# Revisiting Discount Rates: New Evidence from Surveys*

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**Abstract**

This paper studies retail investors' risk-return trade-off. Existing evidence from surveys suggests that households *expect* lower returns, i.e., lower risk compensation, in bad times. Using a direct measure of retail investors' subjective discount rates, we nevertheless find that *required* compensation for risk rises with perceptions of stock market risk. This finding resonates well with long-established principles in asset pricing. We also show that discount rates and perceived risk are more tightly connected for financially literate retail investors and during times of financial and economic distress. Our results have important implications for modelling households' risk-return trade-off and the design of future surveys eliciting return expectations.

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# 1 Introduction

Surveys have recently emerged as a powerful instrument in (financial) economists' tool box, allowing to test and refute long-established models and theories in asset pricing (e.g., Greenwood and Shleifer, 2014; Amromin and Sharpe, 2014; Nagel and Xu, 2022a; Adam et al., 2021; Nagel and Xu, 2022b). Recent survey evidence on expectations of stock market returns has proven particularly unsettling for financial economists: retail investors expect low returns in conjunction with high expected risk or a negative macroeconomic outlook. This raises the question whether households adhere to the fundamental principle of asset pricing that risk averse agents should require additional compensation for taking on higher risk.

Yet, existing evidence on retail investors' risk-return trade-off is based on their return expectations rather than their discount rates. Return expectations and discount rates only coincide if households' willingness to pay equals the current stock market price – a condition that is not met for the majority of survey respondents. Consider the following example for economic intuition: The current price of an asset is 100 and a survey participant expects the asset to be worth 110 in the next period, i.e., the subjective return expectation is 10%. However, assume the survey participants' willingness to pay for the asset deviates from the current market price and only amounts to 95. Then the subjective discount rate is $\frac{110}{95} - 1 \approx 16\%$, which is clearly different from the subjective return expectation of 10%. A clean distinction between discount rates and return expectations is therefore important. Discount rates directly measure required compensation for risk, whereas expectations of returns only capture expected cash flows.[1]

This paper is the first to back out a measure of household investors' subjective discount rates from large-scale survey data. Using this direct measure of discount rates, we investigate the relation between retail investors' perceptions of risk and their required compensation for risk. For a given level of cash flow expectations (i.e., expectations of returns), we find that forward-looking perceptions of higher volatility or less favorable macroeconomic conditions are associated with higher discount rates in the cross-section of household investors. We therefore provide novel evidence that households indeed discount as predicted by theory and intuition in asset pricing. The relation between perceived investment risk and subjective discount rates is stronger for financially literate households and during times of financial and economic distress. Crucially, these results are based on a monthly survey by Gallup/UBS that permits to focus on US households that actively participate in stock markets with a minimum portfolio size of $10.000; over half of our sample even holds a portfolio larger than $100.000. Understanding discount rates of real-life retail investors appears particularly relevant since their way of discounting likely factors into actual decision-taking.

Only about one third of interviewees in our analysis consider the stock market to be fairly valued. As a result, for the majority of survey participants, subjective stock return expectations do not coincide with discount rates. Observations of expected returns alone therefore do not suffice to infer any

[1] We use the terms 'return expectations' and 'cash flow expectations' interchangeably because a given return expectation implies a certain cash flow expectation arising from buying the asset today and selling it at the period end. For example, if the market price of an asset is 100 and an agent expects a one-year return of 10%, this agent expects to generate a one-year ahead cash flow of 110 by buying the asset today and selling in a year (including dividends).

relation between households' perceptions of risk and their required compensation for risk. To address this issue, we isolate variation in subjective discount rates for a fixed level of cash flow expectations in the following way. First, we use the fact that individual households act as price takers. Households that report the same return expectation in a given survey wave therefore hold the same cash flow expectation under the minimal assumption that these households observe roughly the same stock market price at the time of their interview. Second, we exploit a survey question on households' subjective stock market valuation, i.e., households report whether they perceive the market as over-, under- or fairly valued. Without holding cash flow expectations constant, we cannot infer whether households perceive the stock market as overvalued because they have a higher subjective discount rate than the market or lower cash flow expectations. However, comparing only households holding the *same* expectations of returns in a given survey wave, we can infer that households perceiving the market as overvalued must have a higher discount rate than those reporting fair valuation or undervaluation. For a given level of return expectations, we therefore obtain an ordinal measure of subjective discount rates. This measure allows us to cleanly identify correlations between subjective discount rates and expectations of risk or macroeconomic conditions in the cross-section of households holding the same stock return expectations. In order to generalize our idea to survey data with retail investors reporting many different levels of return expectations, we introduce survey$\times$expectations of return fixed-effects. This way, we compare correlations between subjective discount rates and expectations about risk or macro conditions within groups of households that have the same cash flow expectations in a given survey wave.

We apply our identification strategy to the Gallup/UBS survey, which is well established in the finance literature and has been used in various previous studies (e.g., Vissing-Jorgensen, 2003; Malmendier and Nagel, 2011; Amromin and Sharpe, 2014; Nagel and Xu, 2022a; Adam et al., 2021; Nagel and Xu, 2022b), but not to derive an explicit measure of discount rates. The survey elicits expectations of returns on the stock market as a single percentage number, as well as expectations of stock market volatility and the macroeconomy. Importantly, it additionally also asks for households' subjective stock market valuation. As a first step to backing out ordinal discount rates, we verify that retail investors indeed understand the question about stock market valuation correctly. Households thinking the stock market is overvalued expect a lower return. Furthermore, perceived overvaluation predicts a lower probability of reporting that currently is a good time to invest in the stock market. These findings therefore confirm our *ex ante* expectation that retail investors exceeding a portfolio size of $10,000 should generally be sufficiently familiar with the basic jargon of financial investing.

Having established the validity of our measure for perceived stock market valuation, we first apply our identification strategy to a simple setting in which cash flow expectations are constant across households. For this purpose, we only consider the subset of all households that report return expectations equal to 10%.[2] Since these retail investors hold the same cash flow expectations within a given survey wave, households considering the market as overvalued must have a higher discount rate than those considering it as undervalued. Accordingly, our ordinal discount rate measure takes a

[2] 10% corresponds to the mode of the cross-sectional distribution of return expectations, pooled across all survey waves.

value of 1 for households thinking the market is over-, 0 for fairly and -1 for undervalued. We regress this measure on retail investors' expectations of stock market volatility and the macroeconomy with survey fixed-effects. In other words, we analyze the correlation between subjective discount rates and perceived stock investment risk for a given level of cash flow expectations and survey wave. We find a positive relation between the subjective discount rate and expected stock market volatility. We also document a negative relation between the discount rate and expectations about economic growth, the unemployment rate and inflation. Therefore, expectations of a worsening investment environment raise retail investors' discount rates.

In a second step, we generalize our identification strategy to the whole data set, allowing for variation in cash flow expectations across households. For this purpose, we discretize expectations of returns on the stock market by rounding to full percentage points.[3] We then again regress our subjective discount rate measure on expectations of stock market volatility and the macroeconomy, but use survey×expected stock market return fixed-effects. Hence, we always estimate the correlation within groups of households in a given survey wave that hold the same cash flow expectations. Our results fully confirm the findings from the simplified exercise: households that expect higher risk (or a worse macroeconmic environment) have a higher subjective discount rate. These findings are in line with standard asset pricing theory (e.g., Constantinides and Duffie, 1996; Cochrane, 2011).

In a third step, we also explore heterogeneity across individual investors' characteristics and different investment environments. We find a statistically and economically weaker relation between subjective discount rates and expected volatility for investors without college education, with lower income or for female investors. In addition, the period covered by our survey data (1999-2003) allows to examine the relation between retail investors' discount rates and perceptions of risk during two inherently different investment environments: first, a boom phase in stock markets fuelled by the build-up of the infamous dot-com bubble until March 2000; second, a subsequent episode of dramatic falls in stock valuations caused by the burst of the bubble and a recession of the US economy in 2001. We find that the relation between discount rates and retail investors' perceptions of stock investment risk becomes more pronounced during 'risk-off' periods of financial and economic distress.

Finally, we also corroborate our main findings with evidence from an independent second data source for a different time period. Between 2011 and 2013, questions from the RAND American Life Panel survey permit construction of the same measure of ordinal discount rates used in our previous analyses. We relate this ordinal discount rate measure to interviewees' subjective probability of high stock market volatility over the next year and find broad confirmation of our previous results.

Our findings broaden the literature in several ways. First, to the best of our knowledge, we are the first to back out an explicit measure of retail investors' discount rates from large-scale survey data. Charles et al. (2021) investigate the influence of perceived risk on discount rates in a controlled experiment. In their experimental setting subjects repeatedly face a dividend paying asset in a state-switching world. Low dividends have a higher probability of realization in bad than in good states of this world. Subjects have to report expectations of future cash flow distributions and their willingness to pay for this asset without explicitly knowing the identity of the current state. Using

[3] Overall, only 146 of over 30.000 answers were not integers. Therefore, our findings are not sensitive to discretization.

subjects' willingness to pay and their expected future cash flow the authors back out discount rates. In contrast to our findings, their evidence suggests that discount rates *decline* with higher perceived risk, measured as the volatility of the conditional expected cash flow distribution, across as well as within households. Our analysis differs from Charles et al. (2021) along several dimensions: First, we complement their analysis of experimental data with evidence from large-scale survey data elicited at multiple points in time, allowing to also observe discount rates during periods of inherently different investment environments. Second, we focus on real-life retail investors rather than a general sample of households. Third, we isolate variation in expected stock market volatility (i.e., the second moment of cash flow expectations), while keeping the subjective expected value of cash flows (i.e., the first moment) constant. By contrast, in Charles et al. (2021), expected volatility and the expected value of cash flows move simultaneously. Potentially, a channel between the *level* of cash flow expectations and discount rates may therefore be active in their analysis. At the same time, evidence in Charles et al. (2021) can be viewed as complementary to our findings in the sense that their setting allows to analyze the implications of an interplay of discount rates, expected risk and cash flow expectations.

