Behavioral Biases in Intertemporal Decisions

Von der Fakultät für Wirtschaftswissenschaften der

Rheinisch-Westfälischen Technischen Hochschule Aachen

zur Erlangung des akademischen Grades eines Doktors der

Wirtschafts- und Sozialwissenschaften genehmigte Dissertation

vorgelegt von

Kalender Can Soypak

Berichter: Univ.-Prof. Dr.rer.pol. Wolfgang Breuer

Univ.-Prof. Dr.rer.pol. Rüdiger von Nitzsch

Tag der mündlichen Prüfung: 16.10.2013

Summary

Modeling intertemporal decisions is essential to understand many financial decisions both at the household and at the company level. Most of the time, these decisions are very complicated and it is very difficult to develop a single model that can describe the inter-temporal decision making process in different contexts. Still, this does not prevent many researchers from attempting to understand preferences of individuals in intertemporal decision setting, since people face intertemporal decisions very often.

For intertemporal decision modeling, we can distinguish between two different types of theories: normative and descriptive. Normative theories try to explain how decision makers ought to approach to intertemporal decisions and they derive simple guidelines for rational decision making. The most renowned normative theory tackling intertemporal decision process is the standard discounted expected utility (DEU), which basically consists of two parts: expected utility theory and constant subjective discount rates.

Despite its normative quality, expected utility theory is unable to describe the human decision process accurately in many cases, as it emanates from unbounded rationality. In reality, we observe deviations from rational human image that lead to certain unexplained puzzles such as the disposition effect or the equity premium puzzle. These puzzles can only be explained by alternative theories that integrate decision biases resulting from bounded investor rationality into the decision making process. Descriptive theories simply intend to fill this gap and explain the actual preferences in intertemporal decisions.

This point sets up the motivation of this dissertation, as we analyze the relevance of these descriptive decision theories in actual intertemporal decision settings in the fields of corporate and household finance. We begin with a brief introduction presenting the standard discounted expected utility (DEU) theory that aims to solve the intertemporal decision problem. Consequently, we discuss the deviations from the assumptions of DEU model that are

revealed by numerous studies. After this detailed motivation, we analyze the implications of these deviations from DEU model for corporate and household finance in four papers. We specifically focus on the relation between decision anomalies and dividend policy, cash policy, saving/borrowing decisions and credit spreads in P2P markets.

Generally, we use the following approach in each one of our papers: After a brief introduction, we develop hypotheses connecting the behavioral biases to our research question based on a (mathematical) theoretical framework. Consequently, we conduct experiments in settings resembling the actual intertemporal decision process that we want to analyze. Based on these results, we investigate the connection between the behavioral biases revealed in experiments and intertemporal decisions in different scenes of corporate and household finance. In all four papers, the empirical results clearly suggest that DEU model is incapable of explaining the decision process in intertemporal setting completely and it should be extended utilizing the findings obtained in experiments analyzing human decision process from a psychological perspective.

In sum, in all four papers, we reach the conclusion that the limited rationality of investors and the resulting biases identified in experiments shape the intertemporal decision process both in the fields of corporate and household finance. Furthermore, we study new behavioral patterns modifying the designs of some well-known experimental studies and demonstrate that our experiments reflect the actual preferences of individuals quite accurately. Thus, based on this work, we find supporting evidence for the general assumptions of the "Behavioral Finance" story. Additionally, our experiments also strengthen the view defending the relevance of experiments in economics, as not many researchers try to bridge the gap between "Experimental Economics" and "Household Finance".

1. Introduction

A large portion of our daily life decisions are intertemporal choices requiring us to choose between costs and benefits that are due at different points in time. Some of these choices are very simple and of very little importance to our lives such as deciding whether to study for an exam today or go to a party instead. The planning horizon for these types of decisions is relatively short and the decision process is consequently simple. On the other hand, life-cycle consumption planning can present very difficult challenges to individuals, as they are required to forecast many unknown parameters like their potential future labor income, own retirement age and of course, their time of death. Furthermore, planning retirement consumption demands very high information processing abilities and very sophisticated analytical skills.

Sometimes, the intertemporal decisions do not concern the decision maker directly, but she makes the decision on behalf of someone else. For instance, board members of large corporations had to determine the corporate strategy with long term consequences on behalf of their investors. For instance, an integral part of the corporate strategy, dividend payouts are decisive for the consumption path of investors in imperfect capital markets. As a result, investors' character traits and preferences should have implications for the financial policies of the company, if managers try to "cater" to investors' needs (see e.g., Baker and Wurgler, 2004; Polk and Sapienza, 2009). Thus, modeling intertemporal decisions is essential to understand many financial decisions both at the household and at the company level. Most of the time these decisions are very complicated and it is very difficult to come up with a single model that can describe the intertemporal decision making process in different contexts.

Still, this does not prevent many researchers from attempting to understand time preferences of individuals, since they have far reaching implications. The research in this field goes back to the standard discounted expected utility (henceforth, DEU) model proposed by Samuelson (1937). He developed a theory to explain the tradeoff between future and present consumption with the help of a single parameter, which he referred to as the discount rates. To be more precise, Samuelson (1937) works with standard utility functions based on expected utility theory to calculate the expected utility of a given lottery at a given time. He argues that decision makers discount this expected utility using "constant" rates to calculate the present value for each lottery. This way, a decision maker can compare the "subjective" values of lotteries that are separated by temporal distance.

Thus, the DEU model has two components: expected utility theory and constant subjective discount rates. Expected utility theory can be justified based on very simple axioms (von Neumann and Morgenstern, 1947). It is very difficult to disagree with the four axioms that should be satisfied in order to derive expected utility theory: completeness, transitivity, independence, and continuity. The idea of using constant discount rates is also very hard to refute. If subjective discount rates vary over time, there is a possibility that people cannot stay committed to their previous decisions as the decision time approaches and time inconsistencies are contradictory with the rationality assumption underlying DEU model (Strotz, 1956).

Despite its normative quality, expected utility theory is unable to describe the human decision process accurately in many cases, as it emanates from unbounded rationality. However, the reality cannot be simplified this way and many experimental studies reveal evidence of systematic deviations from expected utility theory in individuals' actual preferences (see Camerer, 1995; Rabin, 1998 for reviews). For instance, Allais (1953) presented an experiment challenging the independence axiom of expected utility theory. Of course, these deviations from rational human image lead to certain unexplained puzzles even on aggregate market level such as the disposition effect (Shefrin and Statman, 1985) or the equity premium puzzle (Benartzi and Thaler, 1995). These puzzles can only be explained by alternative theories that integrate biases resulting from bounded investor rationality into the decision making process.

Both the expected utility theory and the constant discount rate concepts are unable to describe decision patterns properly. Furthermore, the descriptive quality of exponential discounting functions is doubted by many researchers. Experimental studies have again attempted to illustrate the shortcomings of the idea of constant discount rates (see e.g., Kirby and Herrnstein, 1995; Kirby, 1997). These studies demonstrate a declining pattern for discount rates over time and hyperbolic discounting functions fit the data much better than exponential discount functions. Later, Laibson (1997) showed that hyperbolic discounting functions explain the interdependence between consumption and income much better than exponential functions, although consumption smoothing arguments do not anticipate such a strong positive correlation (Modigliani and Brumberg, 1954).

Moreover, some researchers have identified other types of anomalies in intertemporal decisions which are related to discounting functions such as size or sign effects (Thaler, 1981; Benzion et al., 1989). These anomalies reveal an interesting relationship between outcome characteristics and the time value of money and suggest that it is not possible to separate utility and discounting functions in intertemporal decisions entirely. In other words, a simple discounting approach might not be very accurate and some researchers have come up with alternative theories to explain intertemporal decisions such as the added compensation approach (Benzion et al., 1989).

In the following series of papers, we are going to investigate these patterns in the intertemporal decision making context that cannot be fully captured by the standard DEU model. Like previous literature, we again rely on experiments to analyze behavioral biases first in simple decision tasks. For this purpose, we carefully design experiments that we expect to reflect the real decision making process more accurately. As a result, we predict that our experimental results have real-life implications. This relation can occur in two different directions:

- indirect impact of the preferences of naïve investors for financial decisions of corporations and

- direct impact of these behavioral biases related to own financial decisions (saving and borrowing decisions).

The first point is related to a branch of literature that focuses on the impact of limited rationality of unsophisticated investors on financial markets and the reaction of “rational” managers to the investor biases. In other words, we question whether and which investor biases shape the strategy of the company. Research talks about the “catering” motive with respect to this relationship between managers and the investor base (see Baker, 2011 for a review). This story conjectures that managers try to satisfy the investor base to increase the stock price, which is related to their compensation and job security.

On the other hand, the second bullet point deals with the question how the proneness to behavioral biases affects own saving, borrowing decisions or stock market participation of naïve investors or households (Rooij et al., 2011; Stango and Yinman, 2009). Hence, under the second point, we analyze the impact of households’ personal biases on their non-delegated personal decisions.

To recap, the objective of this dissertation is to understand the shortcomings of the DEU as a descriptive theory. For this purpose, we conduct experiments isolating certain aspects that might lead to deviations from the DEU model. After that, we discuss and analyze the direct and indirect implications of these deviations empirically. Based on these results, we hope to fill the gaps in the literature dealing with descriptive theories for the intertemporal decision making process and develop new theories that can overtrump the DEU model.

2. Modeling Intertemporal Decisions

For intertemporal decision modeling, we can distinguish between two different types of theories: normative and descriptive. Normative theories try to explain how decision makers ought to approach to intertemporal decisions and they derive simple guidelines for rational decision making. On the other hand, descriptive theories simply intend to understand the decision making process. There is no single descriptive theory that is universally valid in every intertemporal decision context. Instead, descriptive theories mostly tackle certain aspects of normative theories separately and show that their assumptions might be sometimes unworldly. Still, there have been some attempts to replace normative theories with comprehensive descriptive theories such as prospect theory (Kahnemann and Tversky, 1979; Tversky and Kahnemann, 1992) or hyperbolic discounting functions (Ainslie and Herrnstein, 1981). In the following subsections, we present some of the most renowned existing normative and descriptive theories and demonstrate their differences.

2.1 Normative Decision Theories

2.1.1 Expected Utility Theory

Researchers laid the foundations for the expected utility theory a long time ago. Even before the axiomatization of this theory, it was clear that individuals cannot evaluate the outcomes solely according to the expected monetary value. In simple lotteries such as the St. Petersburg paradox, the expected monetary value of the lottery is infinite but individuals are only willing to pay a very small amount to purchase it. This observation implies that utility cannot be simply defined by expected values (Bernoulli, 1954). The main reason for this finding is the diminishing marginal value of money. In Bernoulli's own (translated) words: "There is no doubt that a gain of one thousand ducats is more significant to the pauper than to a rich man though both gain the same amount."

Hence, due to the diminishing marginal utility, it is necessary to assume a concave utility function instead of a linear one. Linear utility functions imply risk neutrality and lotteries are going to be ordered according to expected monetary payoffs. On the other hand, concave utility functions with diminishing marginal utility entail risk aversion and the certainty equivalent of a lottery is lower than the expected value by a positive risk premium in this case.

Researchers have proposed several forms of utility functions such as exponential or power utility functions where the degree of risk aversion can be defined by a single parameter. The most important distinction for different forms of utility functions is the implied degree of absolute and relative risk aversion (Arrow, 1965; Pratt, 1964).

After defining utility functions, it is possible to model the decision making process under risk according to expected utility theory. First of all, expected utility theory assumes that the probability of occurrence is known for every possible scenario in a lottery. With this assumption, for a specific utility function $u(x)$, one can calculate the expected utility of a lottery, x with state probabilities $p^{(i)}$ for respective states, i. This is equal to:

$$E\big(u(x)\big) = \sum_i u(x^{(i)}) \cdot p^{(i)}. \tag{1}$$

If the lottery outcome is a continuous random variable with the probability distribution function, $f(x)$, the expected utility of the lottery is going to be equal to:

$$E\big(u(x)\big) = \int_{-\infty}^{\infty} u(x) f(x) dx. \tag{2}$$

An important feature of expected utility theory is the assumption that individuals evaluate a lottery with respect to its relation to total wealth. Hence, the choice between two lotteries can be different for people with different initial wealth level even if these individuals have the same utility functions, as long as the absolute risk aversion is not constant and/or the lottery return is not stochastically independent of the initial wealth.

2.1.2 Exponential Discounting Function and DEU

As we mentioned above, the best-known normative theory for intertemporal decisions is the DEU. The DEU model arises from the assumptions of expected utility theory and expands it to intertemporal decisions. It integrates a time discounting function in the expected utility model in order to model the tradeoff between present and future consumption. This way, the DEU model allows a decision maker to discount the expected utility of lotteries that accrue at different points of time back to a common point of time. Thus, with the help of time discounting, the value of future consumption is going to be comparable to the value of present consumption. This way, decision makers can eliminate the time component from lotteries.

Samuelson (1937) has proposed in his model a discounting function which can define time preferences with a single parameter. He also realized that in order to model decision makers as rational individuals, subjective discount rates should be constant. Otherwise, decision makers' preferences would change over time, as the decision time moves closer and this produces inconsistent behavior (Strotz, 1956). For a discounting function $\varphi(t)$, discount rates are equal to

$$\rho(t) = -[\ln \varphi(t)]'. \tag{3}$$

Hence, in order to obtain constant discount rates, the discounting function $\varphi(t)$ should be exponential. For instance, an exponential discounting function, $\varphi(t) = e^{-\rho t}$ produces a constant discount rate equal to ρ according to (3). Thus in the DEU model, the expected discounted utility is equal to:

$$\sum_t \frac{\sum_i u\left(x^{(i)}{}_t\right)}{(1+\rho)^t} . \tag{4}$$

2.2 Descriptive Decision Theories

2.2.1 Deviations from Bernoulli Utility Functions

In this section, we point out the differences between the thought process of an idealized rational decision maker ("homo economicus"), which normative theories work with and the actual decision makers. Based on these differences elicited with the help of experimental studies, researchers have developed descriptive theories that we present here. Firstly, we outline psychological biases that imply that the utility functions employed by expected utility theory should be modified. Prospect theory takes most of these biases into account and adjusts the expected utility theory accordingly.

For instance, expected utility theory assumes that individuals have the capability to evaluate total wealth in aggregate. This means a new project or a lottery is judged with respect to its relationship to total wealth. Yet, as Kahneman and Tversky (1979) demonstrate, setting different reference points for two identical choice tasks can lead to preference reversals. This means that gains and losses are defined with respect to a reference point wealth level. This manipulation of choice behavior resulting from rephrasing a question is called "**framing effect**". The reference-dependent evaluation also implies that depending on the task at hand different lotteries might be treated separately in different accounts. Due to this separation, people do not treat money in different accounts as fungible. Researchers refer to this problem as "**mental accounting**" or "**narrow framing**". For instance, households sometimes do not terminate pension accounts and instead borrow at a rate, which is higher than the return for their savings. Moreover, narrow framing causes people to overlook the correlation between the returns of different investment opportunities. As a result, people cannot make the most of the diversification potential.

Furthermore, due to the reference-dependent evaluation of lotteries, some outcomes will be treated as "relative" losses with respect to a reference point in Kahneman and Tversky's prospect theory. According to Kahneman and Tversky (1979): "The aggravation that one experiences in losing a sum of money appears to be greater than the pleasure associated with gaining the same amount." Hence, the utility function should be steeper for losses than for gains, which is called the "**loss aversion**" and reference point shifts might also affect the desirability of lotteries.

Last, but not least, Kahnemann and Tversky (1979) also argued that the sensitivity to both losses and gains decline with increasing distance from the reference point. Hence, the marginal utility is diminishing for gains and increasing for losses, which implies risk averse and risk-seeking behavior for gains and losses, respectively.

Taking these deviations from expected utility theory into account, Kahneman and Tversky (1979) have developed a new form of utility function that can accommodate these features of the decision making process. They refer to this utility function as the **value function (v)** and this function has the following form:

$$v(x) = \begin{cases} x^{\alpha} & for\ x > 0, \\ -\lambda \cdot (-x)^{\alpha} & for\ x \leq 0. \end{cases} \tag{5}$$

The parameters λ and α define loss aversion and risk attitudes, respectively. Just like in the expected utility theory, maximizing the expected value of the value function is the target for the individual. This is calculated by replacing $u(x)$ with $v(x)$ in the equations (1) or (2), respectively. Furthermore, instead of integrating the monetary consequences form other decisions, the expected value of the value function is calculated for each mental account separately.[1]

2.2.2 Decisions under Ambiguity

Another unrealistic feature of the expected utility theory is the assumption regarding the availability of probability distributions. Real-life decisions are not like coin tosses. Decision makers are most of the time not fully informed about the probability distributions of their investment returns (Ellsberg, 1961). Researchers speak of decisions under uncertainty in this context and Gilboa and Schmeidler (1989) develop the maxmin expected utility theory to characterize preferences in ambiguous settings. They simply state that individuals behave based on the worst-case scenario in an ambiguous setting. We borrow the term "**ambiguity aversion**" from previous literature to describe fear of uncertain returns.

Yet, the maxmin expected utility model is too simple and for uncensored return distributions such as the normal distribution, the value of the lottery is going to approach $-\infty$ regardless of the mean or the standard deviation of the distribution function, which is not very realistic. In order to solve this issue, Klibanoff et al. (2005) offer an alternative "smooth ambiguity model" (see also Klibanoff et al., 2012). Simply put, this model integrates an ambigui-

[1] Instead of the objective probabilities, the expected utility in each scenario is actually multiplied by probability weights that might be sometimes overvalued or undervalued. Still, we do not mention this problem and it is also neglected in the following empirical analyses, as we mostly focus on decisions under ambiguity.

ty aversion parameter into the expected utility model. The ambiguity aversion parameter leads to underestimation (overestimation) of the probabilities in good (bad) states. In other words, if there is a set of possible probabilities for a certain scenario and investors do not know which one is a better estimate; decision makers calculate first the certainty equivalent of the uncertain probability set. Consequently, this certainty equivalent is used to compute expected utility according to one's risk preferences. This way, the model of Klibanoff et al. (2005) also allows us to describe different levels of ambiguity aversion unlike the maxmin rule of Gilboa and Schmeidler (1989). Furthermore, the smooth ambiguity model can be utilized to explain the decisions concerning uncensored continuous random variables, as is shown later.

2.2.3 Discounting Anomalies

Not only the assumptions regarding the shape of utility functions or the probability distributions, but also the exponential discounting function model came under careful review in the decision making literature. Experimental studies show that exponential discounting functions prescribing time-consistent behavior are not descriptively accurate. These studies disclose how people err in intertemporal decisions systematically (see Frederick et al., 2002 for a survey). Thus, we want to discuss here a couple of examples for the discounting anomalies that we pick up later on in our empirical work.

Decreasing Discount Rates and Hyperbolic Discounting Functions

Samuelson (1937) has come up with the idea of exponential discounting functions with the purpose of ensuring consistent choice behavior in intertemporal decisions. Yet, some researchers argue that this assumption is not very convincing and that inconsistent behavior is the norm rather than the exception. The simple example of Strotz (1956) showed that as decision time approaches, people get less patient and instant gratifications become less resistible. Thus, discount rates seem to be increasing as decision time approaches. Thaler and Shefrin (1981) touch on the same subject as well and show that people cannot commit to their long-term plans and how these self-control problems lead to inconsistent behavior due to an ongoing conflict between the “rational and emotional aspects of an individuals’ personality” (O'Donoghue and Rabin, 2000). Neurological studies confirm this theoretical work as their evidence suggests that separate systems are involved in decisions evaluating immediate and delayed gratification (McClure et al., 2004).

