations | 46923 | 46741 | 46719 | 46923 | 46741 | 46719 |
| Adjusted $R^2$ | 0.219 | 0.260 | 0.278 | 0.218 | 0.259 | 0.277 |
| Demos | | ✓ | ✓ | | ✓ | ✓ |
| Het Int. Rate | | | ✓ | | | ✓ |

## Table 3: Financial Constraints – Availability of Liquid Funds

This table presents estimation results from the specification in equation (4.1). The dependent variable is the respondent's point forecast of expected household spending growth over the next 12 months. We use the respondent's forecast-density implied mean for inflation over the next 12 months as the measure of subjective expected inflation and include the respondent's expected real household income growth over the next 12 months as a control variable. Real household income growth is constructed as the respondent's point forecast of household income growth less their forecast-density implied mean for inflation. Panel A reports results for **Not Constrained** respondents: those who always respond they would be able to produce $2,000 if an unexpected need arose. Panel B reports results for all other respondents, labelled as **Constrained**. The right panel reports results based on an IV estimator using the respondent's point forecast for inflation as the instrument. Columns (1) and (4) report results with no additional control variables; columns (2) and (5) report results using demographic and labor supply variables as controls; columns (3) and (6) further allow for group-based heterogeneity of borrowing rates based on respondent characteristics. A list of all control variables is provided in the Appendix. Robust standard errors, clustered at the individual level, are reported in parentheses. The sample period is 2013:06 – 2017:07.

**Panel A - Not Constrained**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.582*** | -0.583*** | -0.549*** | -0.508*** | -0.499*** | -0.485*** |
| | (0.050) | (0.053) | (0.047) | (0.045) | (0.050) | (0.046) |
| Real Exp. Inc. Growth | 0.160*** | 0.178*** | 0.196*** | 0.175*** | 0.195*** | 0.209*** |
| | (0.017) | (0.015) | (0.018) | (0.012) | (0.013) | (0.014) |
| Observations | 16006 | 15952 | 15960 | 16006 | 15952 | 15960 |
| Adjusted $R^2$ | 0.179 | 0.239 | 0.260 | 0.177 | 0.237 | 0.259 |

**Panel B - Constrained**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.585*** | -0.584*** | -0.568*** | -0.530*** | -0.530*** | -0.521*** |
| | (0.032) | (0.032) | (0.031) | (0.033) | (0.034) | (0.032) |
| Real Exp. Inc. Growth | 0.191*** | 0.210*** | 0.219*** | 0.204*** | 0.225*** | 0.232*** |
| | (0.015) | (0.015) | (0.015) | (0.013) | (0.014) | (0.013) |
| Observations | 24960 | 24860 | 24856 | 24960 | 24860 | 24856 |
| Adjusted $R^2$ | 0.241 | 0.288 | 0.321 | 0.240 | 0.288 | 0.320 |
| Demos | | ✓ | ✓ | | ✓ | ✓ |
| Het Int. Rate | | | ✓ | | | ✓ |

## Table 4: Financial Constraints – Probability of Missing a Debt Payment

This table presents estimation results from the specification in equation (4.1). The dependent variable is the respondent's point forecast of expected household spending growth over the next 12 months. We use the respondent's forecast-density implied mean for inflation over the next 12 months as the measure of subjective expected inflation and include the respondent's expected real household income growth over the next 12 months as a control variable. Real household income growth is constructed as the respondent's point forecast of household income growth less their forecast-density implied mean for inflation. Panel A reports results for **Not Constrained** respondents: those who never report a positive probability of default on their debt payments. Panel B reports results for all other respondents, labelled as **Constrained**. The right panel reports results based on an IV estimator using the respondent's point forecast for inflation as the instrument. Columns (1) and (4) report results with no additional control variables; columns (2) and (5) report results using demographic and labor supply variables as controls; columns (3) and (6) further allow for group-based heterogeneity of borrowing rates based on respondent characteristics. A list of all control variables is provided in the Appendix. Robust standard errors, clustered at the individual level, are reported in parentheses. The sample period is 2013:06 – 2017:07.