Second, we connect to a large strand of literature that documents pro-cyclicality in survey-based time series of households' return expectations (e.g., Greenwood and Shleifer, 2014), or in both the time series and cross-section (e.g., Amromin and Sharpe, 2014; Giglio et al., 2021). Amromin and Sharpe (2014) use cross-sectional data from the Michigan Survey of Consumers to show that expectations about the economy are positively correlated to expectations of returns, while they are negatively correlated to expectations about stock market risk. They interpret their findings as evidence for pro-cyclical Sharpe ratios of households. Giglio et al. (2021) document a positive cross-sectional and time series correlation of expectations of returns and GDP growth. While they find a weak relation between expected stock market variance and equity portfolio share, they do find a strong negative relation between expectations of returns and expected disaster risk. We can reproduce the above-described findings with our data, i.e., expectations of returns positively covary with economic expectations and negatively covary with expected stock market risk, but add new evidence on discount rates. In contrast to the existing literature we mute cash flow expectations and only concentrate on variation in subjective discount rates. We find that subjective discount rates across households behave as predicted by theory (e.g., Constantinides and Duffie, 1996; Cochrane, 2011): households that expect higher stock market risk or worse macroeconomic conditions have a higher subjective discount rate. Our findings would suggests a role for household agents with pro-cyclical return expectations, but counter-cyclical discount rates in asset pricing models.

Third, Nagel and Xu (2022b) study the time-series relation between subjective equity risk premia and subjective perceptions of stock investment risk for both financial professionals and households. They document a positive risk-return relation for professionals, but find no relation for the aggregate time series of households' beliefs. We instead focus on cross-sectional evidence for households that actively participate in stock markets and examine *required* returns, i.e., subjective discount rates, rather than *expected* equity risk premia. In spite of these differences in methodology and scope, an interesting commonality between Nagel and Xu (2022b) and our paper is that a statistically positive risk-return relationship only persists for financially literate agents.

Fourth, our finding of a positive risk-return trade-off also resonates well with Chinco et al. (2022). They do not directly examine discount rates, but find that households as well as financial professionals allocate less funds of a hypothetical portfolio to stocks if corresponding simulated stock returns exhibit higher volatility.

Our findings also add to the literature on optimal survey design (e.g., Bergman et al., 2020) for surveys eliciting expectations of returns. To further improve insights generated through these surveys, they should always also elicit the price an interviewee is willing to pay for a stock market investment. Only long-term efforts to collect subjective discount rates will allow to understand their relation to other macroeconomic aggregates.

Finally, we also relate to the literature on survey expectations in economics and finance on a more general level. An early overview is provided by Manski (2004). Work in macroeconomics ranges from inflation expectations to households' models of the macroeconomy (e.g., Mankiw et al., 2003; Coibion and Gorodnichenko, 2012; Malmendier and Nagel, 2016; Roth and Wohlfart, 2020; Hanspal et al., 2021; Andre et al., 2021). In financial economics survey data has been used to better understand house prices (e.g., Case et al., 2012; Fuster et al., 2018; Kuchler and Zafar, 2019), bonds (e.g., Buraschi et al., 2018), rates (e.g., Schmeling et al., 2020), equity markets (e.g., Amromin and Sharpe, 2014; Greenwood and Shleifer, 2014; Adam et al., 2021; Giglio et al., 2021) and currencies (e.g., Koijen et al., 2015). We also connect to Vissing-Jorgensen (2003), who was the first to explore the cross-sectional and time series dynamics of the Gallup/UBS survey. She outlined that subjective stock market valuations show interesting dynamics in the time series of the survey. Also McCarthy and Hillenbrand (2021) use subjective stock market valuations to provide evidence for heterogeneous agents in the stock market. However, neither of the two studies examines households' subjective risk-return trade-off.

The remainder of this paper is structured as follows. Section 2 provides an overview of the survey data we use. Section 3 replicates stylized facts on retail investors' expectations of stock market returns found in the earlier literature. Section 4 explains our methodology and Section 5 present results for the relation between discount rates and perceived stock investment risk. Section 6 takes a closer look at the heterogeneity across individual retail investors and different investment environments. Section 7 demonstrates robustness of our results to considering an alternative time period and source of survey data. Section 8 concludes.

## 2 Survey data

Our main data is based on a monthly telephone survey of US households conducted by Gallup and UBS between 1999 and 2003.[4] The survey is well established in the finance literature, e.g., see Vissing-Jorgensen (2003) for an early overview of this survey and Malmendier and Nagel (2011); Nagel and Xu (2022a); Adam et al. (2021); Nagel and Xu (2022b) for other applications. The time period covered by the survey allows to study retail investors' discount rates in two inherently different investment environments – a boom phase in stock markets and the subsequent burst of the dot-com bubble.

[4]The survey data is accessible via Roper Center.

Each month a cross-section of household heads with more than $10.000 invested in stocks, bonds and investment accounts was interviewed. The survey elicited return expectations on the stock market, the perceived stock market valuation as well as expectations of future stock market volatility and the macroeconomy. Our paper exploits the following survey questions.

**Expected stock market return.** For measuring expectations of returns on the stock market we use the following question:

> "Thinking about the stock market more generally, what overall rate of return do you think the stock market will provide investors during the coming twelve months?"

which is consistently available from February 1999 until April 2003. We follow Vissing-Jorgensen (2003) and drop answers that in absolute terms are larger than 95%. The variable is called 'Expected Stock Market Return' in the remainder of the paper.

**Stock market valuation.** We measure the perceived stock market valuation with the question:

> "Do you think the stock market is *(overvalued/valued about right/undervalued)* or are you unsure?"

which was asked from February 1999 until January 2003, with an exception from October to December 2000. We recode the answers as follows: 'overvalued' takes a value of 1, 'valued about right' takes a value of 0 and 'undervalued' a value of $-1$. We drop answers reporting 'unsure'. We call the variable 'Stock Market Valuation' in the remainder of the paper and together with our econometric framework it allows to pin down discount rates on an ordinal scale.

**Expected stock market vola.** For measuring forward-looking expectations about risk we turn to the following question:

> "Do you think the amount of volatility in the marketplace during the next twelve months will increase, stay at the same level, or decrease from what it has been during the last several months?"

which is continuously available from February 1999 until October 2000. We again recode the answers to take a value of 1 for an increase, a value of 0 for no change and -1 for a decrease in expected volatility. We call this variable 'Expected Stock Market Vola'.

**Macroeconomic expectations.** Moreover, we exploit a question eliciting expectations about the macroeconomy. More precisely, the question asks:

> "Now, I would like to ask you to think about the factors that could affect the overall investment environment over the next twelve months. On the same five-point scale, as far as the general condition of the economy is concerned, how would you rate *(economic growth/the unemployment rate/inflation)*, over the next twelve months?"

Interviewees could decide between 'very optimistic', 'somewhat optimistic', 'neither optimistic nor pessimistic', 'somewhat pessimistic', 'very pessimistic' or 'don't know'. The question is continuously available from February 1999 until July 2003. We recode answers to take a value of 1 for 'very optimistic' or 'somewhat optimistic', a value of 0 for 'neither optimistic nor pessimistic' and -1 for 'somewhat pessimistic' or 'very pessimistic'. Resulting variables are called 'Expected Economic Growth', 'Expected Unemployment Rate' and 'Expected Inflation' for the remainder of the paper.

**Good time to invest.** Finally, we use a question eliciting whether now it is a good time to invest.

> "Do you think now is a good time to invest in the financial markets, or not?"

Households could answer with 'yes', 'no' or 'don't know'. The question is available from February 1999 until January 2003, with an exception of October to December 2000 and we recode it as a dummy variable ('yes' corresponds to a value of 1). We will use this variable, called 'Good Time to invest', to verify that households understood the stock market valuation question.

Overall, we are now equipped with a measure for households' expected return on the stock market, their subjective stock market valuation and their expectations about stock market volatility and the macroeconomy. The survey also elicited a wide range of standard household characteristics. Throughout the paper, all of our estimations include education (college/no college), age and age squared, log(income), employment status (employed/retired/unemployed), wealth invested in the stock market (below $100k/above $100k) and gender as controls. After recoding all variables, we drop all observations which contain a missing value in the basic household characteristics and additionally we drop all observations which did not report expectations of returns on the stock market and expectations about volatility or the macroeconomy. Summary statistics are presented in Table 1.

[Table 1 about here]

## 3 Expectations of returns and perceived risk

Previous evidence on household investors documents that they expect higher returns when the economy is expected to improve (e.g., Greenwood and Shleifer, 2014; Amromin and Sharpe, 2014; Giglio et al., 2021), or expected risk is low (e.g., Amromin and Sharpe, 2014; Giglio et al., 2021). The present section briefly touches on these well-known stylized facts by demonstrating that similar patterns also exist in the cross-section of survey participants examined in this paper.

To do so we relate retail investors' expectations of 12-month stock market returns to their expectations about stock market volatility and the macroeconomic environment over the same horizon. For this purpose, we estimate the following regression model.

$$E_{it}^{12M}[r] = \alpha_t + \beta_1 * E_{it}^{12M}[\text{Vola}] + \beta_2 * E_{it}^{12M}[\text{Growth}] + \beta_3 * E_{it}^{12M}[\text{Unemp}] + \beta_4 * E_{it}^{12M}[\text{Infl}] + \gamma C_{it} + \varepsilon_{it} \quad (1)$$

where $E_{it}^{12M}[r]$ denotes household investor $i$'s expectation of the 12-month stock market return, elicited in survey $t$. $E_{it}^{12M}[\text{Vola}]$ measures survey participants' expectations that stock market volatility will increase (1), stay the same (0) or fall (-1) during the next 12 months. $E_{it}^{12M}$[Growth], $E_{it}^{12M}$[Unemp] and $E_{it}^{12M}$[Infl] denote expectations about economic growth, unemployment and inflation. In all three cases, a value of 1 for these variables indicates the expectation of improving conditions over the next 12 months, 0 the expectation of no changes and $-1$ the expectation of a deterioration in the respective macro condition. Finally, $\alpha_t$ denotes a survey wave fixed-effect and $C_{it}$ a vector of household-specific characteristics including education, age, age squared, log(income), employment status, wealth invested in the stock market and gender, as detailed in section 2. Standard errors are clustered at the survey level.