In order to model this inconsistency, some researchers have proposed discounting function models, which produce decreasing discount rates over time. Mazur (1987) proposes hyperbolic discounting which implies that discount rates are a monotonously decreasing function of *t* and therefore, it can accommodate time inconsistent behavior. Hyperbolic discounting can also describe time preferences with one single parameter *k* and is modeled the following way:

$$\varphi(t) = \frac{1}{1 + k \cdot t}, \text{with } k > 0\,. \tag{6}$$

Similarly, Loewenstein and Prelec (1992) offer an alternative discounting function which also yields decreasing discount rates as the discounting model in (6). In contrast to (6), this function has two parameters (see equation (7)). The advantage of this model is that the discounting function approaches exponential discounting as α goes to zero. Hence, this model can reproduce the hyperbolic and exponential discounting models only by varying the parameter α:

$$\varphi(t) = \frac{1}{1 + \alpha \cdot t^{\beta/\alpha}}, \text{with } \alpha, \beta > 0. \tag{7}$$

Laibson (1997) has also chimed in with a model involving two parameters. This model suggests that only the discount rates of the first period are larger than the discount rates of subsequent periods, yet the subsequent discount rates are constant (see also Phelps and Pollak, 1968). Laibson (1997) refer discounting model as quasi-hyperbolic discounting and it discounting function has the following form:

$$\varphi(t) = \beta \cdot \delta^t, \text{with } \beta, \delta < 1 \text{ and } \beta, \delta > 0 \tag{8}$$

This model can only elucidate the bias towards present consumption and the preference reversals during the first period. On the other hand, in quasi-hyperbolic discounting models, decision makers are not prone to time inconsistencies if decisions do not involve immediate gratification. Indeed, experimental studies reveal that much of preference reversals occur at early periods, therefore, the quasi-hyperbolic discounting can capture a significant portion of the time inconsistency problems (Frederick et al., 2002).

Sign Effect

In his experimental study, Thaler (1981) has compared discount rates between tradeoffs involving negative and positive outcomes. According to the DEU model, if the outcomes in a given decision task are small compared to the total wealth (as is the case in Thaler (1981)), the shape of utility functions cannot explain large discrepancies between discount rates in tradeoffs with positive and negative outcomes. Yet, he observed significantly smaller discount rates in decisions involving negative outcomes compared to discount rates in decisions involving positive outcomes with an identical absolute value. Thus:

$$v(y) \cdot \varphi(t, y) = v(x), \tag{9}$$

$$v(-y) \cdot \varphi(t, -y) < v(-x) \; for \; y > x \tag{10}$$

This result suggests either that discount rates are a function of the outcome sign or that the expected utility theory is not descriptively accurate to explain the valuation of lotteries. Hence, Loewenstein and Prelec (1992) replace expected utility theory with a prospect theory value function and show sign effects are explainable even if $\varphi(t, -x) = \varphi(t, x)$, i.e. the discount rates are identical for negative and positive outcomes. Prospect theory emanates from reference-point dependent evaluation and the shape of the utility function is different in gain and loss frames. Different studies have shown that the power coefficients of the value function are higher for losses (Fennema and Assen, 1999; Abdellaoui et al,. 2009). This implies:

$$\frac{v(-y)}{v(-x)} > \frac{v(y)}{v(x)} = \frac{1}{\varphi(t, y)} = \frac{1}{\varphi(t, -y)}. \tag{11}$$

Thus, the higher sensitivity to losses explains the emergence of sign effects according to Loewenstein and Prelec (1992).

Size (Magnitude) Effect

Besides sign effects, Thaler (1981) revealed another discounting anomaly in his paper. His results suggest that discount rates are decreasing in the magnitude of the underlying outcome which is referred to as the size or magnitude effect in the literature (see Frederick et al., 2002). In other words, discount rates are smaller for larger payments or receipts:

$$v(y) \cdot \varphi(t, y) = v(x), \tag{12}$$

$$v(\alpha \cdot y) \cdot \varphi(t, \alpha \cdot y) > v(\alpha \cdot x) \; for \; \alpha > 1 \; and \; y > x. \tag{13}$$

Similar to sign effects, size effects also indicate that the DEU model is not accurate in terms of describing intertemporal decision processes. There has been no attempt to integrate outcome size into discounting functions as another variable, either. Instead, Loewenstein and Prelec (1992) try to explain this relationship again based on the characteristics of utility functions. They argue that increasing relative sensitivities of value functions can accommodate the size effect. Increasing relative sensitivities imply that:

$$\frac{v(\alpha \cdot y)}{v(\alpha \cdot x)} > \frac{v(y)}{v(x)}. \tag{14}$$

Yet, the value functions of prospect theory do not meet this requirement which Loewenstein and Prelec (1992) also use to justify size effects. Prospect theory assumes constant relative sensitivities as it works with power utility function (Kahneman and Tversky, 1979).

Hence, Loewenstein and Prelec (1992) cannot exactly explain this particular discounting anomaly. Alternatively, some researchers suggest that people tend to linearize exponential functions (Stango and Zinman, 2009). Due to this inability to accurately work with exponential functions, decision makers might err systematically and these errors can lead to size effects. Yet, there is no reason to believe that these errors should be more noticeable for larger outcomes.

Instead, size effects might possibly imply that the simple discounting/compounding concept is not enough to explain intertemporal decision making processes. Indeed, Benzion et al. (1989) justify size effects with a different approach, which they call the added compensation approach. According to this model, individuals ask for a premium to adjust their consumption position and we can deduce from this model that if this premium is not related to outcome size, discount rates are going to be smaller for larger outcomes. Hence, according to the added compensation approach, a later larger reward is perceived to be equally attractive as the smaller sooner reward if,

$$v(y) \cdot \varphi(t, y) = v(x) + B. \tag{15}$$

If we multiply both the sooner smaller and the later larger reward with the same factor, we have the following relation for prospect theory utility functions even if $\varphi(t,\alpha{\cdot}y) = \varphi(t,y)$:

$$v(\alpha{\cdot}y) \cdot \varphi(t, \alpha{\cdot}y) > v(\alpha{\cdot}x) + B. \tag{16}$$

Thus, the later larger reward becomes more attractive if both alternatives are multiplied with the same factor and size effects can be justified by the added compensation approach, since the added compensation premium (B) does not depend on the outcome. Furthermore, this theory can also explain emergence of size effects together with loss aversion, if underlying outcomes are negative (Benzion et al., 1989).

3. Application of Descriptive Decision Theories in Intertemporal Decisions

After citing the set of anomalies that previous research has revealed over the years, in what follows, we discuss the relevance of these issues for financial decisions of households or corporations. As we mentioned in the introduction, many complicated decisions in the field of household and corporate finance involve an intertemporal tradeoff and those decisions shape the life-cycle consumption stream of individuals.

For instance, in corporate finance, managers have to determine whether they should retain earnings to invest more in the future or to distribute earnings so that investors can consume more right away. Obviously, this requires that investors do not treat capital gains and dividends as substitutes. As we mentioned above, due to mental accounting issues, the wealth is indeed not fungible. As a result, investors cannot replace the consumption from one account (dividends) using funds in another account (capital gains). Although this seems rather unrealistic at first glance, researchers have found plenty of empirical evidence for framing effects resulting from mental accounting of wealth and that dividend income is processed in a different account than capital gains (see e.g., Shefrin and Thaler, 1988). In our first paper, “The Behavioral Foundations of Corporate Dividend Policy: A Cross-Country Analysis”, we combine the principles of mental accounting with investors’ biases that we mentioned above such as loss aversion and ambiguity aversion to analyze empirically whether “rational” managers cater to investors’ consumption preferences by adjusting dividend payouts. We also try to understand the relevance of time preferences, i.e. discount rates for corporate dividend strategy. We also contribute to the catering literature by analyzing which behavioral biases are exactly responsible for the relation between dividend policy and market value of a company.

In a related manner, we examine cash holding polices in another paper entitled “Ambiguity Aversion and Cash Holdings”. Previous literature conjectures that cash holdings serve as an insurance tool for illiquidity and based on this theory we investigate how investors value cash with increasing ambiguity aversion. We distinguish between financially constrained firms and unconstrained firms. Our results suggest that the relationship between ambiguity and cash holdings is only significant for companies facing a noticeable risk of being financially constrained in line with or theoretical model. Again, our study contributes to the existing literature by demonstrating how limited rationality of investors affects cash management decisions and how managers react to investors’ biases. This catering related explanation for cash holding decisions has not been explored before us and we also elaborate on why only ambiguity aversion (and not risk aversion) should be relevant for cash holdings.

In both papers, we rely on a cross-country data set collected with the international test of risk attitudes (INTRA) survey (Wang et al., 2010; Rieger et al., 2011, Rieger and Wang,

2012) to investigate our main hypotheses. Thus, we study the link between country-specific behavioral preference parameters and company-specific financial policies. In this sense, our studies are also linked to literature branches such as “Law and Finance” (see e.g., La Porta et al., 2008) or “Cultural Finance” (see e.g., Breuer and Quinten, 2008) that try to explain different international financial practices considering cross-country differences in legal institutions or differences in fundamental cultural values as main determinants. Yet, instead of analyzing legal institutions or cultural values, in our papers, we rely on investors’ preference parameters as the main explanatory variables. This approach is called “Behavioral Finance” and in broad terms, it tries to explain puzzling financial behavior that cannot be explained by traditional approaches relaxing the assumption of rational market participants. Although it is not unusual to rely on findings from behavioral decision making analyses in the research field of corporate finance (see Baker and Wurgler, 2011 for a review), the cross-country differences in financial practices of corporations have not yet been studied based on this framework due to lack of data. With our unique dataset, we are able to fill this gap in research.

In the first two papers, we discuss the indirect influence of behavioral biases on intertemporal decisions in a company. We assume that managers try to satisfy their investors even when this might be detrimental to the company value in the long run. Yet, limited rationality implies that investors cannot ascertain the market value of future dividends accurately. Therefore, managers pursue increasing the present (subjective) market value of their company, which would minimize the takeover risk and increase their job security, even when their actions are detrimental to the market value of the company in the long term.

As we mentioned above, we also try to understand the relevance of behavioral biases for personal financial decisions of households. In “Framing Effects in Intertemporal Choice Tasks and Financial Implications”, we discuss how shifting the reference point of time affects the saving/borrowing decisions of households and under which conditions households are especially prone to framing effects. For this purpose, we design an experiment investigating framing effects in choice tasks. In choice tasks, framing effects are based on the principle of shifting the reference point of time, instead of the reference point of outcome. This way, we can effectively reduce the impact of framing effects. In choice tasks, the reference point shifts due to framing effects are only related to the difference amount between the sooner and the later outcome because of the editing process that we discuss in the paper. Moreover, our design resembles the actual decision frame in intertemporal saving/borrowing decisions more and as a result, our experimental results mirror the framing effects in actual saving/borrowing decisions more accurately.

Similarly, in the paper "Size Effects and Implications for P2P Credit Markets", we investigate size effects in intertemporal decisions with the help of an experiment. Unlike the previous experiments, we have described the magnitude of the later alternative not with monetary units but with return on investment. Like in "Framing Effects in Intertemporal Choice Tasks and Financial Implications", the design that we rely on is closer to the decision tasks in real life. Therefore, we speculate that the results of our experiments should reproduce the relation between the credit amount and interest rates in P2P lending markets much more accurately. Our results support the added compensation theory and reject the notion that size effects are due to the inability of naïve investors to discount correctly, as size effects are still existent, even if the underlying discount rates are given.

In sum, in all four papers, we reach the conclusion that the limited rationality of investors and the resulting biases identified in experiments shape the intertemporal decision process both in the fields of corporate and household finance. Furthermore, we study new behavioral patterns modifying the designs of some well-known experimental studies and demonstrate that our experiments reflect the actual preferences of individuals quite accurately. Thus, based on this work, we find supporting evidence for the general assumptions of the "Behavioral Finance" story. Additionally, our experiments strengthen the view defending the relevance of experiments in economics, as not many researchers have tried to bridge the gap between “Experimental Economics” and “Household Finance”.

References

Abdellaoui, M., Attema, A., Bleichrodt, H. (2009) Intertemporal tradeoffs for gains and losses: An experimental measurement of discounted utility. Economic Journal 120, 845-866.
Ainslie, G., Herrnstein, R. J. (1981) Preference reversal and delayed reinforcement. Animal Learning and Behavior 9, 476–482
Allais, M. (1953) Le comportement de l'homme rationnel devant le risque: critique des postulats et axiomes de l'école Américaine. Econometrica 21, 503-546.
Arrow, K. (1965) Aspects of the theory of risk bearing. Academic Bookstores, Helsinki.
Baker, M., Wurgler, J. (2004) A catering theory of dividends. Journal of Finance 59, 1125-1165.
Baker, M., Wurgler, J. (2011) Behavioral Corporate Finance: An Updated Survey. Unpublished working paper.
Benartzi, S., Thaler, R.H. (1995) Myopic Loss Aversion and the Equity Premium Puzzle. Quarterly Journal of Economics 110, 75-92.
Benzion, U., Rapoport, A., Yagil, J. (1989) Discount rates inferred decisions: An experimental study. Management Science 35, 270-284.
Bernoulli, D. (1954). Exposition of a New Theory on the Measurement of Risk. Econometrica 22, 23-36.
Breuer, W., Quinten, B. (2009) Cultural Finance. Unpublished working paper.
Camerer, C. (1995) Individual decision making, in: Kagel, J., and Roth, A. (eds.), Handbook of Experimental Economics. Princeton University Press, New Jersey.
Fennema, H., Van Assen, M. (1999). Measuring the utility of losses by means of the tradeoff method. Journal of Risk and Uncertainty, 17, 277-295.
Frederick, S., Loewenstein, G., O'Donoghue, T. (2002) Time discounting and time preference: A critical review. Journal of Economic Literature 40, 351-401.
Gilboa, I., Schmeidler, D. (1989) Maxmin Expected Utility with a Non-Unique Prior. Journal of Mathematical Economics 18, 141-153.
Kahnemann, D., Tversky, A. (1979) Prospect theory: an analysis of decision under risk. Econometrica 47, 263-291.
Kirby, K. N. (1997) Bidding on the future: Evidence against normative discounting of delayed rewards. Journal of Experimental Psychology: General 126, 54-70.
Kirby, K. N., Herrnstein, R. J. (1995). Preference reversals due to myopic discounting of delayed reward. Psychological Science 6, 83-89.
Klibanoff, P., Marinacci, M., Mukerji, S. (2005) A smooth model of decision making under ambiguity. Econometrica 73, 1849-1892.
Klibanoff, P., Marinacci, M., Mukerji, S. (2012) On the smooth ambiguity model: A reply. Econometrica 80, 1303-1321.
Laibson D. (1997) Golden Eggs and Hyperbolic Discounting. Quarterly Journal of Economics 112, 443-477.
La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R.W. (2000) Agency problems and dividend policies around the world. Journal of Finance 55, 1-33.
Loewenstein, G., Prelec. D. (1992) Anomalies in intertemporal choice: Evidence and an interpretation. Quarterly Journal of Economics May, 573-97.
McClure, S.M., Ericson, K.M., Laibson, D.I., Loewenstein, G., Cohen, J.D. (2007) Time discounting for primary rewards. Journal of Neuroscience 27, 5796-5804.
Modigliani, F., Brumberg, R.H. (1954) Utility analysis and the consumption function: an interpretation of cross-section data, in: Kurihara, K. (ed.), Post Keynesian Economics. Rutgers University Press, New Jersey, pp. 388-436.
O'Donoghue, T., Rabin, M. (2000) The Economics of Immediate Gratification. Journal of Behavioral Decision Making 13, 233-250.

Phelps, E. S., Pollak. R. (1968) On Second-Best National Saving and Game-Equilibrium Growth. Review of Economic Studies 35, 185-199.
Polk, C., P. Sapienza, P. (2009) The stock market and corporate investment: a test of catering theory. Review of Financial Studies 22, 187-217.
Pratt, J. W. (1964) Risk Aversion in the Small in the Large. Econometrica 32, 122-136.
Rabin, M. (1998) Psychology and economics. Journal of Economic Literature 36, 11-46.
Rieger, M.O., Wang, M., Hens, T. (2011) Prospect theory around the world. Unpublished working paper.
Riger, M. O. and Wang, M. (2012) Can ambiguity aversion solve the equity premium puzzle? Survey evidence from international data. Finance Research Letters 9, 63-72.
Samuelson, P. A. (1937) A note on measurement of utility. The Review of Economic Studies 4, 155-161.
Shefrin, H., Statman, M. (1985) The disposition to sell winners too early and ride losers too long: Theory and evidence. Journal of Finance 40, 777-790.
Shefrin, H.M., Thaler, R. (1988) The behavioral life-cycle hypothesis. Economic Inquiry 26, 609-643.
Stango, V., Zinman, J. (2009) Exponential Growth Bias and Household Finance, Journal of Finance 64, 2807-2849.
Strotz, R. (1956) Myopia and Inconsistency in Dynamic Utility Maximization. Review of Economic Studies 23, 165-180.
Thaler, R.H. (1981) Some empirical evidence on dynamic inconsistency. Economics Letters 8, 201-207.
Thaler, R.H., Shefrin, M. (1981) An Economic Theory of Self-Control. Journal of Political Economy 89, 392-406.
Tversky, A., Kahneman, D. (1992) Advances in prospect theory: cumulative representation of uncertainty. Journal of Risk and Uncertainty 5, 297-323.
von Neumann, J., Morgenstern, O. (1947) Theory of Games and Economic Behavior. Princeton University Press, New Jersey.
van Rooij, M., Lusardi, A., Rob, A. (2011) Financial literacy and stock market participation. Journal of Financial Economics, 101, 449-472.
Wang, M., Rieger, M. O., Hens, T. (2010) How time preferences differ: evidence from 45 Countries. Unpublished working paper.

The Behavioral Foundations of Corporate Dividend Policy
A Cross-Country Analysis

Wolfgang Breuer, M. Oliver Rieger, K. Can Soypak

Abstract. We study a model that relates dividend payout policy to behavioral issues based on the ideas of mental accounting. A panel analysis across 31 countries and over 46,000 firm-years demonstrates that the connection between country-specific preference parameters and dividend payouts can be verified empirically. Our paper seems to be the first that highlights empirically in a straightforward way the relevance of behavioral preference parameters regarding investors' patience, loss aversion and ambiguity aversion as important determinants for corporate dividend policy, while previous empirical studies could tackle this issue only indirectly. With several robustness tests we also address potential doubts concerning the quality of our data and analyze further implications of our theory.

JEL Classification: A12, D03, G35, Z10

Keywords: ambiguity aversion; behavioral decision theory; corporate dividend policy; loss aversion; patience

We would like to thank Axel F. A. Adam-Müller, Ron Antonczyk, Gulfem Bayram, Philipp Immenkötter, Andreas Jacobs, Heiko Jacobs, Benjamin Quinten, Evangelos Vagenas-Nanos, and seminar participants at the Campus for Finance Meeting 2012 in Vallendar, at the annual meeting of the Swiss Society for Financial Market Research 2012 in Zurich, at the INFINITI Conference on International Finance in Dublin 2012, at the 2012 European Conference of the Financial Management Association in Istanbul, at the annual conference of the European Financial Management Association 2012 in Barcelona and at the annual meeting 2012 of the German Finance Association (DGF) in Hannover for many helpful comments and suggestions.

The Behavioral Foundations of Corporate Dividend Policy
A Cross-Country Analysis

Abstract. We study a model that relates dividend payout policy to behavioral issues based on the ideas of mental accounting. A panel analysis across 31 countries and over 46,000 firm-years demonstrates that our model hypotheses can be verified empirically. Our paper seems to be the first that highlights empirically in a straightforward way the relevance of behavioral patterns as important determinants for corporate dividend policy, while previous empirical studies could tackle this issue only indirectly. With several robustness tests we also address potential doubts concerning the quality of our data and analyze further implications of our theory.