**Panel A - Not Credit Constrained**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.536*** | -0.559*** | -0.506*** | -0.453*** | -0.457*** | -0.404*** |
| | (0.058) | (0.058) | (0.048) | (0.053) | (0.055) | (0.050) |
| Real Exp. Inc. Growth | 0.179*** | 0.187*** | 0.201*** | 0.197*** | 0.211*** | 0.226*** |
| | (0.021) | (0.019) | (0.022) | (0.017) | (0.016) | (0.018) |
| Observations | 11351 | 11281 | 11271 | 11351 | 11281 | 11271 |
| Adjusted $R^2$ | 0.193 | 0.255 | 0.302 | 0.192 | 0.253 | 0.300 |

**Panel B - Credit Constrained**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.593*** | -0.595*** | -0.580*** | -0.536*** | -0.539*** | -0.527*** |
| | (0.026) | (0.026) | (0.026) | (0.028) | (0.029) | (0.028) |
| Real Exp. Inc. Growth | 0.190*** | 0.204*** | 0.215*** | 0.202*** | 0.218*** | 0.228*** |
| | (0.012) | (0.012) | (0.012) | (0.010) | (0.011) | (0.011) |
| Observations | 35546 | 35434 | 35422 | 35546 | 35434 | 35422 |
| Adjusted $R^2$ | 0.227 | 0.274 | 0.298 | 0.226 | 0.273 | 0.297 |
| Demos | | ✓ | ✓ | | ✓ | ✓ |
| Het Int. Rate | | | ✓ | | | ✓ |

## Table 5: Controlling for Higher Order Moments

This table presents regression results from the specification in equation (4.1), using only respondents who are currently working. The dependent variable is the respondent's point forecast of expected household spending growth over the next 12 months. We use the respondent's forecast-density implied mean for inflation over the next 12 months as the measure of subjective expected inflation. We include real expected earnings growth over the next 12 months, earnings growth density variance, and inflation density variance as control variables. Real expected earnings growth is constructed as the respondent's forecast-density implied mean of their earnings growth less their forecast-density implied mean for inflation. The right panel reports results based on an IV estimator using the respondent's point forecast for inflation as the instrument. Columns (1) and (5) report results with no additional control variables; columns (2) and (6) report results using demographic and labor supply variables as controls; columns (3) and (7) further allow for group-based heterogeneity of borrowing rates based on respondent characteristics; columns (4) and (8) add survey responses about expected macroeconomic conditions. A list of all control variables is provided in the Appendix. Robust standard errors, clustered at the individual level, are reported in parentheses. The sample period is 2013:06 – 2017:07.

| | OLS | | | | IV | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Exp. Inflation | -0.616*** | -0.632*** | -0.611*** | -0.613*** | -0.561*** | -0.568*** | -0.547*** | -0.568*** |
| | (0.037) | (0.038) | (0.036) | (0.036) | (0.042) | (0.045) | (0.043) | (0.043) |
| Real Exp. Earnings Growth | 0.183*** | 0.182*** | 0.195*** | 0.197*** | 0.212*** | 0.216*** | 0.229*** | 0.220*** |
| | (0.025) | (0.024) | (0.026) | (0.026) | (0.026) | (0.026) | (0.026) | (0.026) |
| Earnings Growth Density Variance | 0.007 | 0.005 | 0.009 | 0.009 | 0.006 | 0.004 | 0.008 | 0.008 |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.005) | (0.005) | (0.005) | (0.006) |
| Inflation Density Variance | 0.026*** | 0.029*** | 0.029*** | 0.031*** | 0.025*** | 0.028*** | 0.029*** | 0.031*** |
| | (0.006) | (0.006) | (0.007) | (0.007) | (0.006) | (0.006) | (0.006) | (0.006) |
| Observations | 32490 | 32412 | 32388 | 31318 | 32490 | 32412 | 32388 | 31318 |
| Adjusted $R^2$ | 0.174 | 0.218 | 0.222 | 0.229 | 0.174 | 0.218 | 0.222 | 0.229 |
| Demos | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Het Int. Rate | | | ✓ | ✓ | | | ✓ | ✓ |
| Macro | | | | ✓ | | | | ✓ |