Table 2 presents coefficient estimates for the model in equation 1. Columns 1–4 relate household investors' expectations of returns to forward-looking perceptions of stock market volatility respectively expectations about one macroeconomic variable at a time. Column 5 comprises all expectations about volatility and macroeconomic conditions in one specification. Resonating well with stylized facts about household investors' stock return expectations, bad times – i.e., higher expectations of future volatility respectively a more pessimistic outlook on macroeconomic conditions – tend to be associated with *lower* expectations of stock market returns.

[Table 2 about here]

However, based on this evidence alone we cannot necessarily conclude that household investors who hold a more pessimistic outlook on stock market risk and economic fundamentals also apply a lower *discount rate* to value expected future cash flows. This is because households with heterogeneous beliefs and preferences can disagree with the current stock market valuation. Subjective discount rates therefore can deviate from reported expectations of returns in any direction. Potentially, they could also still align with the principles and intuition from the asset pricing literature that perceived risk should be positively related to discount rates.

As a first tentative piece of evidence in this direction, we re-estimate the first specification presented in column 1 of Table 2 above, but this time only consider the subset of retail investors that report that the market is fairly valued. We do so for two reasons. First, expected stock market volatility most cleanly isolates perceptions about future stock investment risk, separately from cash flow expectations. Second, for households in this subset, which represent about a third of our overall sample, expectations of stock market returns need to equal the their subjective discount rate. Re-estimating the first specification thus tests how expected stock market volatility, i.e., risk, varies with subjective discount rates across households. The main coefficient of interest is reported in equation (2).

$$E_{it}^{12M}[r] = \widehat{\alpha_t} + \mathbf{0.6198} * E_{it}^{12M}[\text{Vola}] + \widehat{\gamma} C_{it} + \widehat{\varepsilon_{it}} \quad (2)$$

Compared to column 1 in Table 2, the coefficient of expected stock market volatility flips sign to positive and is significant with a p-value below 5% percent (SE=0.2258). In other words, expectations of higher volatility are now associated with higher return expectations, which in this subset of households equal their discount rate.

The remainder of this paper further investigates the relation between discount rates and expected risk. More precisely, we first explain our approach to backing out a measure of household investors' discount rates and subsequently explore how discount rates relate to forward-looking perceptions of risk.

# 4 Backing out discount rates from survey data

Observing the current stock market value and an investor's subjective 12-month expectation of returns does not automatically imply the investor's discount rate. Rather, given a fixed current stock market price, it reveals information about the investor's subjective 12-month cash flow expectation. As a consequence of heterogeneity in beliefs and preferences, individual investors' willingness to pay might – and in most cases *does* – deviate from the current stock market valuation. Indeed, only 36% of households report the stock market to be fairly valued across our whole sample. In the following, we describe how we exploit two questions from the Gallup/UBS survey on household investors' stock return expectations and their perceptions of current stock market valuations to back out an ordinal measure of their individual discount rate, *conditional* on a fixed level of stock return expectations.

## 4.1 Motivating example

We introduce our approach with the following motivating example. Assume that the stock market currently stands at $S_t = 100$ and you run a survey with household investors $i$ asking for their subjective cash flow expectations, $E_t^i[S_{t+1}]$, and their perception of the current stock market valuation (undervalued/fair/overvalued). Consider two survey participants, M and P, who hold the same cash flow expectations of $E_t^i[S_{t+1}] = 110$ over the next period (equivalently, they could report the same expectations of returns of 10%), but differ in their valuation assessment regarding $S_t$ in the following way:

| Survey participant | Cash flow expectations | Perceived stock market valuation |
|---|---|---|
| M | $E_t^M[S_{t+1}] = 110$ | overvalued |
| P | $E_t^P[S_{t+1}] = 110$ | undervalued |

Survey participants' view about the current stock market valuation directly implies the following statement about their current willingness to pay, $S_t^i$, for a stock market investment:

$$S_t^M < S_t = 100, \text{ since `overvalued'} \tag{3}$$

$$S_t^P > S_t = 100, \text{ since `undervalued'} \tag{4}$$

Furthermore, since $E_t^M[S_{t+1}] = E_t^P[S_{t+1}] = 110$, it follows for survey participants' discount rate $r^i$ that

$$\frac{110}{r^M} = S_t^M < S_t < S_t^P = \frac{110}{r^P} \tag{5}$$

$$\Rightarrow r^M > r^P \tag{6}$$

In words: Since M and P hold the same one-period cash flow expectations (110), but M thinks the market is overvalued while P thinks it is undervalued, it follows that M must have a higher discount rate than P.

### 4.2 Construction of an ordinal discount rate measure from survey data

We now extend the idea underlying the above example to actual responses to the Gallup/UBS survey. Under the minimal assumption that participants surveyed at the same point in time observe roughly the same stock market value, participants within a given survey wave and reporting the same subjective stock return expectations should also hold the same 12-month cash flow expectations. For a given survey wave, *within* the group of all survey participants with the *same* level of stock return expectations (e.g. 10%), we can therefore construct an ordinal measure of discount rates: Survey participants who think the stock market is overvalued have relatively higher discount rates, participants who regard the market to be fairly valued have 'medium' discount rates and participants who think the market is undervalued have relatively lower discount rates. Accordingly, for participant $i$ in survey $t$ holding a return expectation of level $z$, we define the ordinal discount rate measure as

$$r_{itz}^{ord} = \begin{cases} 1 & \text{if 'overvalued'} \\ 0 & \text{if 'fair'} \\ -1 & \text{if 'undervalued'} \end{cases} \tag{7}$$

Note that the economic interpretation of $r_{atz}^{ord}$ as the ordinal discount rate is only valid within the group of all participants in survey $t$ reporting the same 12-month expected stock market return equal to level $z$. In the next section, we describe an econometric approach tailored to this interpretation to relate household investors' discount rates to their outlook on stock market risk. First, however, the remainder of the present section discusses evidence that survey participants indeed appear to correctly understand and answer the survey question regarding their assessment of current stock market valuations.

### 4.3 Do survey participants understand over- and undervaluation?

A fundamental prerequisite for the construction of the ordinal discount rate measure $r_{it}^{ord}$ described above (equation (7)) is that survey participants understand the notion of 'overvaluation', 'fair valuation' and 'undervaluation'. For example, it would be a problem if survey respondents erroneously answered that the stock market is 'overvalued' but meant to express favorable valuation levels or high future growth potential for stock prices. In the context of the Gallup/UBS survey, such systematic misinterpretation *ex ante* appears rather implausible, since survey participants have at least \$10,000 invested in the stock market and are therefore likely familiar with the basic jargon of financial investing. Nevertheless, we also empirically back this assumption. For this purpose, we define a variable *valuation* for participant $i$ in survey $t$ as

$$valuation_{it} = \begin{cases} 1 & \text{if 'overvalued'} \\ 0 & \text{if 'fair'} \\ -1 & \text{if 'undervalued'} \end{cases} \tag{8}$$

Note that *valuation* is defined identically to $r^{ord}_{atz}$, the ordinal discount rate (equation (7)). We use two separate variables and drop the subscript $z$ for *valuation* to explicitly stress that $r^{ord}_{atz}$ can only be interpreted as the ordinal discount rate *conditional* on a fixed level $z$ of stock return expectations, whereas an unconditional interpretation of *valuation* is possible – values of 1 indicate that stocks are regarded as too expensive, values of $-1$ indicate that prices are seen as too low. To check whether this interpretation also matches the notion that survey participants have in mind, we run regressions of the form

$$y_{it} = \alpha_t + \beta * valuation_{it} + \boldsymbol{\gamma} C_{it} + \varepsilon_{it} \tag{9}$$

where $y_{it}$ denotes i) the subjective 12-month stock return expectation or ii) a binary variable indicating whether the respondent thinks that now is a good time to invest (1) or not (0). $\alpha_t$ denotes a survey wave fixed-effect and $valuation_{it}$ the perceived stock market valuation defined as in equation 8. Finally, $C_{it}$ is a vector of household-specific characteristics with corresponding coefficient vector $\boldsymbol{\gamma}$. Characteristics include education, age, age squared, log(income), employment status, wealth invested in the stock market and gender, as detailed in section 2. Standard errors are clustered at the survey level.

[Table 3 about here]

Coefficient estimates are presented in Table 3. According to column 1, household investors who think that the stock market is currently overvalued (1) hold lower stock market return expectations than investors who think that the market is fairly valued (0) or undervalued (-1). Similarly, respondents who regard the market as overvalued are less likely to believe that now is a good time to invest. Both results therefore consistently confirm that survey participants correctly understand the notion of over- and undervaluation.

# 5 Discount rates and perceived risk

As demonstrated in Section 3 and consistent with the earlier literature, (prospective) bad times tend to be associated with lower stock return expectations in the cross-section of households. However, the relation between expected risk and expectations of returns switches sign as soon as we only consider investors whose willingness to pay equals the current price. The present section dives deeper into the fundamental relation between retail investors' discount rates and their expectations of stock investment risk.