JEL Classification: A12, D03, G35, Z10

Keywords: ambiguity aversion; behavioral decision theory; corporate dividend policy; loss aversion; patience

1. Introduction

Corporate dividend policies vary a lot across different countries. Traditionally, these variations are explained by differences in the tax system and the relevance of informational asymmetries depending on the cross-country differences in legal frameworks (see La Porta et al., 2000; Brockman and Unlu, 2009). Recently, cultural aspects have been suggested as another reason for this finding (see Khambata and Liu, 2005; Fidrmuc and Jacob, 2010; Shao et al., 2010; Bae et al., 2012). Moreover, it is often argued that behavioral biases resulting from bounded investor rationality identified by descriptive decision theory may be a main determinant of corporate dividend policy as well, since firms adapt their policies in order to cater to investor demand (Baker and Wurgler, 2004; Becker et al., 2011). However, up to now, there has been no empirical analysis aiming at explaining cross-country differences in corporate dividend policy by behavioral patterns. Furthermore, previous behavioral approaches have not discussed which factors would drive investors' demand for dividends in the first place and they have not yet succeeded in tying behavioral factors to investors' dividend demand empirically in a straightforward way.

In this paper, we want to close these gaps: We show that loss aversion, ambiguity aversion, and the level of time discounting (i.e. the extent of investors' (im-) patience) are main determinants for corporate dividend policies across a sample of 46,000 firm-years from 31 countries for which data on behavioral variables have been collected via a comprehensive survey. By doing so, our paper contributes to the existing literature in several ways: First of all, we seem to be the first who address empirically the influence of loss aversion and ambiguity aversion on corporate dividend policy. Secondly, we contribute to the literature which investigates the relevance of time preferences for optimal dividend levels, as up to now this issue has only been examined in an indirect manner. Thirdly, by doing so, we are able to offer an alternative behavioral explanation for cross-country differences in corporate dividend policy and the valuation of dividends. Finally, our paper also provides a new theoretical model that can explain the impact of different preference parameters simultaneously.

Our paper is organized as follows: In Section 2, we present the current state of research with respect to the determinants of corporate dividend policy. Section 3 explains the role which behavioral patterns may play in determining corporate dividend policy and how preferences of boundedly rational investors become relevant for dividend policy decisions. In order to examine these relations in a more rigorous manner, we present a formal model that is motivated by Shefrin and Statman (1984) as well as by Shefrin and Thaler (1988). Based on our theory, we state our hypotheses. Section 4 describes our data and in Section 5 empirical results are presented. Section 6 is devoted to the discussion of our results and robustness tests, where we study an alternative measure of time preferences, analyze the relevance of local investors' preferences for companies controlled by foreign investors, investigate the investors' reaction to changes in dividend policy and allow for additional control variables. Section 7 concludes.

2. The Determinants of Corporate Dividend Policy: Literature Overview

The analysis of the determinants of corporate dividend policy belongs to the core issues in modern financial theory. Beginning with the celebrated irrelevancy theorem of Miller and Modigliani (1961) which relies on cash dividends and capital gains being substitutes in a perfect capital market, several avenues have been taken to identify reasons for the importance of corporate dividend policy. First of all, it is easy to understand that the tax system may influence corporate dividend policy. Although it started to change in recent years, dividends are typically taxed more than capital gains and, thus, paying dividends makes very little sense under those considerations. This finding leads Black (1976) to speak of a dividend puzzle (see also Feldstein and Green, 1983). In order to resolve the dividend puzzle, informational asymmetries have been propagated as another main determinant of corporate dividend policy. In this regard, in a world with less informed investors, dividend payments may have benefits, since they can be perceived as a signal for the future profitability of a company (Bhattacharya, 1979; Miller and Rock, 1985; Kumar, 1988).

In addition to signaling aspects, agency problems may affect corporate dividend policy. According to the free cash flow hypothesis (Jensen and Meckling, 1976), managers invest in projects with negative net present values in order to increase personal utility by a growth in power and company size. Such an overinvestment problem can be counteracted by increasing dividend payments in order to reduce free cash flow available to the firm. Therefore, all other things being equal, corresponding agency costs are decreasing in dividends. This will enhance the popularity of dividends as a commitment device (see Grossman and Hart, 1982; Easterbrook, 1984).

However, dividend payments also increase the risk of default by reducing the amount of assets that is accessible for debt holders. Thus, Kalay (1982) suggests that the observed dividend restrictions serve as a prerequisite for borrowing to take this issue under control. This would imply that firms with higher debt-equity ratios should favor lower dividend rates. This linkage is going to be especially strong for firms with higher idiosyncratic risk (Brav et al., 2005).

Still, tax considerations, signaling aspects, and agency problems can only account for a small portion of the variation in corporate dividend policies. Furthermore, these theories come up short to explain several issues such as reactions to stock dividends, which are basically stock splits (De Bondt and Thaler, 1985), or a preference for non-decreasing dividends (Lintner, 1963). Moreover, many empirical studies suggest a higher marginal propensity to consume from dividends than from capital gains (see Baker et al., 2007) indicating that investors do not treat dividends as a substitute for capital gains and process them in different accounts as a result of their limited information processing abilities.

Hence, those observations led to a discussion regarding the role of bounded investor rationality for dividend policies. The behavioral explanation of dividend policy of Shefrin and

Statman (1984) provides such an approach. Its main element is the distinction of different mental accounts for dividends and capital gains which brings us to the behavioral life cycle model of Shefrin and Thaler (1988). According to this model, people allocate their income in three different accounts: the current income account (*I*), the (current) asset account (*A*), and the future income account (*F*). Based on this differentiation, several reasons have been proposed to explain why investors with different preferences may prefer different dividend distributions.

1) Consumption financed from the account *A* and especially from *F* involves subjectively felt "penalties", as investors want to exercise self-control regarding the potential danger of excessive consumption due to time-inconsistent behavior. Current cash dividends are placed into the *I* account and therefore there is no penalty involved for the consumption financed by cash dividends, whereas future dividends are placed into the *F* account and consuming from this account will cause disutility. Hence, dividends are better suited for consumption purchases and impatient investors who want to consume with a clear conscience will prefer firms that pay out a larger share of their earnings as dividends. On the other hand, when investors want to save, but lack the willpower to do so, companies should retain earnings. In both scenarios, the dividend policy should account for investors' time preferences (Shefrin and Statman, 1984; Becker et al., 2011).

2) Dividends are "a bird in the hand", while retained earnings only lead to uncertain future earnings so that ambiguity averse investors prefer dividends even if retained and future earnings are completely reflected in current stock prices. Investors thus tend to perceive dividends as a safety net. This is solely a psychological phenomenon, because investors can obtain the same consumption path by selling their stocks. The study of Cyert and March (1993) emanates from this "bird in the hand" explanation as well and argues that people prefer dividend payments to retained earnings, because they are ambiguity averse.

3) Dividends reduce the exposure of investors to future shocks. If there is a positive probability that future shocks cause negative returns, dividends can be utilized in order to reduce the exposure to potential future losses for investors. This result is driven by the specific curvature of the investors' value functions which have a kink according to prospect theory implying that avoiding a loss is more important for investors than to acquire a gain of the same size. Due to this "loss aversion", investors may try to avoid potential future losses by increased current dividends.

These behavioral aspects of investor preferences thus provide an alternative approach to explain the relevance of corporate dividend policies. Moreover, they explain why corporate dividends and share repurchases are not perfect substitutes for investors as – according to Shefrin and Thaler (1988) – share repurchases are evaluated in investors' current asset account and not in their current income account and the consumption financed by share repurchases involves subjectively felt penalties. In addition, according to this theory we would expect different clienteles with different preferences to favor different companies because of the respective dividend policies which suit investors' consumption preferences best.

Up to now, there are two kinds of empirical approaches in order to verify the relevance of behavioral aspects for corporate dividend policy – with both of them being of a somewhat indirect character. Some empirical studies show that traditional approaches considering tax disadvantages of dividends, signaling aspects, and agency problems are not fully capable of explaining actual corporate dividend policies and thus conclude that there must be "something else" missing in these analyses, i.e. behavioral aspects of dividend policy (see, e.g., Baker et al., 2007). Secondly, one may refer to potential clientele effects which may have a behavioral background compatible to the arguments presented above. For instance, the early empirical study of Lease et al. (1976) supports the theoretical conclusions of Shefrin and Statman (1984) by comparing the investment decisions of different clienteles with potentially different preferences distinguished by demographic factors. According to their study, different clienteles with potentially different time preferences prefer stocks with different dividend to earnings ratios. While long-term oriented young investors favor stocks distributing lower dividends, the elderly prefer stocks with high dividend ratios. No possible reason other than mental editing can account for this outcome, since both groups can achieve the preferred consumption stream with the help of secondary market transactions regardless of the dividend policies of the companies they hold a share of. The later empirical works of Graham and Kumar (2006) and Becker et al. (2011) focus on the relation between portfolio structures and demographic factors as well and confirm the earlier findings of Lease et al. (1976).

Apparently, there is a lack of studies examining the relevance of behavioral aspects in corporate dividend policy in a more straightforward way. The simple reason for this gap is that this requires access to investors' preference parameters for different firms under consideration in order to identify the consequences of those differences for corporate dividend policies. In this paper, we want to resolve this issue by referring to differences in preference parameters across countries. This makes it possible for us to trace back cross-country differences in corporate dividend policies to behavioral differences among investors, since thanks to the well-documented home bias, investors prefer to invest in companies of their own countries (see also Section 6). Moreover, this approach allows us to identify other preference parameters besides time preferences that can explain the investors' demand for dividends and we do so by using straightforward proxies.

Our empirical approach is also related to recent literature which focuses on the role of cultural values and utilizes cross-country data sets on cultural aspects in order to explain differences in dividend policy choices. Although such studies can rely on comprehensive cross-country data, cultural analyses still lack a sound theoretical foundation which can connect these aspects to investor preferences and their economic decision making process. A clear advantage of investigations based on descriptive decision theory lies in this regard.

3. Behavioral Patterns of Corporate Dividend Policy: A Simple Model

As outlined in the preceding section, most of the theoretical literature on "behavioral corporate dividend policy" is based on an intuitive presentation of the most relevant relationships separately. Instead, we present a formal model in order connect the aforementioned three different behavioral preference parameters to dividend policy decisions in the same framework. This helps us to broaden the basis for our empirical examination in the next section.

The main purpose of our formal model is to demonstrate the relation between dividend policy and the level of self-control problems (i.e. investors' "*(Im-) Patience*"), of ambiguity aversion and of loss aversion which have already been mentioned in the informal discussion of the preceding section. Investors will attach a higher weight to future income, if they are patient, and will thus transfer more wealth from the present time to the future; therefore they will not ask for immediate compensation for their investments and will be more willing to wait for future dividend payments (see argument 1 of the preceding section). Furthermore, ambiguity aversion should lead to higher dividend payout levels, as ambiguity averse investors will shy away from uncertain investments more and instead prefer to realize their gains as quickly as possible (argument 2). Moreover, we propose that loss averse investors will experience more fear, when they invest in projects with potentially negative returns. Since there is a loss possibility linked with corporate investments, loss averse investors may prefer higher dividend ratios (argument 3). Although the aforementioned empirical papers analyzing different dividend clienteles indirectly support the first argument, there has been no study focusing on this aspect of dividend policies in a more straightforward way. Moreover, there is no empirical work at all concerning the second and the third argument.

To grasp these ideas more rigorously, it is necessary to set up a formal model. Unfortunately, at least up to now, such approaches seem to be quite rare in the literature. We only know of Yang et al. (2009) who have tried to analyze some aspects of behavioral corporate dividend policy in a more formal manner. However, they assume a value function that is not completely in line with prospect theory, they refrain from taking ambiguity aversion into account and they do not distinguish between different mental accounts for dividends and assets which are at the core of the general ideas of Shefrin and Thaler (1988). In what follows, we mainly attempt to depict the approach of Shefrin and Thaler (1988) in a more quantitative framework. As opposed to their original work, which focuses on the possible influence of wealth transfer among accounts on household savings, we take a closer look at the subjective perception of these simple wealth transfers by investors.

In order to do so, consider a two-period model (see also Figure I). At time $t = 1$ a dividend d_1 is paid out, thus reducing the value of the company x_1 (before dividends) to $S_1 = x_1 - d_1$. The company is now investing the remaining value S_1 into its operations yielding an uncertain return r_1 with probability distribution f. At time $t = 2$, the company's value is therefore $S_2 = (1+r_1)\cdot S_1$.

For this very simple setting, we are now interested in that dividend policy d_1 that maximizes the (representative) investor's overall utility U which is computed as the sum of utility $u(d_1 - d_1^{(R)})$ and $u(S_1 - S_1^{(R)})$ in the first period and the subjectively discounted expected utility $(2-\delta)\cdot\int_0^{\infty} u(S_2 - S_2^{(R)}) f(r_1)dr_1 + \delta\cdot\int_{-\infty}^{0} u(S_2 - S_2^{(R)}) f(r_1)dr_1$ of the second period:

$$U(d_1) := u(d_1 - d_1^{(R)}) + u(S_1 - S_1^{(R)}) + \beta\cdot(2-\delta)\cdot\int_0^{\infty} u(S_2 - S_2^{(R)}) f(r_1)dr_1 + \beta\cdot\delta\cdot\int_{-\infty}^{0} u(S_2 - S_2^{(R)}) f(r_1)dr_1. \quad (1)$$

In (1), the index "(R)" denotes reference values to distinguish between gains and losses, i.e. for $x \in \{d, S\}$ we assume

$$u(x_t - x_t^{(R)}) = \begin{cases} (x_t - x_t^{(R)})^{\alpha^+} & x_t \geq x_t^{(R)}, \\ -\lambda\cdot(x_t^{(R)} - x_t)^{\alpha^-} & x_t < x_t^{(R)}, \end{cases} \quad (2)$$

with λ being a loss aversion parameter typically greater than 1 and α^+ as well as α^- being variables that determine the curvature of u for $x_t \geq x_t^{(R)}$ and $x_t < x_t^{(R)}$, respectively. Following Shefrin and Thaler (1988), we interpret the term $u(d_1 - d_1^{(R)})$ as the utility contribution of the current income account while $u(S_2 - S_2^{(R)})$ stands for the (uncertain) utility component of the future income account and $u(S_1 - S_1^{(R)})$ for the investor's current asset account.

>>> Insert Figure I about here <<<

The future income account is discounted by the factor β. In addition, we want to allow for ambiguity aversion. However, as a general problem, up to now, it is not clear how to formally model ambiguity aversion in a consistent way. As we are mainly interested in comparative static results, we refer to just one main consequence of ambiguity aversion: Instead of simply evaluating a future alternative by its expected utility, ambiguity averse individuals will levy a discount on this value thus reducing the overall utility, since an uncertain return distribution is disturbing for ambiguity averse investors. We account for ambiguity aversion by introducing an ambiguity parameter δ between 1 and 2 where for δ = 1 investors are ambiguity neutral and ambiguity aversion is increasing in δ. As a consequence, the subjectively discounted expected utility in the future income account is decreasing in ambiguity aversion. Our way of modeling ambiguity aversion can be interpreted as a simplified version of the approach by Klibanoff et al. (2005).

Certainly, an investor exhibiting such preferences is only boundedly rational, as full rationality would imply to set all reference values equal to zero and the ambiguity aversion parameter equal to 1, neglect the asset account and to discount expected future stock prices by a risk-adjusted capital market interest rate. It is well-known that under these conditions we would arrive at the irrelevancy of corporate dividend policy. Nevertheless, we are interested in the consequences of limited rationality and mental accounting for optimal dividend decisions. In particular, we ask how certain investors' preference parameters (loss aversion λ, ambiguity aversion δ, and patience β) affect the optimal dividend level d_1. In order to do so, we assume $S_2^{(R)}$ to be identical to S_1 which means that changes in the value of an investor's stock holdings from $t = 1$ to $t = 2$ enter the future income account. We thus have

$$S_2 - S_2^{(R)} = (x_1 - d_1) \cdot (1 + r_1) - (x_1 - d_1) = (x_1 - d_1) \cdot r_1. \tag{3}$$

In such a situation, there will be a loss in the future income account only for $r_1 < 0$ and hence independent of the specific level of d_1 (at least, as long as dividends at time $t = 1$ are not greater than the overall value of the firm x_1). Nevertheless, the "exposure" for potential losses is determined by d_1. From this finding, we may directly conclude that higher values of the loss aversion parameter λ will lead to greater dividend levels d_1 at time $t = 1$ just in order to reduce the exposure to potential losses in the future income account. At least, this holds true as long as there are no violations of stock price reference points at time $t = 1$ in the current asset account.

Similarly, dividends will also reduce the exposure to uncertainty concerning future shocks which (only) affects the utility of the future income account. For investors with higher ambiguity aversion δ, this problem will be more acute and they will prefer to realize capital gains rather than to wait for the uncertain outcomes from investments.

On the other hand, the impact of the patience level β on the optimal dividend level is somewhat more complex. First of all, higher values of β also enhance the importance of the utility contribution of the future income account. For this reason, increased values of β imply decreased values of d_1 only if future reference point violations are sufficiently unlikely. Otherwise, we should expect to find a *positive* relation between β and d_1. Therefore, in particular, the distribution of r_1 becomes relevant as determinant of the connection between β and d_1. If the overall utility contribution of the future income were indeed negative, the investor would certainly prefer to liquidate his or her stock holdings at time $t = 1$. This means that investors who are willing to hold their stocks will be characterized by quite positive subjective expectations regarding future rates of return r_1. Therefore, we should typically observe a negative relation between β and d_1 for our simple decision problem.

All of our arguments so far can also be verified by a more formal analysis of the decision problem under consideration. The maximization of (1) with respect to d_1 thus gives us the following necessary condition for an inner solution:

$$\begin{aligned} g(d_1) := U'(d_1) = u'(d_1 - d_1^{(R)}) - u'(x_1 - d_1 - S_1^{(R)}) - \beta\cdot(2-\delta)\cdot\int_0^{\infty} u'((x_1-d_1)\cdot r_1)\cdot r_1\cdot f(r_1)dr_1 \\ -\beta\cdot\delta\cdot\int_{-\infty}^{0} u'((x_1-d_1)\cdot r_1)\cdot r_1\cdot f(r_1)dr_1 = 0. \end{aligned} \tag{4}$$

First, we observe that as long as g is a decreasing function around the optimal value of d_1, i.e. the sufficient condition for an inner maximum is fulfilled,

$$\begin{aligned} g'(d_1) = u''(d_1 - d_1^{(R)}) + u''(x_1 - d_1 - S_1^{(R)}) + \beta\cdot(2-\delta)\cdot\int_0^{\infty} u''((x_1-d_1)\cdot r_1)\cdot r_1^2\cdot f(r_1)dr_1 \\ +\beta\cdot\delta\cdot\int_{-\infty}^{0} u''((x_1-d_1)\cdot r_1)\cdot r_1^2\cdot f(r_1)dr_1 < 0, \end{aligned} \tag{5}$$

the root of g increases when g increases. We therefore just need to study how g changes, when β, δ, and λ change, thus we determine $\partial g/\partial\beta$, $\partial g/\partial\delta$, and $\partial g/\partial\lambda$:

Dependence on β: Only the last two terms of g depend on β. Rewriting $\int_0^{\infty} u'((x_1-d_1)\cdot r_1)\cdot r_1\cdot f(r_1)dr_1 = \text{Prob}(r_1>0)\cdot \text{E}\left[u'((x_1-d_1)\cdot r_1)\cdot r_1 \,\middle|\, r_1>0\right]$ and the analogous integral for $r_1 < 0$, we have

$$\begin{aligned} \frac{\partial g}{\partial\beta} = -(2-\delta)\cdot\text{Prob}(r_1>0)\cdot\text{E}\left[u'((x_1-d_1)\cdot r_1)\cdot r_1 \,\middle|\, r_1>0\right] \\ -\delta\cdot\text{Prob}(r_1<0)\cdot\text{E}\left[u'((x_1-d_1)\cdot r_1)\cdot r_1 \,\middle|\, r_1<0\right]. \end{aligned} \tag{6}$$

As long as positive rates of return being sufficiently probable, i.e. Prob(r_1 > 0) being sufficiently large, we get $\partial g/\partial\beta < 0$ and therefore a negative correlation between optimal dividend level d_1 and β. As a consequence, for high enough probabilities of positive rates of returns, the investor should be willing to hold the asset until t = 2 and optimal dividends d_1 should be decreasing in the investor's patience level β.