## Table 6: Habit Formation

This table presents estimation results from the specification in equation (4.1). The dependent variable is the respondent's point forecast of expected household spending growth over the next 12 months. We use the respondent's forecast-density implied mean for inflation over the next 12 months as the measure of subjective expected inflation. We include the respondent's point forecast of expected household income growth and their reported change in household spending over the last 12 months as control variables. Real household income growth is constructed as the respondent's point forecast of household income growth less their forecast-density implied mean for inflation. The right panel reports results based on an IV estimator using the respondent's point forecast for inflation as the instrument. Columns (1) and (4) report results with no additional control variables; columns (2) and (5) report results using demographic and labor supply variables as controls; columns (3) and (6) further allow for group-based heterogeneity of borrowing rates based on respondent characteristics. A list of all control variables is provided in the Appendix. Robust standard errors, clustered at the individual level, are reported in parentheses. The sample consists of observations from the special spending modules fielded in April, August and December from 2014:04 – 2017:04.

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.676*** | -0.637*** | -0.675*** | -0.698*** | -0.622*** | -0.661*** |
| | (0.063) | (0.064) | (0.063) | (0.078) | (0.081) | (0.071) |
| Real Exp. Inc. Growth | 0.207*** | 0.226*** | 0.235*** | 0.202*** | 0.230*** | 0.239*** |
| | (0.030) | (0.027) | (0.029) | (0.030) | (0.028) | (0.027) |
| Real Spend Change | 0.028 | 0.027 | 0.025 | 0.028 | 0.027 | 0.025 |
| | (0.023) | (0.029) | (0.029) | (0.023) | (0.029) | (0.029) |
| Observations | 4837 | 4830 | 4831 | 4837 | 4830 | 4831 |
| Adjusted $R^2$ | 0.277 | 0.353 | 0.342 | 0.277 | 0.353 | 0.342 |
| Demos | | ✓ | ✓ | | ✓ | ✓ |
| Het Int. Rate | | | ✓ | | | ✓ |

## Table 7: Forecast Density for Expeced Spending Growth

This table presents estimation results for specifications analogous to those in Table 1 and 2, which replace the respondent's point forecast of household spending growth with their forecast-density implied mean as the dependent variable. We use the respondent's forecast-density implied mean for inflation over the next 12 months as the measure of subjective expected inflation and include the respondent's expected real household income growth over the next 12 months as a control variable in Panel B. Real household income growth is constructed as the respondent's point forecast of household income growth less their forecast-density implied mean for inflation. The right panel reports results based on an IV estimator using the respondent's point forecast for inflation as the instrument. Columns (1) and (4) report results with no additional control variables; columns (2) and (5) report results using demographic and labor supply variables as controls; columns (3) and (6) further allow for group-based heterogeneity of borrowing rates based on respondent characteristics. A list of all control variables is provided in the Appendix. Robust standard errors, clustered at the individual level, are reported in parentheses. The sample consists of observations from the special spending modules fielded in April, August and December from 2014:04 – 2017:04.

**Panel A - Table 1**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.702*** | -0.675*** | -0.666*** | -0.737*** | -0.709*** | -0.709*** |
| | (0.067) | (0.061) | (0.065) | (0.061) | (0.061) | (0.063) |
| Observations | 4841 | 4834 | 4835 | 4841 | 4834 | 4835 |
| Adjusted $R^2$ | 0.255 | 0.378 | 0.342 | 0.254 | 0.378 | 0.342 |