More specifically, we examine how our ordinal measure of discount rates defined in equation (7), $r^{ord}_{atz}$, relates to household investors' subjective expectations of stock market volatility during the next

12 months. Expectations of stock market volatility represent our cleanest and therefore preferred measure of forward looking perceptions of stock investment risk. In addition, however, we also explore expectations about economic growth, unemployment and inflation as potential drivers behind the discount rate. Recall that an economic interpretation of $r^{ord}_{atz}$ as an ordinal measure of the discount rate is only sensible within the group of households with the same cash flow expectations $z$ (respectively expectations of stock returns for a fixed current stock market value). In a first step, we therefore restrict our sample to only those investors that report an expected return on the stock market of $k = 10\%$ (we relax this restriction further below). As Figure 1 in the Internet Appendix shows, this is the most frequently reported value in our data. The corresponding baseline regression specification reads

$$r^{ord}_{atz=10} = \alpha_t + \beta_1 * E^{12M}_{it}[\text{Vola}] + \beta_2 * E^{12M}_{it}[\text{Growth}] + \beta_3 * E^{12M}_{it}[\text{Unemp}] + \beta_4 * E^{12M}_{it}[\text{Infl}] + \boldsymbol{\gamma} C_{it} + \varepsilon_{it} \quad (10)$$

where $E^{12M}_{it}[\text{Vola}]$ measures survey participants' expectations that volatility will increase (1), stay the same (0) or fall (-1) during the next 12 months. $E^{12M}_{it}[\text{Growth}]$, $E^{12M}_{it}[\text{Unemp}]$ and $E^{12M}_{it}[\text{Infl}]$ denote expectations about economic growth, unemployment and inflation. In all three cases, a value of 1 for these variables indicates the expectation of improving conditions over the next 12 months, 0 the expectation of no changes and $-1$ the expectation of deterioration in the resprective macro variable. Finally, $\alpha_t$ denotes a survey wave fixed effect and $C_{it}$ a vector of household-specific characteristics including education, age, age squared, log(income), employment status, wealth invested in the stock market and gender, as detailed in section 2. Standard errors are clustered at the survey level.

Table 4 presents coefficient estimates for the model in equation (10).[5] In columns 1–4, we include one measure of expected risk at a time, while column 5 simultaneously incorporates all four measures. For our preferred and most direct measure of expected stock market risk, the expected change in stock market volatility, we find that household investors expecting an increase in volatility apply relatively higher discount rates. In line with this notion, a less favourable outlook on the other three macro variables is also associated with a higher subjective discount rate.

[Table 4 about here]

In a second step, we now broaden our analysis to include all survey participants, across all levels of expectations of returns (rather than just those reporting 10% return expectation, as in the previous exercise). For this purpose, it is necessary to refine the model in equation (10) to include fixed-effects $\alpha_{zt}$ for the interaction between survey waves (time) and each level of subjective return expectations:

$$r^{ord}_{itz} = \alpha_{zt} + \beta_1 * E^{12M}_{it}[\text{Vola}] + \beta_2 * E^{12M}_{it}[\text{Growth}] + \beta_3 * E^{12M}_{it}[\text{Unemp}] + \beta_4 * E^{12M}_{it}[\text{Infl}] + \boldsymbol{\gamma} C_{it} + \varepsilon_{it} \quad (11)$$

This way, we again exploit variation within groups of household investors holding the same cash flow expectations at the same point in time. To obtain sensible groups, we discretize particpants' expec-

[5] We do not use survey weights out of efficiency concerns (see Deaton, 1997, page 70). However, we checked and confirmed robustness of our main results to using sample weights.

tations about the 12-month stock market return by rounding to full percentage points.[6] Coefficient estimates are presented in Table 5 and fully confirm results from Table 4. Unambiguously, we find that for a given level of cash flow expectations, household investors with perceptions of higher future risk apply higher discount rates.

[Table 5 about here]

Overall, our results are therefore in line with a mechanism emphasized by standard asset pricing theory: households apply higher discount rates if they expect higher risk. Our findings contrast with recent experimental evidence by Charles et al. (2021) who find that subjects' discount less when perceived risk is high. However, our analysis differs from Charles et al. (2021) along several dimensions: First, we analyze large-scale survey data for real-life retail investors rather than a sample of general households. Deviations in findings would therefore resonate well with our results in the next section that the positive relation between discount rates and perceived risk found in our analysis vanishes for supposedly less sophisticated retail investors. Second, we isolate variation in expected stock market volatility (i.e., the second moment of cash flow expectations), while keeping the subjective expected value of cash flows (i.e., the first moment) constant. By contrast, in Charles et al. (2021), expected volatility and the expected value of cash flows move simultaneously. Potentially, a channel between the *level* of cash flow expectations, i.e., the first moment, and discount rates may therefore be active in their analysis. At the same time, evidence in Charles et al. (2021) can be viewed as complementary to our findings in the sense that their setting allows to analyze the implications of an interplay of discount rates, expected risk and cash flow expectations.

# 6 Heterogeneity across households and investment environments

Having established a negative relation between subjective discount rates and expected risk in the cross-section of retail investors, we now explore heterogeneity of this effect across individual households and different investment environments.

## 6.1 Heterogeneity across households

First, to start with cross-sectional heterogeneity, we estimate the following equation, focusing on expected volatility, our cleanest and therefore preferred measure of perceived stock investment risk.

$$r_{itz}^{ord} = \alpha_{zt} + \beta_1 * E_{it}^{12M}[\text{Vola}] + \delta_1 * E_{it}^{12M}[\text{Vola}] \times \mathit{Characteristic} + \gamma C_{it} + \varepsilon_{it} \tag{12}$$

The model is similar to equation (11), except that we focus on expected volatility and interact $E_{it}^{12M}[Vola]$ with one household characteristic at a time. These characteristics comprise education, wealth invested, log(income) and gender.

[6] Overall, only 146 of over 30.000 answers were not integers. Thus, our findings are not sensitive to discretization.

In Table 6 we observe a lower correlation of subjective discount rates and expected stock market volatility conditional on having no college education or a lower income. No college education or low income imply a relationship close to zero between subjective discount rates and expected volatility.[7] This suggests that financial literacy potentially plays an important role for setting discount rates in line with asset pricing theory. We also find a significantly lower effect for female investors.

[Table 6 about here]

Interestingly, heterogeneity along proxies for financial literacy only applies to the relation between discount rates and expectations of stock market volatility. As shown in Tables IA.1, IA.2 and IA.3 in the Internet Appendix, we find a broadly homogeneous relationship between discount rates and expectations about macroeconomic fundamentals, i.e., for macro expectations, the relationship holds irrespective of proxies for financial literacy and yields no consistently significant interaction terms.

### 6.2 Heterogeneity across investment environments

The time frame covered by our Gallup/UBS survey data (1999–2003) allows to study the relationship between retail investors' discount rates and expected stock investment risk during two inherently different investment environments – a boom phase in stock market prices and an episode of severe market correction accompanied by an economic recession. From 1995 to its peak in March 2000, the NASDAQ Composite index rose by a factor of five during the build-up of the infamous dot-com bubble, fuelled by speculative investment in internet companies. The subsequent bubble burst saw the index fall by nearly 80% from its peak by October 2002. In addition, in March 2001, the US economy entered an eight-month recession. Accordingly, our subsequent analysis distinguishes two periods illustrated in Figure 1: first, a 'risk-on' period covering the bull-market from the beginning of our sample up to and including the NASDAQ Composite peak in March 2000; second, a 'risk-off' period covering all subsequent observations, characterized by a dramatic fall in valuations across all major US stock market indices and the recession episode.

[Figure 1 about here]

We define a 'risk-off' dummy, $D^{\text{risk-off}}$, that takes a value of 1 for all observations falling into the latter period and augment the model in equation (11) to include interactions between the dummy and expectations of stock market volatility respectively macroeconomic fundamentals.

$$\begin{aligned} r^{ord}_{itz} = \alpha_{zt} + &\beta_1 * E^{12M}_{it}[\text{Vola}] + \delta_1 * E^{12M}_{it}[\text{Vola}] \times D^{\text{risk-off}}_t + \\ &\beta_2 * E^{12M}_{it}[\text{Growth}] + \delta_2 * E^{12M}_{it}[\text{Growth}] \times D^{\text{risk-off}}_t + \\ &\beta_3 * E^{12M}_{it}[\text{Unemp}] + \delta_3 * E^{12M}_{it}[\text{Unemp}] \times D^{\text{risk-off}}_t + \\ &\beta_4 * E^{12M}_{it}[\text{Infl}] + \delta_4 * E^{12M}_{it}[\text{Infl}] \times D^{\text{risk-off}}_t + \\ &\gamma C_{it} + \varepsilon_{it} \end{aligned} \tag{13}$$

[7] The lowest observation for income in our data is \$10000, i.e., $\log(10000) \approx 10$.

Table 7 presents coefficient estimates for the model in equation (13). In columns 1–4, we include one expectation measure of risk at a time, while column 5 simultaneously incorporates all four measures. We find the relation between retail investors' discount rates and their expectations of risk to become more pronounced in the aftermath of the burst of the dot-com bubble. This result is particularly pronounced for our cleanest measure of expected stock investment risk: for retail investors' expected stock market volatility, the interaction remains significant also when simultaneously including all four measures of expectations (volatility and macro conditions) at once.

[Table 7 about here]

The statistical insignificance of the interaction for expectations of growth respectively labor market conditions in the most comprehensive specification (column 5) in Table 7, but not in columns 2 and 3, could also be caused by the shorter sample period available for the regression in column 5. Recall that retail investors' expectations of stock market volatility included in this specification are only available until October 2000. While the stock market already dropped in 2000, the real economy only took a hit in the subsequent years.