Dependence on δ: Again, just the last two summands of g depend on δ,

$$\frac{\partial g}{\partial \delta} = \beta \cdot \int_0^{\infty} u'((x_1 - d_1)\cdot r_1)\cdot r_1 \cdot f(r_1)dr_1 - \beta \cdot \int_{-\infty}^{0} u'((x_1 - d_1)\cdot r_1)\cdot r_1 \cdot f(r_1)dr_1. \qquad (7)$$

This term is clearly positive, as the left integral with positive returns is positive and the right integral with negative returns is negative. This means that the optimal dividend payout level d_1 should be increasing in ambiguity aversion.

Dependence on λ: First, consider a situation without a reference point violation at time t = 1. Then, regarding t = 2, the loss aversion coefficient increases the marginal utility u' in losses, i.e. for $r_1 < 0$, and leaves u' otherwise unchanged so that only the fourth term of g is affected. As $\int_{-\infty}^{0} u'((x_1 - d_1)\cdot r_1)\cdot r_1 \cdot f(r_1)dr_1$ is a *decreasing* function of λ, we get $\partial g/\partial\lambda > 0$. Now consider a situation with $d_1 < d_1^{(R)}$. Apparently, the first summand of g is a decreasing function of λ as well. Hence, only in situations where there is a reference point violation in the current asset account ($S_1 < S_1^{(R)}$) with certainty, the sign of $\partial g/\partial\lambda$ could become negative. Nevertheless, at least for long-term oriented investors with reference points $S_1^{(R)}$ being identical to former (small) purchasing prices of their shares, we are allowed to refrain from this countervailing effect completely. Moreover, in our empirical analysis we only investigate firms with positive earnings and cash flows and this also reduces the possibility of decreasing stock prices and thus violation of corresponding reference points in the current asset account. As higher loss aversion could lead to smaller optimal dividend payments only for firms with the majority of investors already facing violations of their reference points $S_1^{(R)}$, we consider a positive relationship between optimal dividend payments and loss aversion parameter λ to be the more plausible case.

Summarizing, we arrive at the following three hypotheses on the basis of our theoretical analysis so far:

Hypothesis 1: *More patient investors (i.e., investors with larger β) will prefer lower dividend ratios.*

Hypothesis 2: *Investors with higher ambiguity aversion δ will prefer higher dividend ratios.*

Hypothesis 3: *The general dividend level is increasing in loss aversion λ.*

The empirical testing of these hypotheses is the object of the next section.

4. Empirical Analysis of Cross-Country Behavioral Patterns of Dividend Policy

As our dependent variables are left-censored at zero for firms that do not pay dividends, we need Tobit estimations in our empirical analysis. Furthermore, since we have multiple observations for the same firms, we cluster our robust standard errors by firms and use year dummies (see Brockman and Unlu, 2009). We refrain from adding industry dummies as well in order to avoid multicollinearity problems and to restrict the number of independent variables to a reasonable size. However, our empirical results remain valid even after adding industry dummies (although we get variance inflation factors larger than 10 for some industry dummies).

While we study mainly behavioral aspects, Section 2 has made it clear that there are other factors that may influence dividend policy besides behavioral biases. Therefore, we include a set of company- and country-specific control variables in our regressions. All variables in our regressions are explained in more detail in the following subsections.

4.1 Data on Behavioral Dimensions

For our behavioral variables, we refer to data on subjective preference parameters obtained from the international test of risk attitudes (INTRA) survey carried out mainly between 2005 and 2009 among undergraduate students of economics in 46 countries. A total of 6,000 university students participated in the survey. Each participant was asked to fill in a questionnaire that included several questions on risk and time preferences and some information about his or her personal background (Wang et al., 2010; Rieger et al., 2011).

In order to measure time preferences, participants answered a hypothetical question involving a smaller sooner and a larger later reward. It should be mentioned that purchasing power differences were taken into account when asking the questions and that the questions were formulated in the countries' own currencies. Differences between countries were large, even when considering the variation in inflation rates (see Wang et al., 2010, for more details on methodology and results). In the empirical part of our study, we use as a proxy for *Patience* the percentage of subjects in a country willing to wait in this binary choice task.

Similarly, loss aversion has been determined via hypothetical lotteries with a fifty-fifty chance of winning or losing money. The participants had to declare a minimum acceptable gain prospect of X for a given potential loss of Y both in the domestic currency of the respective countries, so that they were just willing to participate in the lottery. The magnitude of the loss aversion has been elicited from this answer. Its theoretical fundaments go back to Kahnemann and Tversky (1979). In a similar manner, the level of ambiguity aversion has been deduced with the help of a modified version of the well-known Ellsberg's urn experiments where participants can choose between a risky and an uncertain lottery with the winning probability (for the same potential payoff) being higher for the uncertain lottery. Therefore, investing in the less profitable risky rather than the more profitable uncertain lottery points to ambiguity aversion.

In what follows, we utilize the data on our survey participants' time and risk preferences as proxies for preference patterns of the whole population in the respective countries. One might criticize such an approach because students are relatively young and inexperienced compared to the rest of the society. Yet, several papers in the field of experimental economics have demonstrated similarities between their experiments with non-student (sometimes even with non-human) and student participants. For instance, King et al. (1993) have shown that asset market bubbles occur in a similar way, when professional fund managers instead of university students participate in the same experiments. In dictator and ultimatum games, Carpenter et al. (2003) have found no significant differences between choices of student and non-student participants. This result has been confirmed later with a trust game designed by Falk et al. (2012). Moreover, since we are conducting a cross-country empirical comparison, the differences between the students of different countries are more important for our analysis than the absolute levels of loss and ambiguity aversion as well as patience and there is no reason to believe that the cross-country differences in these preference parameters should be distributed differently for students compared to the general population.

In addition, in Section 6, we replace one of our behavioral parameters, *Patience,* with an alternative proxy for long-term orientation, which is obtained from a survey based on managers' judgments (data taken from the "Project Globe"). It turns out that both measures of time preference are very highly correlated and that replacing *Patience* with this alternative proxy has no noticeable effect on our empirical results. We conclude that time and risk preferences as revealed by students in different countries should enable us to perform reasonable cross-country comparisons even for the field of corporate finance.

We assume furthermore that, despite globalization, a country's dividend policy is mainly determined by preferences of domestic investors. Though this view is certainly a simplification of actual capital market conditions, according to the well-known home bias anomaly, most individuals are reluctant to invest in stocks listed in foreign countries. For instance, French and Poterba (1991) report that investors with residence in the U.S., Japan, and the U.K. hold 94 %, 98 %, and 82 % of their equity investments in domestic stocks, respectively (see Lau et al., 2010 for a more recent study). We are in line here with all recent papers that investigate the influence of cultural differences across countries on corporate dividend policy, since they must ultimately also rely on this argument. Hence, we deem it admissible to examine the potential consequences of only domestic investors' preferences for corporate dividend policies. Still, in Section 6, we examine whether our results look different for those companies where a majority of shares is owned by foreign investors and observe that local investors' parameters are less decisive for the dividend policy in these companies, as we predict. We also observe that the subsample of companies owned by foreign investors is very small which is again in line with the home bias effect. This additional finding also serves as an indirect confirmation of our assumption regarding the representative quality of students' preferences for the whole underlying respective population.

4.2 Data on Dividend Ratios

There are several possible ways to measure firms' dividend levels. In particular, we relate total dividends to EBIT (*Div/EBIT)*, to total cash flow (*Div/Cash*) and to net sales (*Div/Sales).* All these measures have different merits and weaknesses. For instance, *Div/EBIT* can easily be manipulated by firm management. Furthermore, different accounting conventions in different countries aggravate the problem of cross-country comparability based on this measure. Besides, in some cases, dividends are reported before the final net earnings are reckoned, which also casts doubt on the relevance of earnings measures like EBIT for corporate dividend policy. On the other hand, sales and cash flows are only poor proxies for a firm's actual earnings situation. Hence, we take all three dividend measures into account, which will also serve as a robustness check due to the qualitative differences of these items.

Data regarding company information including annual returns and other control variables are extracted from Datastream, a service of Thomson Reuters. We have chosen to analyze all the companies listed under the constituent list "World Market" provided by Datastream consisting of 6,922 companies from 59 countries. Our analyses cover all the firm years between 1992 and 2012. Cross matching this sample with the countries for which we have data for our behavioral preference parameters leaves us with at least 45,721 firm-years (3,382 companies) from 31 countries. We find this sample much better suited for our purposes than the Compustat Global Data, since Compustat Global Data are dominated by companies located in the United States, especially in the early years (over 38 % even for 2002). On the other hand, our sample is much more balanced across different countries, as US located firms comprise only 21.66 % of the total firm-years. Furthermore, we omit all financial and utility companies (four digit SIC classification numbers between 6000-6999 and 4900-4949, respectively), since these firms are mostly regulated. Moreover, we exclude all firms with negative EBIT, cash flow and net sales, as negative dividend payout ratios are not comparable with positive values.

4.3 Data on Control Variables

According to our discussion of Section 2, we have to control for other market imperfections in our analysis, which may have an impact on corporate dividend policies. Our goal is not to challenge the theories that claim such aspects to be relevant; rather we try to reveal some missing ingredients of corporate dividend policy. We allow for firm-specific as well as country-specific control variables.

We rely once again on the Datastream database in order to utilize firm-specific controls, which are *Firm Size*, *Debt-Equity Ratio*, *Sales Growth* and *Profitability* in our analysis. Besides, we extend the set of our control variables by including year dummies.

Firm Size is simply defined as the logarithm of the total assets in constant 1992 dollars. The relevance of such a variable is well-known from the empirical literature regarding firm capital structure decisions. The information flow between investors and managers is slower for larger companies, since their shares are spread among more investors, which aggravates free rider problems attached to manager monitoring (Fama and French, 2001). In order to counteract the agency problems resulting from inefficient monitoring, the investors of larger firms will demand higher dividend payouts. We therefore deem it reasonable to control for company size effects also when looking at corporate dividend policy.

Debt-Equity Ratio is the ratio between the book value of debt and equity. We would expect a negative correlation between *Debt-Equity Ratio* and our dividend measures because of dividend constraints set by debt holders in order to reduce the agency problems of debt financing.

Sales Growth is computed as the quotient of net sales$_t$ at time t and net sales$_{t-1}$ one period earlier of a company (see Brockman and Unlu, 2009). According to Fama and French (2001), firms with higher growth rates are less likely to pay out dividends because of the higher financing needs of growing firms and the reduced free cash flow problems. Hence, we expect a negative relationship between growth and dividends.

Finally, we define EBIT scaled by firm assets as *Profitability*. More profitable firms are going to signal their quality by paying out dividends and for this reason we expect a positive relation between *Profitability* and dividend payouts (LaPorta et al., 2000).

In addition to company-specific control variables, we also have a couple of country-specific controls. The data for *Total Taxes* − which stem from Djankov et al. (2010) − express country-specific tax ratios. According to our consideration of Section 2, one would expect higher taxes to coincide with lower dividends as capital gains, e.g. profits from stock sales, are generally less heavily taxed than dividend income.

We have repeated our empirical analysis with an alternative measure of tax influences which refers to the *differences* in taxation regarding dividends and capital gain (data taken from Fidrmuc and Jacob, 2010, who adopted the concept defined by La Porta et al., 2000, to quantify tax disadvantages of dividends and expanded their analysis to more countries). The results are the same with this alternative tax measure measuring tax disadvantages of dividend payments as well. We refrain from presenting these additional results, since the data on *Tax Differences* are only available for 23 countries instead of all of the 31 countries in our sample.

Anti-Self-Dealing Index developed by Djankov et al. (2008) is another helpful variable to control for the relevance of informational asymmetries and agency problems on the country level. For example, higher values of *Anti-Self-Dealing Index* point out that it may be easier for outside investors to directly overcome managerial overinvestment problems so that dividend payments may be ceteris paribus higher. At the same time, in a country with weak shareholder protections, firms may benefit more from establishing a good reputation which they can achieve through higher dividend payouts. Hence, the impact of legal protections of such sort is not unambiguous. In any case, it seems necessary to account for these aspects in our analysis. Therefore, we integrate *Anti-Self-Dealing Index* in our empirical analysis. Table I gives an overview of descriptive statistics with respect to all variables in our regressions.

>>> Insert Table I about here <<<

In contrast to our firm-specific data, country-specific data including our behavioral preference parameter estimates are not given as panel data. However, we assume that country-specific characteristics change only relatively slowly across time so that we are allowed to work with given country-specific data over the whole observation period from 1992 to 2012. For example, a corresponding assumption typically also underlies cross-country analyses that are based on cultural features (Bae et al., 2012) or governance structures (Brockman and Unlu, 2009; Alzahrani and Lasfer, 2012).

5. Results

As already mentioned, we utilize a Tobit regression model with firm-clustered robust standard errors to explicitly account for the left-censored nature of dividend payout ratios with *Div/Cash*, *Div/EBIT*, and *Div/Sales* being the respective dependent variables. The first regressions in columns (1), (3), and (5) of Table II are only based on the control variables introduced before, while the regressions in columns (2), (4), and (6) present results based on all control variables as well as on the three behavioral parameters. For all regressions, we check multicollinearity problems with the help of the variance inflation factor (VIF) and no variable has a VIF larger than 4, hence multicollinearity does not seem to be a problem (Kutner et al., 2004).

Our findings are essentially identical for all three dividend measures. The signs of the corresponding coefficients are always in line with our hypotheses and different from zero on high significance levels for each of the three behavioral parameters. Furthermore, all control variables other than *Anti-Self-Dealing Index* seem to have most of the time a significant impact on dividend policy with signs in line with the literature even after accounting for our behavioral parameters. *Anti-Self-Dealing Index* is positively correlated with dividend payouts in columns (1), (3), and (5), hence without behavioral parameters supporting the previous results of La Porta et al. (2000). Yet after introducing behavioral factors, *Anti-Self-Dealing Index* becomes insignificant suggesting that behavioral parameters cover the same grounds as *Anti-Self-Dealing Index*. Contrary to our expectations, *Profitability* seems to be negatively correlated with *Div/EBIT*, but this is probably due to the fact that EBIT enters the numerator in the definition of *Profitability*. In the next section, we are going to discuss the impact of further control variables in our empirical model, but these additional factors are not going to change our main results.

>>> Insert Table II here <<<

According to our findings, *Patience*, *Loss Aversion*, and *Ambiguity Aversion* seem to be of high practical importance for the determination of cross-country differences. The influence is also economically significant. An increase of one standard deviation in the standardized regression coefficient of *Patience* causes a decrease in the original dividend to cash flow (EBIT, sales) ratio of about 8.12 (5.76, 8.33) % of the corresponding mean and thus seems to be economically highly significant. For *Loss Aversion*, a one standard deviation increase implies an even more significant increase in the original dividend to cash flow (EBIT, sales) ratio of 28.83 (31.11, 27.42) % of the respective mean values. Once again, this change seems to be of high economic significance. For *Ambiguity Aversion*, this effect is again very strong with corresponding values of 17.65 (16.95, 15.89) %.

Our analysis considers also firms located in Chile, Germany, and Greece. According to La Porta et al. (2000), Chile and Greece have mandatory dividend rules. Moreover, La Porta et al. (2000) state that there is some kind of minimum dividend requirement in Germany as well. For this reason, we exclude firms located in Chile and Greece as a first robustness check and firms from Chile, Greece, and Germany as a second robustness check. In both cases, we reached exactly the same results as before. Hence, our findings are not driven by legal regulations regarding dividend payments.

6. Discussion

6.1 An Alternative Measure of Time Preferences

Up to now, our empirical results seem to be quite promising. Nevertheless, our findings critically hinge upon the fact that our cross-country data regarding *Patience*, *Loss Aversion*, and *Ambiguity Aversion* are sufficiently reliable. As our data set is unique, it is difficult to verify its quality. However, at least, it seems possible to compare our data for *Patience* with a related variable named *Future Orientation*. In the Project Globe survey (House et al., 2004), leadership and processes within firms were studied with respect to cross-country differences, whereby one of the considered dimensions was *Future Orientation*, reflecting the tendency to think and act in a future-oriented way, such as planning, investing in the future, and delaying gratification. In the survey, managers judged on a scale from one to seven whether people in their country were more present-oriented or more future-oriented. Lower values indicate lower future orientation, whereas higher values indicate higher future orientation.

Since the Project Globe survey analyzes work values in the working environment and is also related to aspects like flexibility of organizations in a country and the level of importance attached to spiritual fulfillment or traditional values, it is not as adequate as our *Patience* variable to reproduce time preferences, but it may still be utilized to cross-check the results of the preceding section. First of all, the correlation between *Patience* and *Future Orientation* is 0.74, which is significantly positive at the 0.1 % level for a two-tailed Pearson correlation test. Replacing *Patience* with *Future Orientation* in our multivariate regression approach actually verifies all of our previous results in Table II, although the results are less significant with *Future Orientation*. This is not very surprising considering that this indicator is related to other aspects than the propensity to save.

>>> Insert Table III here <<<

Moreover, there are some studies that try to investigate the relevance of Long-Term Orientation on dividend policy – a cultural dimension introduced by Hofstede (2001). Although this latter variable is not quite easy to understand (see Yeh and Lawrence, 1995), there is certainly a connection to time preferences. Results by Bae et al. (2012) as well as Khambata and Liu (2005) reveal a negative influence of this cultural dimension on dividend levels which is in line with our finding for *Patience*. Another reliability check can be found in Wang et al. (2010) where a highly significant correlation of *Patience* with the "Time Pace" variable of Levine (1997) is reported.

6.2 Foreign Ownership and The Impact of Preference Parameters

So far, we have assumed that domestic investors dominate every company in our sample, hence mainly the preferences of those investors that are located in a certain country should be relevant for the regulation of corporate dividend policies. As we have mentioned above, several papers have demonstrated that indeed companies are owned to a large proportion by domestic investors even in free market economies.

Our theory, however, predicts that local investor preferences should render (rather) unimportant in companies controlled by foreigners. Using data on *Foreign Ownership*, which is defined in Datastream as the percentage of strategic share holdings of 5 % or more held in a country outside that of the issuer, we divide our sample in two subsets: companies with *Foreign Ownership* smaller than 50 % and companies with higher *Foreign Ownership*. First of all, we see that only a very small portion of companies in our sample is controlled by foreign investors which backs up our earlier assumption based on the home bias effect.

We run our regression models of the previous section for both subsamples and observe that *Patience* and *Loss Aversion* are only relevant, as long as the majority of shares belongs to domestic investors (see Table IV). While *Ambiguity Aversion* is significantly positively related to dividend payouts for companies controlled by foreign investors as well, the correlation becomes substantially smaller. These findings circumstantiate the validity of our theory and also address concerns regarding the representativeness of our student sample for the whole population: Students' preferences work well as a proxy for overall preferences only in exactly those situations in which we expect them to do so.

In addition, other differences in our results for the sample with a majority share owned by domestic investors and for the sample with a majority share held by foreign owners seem reasonable: In the case of dominant foreign ownership, domestic taxes will be typically of less relevance. Similarly, a firm's debt-equity ratio is less important for dividend policy, if it is dominated by foreign owners. This is also plausible, as these firms may be often part of a multinational conglomerate. In contrast, sales growth and profitability remain important determinants of corporate dividend policy even with increased foreign ownership.

>>> Insert Table IV here <<<

6.3 Market Valuation and Preference Parameters

We argue in our model that managers try to satisfy their investors' preferences. A potential reason for this managerial behavior might be to strive for firm value maximization which will lead to higher bonus payments for managers and help them keep their jobs.

This assumption has also further implications that need to be investigated. If managers indeed use dividend payouts to cater to their investors' needs, the relationship between dividend policy and firm value should also be related to investor preferences (Brockman and Unlu, 2009). In order to test this hypothesis, we rely on a method first applied by Faulkender and Wang (2006) to analyze the impact of cash holdings on excess market returns.