**Panel B - Table 2**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.624*** | -0.569*** | -0.563*** | -0.669*** | -0.616*** | -0.622*** |
| | (0.070) | (0.061) | (0.070) | (0.066) | (0.065) | (0.070) |
| Real Exp. Inc. Growth | 0.075*** | 0.103*** | 0.100*** | 0.065*** | 0.092*** | 0.085*** |
| | (0.020) | (0.018) | (0.022) | (0.018) | (0.017) | (0.021) |
| Observations | 4841 | 4834 | 4835 | 4841 | 4834 | 4835 |
| Adjusted $R^2$ | 0.266 | 0.393 | 0.356 | 0.265 | 0.392 | 0.355 |
| Demos | | ✓ | ✓ | | ✓ | ✓ |
| Het Int. Rate | | | ✓ | | | ✓ |

## Table 8: Alternative Wording of Spending Growth Expectations Question

This table presents estimation results from our baseline specification in equation (4.1). The dependent variable is the respondent's point forecast of expected household spending growth over the next 12 months. We use the respondent's forecast-density implied mean for inflation over the next 12 months as the measure of subjective expected inflation. The sample consists of observations from the special spending modules fielded in April 2015, where a different wording of the question on expected household spending growth was fielded. Panel A reports results using the original wording of the question for this sample. Panel B reports the results using the alternative wording. The right panel reports results based on an IV estimator using the respondent's point forecast for inflation as the instrument. Columns (1) and (4) report results with no additional control variables; columns (2) and (5) report results using demographic and labor supply variables as controls; columns (3) and (6) further allow for group-based heterogeneity of borrowing rates based on respondent characteristics. A list of all control variables is provided in the Appendix. Robust standard errors, clustered at the individual level, are reported in parentheses.

**Panel A - Original Wording**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.691*** | -0.557*** | -0.599*** | -0.502*** | -0.286 | -0.355* |
| | (0.130) | (0.191) | (0.155) | (0.187) | (0.201) | (0.184) |
| Observations | 856 | 855 | 855 | 856 | 855 | 855 |
| Adjusted $R^2$ | 0.132 | 0.299 | 0.251 | 0.122 | 0.286 | 0.238 |

**Panel B - Alternative Wording**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.675*** | -0.644*** | -0.640*** | -0.454*** | -0.207 | -0.353** |
| | (0.105) | (0.156) | (0.118) | (0.144) | (0.166) | (0.138) |
| Observations | 856 | 855 | 855 | 856 | 855 | 855 |
| Adjusted $R^2$ | 0.097 | 0.303 | 0.215 | 0.086 | 0.276 | 0.201 |
| Demos | | ✓ | ✓ | | ✓ | ✓ |
| Het Int. Rate | | | ✓ | | | ✓ |

# Appendix

The first section of the Appendix provides the exact wording for the main questions underlying the empirical exercises in the paper.[33] The second section provides details on the control variables used in the different regression specifications reported in the tables.

## *Survey Questions*

**Question Q8** The next few questions are about inflation.

(a) **Over the next 12 months**, do you think that there will be inflation or deflation? (Note: deflation is the opposite of inflation)

- ○ Inflation
- ○ Deflation (the opposite of inflation)

What do you expect the rate of [inflation/deflation] to be over the next 12 months? Please give your best guess.

(b) **Over the next 12 months**, I expect the rate of [inflation/deflation] to be ______ %

**Question Q9** Now we would like you to think about the different things that may happen to inflation **over the next 12 months**. We realize that this question may take a little more effort.

(a) In your view, what would you say is the percent chance that, **over the next 12 months** ...

| | |
|---|---|
| the rate of inflation will be 12% or higher | ____ percent chance |
| the rate of inflation will be between 8% and 12% | ____ percent chance |
| the rate of inflation will be between 4% and 8% | ____ percent chance |
| the rate of inflation will be between 2% and 4% | ____ percent chance |
| the rate of inflation will be between 0% and 2% | ____ percent chance |
| the rate of deflation (opposite of inflation) will be between 0% and 2% | ____ percent chance |
| the rate of deflation (opposite of inflation) will be between 2% and 4% | ____ percent chance |
| the rate of deflation (opposite of inflation) will be between 4% and 8% | ____ percent chance |
| the rate of deflation (opposite of inflation) will be between 8% and 12% | ____ percent chance |
| the rate of deflation (opposite of inflation) will be 12% or higher | ____ percent chance |

**Question Q25** Next we would like to ask you about your overall household income going forward. By household we mean everyone who usually lives in your primary residence (including yourself), excluding roommates and renters.