To further explore the evolution of coefficients over time, we also re-estimate the model in equation (13) with year-dummies instead of $D^{\text{risk-off}}$, considering one measure of risk expectations at a time. Figure 2 visualizes the estimated year-specific relation between discount rates and expectations about volatility respectively macro conditions. Indeed, for expectations of volatility, the relation immediately strengthens in the year of the stock market bubble burst. By contrast, for expectations of growth and labor market conditions, the relation to discount rates only becomes more pronounced in 2001, the year of the US recession.

[Figure 2 about here]

Overall, our findings from this section therefore strongly suggest that the general investment environment plays an important role for the responsiveness of retail investors' discount rates to their expectations of stock investment risk. During 'risk-off' periods, i.e., episodes of financial and economic distress, the positive relation between discount rates and perceptions of risk becomes more pronounced.

# 7 Additional evidence from the American Life Panel survey

Finally, we corroborate our main findings with evidence from an independent second survey source for a different time period. With the caveat of focusing on a sample of general US households rather than retail investors, 15 survey waves from the RAND American Life Panel, fielded between 2011 and 2013, strongly support our results. During this period, the survey included the following three questions: i) it asked interviewees what a $1000 investment in the S&P500 index would be worth in a year; ii) it elicited the perceived probability that the actual realization would fall within ±5% around this subjective expectation respectively would fall outside the interval; iii) it asked survey participants whether they perceived the stock market as under-, fairly or overvalued.

The first question directly reveals households' one-year cash flow expectations. Using the second question, we construct a proxy for expected stock market volatility. More specifically, we interpret the perceived probability that the realized value would deviate by more than ±5% from the subjective expected value as the perceived probability of high stock market volatility. That is, for survey participant $i$ at time $t$,

$$P_t^i(\text{high vola}) = P_t^i\left(\text{S\&P500}_{t+12M} < 0.95E_t^i[\text{S\&P500}_{t+12M}] \mid \text{S\&P500}_{t+12M} > 1.05E_t^i[\text{S\&P500}_{t+12M}]\right) \tag{14}$$

The third question again allows to construct an ordinal discount rate measure for a fixed level of cash flow expectations.

Column 1 in Table 8 presents coefficient estimates for re-estimating the model in equation (11) with data from the American Life Panel, i.e., we regress the ordinal discount rate measure on the perceived probability of high stock market volatility, including controls for household characteristics and fixed effects for the interaction between survey waves and each level of subjective return expectations.[8] In line with our previous findings, an increase in the subjective probability of high stock market volatility is associated with a higher discount rate. In columns 2–4, we additionally interact the subjective probability of high volatility with selected household characteristics (cf. the model in equation (12)). Confirming our previous results, proxies for low levels of financial literacy (no college, low income) are associated with a weaker respectively less positive relation between perceived stock investment risk and subjective discount rates.[9]

[Table 8 about here]

# 8 Conclusion

For the majority of retail investors, return expectations do not coincide with their discount rate since their subjective stock market valuation does not equal the current market price. We back out retail investors' subjective discount rates by exploiting their stock return expectations and perceptions of current stock market valuations elicited in a survey by Gallup/UBS. We then relate subjective discount rates to perceived investment risk in the cross-section of households. Whereas the existing literature generally finds a negative relation between perceived investment risk and *expectations* of risk compensation, i.e., return expectations, we find a positive relationship between perceived risk and *required* risk compensation, i.e., discount rates. This result is broadly in line with standard asset pricing theory. The positive risk-return trade off appears stronger for financially literate retail investors. Moreover, we document a stronger relation in 'risk-off' periods, i.e., after the burst of the dot-com bubble and the subsequent recession of the US economy, compared to 'risk-on' periods, i.e., in the run-up to the bubble peak. Furthermore, our results also speak to the literature on the optimal design of surveys: to further improve insights about households' discount rates, these surveys

[8] See Table 4 in the Internet Appendix for summary statistics of the sample.

[9] In Table 6 for the Gallup/UBS data, we also consider the interaction with a dummy for wealth invested below \$100k. This variable is not observable in the American Life Panel Survey and therefore omitted in Table 8.

should also include questions about the price investors are willing to pay for the stock market. Only long-term efforts to collect subjective discount rates will allow to understand their relation to other macroeconomic aggregates.

# References


Adam, K., Matveev, D., and Nagel, S. (2021). Do survey expectations of stock returns reflect risk adjustments? *Journal of Monetary Economics*, 117:723–740.

Amromin, G. and Sharpe, S. A. (2014). From the horse's mouth: Economic conditions and investor expectations of risk and return. *Management Science*, 60(4):845–866.

Andre, P., Haaland, I., Roth, C., and Wohlfart, J. (2021). Narratives about the macroeconomy. Technical report, CEBI Working Paper Series.

Bergman, A., Chinco, A., Hartzmark, S. M., and Sussman, A. B. (2020). Survey curious? start-up guide and best practices for running surveys and experiments online. *Start-Up Guide and Best Practices For Running Surveys and Experiments Online (October 05, 2020)*.

Buraschi, A., Piatti, I., and Whelan, P. (2018). Rationality and subjective bond risk premia. *Said Business School Research Papers*, 36.

Case, K. E., Shiller, R. J., and Thompson, A. (2012). What have they been thinking? home buyer behavior in hot and cold markets. Technical report, National Bureau of Economic Research.

Charles, C., Frydman, C., and Kilic, M. (2021). Discounting less in bad times: Shining the light on cash flow expectations. *Available at SSRN*.

Chinco, A., Hartzmark, S. M., and Sussman, A. B. (2022). A new test of risk factor relevance. *The Journal of Finance*, 77(4):2183–2238.

Cochrane, J. H. (2011). Presidential address: Discount rates. *The Journal of finance*, 66(4):1047–1108.

Coibion, O. and Gorodnichenko, Y. (2012). What can survey forecasts tell us about information rigidities? *Journal of Political Economy*, 120(1):116–159.

Constantinides, G. M. and Duffie, D. (1996). Asset pricing with heterogeneous consumers. *Journal of Political economy*, 104(2):219–240.

Deaton, A. (1997). *The analysis of household surveys: a microeconometric approach to development policy*. World Bank Publications.

Fuster, A., Perez-Truglia, R., Wiederholt, M., and Zafar, B. (2018). Expectations with endogenous information acquisition: An experimental investigation. *The Review of Economics and Statistics*, pages 1–54.

Giglio, S., Maggiori, M., Stroebel, J., and Utkus, S. (2021). Five facts about beliefs and portfolios. *American Economic Review*, 111(5):1481–1522.

Greenwood, R. and Shleifer, A. (2014). Expectations of returns and expected returns. *The Review of Financial Studies*, 27(3):714–746.

Hanspal, T., Weber, A., and Wohlfart, J. (2021). Exposure to the covid-19 stock market crash and its effect on household expectations. *The Review of Economics and Statistics*, 103(5):994–1010.

Koijen, R. S., Schmeling, M., and Vrugt, E. B. (2015). Survey expectations of returns and asset pricing puzzles. *London Business School, City University London, and VU University Amsterdam*, 1:66.

Kuchler, T. and Zafar, B. (2019). Personal experiences and expectations about aggregate outcomes. *The Journal of Finance*, 74(5):2491–2542.

Malmendier, U. and Nagel, S. (2011). Depression babies: do macroeconomic experiences affect risk taking? *The quarterly journal of economics*, 126(1):373–416.

Malmendier, U. and Nagel, S. (2016). Learning from inflation experiences. *The Quarterly Journal of Economics*, 131(1):53–87.

Mankiw, N. G., Reis, R., and Wolfers, J. (2003). Disagreement about inflation expectations. *NBER macroeconomics annual*, 18:209–248.

Manski, C. F. (2004). Measuring expectations. *Econometrica*, 72(5):1329–1376.

McCarthy, O. and Hillenbrand, S. (2021). Heterogeneous investors and stock market fluctuations. *Available at SSRN 3944887*.

Nagel, S. and Xu, Z. (2022a). Asset Pricing with Fading Memory. *The Review of Financial Studies*, 35(5):2190–2245.

Nagel, S. and Xu, Z. (2022b). Dynamics of subjective risk premia. Technical report, National Bureau of Economic Research.

Roth, C. and Wohlfart, J. (2020). How do expectations about the macroeconomy affect personal expectations and behavior? *Review of Economics and Statistics*, 102(4):731–748.

Schmeling, M., Schrimpf, A., and Steffensen, S. (2020). Monetary policy expectation errors. *Available at SSRN 3553496*.

Vissing-Jorgensen, A. (2003). Perspectives on behavioral finance: Does" irrationality" disappear with wealth? evidence from expectations and actions. *NBER macroeconomics annual*, 18:139–194.