We adapt this novel methodology to analyze the market reaction to changes in dividend payouts and we run regressions of excess market returns (defined as yearly stock return−riskless return−beta×(index return−riskless return) for the firm under consideration) on the interactions between dividend payout changes and our preference parameters. We have retrieved data on national stock exchange index returns from the Datastream list of key economic indicators for each country in our analysis. Similarly, we work with data on policy interest rates in the same database as country-specific riskless returns. According to our theoretical model and our empirical results so far, we would expect to find more affirmative market reactions to dividend changes in countries with high values of *Loss Aversion* and *Ambiguity Aversion* as well as small values for *Patience*.

Except for leverage, all firm-specific control variables are also deflated by lagged market value of equity and they are all winsorized at the 1 % level. Running a regression model with firm-clustered robust standard errors and year dummies, we find indeed – according to Table V – that excess market returns are increasingly positively correlated with dividend payouts in countries with high values for *Loss Aversion* and *Ambiguity Aversion* and low values for *Patience*. This suggests that investors with high loss and ambiguity aversion and low patience value changes in dividend payouts relative to their reference points more favorably and are willing to pay more to own these stocks that distribute more dividends.

>>> Insert Table V here <<<

6.4 Additional Control Variables

The literature on dividend policy decisions are growing vastly and new empirical work has been successful in identifying new key determinants for dividend policy decisions. Institutional ownership constitutes one such example, as different papers have found evidence that institutions favor lower dividend payouts (Grinstein and Michaely, 2005), which is mostly driven by tax disadvantages and other specific transaction costs of dividends for institutions (Desai and Jin, 2011). To control for the impact of the institutional ownership on dividend payouts, we integrate *Institutional Ownership*, defined as the percentage of total shares in issue held as long-term strategic holdings by investment banks or institutions seeking a long-term return according to Datastream.

Furthermore, DeAngelo et al. (2006) proposed recently a life-cycle theory of firms predicting that the propensity to pay dividends increases in later stages of the life-cycle of the company. In order to account for the life-cycle of the company, we include *Age* of the company as another control variable, which is equal to the days past since the foundation of the company.

We have neglected to control for these aspects in our original regressions of Table II, since including these control variables reduces the number of our firm-years in our analysis drastically. At the same time, these factors are shown to be important determinants of dividend policies in recent empirical studies; hence ignoring them might raise some concerns that an omitted variable bias is driving the results. In particular, controlling for institutional ownership may be interpreted as a further robustness check of the representativeness of our estimates regarding naïve investors' preferences based on students' choices in our survey. After incorporating these factors in our regressions, our behavioral parameters remain highly significant, as is revealed in Table VI. We only observe that *Age* replaces *Size* to a certain extent and this makes sense, as both variables are related to company-specific informational asymmetries in the same vein. Hence, we can rule out a potential omitted variable bias due to neglecting these factors in our analysis.

>>> Insert Table VI here <<<

7. Conclusion

The main objective of our study was to investigate the relevance of behavioral preference patterns for investors' dividend preferences in a straightforward way. We showed analytically and empirically that there is a negative relationship between investors' patience level and dividend payouts and that there are positive relationships between loss aversion and ambiguity aversion on the one side and dividend payouts on the other side. This presents evidence for the boundedly rational investor story, as for rational investors behavioral biases should be completely unrelated to dividend payout strategies. Hence, our paper is the first one to analyze the connection between boundedly rational investor preferences and corporate dividend policies in a rigorous way. Most importantly, we have provided the first empirical results to back up the theories that link loss aversion and ambiguity aversion to dividend policies. Furthermore, our results concerning the relationship between time preferences and dividend payouts are much more straightforward than previous empirical work focusing on dividend clienteles.

As we relied on cross-country comparisons for the empirical part of our study, we also contributed to the literature researching the differences in corporate dividend policies across countries. Behavioral preference parameters like patience, loss aversion, and ambiguity aversion can explain a very significant portion of the variation in cross-country differences in corporate dividend policies. Our study could also be linked to a new branch of literature that is called "cultural finance". The economic background of cultural values, however, is still not clearly understood and their link to investor preferences and decision making processes is not theoretically well-founded. Certainly, this is why we prefer behavioral parameters because of their unambiguous economic relevance, while cultural variables are much harder to interpret from an economical point of view.

References

Alzahrani, M., Lasfer, M. (2012) Investor protection, taxation, and dividends. Journal of Corporate Finance 18, 745-762.

Bae, S.C., Chang, K., Kang, E. (2012) Culture, corporate governance, and dividend policy: international evidence. Journal of Financial Research 35, 298-316.

Baker, M., Wurgler, J. (2004) A catering theory of dividends. Journal of Finance 59, 1125-1165.

Baker, M., Nagel, S., Wurgler, J. (2007) The effect of dividends on consumption. Brookings Papers of Economic Activity 1, 277-291.

Becker, B., Ivkociv, Z., Weisbenner, S. (2011) Local dividend clienteles. Journal of Finance 66, 655-684.

Bhattacharyya, S. (1979) Imperfect information, dividend policy, and "the bird in the hand" fallacy. Bell Journal of Economics 10, 259-270.

Black, F. (1976) The dividend puzzle. Journal of Portfolio Management 2, 5-8.

Brav, A., Graham, J., Harvey, C., Michaely, R. (2005) Payout policy in the 21st century. Journal of Financial Economics 77, 483-527.

Brockman, P., Unlu, E. (2009) Dividend policy, creditor rights, and the agency costs of debt. Journal of Financial Economics 92, 276-299.

Carpenter, J., Burks, S., Verhoogen, E. (2003) Comparing students to workers: the effects of social framing on behavior in distribution games, in: Carpenter, J., List, J., Harrison, G. (eds.), Field Experiments in Economics, Elsevier, Netherlands, pp. 261-290.

Cyert, R., March, J. (1993) A Behavioral Theory of the Firm. Blackwell, Massachusetts.

De Bondt, W., Thaler, R. (1985) Does the stock market overreact? Journal of Finance 40, 793-805.

DeAngelo, H., DeAngelo, L., Stulz, R. (2006) Dividend policy and the earned contributed capital mix: a test of the life-cycle theory. Journal of Financial Economics 81, 227-254.

Desai, M., Jin, L. (2011) Institutional tax clienteles and payout policy. Journal of Financial Economics 100, 68-84.

Djankov, S., Ganser, T., McLiesh, C., Ramalho, R., Shleifer, A. (2010) The effect of corporate taxes on investment and entrepreneurship. American Economic Journal: Macroeconomics 2, 31-64.

Djankov, S., La Porta, R., Lopez-de-Silanes, F., Shleifer, A. (2008) The law and economics of self-dealing. Journal of Financial Economics 88, 430-465.

Easterbrook, F. (1984) Two agency-cost explanations of dividends. American Economic Review 74, 650-659.

Falk, A., Meier, S., Zehnder, C. (2012) Do lab experiments misrepresent social preferences? The case of self-selected student samples. Journal of the European Economic Association, forthcoming.

Fama, E., French, K. (2001) Disappearing dividends: changing firm characteristics or lower propensity to pay? Journal of Financial Economics 60, 3-44.

Faulkender, M., Wang, R. (2006) Corporate financial policy and the value of cash. Journal of Finance 61, 1957-1990.

Feldstein, M., Green, J. (1983) Why firms pay dividends. American Economic Review 73, 312-328.

Fidrmuc, J., Jacob, M. (2010) Culture, agency costs and dividends. Journal of Comparative Economics 38, 321-339.

French, K., Poterba, J. (1991) Investor diversification and international equity markets. American Economic Review 8, 222-226.

Graham, J., Kumar, A. (2006) Do dividend clienteles exist? Evidence on dividend preferences of retail investors. Journal of Finance 61, 1305-1335.

Grinstein, Y., Michaely, R. (2005) Institutional holdings and payout policy. Journal of Finance 60, 1389–426.
Grossman, S., Hart, O. (1982) Corporate financial structure and managerial incentives, in: McCall, J. (ed.), The Economics of Information and Uncertainty. University of Chicago Press, Chicago, pp. 107-140.
Hofstede, G. (2001) Culture's Consequences – Comparing Values, Behaviors, Institutions, and Organizations across Nations. Sage Publications, California.
House, R.J., Hanges, P.J., Javidan, M., Dorfman, P.W., Gupta, V. (2004) Culture, Leadership, and Organizations. Sage Publications, California.
Jensen, M.C., Meckling, W.H. (1976) Theory of the firm: managerial behavior, agency costs and ownership structure. Journal of Financial Economics 3, 305-360.
Kahnemann, D., Tversky, A. (1979) Prospect theory: an analysis of decision under risk. Econometrica 47, 263-291.
Kalay, A. (1982) Stockholder-bondholder conflict and dividend constraints. Journal of Financial Economics 10, 211-233.
Khambata, D., Liu, W. (2005) Cultural dimensions, risk aversion and corporate dividend policy. Journal of Asia-Pacific Business 6, 31-43.
King, R.R., Smith, V., Williams, A., Van Boening, M. (1993) The robustness of bubbles and crashes in experimental stock markets, in: Day, R., and Ping, C. (eds.), Nonlinear Dynamics and Evolutionary Economics. Oxford University Press, Oxford, pp. 183-200.
Klibanoff, P., Marinacci, M., Mukerji, S. (2005) A smooth model of decision making under ambiguity. Econometrica 73, 1849-1892.
Kumar, P. (1988) Shareholder-manager conflict and the information content of dividends. Review of Financial Studies 1, 111-136.
Kutner, M., Nachtsheim, C., Neter, J. (2004) Applied Linear Regression Models. McGrawHill, New York.
La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R.W. (2000) Agency problems and dividend policies around the world. Journal of Finance 55, 1-33.
Lau, S.T., Ng, L., Zhang, B. (2010) The world price of home bias. Journal of Financial Economics 97, 191-217.
Lease, R., Lewellen, W., Schlarbaum, G. (1976) Market segmentation: evidence on the individual investor, Financial Analysts Journal 32, 53-60.
Levine, R.V. (1997) A Geography of Time: The Temporal Misadventures of a Social Psychologist, or How Every Culture Keeps Time Just a Little Bit Differently. Basic Books, New York.
Lintner, J. (1963) The determinants of corporate savings, in: Heller, W. (ed.), Savings in the Modern Economy. University of Minnesota Press, Minneapolis, pp. 230-255.
Miller, M.H., Modigliani, F. (1961) Dividend policy, growth, and the valuation of shares. Journal of Business 31, 411-433.
Miller, M.H., Rock, K. (1985) Dividend policy under asymmetric information. Journal of Finance 40, 1031-1051.
Rieger, M.O., Wang, M., Hens, T. (2011) Prospect theory around the world. Unpublished working paper.
Shao, Y., Kwok, C., Guedhami, O. (2010) National culture and dividend policy. Journal of International Business Studies 41, 1391-1414.
Shefrin, H.M., Statman, M. (1984) Explaining investor preference for cash dividends. Journal of Financial Economics 13, 253-282.
Shefrin, H.M., Thaler, R. (1988) The behavioral life-cycle hypothesis. Economic Inquiry 26, 609-643.
Wang, M., Rieger, M., Hens, T. (2010) How time preferences differ: evidence from 45 Countries. Unpublished working paper.

Yang, Y., Shoji, I., Kanehiroc, S. (2009) Optimal dividend distribution policy from the perspective of the impatient and loss-averse investor. Journal of Socio-Economics 38, 534-540.
Yeh, R., Lawrence, J. (1995) Individualism and Confucian dynamism: a note on Hofstede's Cultural root to economic growth. Journal of International Business Studies 26, 655-669.

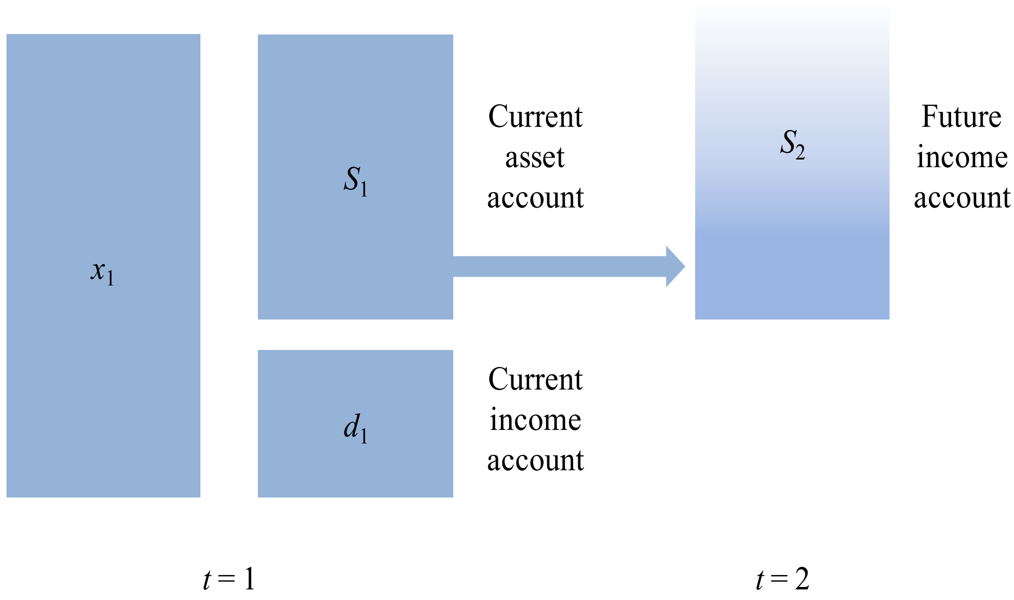

Figure I. Illustration of our two-period model with three mental accounts. Due to the payment of dividends d_1 at time t = 1 firm value depreciates from x_1 to S_1. We are looking at a (representative) boundedly rational investor with different mental accounts. While d_1 is assigned to the investor's current income account, S_1 is part of the investor's current asset account. From t = 1 to t = 2 firm value changes from S_1 to S_2 and this change is evaluated in the investor's future income account.

Table I. Summary statistics

This table presents the mean, standard deviation (STD), minimum (Min), maximum (Max) and number of observations (N) for all the variables used in the paper.

Variable	Mean	STD	Min	Max	N
Div/Cash	0.71	2.82	0	28.24	63,323
Div/EBIT	0.21	0.29	0	1.98	64,180
Div/Sales	0.03	0.07	0	0.71	65,232
Behavioral Variables					
Patience	0.70	0.11	0.37	0.89	73,612
Future Orientation	4.12	0.34	3.06	4.80	68,776
Loss Aversion	3.28	2.84	0.43	13.66	73,612
Ambiguity Aversion	0.56	0.09	0.42	0.80	73,612
Company-Specific Control Variables					
Company Size	15.39	2.89	10.47	21.02	66,262
Debt-Equity Ratio	22.89	17.28	0	79.51	66,409
Sales Growth	1.16	0.35	0.40	4.01	62,467
Profitability	0.11	0.08	0.00	0.39	65,222
Age	1.39E+07	3.45E+07	444	1.00E+08	48,586
Institutional Ownership	7.13	12.86	0	99	39,984
Country-Specific Control Variables					
Total Taxes	47.27	11.26	24.35	107.38	73,242
Anti-Self-Dealing Index	0.57	0.22	0.17	0.96	72,554

Table II. Results of regressions of *Div/Cash, Div/EBIT, Div/Sales* on behavioral parameters controlling for other factors

This table presents the results of firm level Tobit regression results on dividend to cash flow, dividend to earnings before interest and taxes (*EBIT*) and dividend to net sales ratios, respectively in Columns (1) and (2), (3) and (4), and (5) and (6). Sample period is 1992 to 2012. All dependent variables and firm-specific control variables are winsorized at the 1% level. Robust standard errors are clustered at the firm level and we use year dummies. *t*-values are reported under the coefficient estimates. Statistical significance at the 0.1 %, 1 %, and 5 % level are indicated by ***, **, and *, respectively.

	Div/Cash		*Div/EBIT*		*Div/Sales*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Patience		*-0.155****		*-0.102***		*-0.038****
		-4.643		*-2.844*		*-3.364*
Loss Aversion		*0.022****		*0.022****		*0.005****
		13.984		*13.653*		*7.482*
Ambiguity Aversion		*0.446****		*0.397****		*0.096****
		9.647		*7.574*		*6.902*
Firm Size	*0.002**	*0.005****	-0.001	0.002	*0.001***	*0.001****
	2.011	*3.742*	-0.475	1.604	*2.889*	*3.453*
Debt-Equity Ratio	*-0.001****	*-0.001****	*-0.001****	*-0.001****	-0.000	-0.000
	-4.456	*-4.156*	*-6.570*	*-6.169*	-1.448	-1.311
Sales Growth	*-0.148****	*-0.150****	*-0.158****	*-0.160****	*-0.026****	*-0.027****
	-16.357	*-16.616*	*-16.94*	*-17.038*	*-10.451*	*-10.505*
Profitability	*0.266****	*0.324****	*-0.485****	*-0.432****	*0.165****	*0.178****
	4.754	*6.206*	*-7.647*	*-7.121*	*10.898*	*12.229*
Total Taxes	*-0.001***	*-0.002****	*-0.002****	*-0.002****	*-0.000**	*-0.000***
	-3.254	*-4.159*	*-5.261*	*-5.181*	*-2.110*	*-3.083*
Anti-Self-Dealing Index	*0.126****	-0.037	*0.132****	-0.014	*0.033****	-0.009
	7.129	-1.830	*7.069*	-0.628	*5.614*	-1.364
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	*0.293*	*0.154*	*0.439*	*0.263*	0.013	-0.006
	*10.179****	*3.035***	*14.042****	*4.641****	1.449	-0.364
F statistics	*27.02****	*32.01****	*35.37****	*36.61****	*17.43****	*19.46****
Observations	46,875	45,721	47,364	46,210	47,364	46,210

Table III. Future orientation and dividend policy

This table presents the results of firm level Tobit regression results on dividend to cash flow, dividend to earnings before interest and taxes (*EBIT*) and dividend to net sales ratios, respectively in Columns (1), (2), and (3). Behavioral parameter *Patience* of Table III is replaced by *Future Orientation* (House et al., 2004) in an attempt to circumstantiate the quality of our data. Sample period is 1992 to 2012. All dependent variables and firm-specific control variables are winsorized at the 1% level. Robust standard errors are clustered at the firm level and we use year dummies. *t*-values are reported under the coefficient estimates. Statistical significance at the 0.1 %, 1 %, and 5 % level are indicated by ***, **, and *, respectively.

	Div/Cash	*Div/EBIT*	*Div/Sales*
	(1)	*(2)*	*(3)*
Future Orientation	*-0.047****	*-0.033**	*-0.018****
	-3.487	*-2.254*	*-3.450*
Loss Aversion	*0.024****	*0.023****	*0.005****
	14.664	*14.038*	*7.654*
Ambiguity Aversion	*0.444****	*0.393****	*0.089****
	9.473	*7.199*	*6.170*
Firm Size	*0.005****	0.002	*0.002****
	3.487	1.357	*3.405*
Debt-Equity Ratio	*-0.001****	*-0.001****	-0.000
	-4.213	*-6.235*	-1.833
Sales Growth	*-0.153****	*-0.162****	*-0.028****
	-16.72	*-16.784*	*-10.815*
Profitability	*0.320****	*-0.442****	*0.173****
	6.053	*-7.215*	*11.835*
Total Taxes	*-0.001***	*-0.002****	*-0.000***
	-2.718	*-3.805*	*-2.607*
Anti-Self-Dealing Index	-0.017	0.000	-0.007
	-0.868	0.016	-1.05
Year Dummies	Yes	Yes	Yes
Constant	*0.214***	*0.311****	0.043
	2.722	*3.544*	1.503
F statistics	*31.56****	*35.91****	*18.73****
Observations	44,735	45,224	45,224

Table IV. Differences in dividend policies between firms controlled by domestic and foreign owners

This table presents the results of firm level Tobit regression results on dividend to cash flow, dividend to earnings before interest and taxes (*EBIT*) and dividend to net sales ratios, respectively in Columns (1) and (2), (3) and (4), and (5) and (6). In Columns (1), (3) and (5) we report the results for the subsample of firms with the majority of stocks owned by domestic investors. In Columns (2), (4) and (6), we only examine firms with 50 % or more of the shares are owned by foreign investors. Sample period is 1992 to 2012. All dependent variables and firm-specific control variables are winsorized at the 1% level. Robust standard errors are clustered at the firm level and we use year dummies. *t*-values are reported under the coefficient estimates. Statistical significance at the 0.1 %, 1 %, and 5 % level are indicated by ***, **, and *, respectively.