**Over the next 12 months**, what do you expect will happen to the total income of all members of your household (including you), from all sources before taxes and deductions?

[33] The complete questionnaire is available at http://www.newyorkfed.org/microeconomics/sce/.

(a) **Over the next 12 months**, I expect my total household income to ...

- ○ increase by 0% or more
- ○ decrease by 0% or more

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

(b) **Over the next 12 months**, I expect my total household income to [increase/decrease] by ______ %

**Question Q26** 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).

**Over the next 12 months**, what do you expect will happen to the total spending of all members of your household (including you)?

(a) **Over the next 12 months**, I expect my total household spending to ...

- ○ increase by 0% or more
- ○ decrease by 0% or more

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

(b) **Over the next 12 months**, I expect my total household spending to [increase/decrease] by ______ %

**Question Q26 (April 2015 variant)**† And now thinking of all spending categories combined, what do you think will happen to your overall monthly household spending **12 months from now, compared to your current monthly spending?**

(a) **12 months from now**, I expect my overall monthly household spending to ...

- ○ have increased by 0% or more
- ○ have decreased by 0% or more

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

(b) **12 months from now**, I expect my overall monthly household spending to have [increased/decreased] by ______ %

†This question comes immediately after a question about expenditure shares for various spending categories and a question about the expected change in monthly household spending in each category 12 months from now compared to current monthly spending.

## *Conditioning Variables and Specifications*

Here we list the conditioning variables used as controls in our regression specifications. There are three sets of control variables: "Demos" represents demographic and labor supply variables; "Het Int. Rate" which comprises of interactions between month dummies and other variables; "Macro" which is based on expectations about economy-wide variables.

### Control Variables: Demos

**Age** (Categorical): 40 and below; 41-59 years old; 60 and above

**Married** (Indicator)

**Female** (Indicator)

**Hispanic** (Indicator)

**Race** (Categorical): White; Black; American Indian; Asian; Hawaiian/Pacific Islander; Other

**Education** (Categorical): No College; Some College/Associate's Degree; Bachelor's Degree

**Spouse** (Indicator): 0 if no spouse living in residence; 1 if one or more spouse/partner living in residence

**Children Under 18** (Categorical): 0 if no children under 18 in residence; 1 if one child under 18; 2 if two children under 18; 3 if three or more children under 18

**Children Over 18** (Indicator): 0 if no children over 18 in residence; 1 if one or more children over 18

**Non-Relatives** (Indicator): 0 if no non-relatives in residence; 1 if one or more non-relatives

**Other Relatives - e.g. Parents/Spouses Parents** (Indicator): 0 if no other relatives in residence; 1 if one or more other relatives

**Living Situation**: This variable takes on values of all of the possible combinations of the number of: Spouses; Children over 25; Children 18-24; Children 6-17; Children younger than 6, Parents/Spouse's Parents; Other Relatives; Non-relatives

**Labor Force Status**: This variable takes on values of all of the possible combinations of these job statuses for the respondent and spouse (where No=0, Yes=1): Working full-time; Working part-time; Not working, but would like to work; Temporarily laid off; Self-employed; On sick or other leave; Permanently disabled or unable to work; Retiree or early retiree; Student; Homemaker

**Multiple jobs** (Indicator): 0 if no job or 1 job; 1 if more than one job.

**Numeracy** (Indicator): 0 if low numeracy; 1 if high numeracy[34]

[34]The numeracy measure is based on five questions in the survey about concepts such as probability and compound interest. High numeracy respondents are designated by answering at least four questions correctly. This approach to measuring numeracy is standard (see, e.g., Lipkus, Samsa, and Rimer 2001, Lusardi 2008).