Table 1: **Summary statistics Gallup/UBS survey sample**

This table displays summary statistics for the Gallup/UBS survey sample. Panel A shows summary statistics for the main regression variables, while panel B summarizes household characteristic used as control variables.

| | Mean | Median | SD | Min | Max |
|---|---|---|---|---|---|
| *Panel A. Main Variables* | | | | | |
| Expected Stock Market Return | 10.22 | 9.06 | 10.99 | -74.00 | 95.00 |
| Stock Market Valuation (Ordinal Discount Rate) | 0.28 | 0.34 | 0.75 | -1.00 | 1.00 |
| Expected Stock Market Vola | 0.27 | 0.32 | 0.72 | -1.00 | 1.00 |
| Expected Economic Growth | 0.36 | 0.47 | 0.83 | -1.00 | 1.00 |
| Expected Labor Market Cond. | 0.25 | 0.34 | 0.86 | -1.00 | 1.00 |
| Expected Inflation | 0.26 | 0.35 | 0.83 | -1.00 | 1.00 |
| Good Time to invest | 0.72 | 0.72 | 0.45 | 0.00 | 1.00 |
| *Panel B. Household Characteristics* | | | | | |
| Education (college) | 0.63 | 0.63 | 0.48 | 0.00 | 1.00 |
| Age | 48.23 | 47.09 | 13.27 | 18.00 | 99.00 |
| Age squared | 2502.12 | 2217.48 | 1373.23 | 324.00 | 9801.00 |
| Income | 74940.50 | 79936.74 | 24363.40 | 10000.00 | 100000.00 |
| Wealth invested (above 100k) | 0.55 | 0.55 | 0.50 | 0.00 | 1.00 |
| Gender (female) | 0.38 | 0.38 | 0.49 | 0.00 | 1.00 |
| Employed | 0.77 | 0.77 | 0.42 | 0.00 | 1.00 |
| Unemployed | 0.16 | 0.16 | 0.37 | 0.00 | 1.00 |
| Retired | 0.07 | 0.07 | 0.25 | 0.00 | 1.00 |

Table 2: **Expectations of returns, expected risk and macroeconomic conditions**

This table presents regression results for equation (1). The dependent variable is the expected stock market return over the next 12 months at the household level measured in percentage points. The main independent variables are the expected stock market volatility, expected economic growth, expected labor market conditions and expected inflation at the household level over the next 12 months. Expected stock market volatility can take values $\in \{-1, 0, 1\}$, where $-1$ corresponds to an expected decrease, 0 to no change and 1 to an increase in volatility over the next 12 months. For expected economic growth, expected labor market conditions and expected inflation a value of 1 indicates the expectation of improving conditions over the next 12 months, 0 the expectation of no changes and $-1$ the expectation of deterioration in the respective macro condition. All estimations include age, age squared, log(income), employment status, wealth invested in the stock market and gender as controls. Survey wave fixed-effects are included in all estimations. Standard errors are clustered at the survey level.

| Dependent Variable: | Expected Stock Market Return | | | | |
|---|---|---|---|---|---|
| Model: | (1) | (2) | (3) | (4) | (5) |
| *Variables* | | | | | |
| Expected Stock Market Vola | -0.3150$^{*}$ | | | | -0.2592 |
| | (0.1534) | | | | (0.1603) |
| Expected Economic Growth | | 2.194$^{***}$ | | | 1.551$^{***}$ |
| | | (0.1055) | | | (0.1475) |
| Expected Labor Market Cond. | | | 1.512$^{***}$ | | 0.1205 |
| | | | (0.1151) | | (0.1192) |
| Expected Inflation | | | | 1.062$^{***}$ | 0.6071$^{***}$ |
| | | | | (0.0721) | (0.1333) |
| *Fixed-effects* | | | | | |
| Survey | Yes | Yes | Yes | Yes | Yes |
| *Fit statistics* | | | | | |
| Observations | 13,690 | 31,645 | 31,400 | 31,398 | 13,416 |
| $R^2$ | 0.03849 | 0.12441 | 0.11211 | 0.10668 | 0.05409 |
| Within $R^2$ | 0.03134 | 0.05042 | 0.03670 | 0.03043 | 0.04698 |

*One-way (Survey) standard-errors in parentheses*

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 3: **Stock market valuation is a valid measure**

This table presents regression results for equation (9). The first column presents results for regressing the expected stock market return over the next 12 months on the current stock market valuation at the household level. The second column presents results for regressing a dummy variable indicating whether a household reported that it is a good time to invest on the current stock market valuation at the household level. Stock market valuation can take values $\in \{-1, 0, 1\}$, where $-1$ corresponds to an under-, 0 to a fair and 1 to an overvaluation. All estimations include age, age squared, log(income), employment status, wealth invested in the stock market and gender as controls. Survey wave fixed-effects are included in all estimations. Standard errors are clustered at the survey level.

| Dependent Variables: | Expected Stock Market Return | Good Time to Invest |
|---|---|---|
| Model: | (1) | (2) |
| *Variables* | | |
| Stock Market Valuation | -1.624*** | -0.1477*** |
| | (0.1146) | (0.0045) |
| *Fixed-effects* | | |
| Survey | Yes | Yes |
| *Fit statistics* | | |
| Observations | 25,726 | 25,413 |
| $R^2$ | 0.11197 | 0.08950 |
| Within $R^2$ | 0.03443 | 0.07009 |

*One-way (Survey) standard-errors in parentheses*

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 4: **Discount rates, volatility and macro expectations – 10% return expectations**

This table presents regression results for equation (10). The sample consists of all households that reported stock market return expectations of 10%. The dependent variable is our ordinal discount rate measure (1 for high, 0 for medium and −1 for low discount rate). The main independent variables are the expected stock market volatility, expected economic growth, the expected labor market conditions and expected inflation at the household level over the next 12 months. Expected stock market volatility can take values $\in \{-1, 0, 1\}$, where −1 corresponds to an expected decrease, 0 to no change and 1 to an increase in volatility over the next 12 months. For expected economic growth, the expected labor market conditions and expected inflation a value of 1 indicates the expectation of improving conditions over the next 12 months, 0 the expectation of no changes and −1 the expectation of deterioration in the respective macro condition. All estimations include age, age squared, log(income), employment status, wealth invested in the stock market and gender as controls. Survey wave fixed-effects are included in all estimations. Standard errors are clustered at the survey level.

| Dependent Variable: | Ordinal Discount Rate | | | | |
|---|---|---|---|---|---|
| Model: | (1) | (2) | (3) | (4) | (5) |
| *Variables* | | | | | |
| Expected Stock Market Vola | 0.0772*** | | | | 0.0691*** |
| | (0.0129) | | | | (0.0137) |
| Expected Economic Growth | | -0.0811*** | | | -0.0547*** |
| | | (0.0135) | | | (0.0184) |
| Expected Labor Market Cond. | | | -0.0572*** | | 0.0088 |
| | | | (0.0140) | | (0.0179) |
| Expected Inflation | | | | -0.0711*** | -0.0417*** |
| | | | | (0.0108) | (0.0109) |
| *Fixed-effects* | | | | | |
| Survey | Yes | Yes | Yes | Yes | Yes |
| *Fit statistics* | | | | | |
| Observations | 2,764 | 5,126 | 5,080 | 5,083 | 2,707 |
| $R^2$ | 0.04795 | 0.23467 | 0.23106 | 0.23260 | 0.05676 |
| Within $R^2$ | 0.02286 | 0.01644 | 0.01331 | 0.01597 | 0.03132 |

*One-way (Survey) standard-errors in parentheses*

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 5: **Discount rates, volatility and macro expectations – full sample**

This table presents regression results for equation (11). The dependent variable is our ordinal discount rate measure (1 for high, 0 for medium and $-1$ for low discount rate). The main independent variables are the expected stock market volatility, expected economic growth, expected labor market conditions and expected inflation at the household level over the next 12 months. Expected stock market volatility can take values $\in \{-1, 0, 1\}$, where $-1$ corresponds to an expected decrease, 0 to no change and 1 to an increase in volatility over the next 12 months. For expected economic growth, expected labor market conditions and expected inflation a value of 1 indicates the expectation of improving conditions over the next 12 months, 0 the expectation of no changes and $-1$ the expectation of deterioration in the respective macro condition. All estimations include age, age squared, log(income), employment status, wealth invested in the stock market and gender as controls. Survey wave $\times$ expected stock market return fixed-effects are included in all estimations. Standard errors are clustered at the survey level.

| Dependent Variable: | Ordinal Discount Rate | | | | |
|---|---|---|---|---|---|
| Model: | (1) | (2) | (3) | (4) | (5) |
| *Variables* | | | | | |
| Expected Stock Market Vola | 0.0483*** | | | | 0.0435*** |
| | (0.0090) | | | | (0.0087) |
| Expected Economic Growth | | -0.0945*** | | | -0.0640*** |
| | | (0.0074) | | | (0.0066) |
| Expected Labor Market Cond. | | | -0.0659*** | | 0.0039 |
| | | | (0.0088) | | (0.0100) |
| Expected Inflation | | | | -0.0626*** | -0.0306*** |
| | | | | (0.0081) | (0.0074) |
| *Fixed-effects* | | | | | |
| Survey×Expected Stock Market Return | Yes | Yes | Yes | Yes | Yes |
| *Fit statistics* | | | | | |
| Observations | 11,682 | 25,635 | 25,442 | 25,445 | 11,464 |
| $R^2$ | 0.11667 | 0.23478 | 0.23033 | 0.22993 | 0.12502 |
| Within $R^2$ | 0.01356 | 0.01798 | 0.01310 | 0.01291 | 0.02281 |

*One-way (Survey) standard-errors in parentheses*

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 6: **Heterogeneity across investor characteristics – expected stock market volatility**

This table presents regression results for equation (12). The dependent variable is our ordinal discount rate measure (1 for high, 0 for medium and $-1$ for low discount rate). The main independent variable is the expected stock market volatility at the household level over the next 12 months. Expected stock market volatility can take values $\in \{-1, 0, 1\}$, where $-1$ corresponds to decrease, 0 to no change and 1 to increase of volatility over the next 12 months. All estimations include age, age squared, log(income), employment status, wealth invested in the stock market and gender as controls. Survey wave $\times$ expected stock market return fixed-effects are included in all estimations. Standard errors are clustered at the survey level.

| Dependent Variable: | Ordinal Discount Rate | | | |
|---|---|---|---|---|
| Model: | (1) | (2) | (3) | (4) |
| *Variables* | | | | |
| Expected Stock Market Vola | 0.0655*** | 0.0441*** | -0.4298*** | 0.0667*** |
| | (0.0108) | (0.0105) | (0.1098) | (0.0109) |
| Expected Stock Market Vola × No College | -0.0472** | | | |
| | (0.0166) | | | |
| Expected Stock Market Vola × Wealth Invested below $100k | | 0.0092 | | |
| | | (0.0144) | | |
| Expected Stock Market Vola × log(Income) | | | 0.0429*** | |
| | | | (0.0099) | |
| Expected Stock Market Vola × Female | | | | -0.0510** |
| | | | | (0.0179) |
| *Fixed-effects* | | | | |
| Survey×Expected Stock Market Return | Yes | Yes | Yes | Yes |
| *Fit statistics* | | | | |
| Observations | 11,682 | 11,682 | 11,682 | 11,682 |
| $R^2$ | 0.11739 | 0.11670 | 0.11712 | 0.11751 |
| Within $R^2$ | 0.01437 | 0.01360 | 0.01407 | 0.01450 |