	Div/Cash		*Div/EBIT*		*Div/Sales*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Patience	*-0.179****	-0.105	*-0.118***	-0.176	*-0.035***	-0.019
	-4.548	-0.701	*-2.634*	-0.827	*-2.743*	-0.396
Loss Aversion	*0.022****	0.008	*0.022****	0.01	*0.005****	-0.001
	12.444	1.101	*11.797*	0.954	*6.520*	-0.653
Ambiguity Aversion	*0.497****	*0.854***	*0.529****	*1.025***	*0.112****	*0.335***
	9.265	*3.137*	8.294	*2.720*	*6.205*	*3.163*
Firm Size	*0.004**	*0.020**	0.002	0.020	*0.001**	*0.008**
	2.050	*2.367*	0.923	1.657	*2.566*	*1.989*
Debt-Equity Ratio	*-0.001***	0.000	*-0.001****	-0.002	0.000	-0.000
	-3.091	0.003	*-3.424*	-1.193	0.798	-0.586
Sales Growth	*-0.139****	-0.285***	*-0.162****	-0.296***	*-0.023****	*-0.089****
	-10.494	-5.498	*-11.197*	-4.887	*-6.822*	*-3.588*
Profitability	*0.399****	1.312***	*-0.403****	0.370	*0.214****	*0.371****
	6.696	5.521	*-5.614*	1.167	*12.66*	4.141
Total Taxes	*-0.002****	-0.002	*-0.003****	-0.001	*-0.000****	-0.001
	-4.373	-1.016	-5.266	-0.549	-3.386	-0.974
Anti-Self-Dealing Index	*-0.063***	-0.093	-0.031	-0.124	-0.007	-0.015
	-2.577	-1.026	-1.142	-0.976	-1.067	-0.401
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.132*	-0.212	0.245***	-0.017	-0.033	-0.147
	2.179	-0.748	3.535	-0.043	-1.845	-1.412
F statistics	*35.18****	*4.27****	*36.39****	*3.11****	*23.97****	*4.19****
Observations	25,904	942	25,907	942	25,907	942

Table V. Valuation of dividend policy

This table presents the results of regressing the excess stock return on changes in firm characteristics over the fiscal year. All variables except leverage (L_t) and excess stock return are deflated by the lagged market value of equity. NF_t is calculated as the total equity issuance minus repurchases plus debt issuance minus debt redemption. ΔE_t is the change in earnings before interests paid and taxes (*EBIT*), and ΔNA_t is the change in total assets minus cash holdings. ΔRD_t represents the changes in R&D expenditures, which is set to zero if missing. ΔI_t is the yearly change in interest expense and ΔD_t is the change in total dividends. ΔC_t is the notation for the realized 1-year change in cash. Dependent variable and firm-specific control variables are winsorized at the 1% level. Robust standard errors are clustered at the firm level and we use year dummies. *t*-values are reported under the coefficient estimates. Statistical significance at the 0.1 %, 1 %, and 5 % level are indicated by ***, **, and *, respectively.

	Excess Stock Return
ΔD_t×*Patience*	*-5.378****
	-4.137
ΔD_t×*Loss Aversion*	*0.111**
	2.174
ΔD_t×*Ambiguity Aversion*	*6.769****
	3.989
ΔD_t	*-0.490***
	-3.027
ΔE_t	*0.563****
	28.161
ΔNA_t	*0.097****
	12.702
ΔRD_t	*2.981****
	8.149
ΔI_t	*-1.977****
	-11.049
L_t	*-0.001****
	-5.171
C_t	*0.484****
	22.129
NF_t	*-0.059****
	-4.251
Patience	*0.074**
	2.35
Loss Aversion	*0.003***
	3.144
Ambiguity Aversion	-0.014
	-0.515
Constant	*0.074****
	26.735
Adjusted R^2	0.074
F statistics	*156.84****
Observations	27,545

Table VI. Additional Control variables

This table presents the results of firm level Tobit regression results on dividend to cash flow, dividend to earnings before interest and taxes (EBIT) and dividend to net sales ratios, respectively in Columns (1) (2) and (3). We consider here additionally two new control variables, *Age* and *Institutional Ownership.* Sample period is 1992 to 2012. All dependent variables and firm-specific control variables are winsorized at the 1% level. Robust standard errors are clustered at the firm level and we use year dummies. *t*-values are reported under the coefficient estimates. Statistical significance at the 0.1 %, 1 %, and 5 % level are indicated by ***, **, and *, respectively.

	Div/Cash	*Div/EBIT*	*Div/Sales*
	(1)	*(2)*	*(3)*
Patience	*-0.234****	*-0.184****	*-0.057****
	-4.769	*-3.431*	*-3.686*
Loss Aversion	*0.017****	*0.019****	*0.003***
	5.837	*5.711*	*2.918*
Ambiguity Aversion	*0.410****	*0.456****	*0.073***
	5.111	*4.923*	*3.153*
Firm Size	-0.000	-0.002	0.000
	-0.178	-0.757	0.650
Debt-Equity Ratio	*-0.001****	*-0.001****	0.000
	-4.719	*-5.035*	*1.417*
Sales Growth	*-0.125****	*-0.134****	*-0.018****
	-7.032	*-6.666*	*-5.219*
Profitability	*0.272****	*-0.558****	*0.197****
	3.720	*-6.501*	*11.084*
Age	*0.000****	*0.000****	*0.000**
	4.986	*4.760*	2.292
Institutional Ownership	*-0.001***	-0.001	*-0.000****
	-2.723	-1.779	*-4.043*
Total Taxes	*-0.002****	*-0.003****	*-0.001****
	-3.377	*-5.649*	*-4.609*
Anti-Self-Dealing Index	-0.004	0.024	0.002
	-0.134	0.652	0.254
Year Dummies	Yes	Yes	Yes
Constant	*0.286****	*0.403****	0.026
	3.619	*4.801*	1.313
Observations	16,896	16,898	16,898

Ambiguity Aversion and Cash Holdings

Wolfgang Breuer, M. Oliver Rieger, K. Can Soypak

Abstract. Previous literature on cash management has revealed that cash holdings are treated like an insurance policy against liquidity shocks that limit future profitable investments. In a theoretical model, we analyze how investors' attitude towards uncertain investment returns affects the valuation of cash and the amount of cash holdings. A panel analysis across 29 countries and over 30,000 firm-years demonstrates that our model hypotheses can be verified empirically. This way, we contribute to the catering literature, as cash policies have not been investigated from this perspective before. Furthermore, unlike previous studies, our paper highlights this relationship in a straightforward way, as we have command of a unique dataset on individual preferences. With several robustness tests we also address potential doubts concerning the quality of our data and analyze further implications of our theory.

JEL Classification: A12, D03, G35, Z10

Keywords: ambiguity aversion, behavioral decision theory, cash policy, corporate finance.

Ambiguity Aversion and Cash Holdings

Abstract. Previous literature on cash management has revealed that cash holdings are treated like an insurance policy against liquidity shocks that limit future profitable investments. In a theoretical model, we analyze how investors' attitude towards uncertain investment returns affects the valuation of cash and the amount of cash holdings. A panel analysis across 29 countries and over 30,000 firm-years demonstrates that our model hypotheses can be verified empirically. This way, we contribute to the catering literature, as cash policies have not been investigated from this perspective before. Furthermore, unlike previous studies, our paper highlights this relationship in a straightforward way, as we have command of a unique dataset on individual preferences. With several robustness tests we also address potential doubts concerning the quality of our data and analyze further implications of our theory.

JEL Classification: A12, D03, G35, Z10

Keywords: ambiguity aversion, behavioral decision theory, cash policy, corporate finance.

1. Introduction

The traditional corporate finance literature neglected to analyze determinants of cash policies for a long time. Mostly, cash is regarded as negative debt and therefore, it is considered to be a tool to reach the optimal leverage target (Opler et al., 1999; Acharya et al., 2007). Of course, under this assumption, debt redemption and cash holdings are substitutes and only net leverage should matter for the market value of a company.

However, the markets are far from being perfect and financially constrained firms do not always have access to external financing channels in times of need or they have to sell new securities for unreasonable prices to finance new investments or they have to terminate profitable investments too early due to liquidity constraints. In this sense, preserving liquidity serves as an insurance policy, which safeguards a firm against possibly terminating good projects or issuing new equity or debt under unfavorable conditions (Holmstrom and Tirole, 1998; Almeida et al., 2004; Han and Qiu, 2007). In these scenarios, companies may prefer to cut down dividends or share repurchases today in order to hoard cash for future investments.

Different papers have found empirical support for this story which we refer to as the precautionary motive of cash holdings (Keynes, 1936). For instance, Opler et al. (1999) demonstrated that growth firms with volatile cash flows are more likely to retain their earnings as cash instead of distributing them to shareholders. More recently, Bates et al. (2009) showed that firms started to hoard more cash in the last decade and this rise is related to increased opaqueness (high R&D spending) and cash flow volatility. Due to augmented underinvestment (Myers, 1977) and asset substitution problems (Jensen and Meckling, 1976; Jensen, 1986), these firms face larger agency costs of debt and they should respond to increased costs of external financing by building up cash reserves in order to avoid agency costs of debt. Furthermore, this relationship should disappear for unconstrained firms, as they already have enough funds in place or unutilized credit lines to implement value-increasing projects. Indeed, Almeida et al. (2004) advocates that the cash holding policy is sensitive to cash flow only for constrained firms, i.e. firms facing difficulties raising external funds.

Following these results, another branch of research has focused on the relation between cash holdings and the market value of a company. Although the literature in this field is relatively scarce, the empirical evidence suggests that investors of constrained firms benefit from cash holdings to a larger extent compared to the investors of non-constrained firms (Faulkender and Wang, 2006; Pinkowitz and Williamson, 2007; Denis and Sibikov, 2010). This result is consistent with earlier work analyzing the amount of cash holdings and it explains why constrained firms prefer to retain a larger portion of their earnings as cash.

Thus, until now, the literature on cash holdings has tried to justify large cash reserves with the precautionary motive story, while some papers also discussed how cash holdings might amplify agency problems (Pinkowitz, 2002; Dittmar et al., 2003). Yet, these papers have not considered another important financial imperfection that might affect the valuation of cash and firms' cash policy as well. In imperfect markets with financial constraints, investors' bounded rationality would also play a role for the valuation of cash holdings and managers should try to satisfy investors' needs and secure their jobs. Thus, investors' preferences may have an impact on cash policies.

Interestingly, the cash holding decisions have not been dissected from this perspective, although there is extensive evidence that companies adjust other financial decisions such as dividend payouts (Baker and Wurgler, 2004) or mergers and acquisitions (Baker et al., 2009) according to investors' preferences. Similarly, evidence also hints that investors' reaction to corporate financial policies and the returns after the announcement of specific corporate events are correlated with investor sentiment (see e.g., Becker et al., 2011, Bouwman et al., 2004).

In this paper, we want to close this research gap extending the “catering” literature by investigating the connection between investor preferences and cash management. For this purpose, we analyze how the valuation of cash depends on investor preferences and how managers choose cash holding policies as a tool to satisfy investors.

Furthermore, the previous catering literature has neglected to discuss which aspects of investors’ preferences are responsible for the investors’ demand for certain financial policy decisions. Instead, researchers either focus on geographical or demographical aspects to identify certain clienteles with similar preferences which companies need to cater to in order to have higher returns (Graham and Kumar, 2006) or discuss how changes in market sentiment force managers to adjust their decisions (Baker and Wurgler, 2004). To our knowledge, Breuer et al. (2013) is the only paper to discuss the relevance of investors’ risk and time preferences for their reaction to financial decisions (for the example of dividend policy) in a straightforward way. Breuer et al. (2013) utilize a unique dataset on actual (country-specific) preference parameters according to prospect theory (Kahmenann and Tversky, 1979). Similarly, this paper also elaborates on a specific aspect of investors’ risk preferences (ambiguity aversion) that might affect the valuation of cash holdings. In a related manner, this paper allows us to discuss whether management pays attention to investors’ ambiguity preferences as a determinant of the cash holding policy.

Last but not least, we can also contribute to the literature focusing on cross-country differences in corporate cash holdings examining whether investor preferences can explain cross-country differences in the valuation of cash holdings and in cash policies besides investor protection (Dittmar and Marth-Smith, 2007), the development of credit markets (see, e.g., Lins et al., 2010) or cultural aspects (see, e.g., Chang and Noorbakhsh, 2009).

To recap, the contribution of our paper is threefold. First of all, our paper is the first one studying cash holdings as a vehicle to cater for investors' needs, as we analyze how investors value cash and whether managers correctly adapt cash holding policies to satisfy their investors. Secondly, emanating from the precautionary motive story for cash holdings, we connect investor preferences directly to cash management decisions both theoretically and empirically for the first time in the literature. This way, thirdly, we also offer an alternative explanation for cross-country differences in the valuation of cash and in cash holdings based on investor preferences and biases.

Our paper is organized as follows: In the next section, we present a theoretical model linking investors' ambiguity preferences to the valuation of cash. Section 3 describes the obtained data, our regression model and the initial results for our empirical analysis. Consequently, in Section 4, we discuss further implications of our theory and the robustness of our results. Section 5 concludes.

2. The Behavioral Explanation for Cash Holdings: A Simple Model

As we have mentioned above, some papers have demonstrated that the reaction to certain corporate events is not consistent over time and depends on the respective temporary investor sentiment. At the same time, certain demographic characteristics of investors such as age or income level are also instrumental in understanding stock price movements after corporate events. Yet, other than Breuer et al. (2013), we are not aware of any attempt that investigate the relation between the actual investor preference parameters and different corporate financial decisions in a straightforward way. More astonishingly, the question of whether cash holding policies serve to catering purposes has not been discussed before us at all, not even in a time series context.

To fill these gaps, we want to analyze the impact of investors' ambiguity aversion on their attitude towards cash policies. As we discussed above, cash holdings are treated as an insurance tool against the illiquidity risks in imperfect markets according to the precautionary motive story. We argue that if an investor exhibits high ambiguity aversion, she prefers to limit investments with uncertain outcomes and to receive dividends instead (see also Breuer et al., 2013), since investment opportunities are afflicted with uncertainty. As a result, this would render cash holdings rather unnecessary, as future investments are not very valuable for ambiguity averse investors. In other words, if cash holdings serve as an important insurance tool against the risks of illiquidity in imperfect markets, their value should depend on investors' preferences towards ambiguity.

To grasp this idea more rigorously, it is necessary to set up a formal model. Our model is based on the same principles as the models of Almeida et al. (2004) or Han and Qiu (2007), but it additionally integrates investors' preferences into the problem setting. Like these models, we also abstract from the managerial entrenchment problem and assume that managers choose the investment, cash and dividend policy in order to maximize the market value of the company and there are no conflicts of interest between managers and investors. Hence, we ignore agency problems between managers and investors. We discuss this issue further in our empirical analysis.

Our model has a finite planning horizon. In the first period (period 1), the manager determines the amount of cash that she wants to retain in the company. At the beginning of the second period (period 2), she decides simultaneously how much the company should borrow and invest. In the following and last period (period 3), all uncertainty is resolved, investment projects are terminated and debt is going to be repaid (see also Figure 1).

>> Insert Figure 1

In period 1, the firm starts with an initial distributable free cash flow, $X \geq 0$. After holding some portion of X as cash (C), the rest is distributed as dividends. In period 2, C is paid out to investors as dividends or deployed to finance new investments (I) with uncertain earnings $g(I, \tilde{\varepsilon})$ where $\tilde{\varepsilon}$ describes the uncertainty of investment payoffs. The cash reserves C are dissolved completely, because the company is terminated after the period 3. Furthermore, the company has current operations that can generate non-negative cash flow ($\tilde{c}$) during the first period as well and it can issue new debt (B). With respect to cash flow c in period 2, we assume this to be risky, but – in contrast to $g(I, \tilde{\varepsilon})$ – not to be uncertain. This means ambiguity is only associated with $g(I, \tilde{\varepsilon})$, but not with $\tilde{c}$. We assume that the company can assess the return distributions of the cash flows from assets in place much easier, as it gained experience based on the performance in the past and observed some error terms already, while new investments might have unforeseeable results for the company. Alternatively, we can also assume that return uncertainty (according to the plans in period 1) is only related to the returns in period 3, as this would also imply that only earnings from new investments are uncertain. Moreover, without loss of generality we assume – for ease of exposition – $\tilde{\varepsilon}$ and $\tilde{c}$ to be independent.

The interest rate for debt is equal to the riskless rate R_0, since we assume that creditors do not grant credits that cannot be repaid with certainty after period 3. Hence:

$$B \cdot (1 + R_0) \leq I \cdot \left(1 + R_{liq}\right). \tag{1}$$

R_{liq} stands for the (riskless) return from investments, if the company is forced by debt holders to liquidate its investments. This occurs if investment returns $g(I, \tilde{\varepsilon})$ in the third period are not high enough to repay outstanding loans including interest expenses, hence if $g(I, \tilde{\varepsilon}) < B \cdot (1+R_0)$. We assume R_{liq} to be smaller than R_0, because otherwise there would be no risk for creditors to lose money and the firm under consideration can borrow unlimited amount of credit. Hence, no firm would be financially constrained in this case.

Since we have a three-period-model, we also assume that company operations are terminated at the end of period 3 after receiving returns from investments and after repaying outstanding debt. Taken together, a manager, whose task it is to maximize a representative investor's utility, faces the following optimization problem in period 1:

$$Z\big(C, B(\tilde{c}, C), I(\tilde{c}, C)\big) = X - C + \frac{1}{1+R_0} \cdot \Big(C + E\big(B(\tilde{c}, C)\big) - E\,\big(I(\tilde{c}, C, B)\big) + E(\tilde{c})\Big) + \frac{f(\delta) \cdot E\big(g(I(\tilde{c}, C), \tilde{\varepsilon})\big)}{(1+R_0)^2} - \frac{E\big(B(\tilde{c}, C)\big) \cdot (1+R_0)}{(1+R_0)^2} \quad s.t \tag{2}$$

$$I(\tilde{c}, C) \leq \; \tilde{c} + B(\tilde{c}, C) + C\,, \tag{3}$$

$$B(\tilde{c}, C) \cdot (1 + R_0) \leq I \cdot \big(1 + R_{liq}\big), \tag{4}$$

$$C \geq 0. \tag{5}$$

In period 1, the manager has to determine *C*, while her task in period 2 is to fix the values for *B* and *I*. As a consequence, both *B* and *I* might be depending on the former decision regarding *C* and the resulting state of nature as described by realized cash flows $\tilde{c}$ from assets in place. Therefore we have to write $I(\tilde{c}, C)$ and $B(\tilde{c}, C)$. Moreover, let U_A denote the utility from the uncertain investment returns for an ambiguity averse investor. We model ambiguity aversion similar to Klibanoff et al. (2005), who first calculate the certainty equivalent for an uncertain probability set Δ, the possible probabilities over *S*. Consequently, this certainty equivalent for Δ is used to compute expected utility according to one's risk preferences. Formally, their smooth ambiguity model has the following representation:

$$U_A(g(I)) = \int_{\Delta} \Phi\left(\int_{S} u(g(I))\, d\pi\right) d\mu. \tag{6}$$

We assume that investors are risk neutral so that: $\int_S u(g(I))\, d\pi = E(g(I(\tilde{c}, C), \tilde{\varepsilon}))$. Such a (simplifying) assumption is justified if investors diversify away risk to a large extent on efficient capital markets. In fact, one essential difference between risk and ambiguity features is that uncertainty cannot be diversified away, but risk can (at least the unsystematic risk can) (Epstein and Schneider, 2008; Epstein and Schneider, 2010). However, we will return to this issue in our empirical section.