## Control Variables: Het. Int. Rate

These variables include Age, Female, Race, Education, Numeracy, and Labor Force Status (as defined above) along with:

**Homeownership**: This variable takes on values of all of the possible combinations of two survey responses:

- **Ownership of Primary Residence** (Categorical): 0 if missing; 1 if respondent owns primary residence; 2 if respondent rents primary residence; 3 if other
- **Ownership of Other Homes** (Indicator)

## Control Variables: Macro

**Expected Unemployment** The expected percent chance that the US unemployment rate will be higher 12 months from now

**Expected Interest Rate** The expected percent change that the average interest rate on savings accounts will be higher 12 months from now

**Expected Equity Values** The expected percent chance that average US stock prices will be higher 12 months from now

**Past Credit Availability** Scale from 1 (much harder) to 5 (much easier) in difficulty of obtaining credit compared to one year ago

**Future Credit Availability** Scale from 1 (much harder) to 5 (much easier) in difficulty of obtaining credit one year from now compared to present

# Supplementary Appendix for "Subjective Intertemporal Substitution"

Richard K. Crump, Stefano Eusepi, Andrea Tambalotti & Giorgio Topa

## Table A.1: Baseline Specification (Currently Employed)

This table presents estimation results from our baseline specification in equation (4.1), using only respondents who are currently working. The dependent variable is the respondent's point forecast of expected household spending growth over the next 12 months. We use the respondent's forecast-density implied mean for inflation over the next 12 months as the measure of subjective expected inflation. The right panel reports results based on an IV estimator using the respondent's point forecast for inflation as the instrument. Columns (1) and (4) report results with no additional control variables; columns (2) and (5) report results using demographic and labor supply variables as controls; columns (3) and (6) further allow for group-based heterogeneity of borrowing rates based on respondent characteristics. A list of all control variables is provided in the Appendix. Robust standard errors, clustered at the individual level, are reported in parentheses. The sample period is 2013:06 – 2017:07.

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.770*** | -0.782*** | -0.772*** | -0.723*** | -0.733*** | -0.722*** |
| | (0.028) | (0.030) | (0.030) | (0.027) | (0.029) | (0.028) |
| Observations | 32490 | 32412 | 32388 | 32490 | 32412 | 32388 |
| Adjusted $R^2$ | 0.161 | 0.207 | 0.209 | 0.161 | 0.206 | 0.208 |
| Demos | | ✓ | ✓ | | ✓ | ✓ |
| Het Int. Rate | | | ✓ | | | ✓ |

## Table A.2: Excess Income Sensitivity (Currently Employed)

This table presents estimation results from the specification in equation (4.1), using only respondents who are currently working. The dependent variable is the respondent's point forecast of expected household spending growth over the next 12 months. We use the respondent's forecast-density implied mean for inflation over the next 12 months as the measure of subjective expected inflation and include the respondent's real expected earnings growth over the next 12 months as a control variable. Real expected earnings growth is constructed as the respondent's forecast-density implied mean of their earnings growth less their forecast-density implied mean for inflation. The right panel reports results based on an IV estimator using the respondent's point forecast for inflation as the instrument. Columns (1) and (4) report results with no additional control variables; columns (2) and (5) report results using demographic and labor supply variables as controls; columns (3) and (6) further allow for group-based heterogeneity of borrowing rates based on respondent characteristics. A list of all control variables is provided in the Appendix. Robust standard errors, clustered at the individual level, are reported in parentheses. The sample period is 2013:06 – 2017:07.

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.596*** | -0.614*** | -0.591*** | -0.497*** | -0.512*** | -0.486*** |
| | (0.037) | (0.038) | (0.037) | (0.042) | (0.044) | (0.043) |
| Real Exp. Earnings Growth | 0.186*** | 0.183*** | 0.199*** | 0.236*** | 0.236*** | 0.254*** |
| | (0.023) | (0.023) | (0.024) | (0.024) | (0.025) | (0.025) |
| Observations | 32490 | 32412 | 32388 | 32490 | 32412 | 32388 |
| Adjusted $R^2$ | 0.170 | 0.215 | 0.218 | 0.169 | 0.213 | 0.217 |
| Demos | | ✓ | ✓ | | ✓ | ✓ |
| Het Int. Rate | | | ✓ | | | ✓ |