*One-way (Survey) standard-errors in parentheses*

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 7: **Heterogeneity across 'risk-on' and 'risk-off' episodes**

This table presents regression results for equation (13). The dependent variable is our ordinal discount rate measure (1 for high, 0 for medium and −1 for low discount rate). The main independent variable is the expected stock market volatility at the household level over the next 12 months. Expected stock market volatility can take values $\in \{-1, 0, 1\}$, where −1 corresponds to decrease, 0 to no change and 1 to increase of volatility over the next 12 months. Risk-On is a dummy variable which takes a value of 1 after the burst of the dot-com bubble, i.e., after March 2000. All estimations include age, age squared, log(income), employment status, wealth invested in the stock market and gender as controls. Survey wave × expected stock market return fixed-effects are included in all estimations. Standard errors are clustered at the survey level.

| Dependent Variable: | Ordinal Discount Rate | | | | |
|---|---|---|---|---|---|
| Model: | (1) | (2) | (3) | (4) | (5) |
| *Variables* | | | | | |
| Expected Stock Market Vola | 0.0355*** | | | | 0.0301*** |
| | (0.0092) | | | | (0.0093) |
| Risk-On× Expected Stock Market Vola | 0.0382** | | | | 0.0404** |
| | (0.0152) | | | | (0.0142) |
| Expected Economic Growth | | -0.0741*** | | | -0.0628*** |
| | | (0.0109) | | | (0.0076) |
| Risk-On× Expected Economic Growth | | -0.0268* | | | -0.0021 |
| | | (0.0141) | | | (0.0145) |
| Expected Labor Market Cond. | | | -0.0360*** | | -0.0042 |
| | | | (0.0111) | | (0.0100) |
| Risk-On× Expected Labor Market Cond. | | | -0.0397** | | 0.0251 |
| | | | (0.0154) | | (0.0227) |
| Expected Inflation | | | | -0.0460*** | -0.0316*** |
| | | | | (0.0086) | (0.0092) |
| Risk-On× Expected Inflation | | | | -0.0235 | 0.0021 |
| | | | | (0.0139) | (0.0155) |
| *Fixed-effects* | | | | | |
| Survey×Expected Stock Market Return | Yes | Yes | Yes | Yes | Yes |
| *Fit statistics* | | | | | |
| Observations | 11,682 | 25,635 | 25,442 | 25,445 | 11,464 |
| $R^2$ | 0.11711 | 0.23490 | 0.23062 | 0.23005 | 0.12568 |
| Within $R^2$ | 0.01406 | 0.01813 | 0.01347 | 0.01307 | 0.02354 |

*One-way (Survey) standard-errors in parentheses*

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 8: **Robustness check – American Life Panel survey**

This table presents regression results for equations (11) and (12) estimated with data from the American Life Panel survey. The dependent variable is our ordinal discount rate measure (1 for high, 0 for medium and −1 for low discount rate). The main independent variable is a proxy for the expected stock market volatility, P(High Vola), at the participant level over the next 12 months as defined in equation (14). P(High Vola) can take values from 0 to 100, where 0 represents the lowest possible volatility expectation (zero subjective probability of high volatility). All estimations include age, age squared, log(income), employment status and gender as controls. Survey × expected stock market return fixed-effects are included in all estimations. Standard errors are clustered at the survey as well as the participant level.

| Dependent Variable: | Ordinal Discount Rate | | | |
|---|---|---|---|---|
| Model: | (1) | (2) | (3) | (4) |
| *Variables* | | | | |
| P(High Vola) | 0.0006** | 0.0012** | -0.0072** | 0.0004 |
| | (0.0003) | (0.0004) | (0.0026) | (0.0004) |
| Expected Stock Market Vola × No College | | -0.0008* | | |
| | | (0.0004) | | |
| Expected Stock Market Vola × log(Income) | | | 0.0007*** | |
| | | | (0.0002) | |
| Expected Stock Market Vola × Female | | | | 0.0003 |
| | | | | (0.0005) |
| *Fixed-effects* | | | | |
| Survey×Expected Stock Market Return | Yes | Yes | Yes | Yes |
| *Fit statistics* | | | | |
| Observations | 40,391 | 40,391 | 40,391 | 40,391 |
| $R^2$ | 0.13013 | 0.13031 | 0.13059 | 0.13016 |
| Within $R^2$ | 0.02936 | 0.02956 | 0.02988 | 0.02940 |

*Clustered (Survey & Participant) standard-errors in parentheses*

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Figure 1: **Stock market development and sample period**

This figure displays the evolution of the NASDAQ Composite and the S&P 500 stock market indices from 1996 to 2005. The shaded areas mark our sample period. The blue shaded area indicates our sample period before the dot-com bubble burst, i.e., the 'risk-on' period, while the pink shaded areas indicate the sample period after the burst, i.e., the 'risk-off' period. The dark shaded pink area indicates the period in which expected stock market volatility has been elicited, the dark and light shaded areas together show the period in which macroeconomic expectations have been elicited.

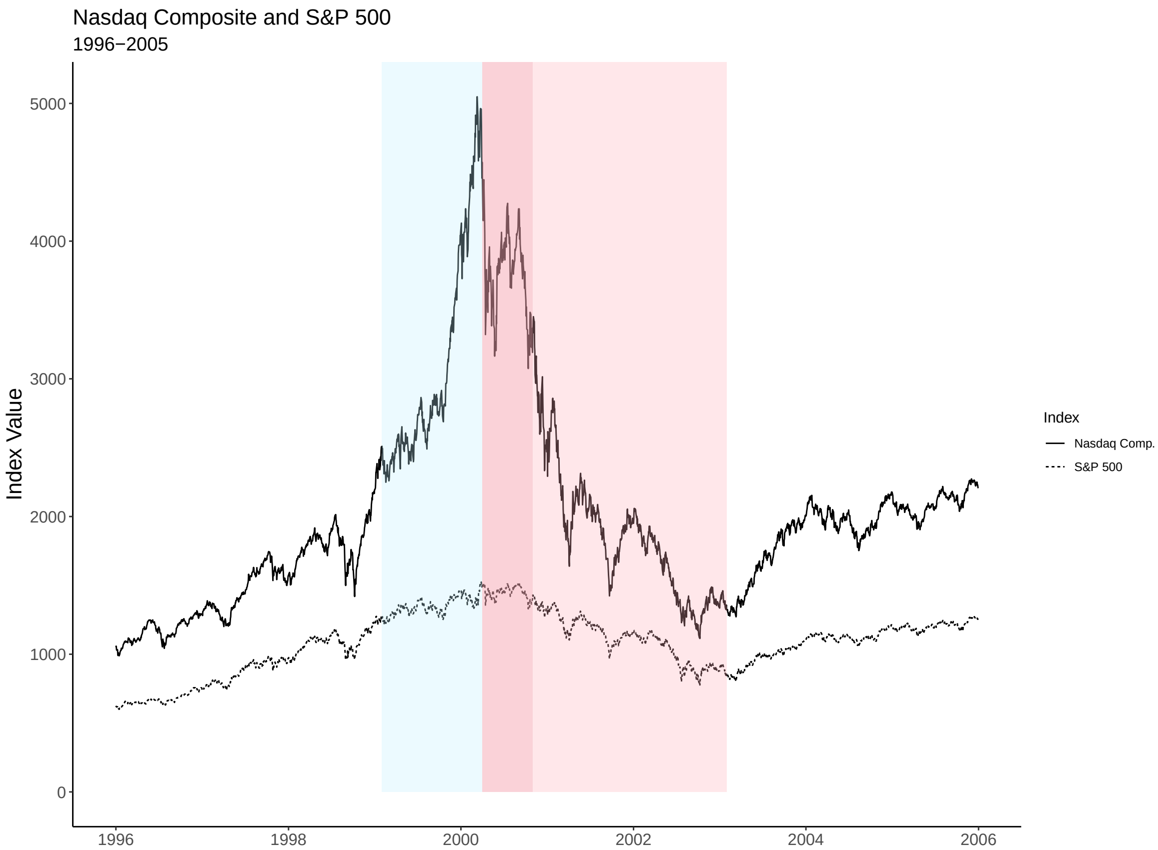
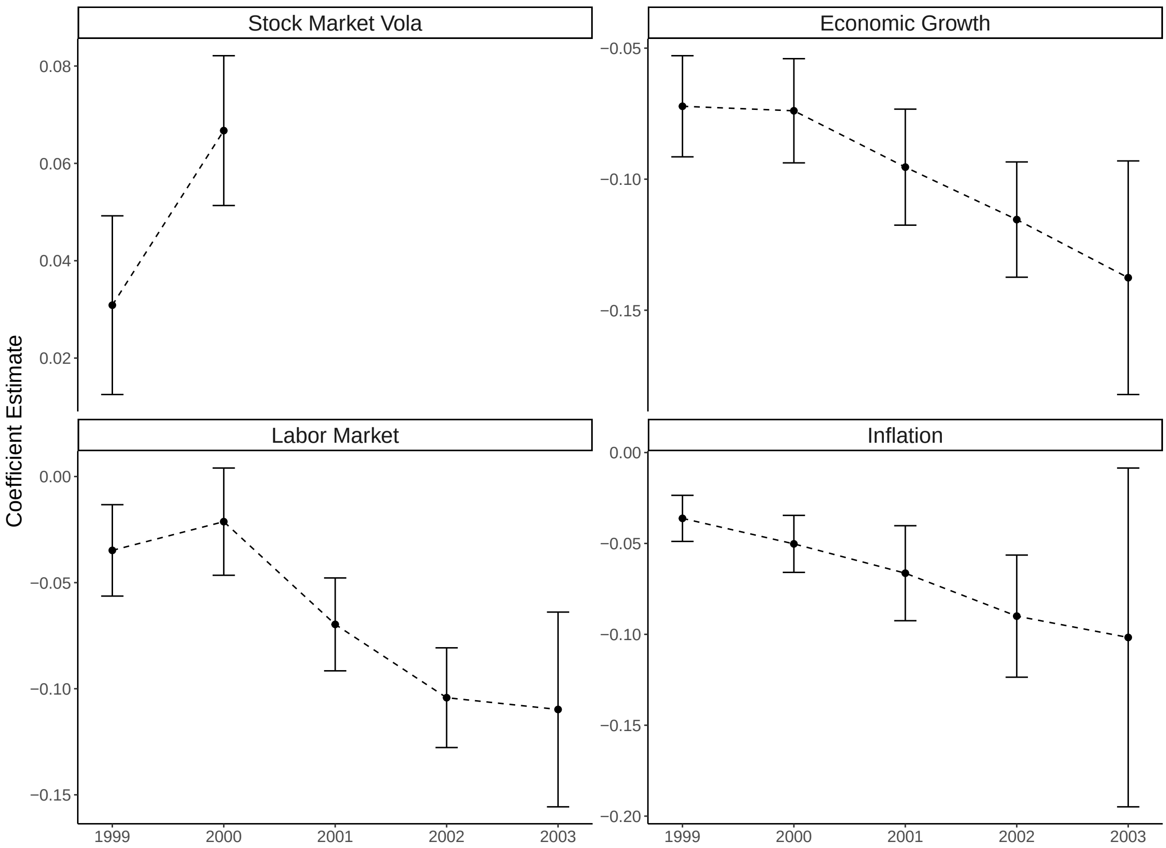