In addition, we further simplify equation (6) by assuming that the decision maker displays a constant ambiguity aversion which requires $\int_\Delta \Phi\,(x) = -\frac{1}{\delta} \cdot e^{-\delta \cdot x}$. Hence, with increasing δ, the decision maker becomes more ambiguity averse and uncertain returns from investments are valued less favorably. These assumptions enable us to rewrite the ambiguity utility $U_A(g(I(\tilde{c}, C)))$ by simply introducing an ambiguity factor $f(\delta) < 1$ as a decreasing function of an ambiguity aversion parameter δ ($f'(\delta) < 0$):

$$U_A(g(I(\tilde{c}, C))) = f(\delta) \cdot E\big(g(I(\tilde{c}, C), \tilde{\varepsilon})\big)\,. \tag{7}$$

As a consequence of assuming risk neutrality and no uncertainty with respect to future cash holdings $\tilde{c}$, there is no need for an ambiguity discount with respect to $I(\tilde{c}, C)$ and $\tilde{c}$. Therefore, in (2), we simply write $E(B(\tilde{c}, C))$, $E(I(\tilde{c}, C))$, and $E(\tilde{c})$.

Based on (2), it is easy to see that riskless borrowing has no *direct* impact on the overall objective function Z. Yet, in order to minimize the risk of forgoing profitable investment opportunities due to limited funds, a manager is going to draw on the entire credit line that is granted to her company. Due to this indirect relation, Z is monotonously increasing in B.

Thus, the inequality (4) of our model is binding with an optimal value B_{opt} of B according to $B_{opt} = I \cdot (1 + R_{liq})/(1 + R_0)$.

This is going to simplify the problem at hand, since at the beginning of period 2, we just have to maximize the objective function with respect to I. In states of high cash flow (c), where the (first-best) optimal investment program I^* is feasible, we have:

$$f(\delta) \cdot E\left(g'(I(c, C), \tilde{\varepsilon})\right) = 1 + R_0. \quad (8)$$

It might be possible that we have $B_{opt}+c+C > I^*$, because of very high cash flows c. In this situation, excess cash $I^*–B_{opt}–c–C$ is paid out as dividends in period 2. Assuming that the second derivative of the investment yield function is negative, equation (8) defines the optimal investment program, I^*. On the other hand, if the company is (ex-post, after period 1) financially constrained ($I^* \geq C + B_{opt} + c$), it needs cash holdings to finance the optimal investment program. In this scenario, the company is going to be able to invest more as cash holdings increase. In other words, the restriction $I \leq C + B_{opt} + c$ is binding and the resulting investment is equal to:

$$I_{con} = \frac{(C + c) \cdot (1 + R_0)}{R_0 - R_{liq}}. \quad (9)$$

Hence, the investment program depends on cash holdings for financially constrained firms, but is completely detached from cash holdings in firms where the optimal investment program can be implemented regardless of cash holdings. This ex-post solution after period 1 molds the cash holding policy at the beginning of period 1.

Let I_{opt} stand for the state-dependent optimal investment. With $h(c)$ being the density function of $\tilde{c}$, we can rewrite the objective function (2):

$$Z(C, I_{opt}, B_{opt}) = X - C + \int_{I^*-B_{opt}-C}^{\infty} \left[\frac{C}{1+R_0} + \frac{\tilde{c}}{1+R_0} - \frac{I^*}{1+R_0} + \frac{I^*(1+R_{liq})}{(1+R_0)^2} + \frac{f(\delta)\cdot E(g(I^*,\tilde{\varepsilon}))}{(1+R_0)^2} - \frac{I^*\cdot(1+R_{liq})}{(1+R_0)^2}\right] \cdot h(c)\, dc + \int_0^{I^*-B_{opt}-C} \left[\frac{f(\delta)\cdot E(g(I_{con}(c,C),\tilde{\varepsilon}))}{(1+R_0)^2} - \frac{I_{con}(c,C)\cdot(1+R_{liq})}{(1+R_0)^2}\right] \cdot h(c)\, dc. \quad (10)$$

It should be noticed that I_{con} – as seen from period 1 – is a random variable as well due to its dependence on *c*. Based on $Z(C, I_{opt}, B_{opt})$, the first-order necessary condition for optimal cash holding runs

$$G(C,\delta) := \frac{dZ(C,I_{opt},B_{opt})}{dC} = -1 + \int_{I^*-B_{opt}-C}^{\infty} \left[\frac{1}{1+R_0}\right] \cdot h(c)\, dc + \left(\frac{f(\delta)\cdot E(g(I^*,\tilde{\varepsilon}))}{(1+R_0)^2} - \frac{I^*\cdot(1+R_{liq})}{(1+R_0)^2}\right) + \int_0^{I^*-B_{opt}-C} \left[\frac{f(\delta)\cdot E(g'(I_{con}(c,C),\tilde{\varepsilon}))-(1+R_{liq})}{(R_0-R_{liq})\cdot(1+R_0)}\right] \cdot h(c)\, dc - \left(\frac{f(\delta)\cdot E(g(I^*,\tilde{\varepsilon}))}{(1+R_0)^2} - \frac{I^*\cdot(1+R_{liq})}{(1+R_0)^2}\right) = 0 \quad (11)$$

In a situation with $I^* \leq B_{opt}$, i.e., even without cash holdings no danger of a binding financial constraint (note that we assume that *c* as well as *C* can only take non-negative values), we have $\int_{I^*-B_{opt}-C}^{\infty} h(c)\, dc = 1$ and $\int_0^{I^*-B_{opt}-C} h(c)\, dc = 0$. In this case, the derivative $\partial Z(C, I_{opt}, B_{opt})/\partial C$ is equal to $-1+1/(1+R_0) < 0$, which directly implies $C_{opt} = 0$ due to (5). Apparently, in such a setting, ambiguity aversion does not influence the marginal utility contribution of cash holdings which is always negative, as $I = I^*$ is possible even for $C = 0$.

However, cash holdings may also serve other purposes. For instance, cash holdings can finance daily operations, which help companies avoid transaction costs of short-term external financing. Hence, optimal cash holding levels are not going to be zero even for financially unconstrained companies, as we demonstrate in the empirical section. Yet, even in such settings with exogenous reasons for cash holdings as transaction costs, we conjecture that the marginal utility contribution and the optimal value C_{opt} would be independent of the magnitude of ambiguity, which is characterized by δ. In other words, we assume that these market imperfections such as transaction costs are not afflicted with uncertainty. As a result, ambiguity preferences are irrelevant for the cash management policy for financially unconstrained companies, as we show below.

For financially constrained firms, i.e. $\int_0^{I^*-B_{opt}-C} h(c)\,dc > 0$, the choice $C = 0$ does not necessarily have to be optimal even if we ignore transaction costs or other advantages of cash holdings. Cash holdings are more valuable, if a company is financially constrained according to our model and potentially positive, as it is evident in (11). This follows from the fact that $\frac{f(\delta)\cdot E(g'(I_{con}(c,C),\tilde{\varepsilon}))-(1+R_{liq})}{(R_0-R_{liq})\cdot(1+R_0)} > \frac{1}{(1+R_0)}$, since $f(\delta)\cdot E(g'(I_{con}(c,C),\tilde{\varepsilon})) > 1 + R_0$ for every $I_{con} < I^*$. This implies that companies facing financial constraints have more valuable investment opportunities. This is logical as these companies cannot implement all profitable investment projects and the second derivative of investment return function, $g''(I_{con}(c,C),\tilde{\varepsilon})$ is negative. As a result, cash holdings are increasingly valuable as the probability of being financially constrained ($\int_0^{I^*-B_{opt}-C} h(c)\,dc$) increases. This result of our model is also in line with the empirical findings regarding marginal expected gross returns of cash holdings of financially constrained firms (Denis and Sibikov, 2010). This conclusion of our model is also in line with the findings of empirical studies such as Opler et al. (1999), Pinkowitz and Williamson (2007), and Bates et al. (2009) that argue that companies with better growth opportunities are going to hold more cash.

In particular, we are interested in the influence of varying degrees of ambiguity aversion on the marginal utility contribution of cash: $\partial^2 Z/\partial C\partial\delta$. We therefore just need to study how G is related to δ, thus we determine $\partial G/\partial\delta$:

$$\frac{\partial G(C,\delta)}{\partial\delta} = f'(\delta)\cdot\int_0^{I^*-B_{opt}-C}\left[\frac{E(g'(I_{con}(c,C),\tilde{\varepsilon}))}{(R_0-R_{liq})\cdot(1+R_0)}\right]\cdot h(c)\,dc < 0 \qquad (12)$$

The sign of this derivative is negative, as $f'(\delta) < 0$. The intuition behind (12) is very simple. Clearly, with cash holdings, firms are going to be able to realize more value-increasing investments in the future even at times when they cannot turn to external credit markets for financing purposes. This might increase the value of the company to a certain extent despite the opportunity costs of cash holdings that are equal to $-1+1/(1+R_0)$. However, with increasing ambiguity aversion, uncertain investments are less valuable for investors and, as a consequence, cash holdings become (relatively) superfluous. At the same time, this relation between ambiguity aversion and value of cash is only apparent for firms that face financial constraints, i.e. if $\int_0^{I^*-B_{opt}-C} h(c)\,dc > 0$. Summarizing, our formal analysis implies that ambiguity aversion determines the marginal utility contribution of cash holdings for financially constrained firms, but not for financially unconstrained firms.

Based on these results, we can also calculate the connection between ambiguity aversion (δ) and the level of optimal cash holdings, C_{opt}. Since we abstract from the managerial entrenchment problem and assume that managers' interests are aligned with the interests of their investors. In other words, we assume that the managers have the same target function Z like their investors. In this case, because of $\partial C_{opt}/\partial\delta = -\frac{\partial G(C_{opt},\delta)}{\partial\delta}\Big/\frac{\partial G(C_{opt},\delta)}{\partial C_{opt}}$, we immediately get $\partial C_{opt}/\partial\delta < 0$ combining the negative sign of (12) with $\frac{\partial G(C_{opt},\delta)}{\partial C_{opt}} < 0$, which simply describes the sufficient condition for an inner solution C_{opt}. This means that the optimal level of cash holdings is decreasing with the level of ambiguity aversion, but this is only true if $\frac{\partial G(C_{opt},\delta)}{\partial\delta} < 0$, i.e., for financially constrained companies. This gives rise to the following four hypotheses.

Hypothesis 1a: *With increasing ambiguity aversion of investors, the market value contribution of cash holdings decreases for financially constrained firms.*

Hypothesis 1b: *For financially unconstrained firms, the market value contribution of cash holdings is not related to the magnitude of investor's ambiguity aversion.*

Hypothesis 2a: *The optimal amount of cash holdings decreases for financially constrained firms with ambiguity aversion of investors.*

Hypothesis 2b: *For financially unconstrained firms, the optimal amount of cash holdings is independent of the magnitude of investor's ambiguity aversion.*

3. Empirical Analysis

After presenting our theoretical model, we want to investigate its implications empirically in the next section. It should be noted that we expect Hypotheses 1a and 1b to be more strongly confirmed than Hypotheses 2a and 2b, because firm valuation is directly related to investor preferences, but for Hypotheses 2a and 2b to hold we also need the assumption that managers act according to investor preferences – and we know from the literature discussed above that managerial behavior may also be driven by egoistic motives as well. Keeping this in mind, we first explain our dataset and then illustrate our regression approach. Last but not least, we discuss our results.

3.1 Data

3.1.1 Ambiguity Aversion

The main variable of interest in our study is the preference parameter ambiguity aversion. We have obtained this parameter via the international test of risk attitudes (INTRA) survey that is carried out mainly between 2005 and 2009 among undergraduate students of economics in 46 countries. Overall, 6,000 university students have participated, as we requested from each participant to complete a questionnaire that included questions on risk and time preferences, cultural attitudes, and some personal information (Wang et al., 2010; Rieger et al., 2011; Rieger and Wang, 2012)

We have elicited average ambiguity aversion of participants in each country based on the answers to the well-known Ellsberg's urn game where participants can choose between an uncertain lottery with an unknown probability of winning and a risky lottery with a winning probability less than 50 % (for the same potential payoff). Investing in the risky rather than the uncertain lottery indicates ambiguity aversion, the unease resulting from dealing with unknown probability distributions, i.e. a concave function, Φ.

In what follows, we utilize elicited preferences in these choice tasks as proxies for preference patterns of the investor population in the respective countries. This might be subject to some critique, since this approach implicitly assumes that our student sample is representative for the whole population in a country. Clearly, students are younger and less experienced compared to the rest of the society and this may cast doubt on the representative quality of our sample. Yet, in different areas of experimental economics, there is enough evidence revealing similarities between average investor preferences in a society and students' preferences (King et al., 1993). Moreover, since we are conducting a cross-country empirical comparison, what really matters is the difference between the preferences located in different countries and there is no reason to believe that cross-country differences in ambiguity aversion should be distributed differently for students compared to the investors.

Furthermore, despite globalization, our empirical analysis emanates from the assumption that only preferences of domestic investors count for the valuation of cash. Although this assumption seems to be very restrictive, many empirical studies document a very strong home bias, i.e., a tendency to invest in stocks listed in domestic stock markets (see Lau et al., 2010). For this reason, we think it is acceptable to work with country-specific investor preference parameters, since even the shares of large companies in open markets are mostly held by local investors. Still, in Section 4, we are going to discuss whether our results become less clear with an increasing proportion of foreign ownership.

3.1.2 Data on Other Dependent and Independent Variables

Data regarding company information including annual returns, cash holdings, and other control variables are extracted from Datastream, a service of Thomson Reuters. We have chosen to analyze all the companies listed under the constituent list "World Market" provided by Datastream consisting of 6,922 companies from 59 countries. Cross matching this sample with the countries for which we have data for ambiguity aversion leaves us with 3,059 companies from 29 countries. We find this sample much better suited for our purposes than the Compustat Global Data, since Compustat Global Data are dominated by companies located in the United States, especially in the early years. Our sample is much more balanced across different countries.

Our analyses cover all firm years between 1992 and 2011, since the global benchmark portfolio returns formed on size and market-to-book ratio are only available for this 20-year period in the data library of Kenneth French, which we use in order to calculate the excess returns required to analyze the first hypothesis. We omit all financial and utility companies from our analysis (four digit SIC classification numbers between 6000-6999 and 4900-4949, respectively), since these firms are mostly regulated and should have a small difference between the cost of internal and external funds.

3.2 Regression Models

Our hypotheses require two different empirical analyses. In the first regression model, we examine the impact of ambiguity aversion on the valuation of cash holdings distinguishing between financially constrained and unconstrained firms. In the second empirical model, we investigate the impact of ambiguity aversion on the amount of cash holdings again separately for financially constrained and unconstrained firms.

3.2.1 First Hypothesis: Valuation Effects of Cash Holdings

We start discussing our empirical analysis concerning the first hypothesis. Generally, we can distinguish between two types of empirical methods investigating the value of cash. The first one goes back to Fama and French (1998) and many papers including Pinkowitz et al. (2006) and Pinkowitz and Williamson (2007) used this method to analyze how the market value of a company (divided by total assets) is related to cash holdings or changes in cash holdings. However, we prefer another approach applied by Faulkender and Wang (2006) for two reasons (see also Denis and Sibikov, 2010). First of all, Fama and French (1998) did not consider time-varying sensitivities to risk factors, i.e. changes in discount rates over time. Faulkender and Wang (2006) address this problem by correcting stock returns with the help of benchmark returns. Secondly, the market-to-book ratio is not comparable across different companies especially across different countries due to different accounting conventions and methods. On the other hand, yearly returns of listed companies are defined identically in every country and for each company.

Hence, we conduct linear regressions of excess returns of the companies in our sample on ambiguity aversion with robust standard errors clustered by firm. We control for several other factors such as leverage, net financing, and change in R&D expenditures and in dividends according to the methodology of Faulkender and Wang (2006) and Denis and Sibikov (2010). All firm-specific control variables and independent variables are winsorized at the 1 % level and all control variables are also deflated by the lagged market value of equity except for leverage.

Moreover, we use the common law dummy (La Porta et al., 1998), a corruption index, the annual inflation rate and total taxes (Djankov et al., 2010) as additional country-specific control variables. In contrast to our firm-specific data, country-specific data (except the annual inflation rate) including our ambiguity aversion parameter are not given as panel data.

However, we assume that country-specific characteristics change only relatively slowly across time so that we are allowed to work with given country-specific data over the whole observation period from 1992 to 2011. For example, a corresponding assumption typically also underlies cross-country analyses of cash holdings that are based on cultural features (Chang and Noorbakhsh, 2009) or governance structures (Dittmar et al., 2003). We also utilize year dummies and industry dummies based on two-digit SIC codes.

Since we analyze companies from 29 different countries, we take the global benchmark portfolios from the database of Kenneth French. Thus, we define the excess return as the difference between the annual stock return and the matching global benchmark portfolio return formed on size and market-to-book ratio. Although we do not report them here, the results are not much different if we run regressions of the excess returns (annual company return minus risk free return) on the factors of Fama and French's three factor model (market index return, size and market-to-book ratio) with the same set of control variables. Including momentum as the fourth risk factor does not affect our results either. Table I gives an overview of descriptive statistics with respect to all variables in our regressions.

>> Insert Table I

3.2.2 Second Hypothesis: The Amount of Optimal Cash Holding

In order to analyze the second hypothesis regarding the relation between cash holdings and ambiguity aversion, we use a similar empirical model as Opler et al. (1999), since this is the most-renowned method for the analysis of cash holding policies of a company. The dependent variable in all regressions is cash holdings divided by total assets minus cash holdings (*Cash/NetAssets*). Since we cannot have negative cash values; we use a Tobit model with the lower bound set equal to zero to account for the non-normal distribution of our dependent variable. Robust standard errors are again clustered at firm-level and like in the first model we use year dummies and industry dummies.

As we perform a cross-country analysis, we again add some country-specific legal variables in our regression model similar to the empirical model of Dittmar et al. (2003) and to the empirical model of the previous section such as the common law dummy, inflation, corruption, and total taxes besides the usual set of company-specific control variables of previous empirical models based on Opler et al. (1999). Table II gives an overview of descriptive statistics with respect to new variables in the second regression model.

>> Insert Table II

3.3 Results

Our model conjectures that ambiguity aversion should only be relevant for financially constrained companies or in other words if the likelihood of experiencing financial difficulties is high. In order to investigate this hypothesis, we divide our dataset into two subsets. One group consists of (relatively) financially constrained firms and the other one includes (relatively) unconstrained firms. We define the level of financial constraints based on three different proxies, which we discuss below.

The investigation of the first hypothesis requires us to compare the impact of ambiguity aversion on the valuation of cash for these two groups. For this purpose, we have to generate an interaction term between changes in cash and the ambiguity aversion parameter. We center both parameters to avoid multicollinearity problems regarding this interaction term. We predict a negative estimator for this interaction term for financially constrained firms which would imply that changes in cash holdings lead to lower excess returns if ambiguity aversion is high in line with Hypothesis 1a). According to our Hypothesis 1b), this interaction term should be insignificant for financially unconstrained firms.

In order to analyze our second hypothesis, we again divide our sample into two groups based on the level of financial constraints. We predict that ambiguity aversion is negatively correlated with cash holdings only for financially constrained firms and it is uncorrelated with cash holdings for unconstrained firms.

The literature has discussed several possibilities to identify the level of financial constraints faced by firms. However, there is no general consensus on a single measure. Therefore, like other researchers before us, we are also going to rely on multiple proxies to distinguish between financially constrained and unconstrained firms (see also Almeida et al., 2004).