## Table A.3: Financial Constraints – Availability of Liquid Funds (Currently Employed)

This table presents estimation results from the specification in equation (4.1), using only respondents who are currently working. The dependent variable is the respondent's point forecast of expected household spending growth over the next 12 months. We use the respondent's forecast-density implied mean for inflation over the next 12 months as the measure of subjective expected inflation and include the respondent's real expected earnings growth over the next 12 months as a control variable. Real expected earnings growth is constructed as the respondent's forecast-density implied mean of their earnings growth less their forecast-density implied mean for inflation. Panel A reports results for **Not Constrained** respondents: those who always respond they would be able to produce $2,000 if an unexpected need arose. Panel B reports results for all other respondents, labelled as **Constrained**. The right panel reports results based on an IV estimator using the respondent's point forecast for inflation as the instrument. Columns (1) and (4) report results with no additional control variables; columns (2) and (5) report results using demographic and labor supply variables as controls; columns (3) and (6) further allow for group-based heterogeneity of borrowing rates based on respondent characteristics. A list of all control variables is provided in the Appendix. Robust standard errors, clustered at the individual level, are reported in parentheses. The sample period is 2013:06 – 2017:07.

**Panel A - Not Constrained**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.547*** | -0.558*** | -0.529*** | -0.438*** | -0.443*** | -0.444*** |
| | (0.072) | (0.080) | (0.068) | (0.071) | (0.080) | (0.070) |
| Real Exp. Earnings Growth | 0.164*** | 0.166*** | 0.177*** | 0.211*** | 0.216*** | 0.215*** |
| | (0.032) | (0.033) | (0.037) | (0.029) | (0.032) | (0.032) |
| Observations | 10230 | 10215 | 10215 | 10230 | 10215 | 10215 |
| Adjusted $R^2$ | 0.135 | 0.200 | 0.189 | 0.133 | 0.198 | 0.188 |

**Panel B - Constrained**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.592*** | -0.616*** | -0.592*** | -0.477*** | -0.496*** | -0.472*** |
| | (0.051) | (0.052) | (0.045) | (0.055) | (0.057) | (0.054) |
| Real Exp. Earnings Growth | 0.211*** | 0.217*** | 0.244*** | 0.274*** | 0.284*** | 0.311*** |
| | (0.035) | (0.036) | (0.037) | (0.034) | (0.035) | (0.034) |
| Observations | 17920 | 17872 | 17872 | 17920 | 17872 | 17872 |
| Adjusted $R^2$ | 0.192 | 0.242 | 0.255 | 0.190 | 0.240 | 0.253 |
| Demos | | ✓ | ✓ | | ✓ | ✓ |
| Het Int. Rate | | | ✓ | | | ✓ |

### Table A.4: Financial Constraint – Probability of Missing a Debt Payment (Currently Employed)

This table presents estimation results from the specification in equation (4.1), using only respondents who are currently working. The dependent variable is the respondent's point forecast of expected household spending growth over the next 12 months. We use the respondent's forecast-density implied mean for inflation over the next 12 months as the measure of subjective expected inflation and include the respondent's real expected earnings growth over the next 12 months as a control variable. Real expected earnings growth is constructed as the respondent's forecast-density implied mean of their earnings growth less their forecast-density implied mean for inflation. Panel A reports results for **Not Constrained** respondents: those who never report a positive probability of default on their debt payments. Panel B reports results for all other respondents, labelled as **Constrained**. The right panel reports results based on an IV estimator using the respondent's point forecast for inflation as the instrument. Columns (1) and (4) report results with no additional control variables; columns (2) and (5) report results using demographic and labor supply variables as controls; columns (3) and (6) further allow for group-based heterogeneity of borrowing rates based on respondent characteristics. A list of all control variables is provided in the Appendix. Robust standard errors, clustered at the individual level, are reported in parentheses. The sample period is 2013:06 – 2017:07.

