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journal homepage: [www.elsevier.com/locate/euroecorev](http://www.elsevier.com/locate/euroecorev)Does everyone use probabilities? The role of cognitive skills<sup>☆</sup>Johannes Binswanger<sup>a,\*</sup>, Martin Salm<sup>b</sup><sup>a</sup> School of Economics and Political Science, University of St. Gallen, Bodanstrasse 8, St. Gallen CH-9000, Switzerland<sup>b</sup> Department of Econometrics and Operations Research, CentER and Netspar, Tilburg University, P.O. Box 90153, Tilburg 5000 LE, The Netherlands

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## ABSTRACT

What is the role of cognitive skills in decision making under uncertainty? We address this question by examining the relationship between responses to survey questions about subjective probabilities of stock market returns and stock holding decisions. Based on data from the Health and Retirement Study (HRS), we find that for individuals with lower cognitive skills the association between measured probabilities and decisions is weaker than for individuals with higher cognitive skills. Additional evidence suggests that individuals with lower cognitive skills are more likely to give heuristic answers to questions about stock return probabilities. A likely explanation is that individuals with lower cognitive skills have a fuzzier mental representation of stock returns that cannot be captured by a unique well-defined probability distribution. In contrast, individuals with higher cognitive skills are more likely to act as if subjective probabilities are meaningful measures of uncertainty. We discuss whether or not the behavior of the latter can be seen as more “rational”.

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## 1. Introduction

A recent and growing literature shows that cognitive skills are an important determinant of economic behavior. For example, [Christelis et al. \(2010\)](#) and [Grinblatt et al. \(2011\)](#) document that higher cognitive skills lead to a significantly higher likelihood to invest in stocks. [Smith et al. \(2010\)](#) show that higher cognitive skills are associated with higher household wealth. [Banks et al. \(2010\)](#) find that wealth trajectories are more hump-shaped for individuals with high cognitive skills. [Agarwal and Mazumder \(2013\)](#) document that those with high cognitive skills make fewer mistakes when it comes to credit card and home equity loans. One possible explanation for the importance of cognitive skills is differences in preferences. For example, [Frederick \(2005\)](#), [Burks et al. \(2009\)](#), [Oechssler et al. \(2009\)](#) and [Dohmen et al. \(2010\)](#) find that higher cognitive skills are associated with more patience and a lower degree of risk aversion.

In this study, we extend the literature on cognitive skills and economic decision making in a new direction. We explore how the relationship between measurements of subjective probabilities and economic decisions varies according to cogni-

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tive skills. Our analysis also relates to the question whether there are differences in the degree of ambiguity with which individuals with higher and lower cognitive skills perceive the world around them. An uncertain prospect is defined as ambiguous to a decision maker if (s)he is not able to quantify the uncertainty by means of a unique well-defined probability distribution (Alon and Schmeidler, 2014; Ellsberg, 1961; Gilboa and Schmeidler, 1989; Gilboa et al., 2008; Knight, 1921).

In this paper we focus on the relationship between investment behavior and answers to a survey question about subjective probabilities of stock returns. We use panel data for a large representative sample of the (near-) elderly U.S. population from the Health and Retirement Study (HRS) for the period from 2002 until 2010. The survey question on subjective probabilities refers to the percent chance that returns for a broad stock index would be positive over the next 12 months.

In our data, we find that individuals with low cognitive skills have difficulties in providing answers to the subjective probability question. Regression analysis shows that they are considerably more likely to provide heuristic answers. We define answers to survey questions as heuristic if they are the result of a response strategy for guessing an acceptable answer when the actual answer is not known, too cumbersome to find out, or, simply, when the question does not make sense to the person asked. Typical examples of heuristic answers are: *don't know*; choose the first, middle or last option on a response scale; or substitute the actual question with a similar one that is easier to answer (Kahneman, 2003; 2011). Many respondents with lower cognitive skills even explicitly state that “no one can know” the respective probability.

In order to answer our main research question, we examine whether the association between subjective probabilities and investment behavior varies according to cognitive skills. Our main finding is that the association between subjective probabilities and investment behavior is much weaker for individuals with low cognitive skills. We investigate several mechanisms that may underlie this result. Our most likely explanation is that individuals with lower cognitive skills perceive the world as more ambiguous than individuals with higher cognitive skills. Therefore, they are less likely to think about stock market returns in terms of a unique well-defined probability distribution. In light of the recent literature on uncertainty and ambiguity,<sup>1</sup> which takes a rather critical view on the *normative* appeal of the expected utility model with associated subjective probabilities, this raises an intriguing question. Could it be that individuals with low cognitive abilities take a more “rational” approach – in a broader sense of rationality – to decision making under uncertainty? While we cannot address this question in any definite way, our evidence suggests that individuals with low cognitive skills more readily acknowledge that, in a world where even econometricians have difficulties estimating the “proper” distribution of future stock returns, simple subjective probabilities may not be applicable.

This paper is related to a number of previous studies that explore subjective probabilities on stock returns. Hurd et al. (2011) use information about subjective probabilities from a Dutch household panel to extract parameters about stock market return distributions on an individual level, and to investigate the heterogeneity of these individual distributions. In contrast to our study, they do not consider the role of cognitive skills. In particular, the authors eliminate all individuals that provide inconsistent answers. Since, as we will discuss below, inconsistent answers are particularly prevalent among individuals with low cognitive skills, their results are unlikely to be representative for that group. Based on their data and methods, the authors conclude that there is a meaningful relationship between return expectations and actual investment behavior.

Kézdi and Willis (2011) investigate the heterogeneity in expectations about stock market returns based on the Health and Retirement Study (HRS). The authors use a structural model to identify individual expectations and also consider the relationship between expectations and actual investment behavior. Kézdi and Willis treat inconsistent probability answers as “errors” made during the survey by individuals who are otherwise assumed to be fully rational expected utility maximizers. Furthermore, they treat the large spikes at probabilities of 0, 50, and 100 percent as rounding and use a structural model to redistribute mass away from these mass points to arrive at a smooth distribution that underlies their analysis. On the basis of this procedure, they conclude that there is a meaningful relationship between return expectations and actual investment behavior.

In contrast to these studies, we take individuals' answers to the probability questions at face value. In particular, we allow for the fact that an individual who, e.g., provides an answer of 50 and, in addition, states that “no one can know” the respective probability may not think about stock market returns in terms of a well-defined probability distribution. Since focal and inconsistent answers are more prevalent among individuals with low cognitive skills, our procedure is well suited to uncover differences in behavior between individuals with low and high cognitive skills. Eliminating or smoothing out inconsistent or focal answers is likely to mask the true difference in behavior between different skill groups.

Hurd and Rohwedder (2012) investigate how changes in stock market expectations react to actual changes in the stock market. Their study is based on panel data that allow for a careful identification of the time lags involved in how expectations potentially react to stock price movements. They find that expectations do react to changes in actual stock price movements; furthermore, changes in expectations trigger responses in stock trading. The authors also document substantial pessimism in comparison to historical stock returns. In contrast to our paper, Hurd and Rohwedder do not consider the role of cognitive skills.

Our paper is organized as follows. Section 2 presents the survey question on subjective probabilities and discusses how individuals may respond to this question. In Section 3 we present the data. Section 4 presents evidence on heuristic answers.

<sup>1</sup> See Gilboa et al. (2008).

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