Figure 2: **Heterogeneity across investment environments**

This figure shows time variation in the relation between subjective discount rates and perceptions of risk. For each panel we estimate a regression model similar to equation (13), but interact expectations of risk with year-specific dummies. Dots indicate the point estimate, bars represent 90% confidence intervals. Standard errors are clustered at the survey level.



Internet Appendix for Revisiting Discount Rates: New Evidence from Surveys

Phillipp Gnan Maximilian Schleritzko

Table IA.1: **Heterogeneity across investor characteristics – economic growth expectations**

This table presents regression results for equation (12). The dependent variable is our ordinal discount rate measure (1 for high, 0 for medium and $-1$ for low discount rate). The main independent variable is expected economic growth at the household level over the next 12 months. Expected economic growth can take values $\in \{-1, 0, 1\}$, where a value of 1 indicates the expectation of improving conditions over the next 12 months, 0 the expectation of no changes and $-1$ the expectation of deterioration in economic growth. All estimations include age, age squared, log(income), employment status, wealth invested in the stock market and gender as controls. Survey wave × expected stock market return fixed-effects are included in all estimations. Standard errors are clustered at the survey level.

| Dependent Variable: | Ordinal Discount Rate | | | |
|---|---|---|---|---|
| Model: | (1) | (2) | (3) | (4) |
| *Variables* | | | | |
| Expected Economic Growth | -0.0957*** | -0.1041*** | -0.2907 | -0.1005*** |
| | (0.0083) | (0.0083) | (0.1785) | (0.0082) |
| Expected Economic Growth × No College | 0.0032 | | | |
| | (0.0123) | | | |
| Expected Economic Growth × Wealth Invested below $100k | | 0.0212** | | |
| | | (0.0104) | | |
| Expected Economic Growth × log(Income) | | | 0.0176 | |
| | | | (0.0160) | |
| Expected Economic Growth × Female | | | | 0.0164 |
| | | | | (0.0126) |
| *Fixed-effects* | | | | |
| Survey×Expected Stock Market Return | Yes | Yes | Yes | Yes |
| *Fit statistics* | | | | |
| Observations | 25,635 | 25,635 | 25,635 | 25,635 |
| $R^2$ | 0.23478 | 0.23490 | 0.23484 | 0.23485 |
| Within $R^2$ | 0.01798 | 0.01813 | 0.01805 | 0.01806 |

*One-way (Survey) standard-errors in parentheses*

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table IA.2: **Heterogeneity across investor characteristics – labor market expectations**

This table presents regression results for equation (12). The dependent variable is our ordinal discount rate measure (1 for high, 0 for medium and −1 for low discount rate). The main independent variable is expected labor market conditions at the household level over the next 12 months. Expected labor market conditions can take values $\in \{-1, 0, 1\}$, where a value of 1 indicates the expectation of improving conditions over the next 12 months, 0 the expectation of no changes and −1 the expectation of deterioration in labor market conditions. All estimations include age, age squared, log(income), employment status, wealth invested in the stock market and gender as controls. Survey wave × expected stock market return fixed-effects are included in all estimations. Standard errors are clustered at the survey level.

| Dependent Variable: | Ordinal Discount Rate | | | |
|---|---|---|---|---|
| Model: | (1) | (2) | (3) | (4) |
| *Variables* | | | | |
| Expected Labor Market Cond. | -0.0673*** | -0.0713*** | -0.4006*** | -0.0667*** |
| | (0.0086) | (0.0093) | (0.1270) | (0.0090) |
| Expected Labor Market Cond. × No College | 0.0036 | | | |
| | (0.0102) | | | |
| Expected Labor Market Cond. × Wealth Invested below $100k | | 0.0117 | | |
| | | (0.0108) | | |
| Expected Labor Market Cond. × log(Income) | | | 0.0300** | |
| | | | (0.0114) | |
| Expected Labor Market Cond. × Female | | | | 0.0021 |
| | | | | (0.0114) |
| *Fixed-effects* | | | | |
| Survey×Expected Stock Market Return | Yes | Yes | Yes | Yes |
| *Fit statistics* | | | | |
| Observations | 25,442 | 25,442 | 25,442 | 25,442 |
| $R^2$ | 0.23033 | 0.23037 | 0.23052 | 0.23033 |
| Within $R^2$ | 0.01311 | 0.01316 | 0.01334 | 0.01311 |

*One-way (Survey) standard-errors in parentheses*

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table IA.3: **Heterogeneity across investor characteristics – inflation expectations**

This table presents regression results for equation (12). The dependent variable is our ordinal discount rate measure (1 for high, 0 for medium and −1 for low discount rate). The main independent variable is the expected inflation at the household level over the next 12 months. Expected inflation can take values $\in \{-1, 0, 1\}$, where a value of 1 indicates the expectation of improving conditions over the next 12 months, 0 the expectation of no changes and −1 the expectation of deterioration in inflation. All estimations include age, age squared, log(income), employment status, wealth invested in the stock market and gender as controls. Survey wave × expected stock market return fixed-effects are included in all estimations. Standard errors are clustered at the survey level.

| Dependent Variable: | Ordinal Discount Rate | | | |
|---|---|---|---|---|
| Model: | (1) | (2) | (3) | (4) |
| *Variables* | | | | |
| Expected Inflation | -0.0689*** | -0.0617*** | -0.0753 | -0.0619*** |
| | (0.0076) | (0.0089) | (0.1554) | (0.0086) |
| Expected Inflation × No College | 0.0172 | | | |
| | (0.0106) | | | |
| Expected Inflation × Wealth Invested below $100k | | -0.0019 | | |
| | | (0.0102) | | |
| Expected Inflation × log(Income) | | | 0.0011 | |
| | | | (0.0140) | |
| Expected Inflation × Female | | | | -0.0019 |
| | | | | (0.0109) |
| *Fixed-effects* | | | | |
| Survey×Expected Stock Market Return | Yes | Yes | Yes | Yes |
| *Fit statistics* | | | | |
| Observations | 25,445 | 25,445 | 25,445 | 25,445 |
| $R^2$ | 0.23000 | 0.22993 | 0.22993 | 0.22993 |
| Within $R^2$ | 0.01301 | 0.01292 | 0.01291 | 0.01292 |

*One-way (Survey) standard-errors in parentheses*

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 4: **Summary Stats American Life Panel**

This table displays summary statistics for our American Life Panel sample. Panel A shows summary statistics for the main regression variables, while panel B summarizes household characteristic used as control variables.

| *Panel A. Main Variables* | | | | | |
|---|---|---|---|---|---|
| | Mean | Median | SD | Min | Max |
| Expected Stock Market Return | 11.49 | 9.93 | 24.08 | -80.00 | 99.90 |
| Stock Market Valuation (Ordinal Discount Rate) | 0.13 | 0.16 | 0.70 | -1.00 | 1.00 |
| P(High Vola) | 35.15 | 30.67 | 23.95 | 0.00 | 100.00 |
| *Panel B. Household Characteristics* | | | | | |
| Education (college) | 0.42 | 0.42 | 0.49 | 0.00 | 1.00 |
| Age | 51.20 | 52.71 | 14.72 | 18.00 | 99.00 |
| Age squared | 2837.91 | 2778.83 | 1495.48 | 324.00 | 9801.00 |
| Income | 63651.22 | 51932.52 | 46629.10 | 2500.00 | 200000.00 |
| Female | 0.56 | 0.56 | 0.50 | 0.00 | 1.00 |
| Employed | 0.59 | 0.59 | 0.49 | 0.00 | 1.00 |
| Unemployed | 0.15 | 0.15 | 0.36 | 0.00 | 1.00 |
| Retired | 0.26 | 0.26 | 0.44 | 0.00 | 1.00 |

Figure 1: **Histogram expectations of returns**

This figure shows the empirical distribution of expectations of returns across our entire Gallup/UBS survey sample.