**Panel A - Not Constrained**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.540*** | -0.563*** | -0.528*** | -0.462*** | -0.458*** | -0.372*** |
| | (0.098) | (0.103) | (0.072) | (0.097) | (0.100) | (0.081) |
| Real Exp. Earnings Growth | 0.142*** | 0.144*** | 0.132*** | 0.177*** | 0.192*** | 0.202*** |
| | (0.044) | (0.043) | (0.047) | (0.044) | (0.042) | (0.043) |
| Observations | 6571 | 6551 | 6543 | 6571 | 6551 | 6543 |
| Adjusted $R^2$ | 0.133 | 0.216 | 0.238 | 0.132 | 0.214 | 0.235 |

**Panel B - Constrained**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.602*** | -0.620*** | -0.592*** | -0.499*** | -0.512*** | -0.488*** |
| | (0.039) | (0.039) | (0.038) | (0.047) | (0.048) | (0.048) |
| Real Exp. Earnings Growth | 0.201*** | 0.201*** | 0.225*** | 0.256*** | 0.259*** | 0.281*** |
| | (0.027) | (0.027) | (0.029) | (0.029) | (0.029) | (0.030) |
| Observations | 25904 | 25846 | 25830 | 25904 | 25846 | 25830 |
| Adjusted $R^2$ | 0.181 | 0.232 | 0.239 | 0.179 | 0.230 | 0.238 |
| Demos | | ✓ | ✓ | | ✓ | ✓ |
| Het Int. Rate | | | ✓ | | | ✓ |

## Table A.5: Controlling for Higher Order Moments including the Spending Growth Density Variance

This table presents estimation results from the specification in equation (4.1), using only respondents who are currently working. The dependent variable is the respondent's point forecast of expected household spending growth over the next 12 months. We use the respondent's forecast-density implied mean for inflation over the next 12 months as the measure of subjective expected inflation. We include real expected earnings growth over the next 12 months, earnings growth density variance, spending growth density variance and inflation density variance as control variables. Real expected earnings growth is constructed as the respondent's forecast-density implied mean of their earnings growth less their forecast-density implied mean for inflation. The right panel reports results based on an IV estimator using the respondent's point forecast for inflation as the instrument. Columns (1) and (4) report results with no additional control variables; columns (2) and (5) report results using demographic and labor supply variables as controls; columns (3) and (6) further allow for group-based heterogeneity of borrowing rates based on respondent characteristics. A list of all control variables is provided in the Appendix. Robust standard errors, clustered at the individual level, are reported in parentheses. The sample consists of observations from the special spending modules fielded in April, August and December from 2014:04 – 2017:04.

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp. Inflation | -0.738*** | -0.731*** | -0.762*** | -0.795*** | -0.780*** | -0.776*** |
| | (0.099) | (0.104) | (0.094) | (0.123) | (0.133) | (0.126) |
| Real Exp. Earnings Growth | 0.190*** | 0.154*** | 0.195*** | 0.159** | 0.127* | 0.187** |
| | (0.053) | (0.052) | (0.056) | (0.080) | (0.076) | (0.085) |
| Earnings Growth Density Variance | -0.001 | -0.001 | 0.010 | 0.000 | -0.000 | 0.010 |
| | (0.018) | (0.019) | (0.018) | (0.018) | (0.019) | (0.018) |
| Spending Growth Density Variance | 0.060*** | 0.055*** | 0.063*** | 0.060*** | 0.055*** | 0.063*** |
| | (0.014) | (0.015) | (0.014) | (0.014) | (0.015) | (0.014) |
| Inflation Density Variance | -0.007 | 0.014 | -0.016 | -0.006 | 0.015 | -0.016 |
| | (0.023) | (0.024) | (0.018) | (0.022) | (0.023) | (0.018) |
| Observations | 3397 | 3394 | 3394 | 3397 | 3394 | 3394 |
| Adjusted $R^2$ | 0.254 | 0.344 | 0.302 | 0.254 | 0.344 | 0.302 |
| Demos | | ✓ | ✓ | | ✓ | ✓ |
| Het Int. Rate | | | ✓ | | | ✓ |