Dividend payout ratio: Fazzari et al. (1988) argue that unconstrained firms are likely to have higher payout ratios, while constrained firms prefer to pay less dividends. Our model also yields a similar prediction, as constrained firms are going to pay less dividends in period t = 1 according to our model. Hence, we assign all firms with a lower than median dividend payout ratio to the group of financially constrained firms and we refer to companies with above-median dividend payout ratios as financially unconstrained companies. Dividend payout ratio is defined as the ratio of cash dividends divided by total assets.

Company size: Diamond and Verrecchia (1991) posit that large firms benefit more from sharing information and, consequently, they suffer less from problems related to informational asymmetry. In our model, this is captured by increased borrowing possibilities (B) or a higher R_{liq}, which reduces the probability that a firm is unable to put the optimal investment program in practice. In other words, large firms need relatively less cash holdings, since they have easier access to outside funding (Fazzari et al., 1988). Thus, we generate another constraint dummy, which assumes the value 1 for all firm-years with above-median total assets and the value 0 for the other firm-years with below-median total assets. All figures for total assets are inflation-adjusted and in constant 1992 dollars.

Company age: Some researchers have also originated indices to measure the degree of financial constraints faced by a company by weighting different factors including company size and dividend payments. In a recent study, Hadlock and Pierce (2010) recommend that researchers rely solely on firm size and age, two relatively exogenous firm characteristics, to identify constrained firms instead of using measures such as the Kaplan and Zingales (Kaplan and Zingales, 1997; Lamont et al., 2001) or the Whited and Wu Index (Whited and Wu, 2006). Leaning on this paper, we use company age as another proxy to distinguish between financially constrained and unconstrained firms. Again, we divide our data sample into two groups based on the median score of company age. This third constraint dummy assumes the value of 0 for young firms, which are more likely to be financially constrained.

For all three financial constraint dummies, we find that the interaction between changes in cash and ambiguity aversion, $\Delta C_t \times$*Ambiguity Aversion* is significantly negative only for the subset of financially constrained firms. Otherwise, ambiguity aversion is not related to the valuation of cash holdings. Furthermore, we observe that both cash holdings (C_t) and changes in cash holdings (ΔC_t) are valued more favorably for financially constrained firms, as is evident by the larger coefficients and higher significance levels. Thus, these results are also in line with the findings of earlier studies of Faulkender and Wang (2006) and Denis and Sibikov (2010). At the same time, all control variables except net financing (NF_t) are significant in our model with the same signs as previous empirical studies by Faulkender and Wang (2006) and Denis and Sibikov (2010), although we use a different sample of companies from 29 different countries. This demonstrates that the results of previous empirical studies investigating only US companies are also valid internationally.

>> Insert Table III

The regressions analyzing our second hypothesis also demonstrate that *Ambiguity Aversion* is negatively significant for the subsample of financially constrained firms. Other control variables taken from the study of Opler et al. (1999) are also significant with the signs in agreement with this work. Hence, in line with Hypotheses 2a and 2b, we find that managers anticipate investors' preferences regarding cash holdings and adjust the cash policy accordingly. On the other hand, for financially constrained firms, the correlation between cash holdings and *Ambiguity Aversion* is most of the time insignificant as we predicted. Although Hypotheses 2a and 2b rely on the additional assumption of managers acting in the interest of shareholders, the empirical evidence backs both hypotheses as well. Yet, we observe in one case (with size dummy) that cash holdings are positively correlated with ambiguity aversion for financially unconstrained firms. This result also implies that managers have other motives than the simple maximization of company value. Still, the strong negative correlation in the sample consisting of constrained firms suggests that the catering motive is dominant.

>> Insert Table IV

4. Discussion

After confirming our main hypotheses, we would like to discuss some further implications of our theory. First, we elaborate on the main assumption of our model, a strong home bias effect. Our model implies that with an increasing foreign ownership share, the correlation between country-specific preference parameters and the value of cash holdings should be decreasing. Secondly, in our model, we have assumed risk neutrality (or perfect risk diversification) and ambiguity aversion. However, risk aversion combined with ambiguity neutrality would also lead to the same conclusions and to the same results in our formal set-up. Therefore, we analyze whether risk aversion or ambiguity aversion is the actual decisive factor for our results.

4.1 Foreign Ownership and the Relationship between Cash and Ambiguity Aversion

As we mentioned in Section 2, our model implicitly assumes that only local investors' preferences are vital for the market reaction to liquidity management. Several papers have demonstrated that indeed a very large portion of companies is owned by domestic investors even in free market economies. Now, we analyze how our results are affected by an increasing foreign ownership share in the company. For this purpose, we use data on *Foreign Ownership*, which is defined in Datastream as the percentage of strategic share holdings of 5 % or more held in a country outside that of the issuer.

We divide our firm-year observations into two groups. The first group consists of firm-years where *Foreign Ownership* is higher than 30 %. The second subsample includes all other firm-years. After that, we run the regressions in Section 3 for both subsamples and observe that the relation between the value of cash and ambiguity aversion is only strong for the financially constrained companies of the second subsample. Changing the cutoff level for the *Foreign Ownership* has no impact on our results, as the interaction between ambiguity aversion and changes in cash remain insignificant for the subsample controlled by foreign owners even when we assign firm-years with a *Foreign Ownership* higher than 40 % or 50 % to this subsample. We report here only the results for the subsample consisting of foreign controlled firms, as the results for the other subsample is basically the same as in Table III, since most of the firms are controlled by domestic investors. The share of firms owned by domestic investors also implies that our assumption regarding the magnitude of the home bias effect is not very critical, as shown in different studies.

>> Insert Table V

After that, we repeat the same comparing analysis for the second regression model as well. We again find that cash holdings are not related to the country-specific ambiguity aversion measure either for constrained or unconstrained firms. Results in Table VI demonstrate a negative correlation between cash holdings and ambiguity aversion only if financially constraints are defined according to company age. Furthermore, this negative relationship disappears if we set the cutoff level for Foreign Ownership to be 50 %. In the other two regressions using different financial constraint criterion (company size and dividend payout ratio), we observe no relation between cash holdings and ambiguity aversion for financially constrained firms consistent with our model predictions.

>> Insert Table VI

Hence, we conclude that our local investor preference parameter for ambiguity aversion is decisive for the market valuation of cash and the optimal amount of cash holdings only if the company is controlled by local investors. This circumstantiates the validity of our theory and also addresses concerns regarding the representativeness of our student sample for the whole population: Students' preferences work well as a proxy for overall preferences only when we expect them to do so.

4.2 Risk Aversion or Ambiguity Aversion

In Section 2, we emanated from risk neutral and ambiguity averse investors. At the same time, it is clear that our model yields exactly the same predictions if we assume risk averse and ambiguity neutral investors. Of course, we use our preference parameter for ambiguity aversion in the regressions; hence our assumption regarding ambiguity aversion seems to hold.

Yet, risk aversion can also have an impact on the value of cash together with ambiguity aversion, if investors are both risk and ambiguity averse. Still, we have ignored the possible relevance of risk preferences until now arguing that investors have diversified unsystematic risk away to a very large extent, i.e. the relevance of risk preferences for subjective valuation and optimization is limited in comparison to the importance of ambiguity aspects. Now, we want to put this assumption into test by investigating the impact of risk aversion on the value of cash and its optimal amount by using a preference parameter for risk aversion that we have obtained in our INTRA survey as well.

Similarly to the preference parameter for ambiguity aversion, risk aversion is also elicited in our survey this time with the help of a matching task. Participants had to declare the minimum amount of certainty equivalent for which they are indifferent between this certainty equivalent and a lottery with a 50 % probability of winning some money. To each country, we have assigned a score for risk aversion depending on the average amount of the certainty equivalent, which we refer to as *Risk Aversion* in our regressions.

Now, we add *Risk Aversion* and its interaction with changes in cash (ΔC_t×*Risk Aversion*) as an additional variable in the regression models of Section 3. We only report the results concerning the main variables of interest, as the addition of the new interaction term ΔC_t×*Risk Aversion* does not change the results with regard to the other control variables.

According to Table VII, we observe no systematically significant correlation between this interaction term and excess returns defined as in Section 3 neither for financially constrained companies nor for unconstrained ones. On the other hand, the interaction term ΔC_t×*Ambiguity Aversion* remains to be significant and negative and it is only significant for financially constrained firms even after including the parameter for *Risk Aversion*. Hence, we can conclude that our results in Table III can be traced back to ambiguity preferences and our assumption regarding the irrelevance of risk preferences seems to hold.

>> Insert Table VII

We perform a similar robustness check for the second regression model as well. Analogously, we add *Risk Aversion* into the second regression model as an additional variable and run our regressions from Table IV one more time. Once again, there is no consistent evidence of a negative relationship between *Risk Aversion* and cash holdings for financially constrained firms while this kind of relationship is confirmed with respect to *Ambiguity Aversion* for each financial constraint proxy. Thus, for constrained companies, *Ambiguity Aversion* is the only preference pattern that shapes the pattern of cash holdings, which is consistent with our model. Yet, we also have to admit that the results are somewhat less consistent with our predictions here, as we observe a positive relation between both *Ambiguity Aversion* and *Risk Aversion* and cash holdings for unconstrained firms in two out of three regressions. However, as we mentioned above, this is understandable, since managers have other incentives than shareholders and this can lead to excess cash holdings and this can be related to *Ambiguity Aversion* or *Risk Aversion*. We are not going to discuss this issue further in this paper, as it is beyond its scope.

>> Insert Table VIII

5. Conclusion

To recap, our paper provides the first theoretical and empirical analysis discussing the potential relevance of investor preferences for the value of cash and cash holding policies. Our empirical evidence suggests that cash is valued less favorably by ambiguity averse investors of financially constrained firms. On the other hand, if insuring a firm against the future illiquidity problem is not value increasing, ambiguity aversion is not related to the value of cash and this insurance is irrelevant for financially unconstrained firms. For the same reasons, ambiguity aversion is related to the amount of cash holdings only for financially constrained firms implying that managers are not only aware of investors' preferences, but they also cater to these needs.

We have also run some other robustness tests revealing that (domestic) ambiguity aversion is only relevant for the value of cash or the amount of cash holdings in companies which are controlled by domestic investors. Moreover, we demonstrated that ambiguity aversion and not risk aversion is responsible for our results which points out to the possibility that risk can be diversified to a good extent, but ambiguity aversion cannot.

Summing up, our paper is the first one to analyze the connection between boundedly rational investor preferences and corporate cash policies. We develop a theoretical framework that can integrate investors' preferences and catering motives in the cash management process investigating both the valuation of cash and aggregate cash demand of a company from this perspective. Furthermore, unlike previous empirical studies with similar scope (mostly concerning dividend policies), our empirical work provides a straightforward test regarding the link between behavioral biases and cash management.

References

Acharya, V., Almeida, H., Campello, M. (2007) Is cash negative debt? A hedging perspective on corporate financial policies. Journal of Financial Intermediation 16, 515-554.
Almeida, H., Campello, M., Weisbach, M. S. (2004) The cash flow sensitivity of cash. Journal of Finance 59, 1777-1804.
Baker, M., Greenwood, R., Wurgler, J. (2009) Catering through nominal share prices. Journal of Finance 64, 2559-2590.
Baker, M., Wurgler, J. (2004) A catering theory of dividends. Journal of Finance 59, 1125-1165.
Bates, T. W., Kahle, K. M., Stulz, R. M. (2009) Why do US firms hold so much more cash than they used to? Journal of Finance 64, 1985-2021.
Becker, B., Ivkociv, Z., and Weisbenner, S. (2011) Local dividend clienteles. Journal of Finance 66, 655-684.
Bouwman, C., Fuller, K., Nain, A., (2009) Market valuation and acquisition quality: empirical evidence. Review of Financial Studies 22, 633-679.
Breuer, W., Rieger, M. O., Soypak, K. C. (2013) The behavioral foundations of corporate dividend policy: a Cross-Country Analysis. Working Paper.
Chang, K., Noorbakhsh, A. (2009) Does national culture affect international corporate cash holdings? Journal of Multinational Financial Management 19, 323-342.
Denis, J. D., Sibikov, V. (2010). Financial constraints, investment, and the value of cash holding. Review of Financial Studies 23, 247-269.
Diamond, D. W., Verrecchia, R. E. (1991) Disclosure, liquidity, and the cost of capital. Journal of Finance 46, 1325-1359.
Dittmar, A., Mahrt-Smith, J. (2007) Corporate governance and the value of cash holdings. Journal of Financial Economics 83, 599-634.
Dittmar, A., Mahrt-Smith, J., Servaes, H. (2003) International corporate governance and corporate cash holdings. Journal of Financial and Quantitative Analysis 38, 111-133.
Djankov, S., Ganser, T., McLiesh, C., Ramalho, R., Shleifer, A. (2010) The effect of corporate taxes on investment and entrepreneurship. American Economic Journal: Macroeconomics 2, 31-64.
Epstein, L.G., Schneider, M. (2008) Ambiguity, information quality and asset pricing. Journal of Finance 63, 197-228.
Epstein, L.G., Schneider, M. (2010) Ambiguity and asset markets. Annual Review of Financial Economics 2, 315-346.
Fama, E. F., French, K. R. (1998) Taxes, financing decisions, and firm value. Journal of Finance 53, 819-843.
Faulkender, M., Wang, R. (2006) Corporate financial policy and the value of cash, Journal of Finance 61. 1957-1990.
Fazzari, S., Hubbard, R.G., Petersen, B. (1988) Financing constraints and corporate investment. Brooking Papers on Economic Activity 1, 141-195.
Graham, J., Kumar, A. (2006) Do dividend clienteles exist? Evidence on dividend preferences of retail investors. Journal of Finance 61, 1305-1335.
Hadlock, C.J., Pierce, J.R. (2010) New evidence on measuring financial constraints: moving beyond the KZ index. Review of Financial Studies 23, 1909-1940.
Han, S., Qiu, J. (2007) Corporate precautionary cash holdings. Journal of Corporate Finance 13, 43-57.
Holmström, B., Tirole, J., (1998) Private and public supply of liquidity. Journal of Political Economy 106, 1-40.

Jensen, M. C., (1986) Agency cost of free cash flow, corporate finance and takeovers. American Economic Review 76, 323-329.
Jensen, M.C., Meckling, W. H., (1976) Theory of the firm: managerial behavior, agency costs, and ownership structure. Journal of Financial Economics 3, 305-360.
Kahnemann, D., Tversky, A. (1979) Prospect theory: an analysis of decision under risk. Econometrica 47, 263-291.
Kaplan, S., Zingales, L. (1997) Do financing constraints explain why investment is correlated with cash flow? Quarterly Journal of Economics 112, 169-215.
Keynes, J.M. (1936) The General Theory of Employment, Interest and Money. McMillan, London.
King, R.R., Smith, V., Williams, A., Van Boening, M. (1993) The robustness of bubbles and crashes in experimental stock markets, in: Day, R., and Ping, C. (eds.), Nonlinear Dynamics and Evolutionary Economics. Oxford University Press, Oxford, pp. 183-200.
Klibanoff, P., Marinacci, M., Mukerji, S. (2005) A smooth model of decision making under ambiguity. Econometrica 73, 1849-1892.
Lamont, O., Polk, C., Saa-Requejo, J. (2001) Financial constraints and stock returns. Review of Financial Studies 14, 529-554.
Lau, S.T., Ng, L., Zhang, B. (2010) The world price of home bias. Journal of Financial Economics 97, 191-217.
La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R.W. (1998) Law and finance. Journal of Political Economy 106, 1113-1155.
Lins, K., Servaes, H., Tufano, P. (2010) What drives corporate liquidity? An international survey of cash holdings and lines of credit. Journal of Financial Economics 98, 160-176.
Myers, S.C., (1977) The determinants of corporate borrowing. Journal of Financial Economics 5, 147-175.
Opler, T., Pinkowitz, L., Stulz, R., Williamson, R. (1999) The determinants and implications of corporate cash holdings. Journal of Financial Economics, 52, 3-46.
Pinkowitz, L., (2002) The market for corporate control and corporate cash holdings. Working Paper.
Pinkowitz, L., Stulz, R., Williamson, R. (2006) Does the contribution of corporate cash holdings and dividends to firm value depend on governance? A cross-country analysis, Journal of Finance 61, 2725-2751.
Pinkowitz, L., Williamson, R., (2007) What is the market value of a dollar of corporate cash? Journal of Applied Corporate Finance 19, 74-81.
Rieger, M.O., Wang, M., Hens, T. (2011) Prospect theory around the world. Unpublished working paper.
Riger, M. O. and Wang, M. (2012) Can ambiguity aversion solve the equity premium puzzle? Survey evidence from international data. Finance Research Letters, 9, 63-72.
Wang, M., Rieger, M. O., Hens, T. (2010) How time preferences differ: evidence from 45 Countries. Unpublished working paper.
Whited, T., Wu, G. (2006) Financial constraints risk. Review of Financial Studies 19, 531-559.

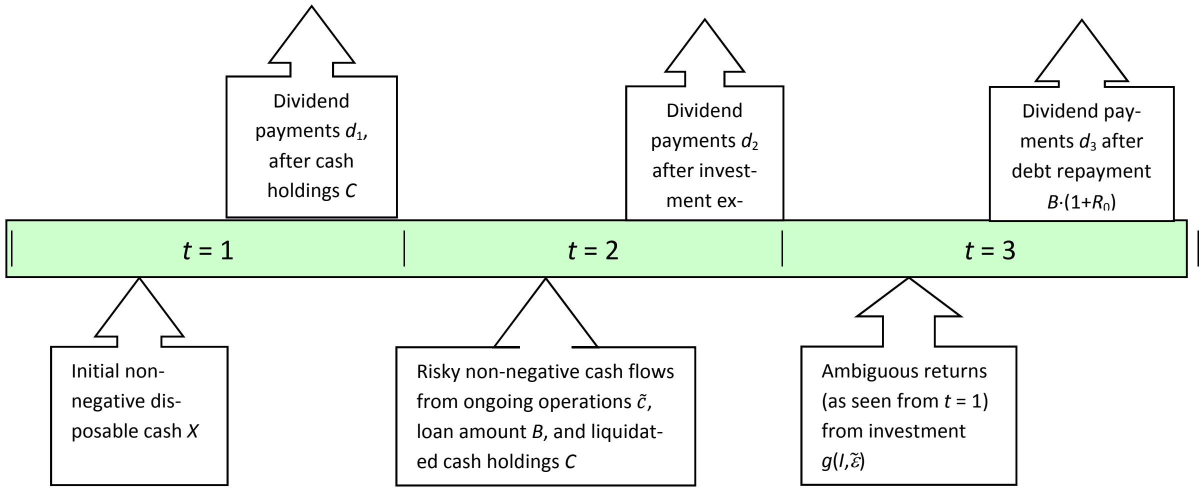

Figure I. Illustration of our three-period model.

Table I. Summary statistics

This table presents the mean, standard deviation (STD), minimum (Min), maximum (Max) and number of observations (N) for all the variables used in the first regression model. All variables except total debt to book value of assets (L_t) and excess stock return are deflated by the lagged market value of equity. ΔE_t is the change in earnings before paid interests and taxes (*EBIT*), and ΔNA_t is the change in total assets minus cash holdings. ΔRD_t represents the changes in R&D expenditures, which is set to zero if missing. ΔI_t is the yearly change in interest expense and ΔD_t is the change in total dividends. NF_t is calculated as the total equity issuance minus repurchases plus debt issuance minus debt redemption. ΔC_t is the notation for the realized 1-year change in cash holdings. Dependent variables and firm-specific control variables are winsorized at the 1 % level.

Variable	Mean	STD	Min	Max	N
Excess returns	0.07	0.54	-0.89	2.44	65,041
Company-Specific Control Variables					
ΔE_t	0.02	0.18	-0.65	1.02	48,695
ΔNA_t	0.09	0.54	-1.93	3.46	49,240
ΔRD_t	0.00	0.01	-0.03	0.04	51,667
ΔI_t	0.00	0.02	-0.10	0.09	32,122
ΔD_t	0.00	0.02	-0.09	0.10	48,733
NF_t	0.01	0.32	-1.07	2.91	56,996
ΔC_t	0.02	0.15	-0.54	0.86	49,328
L_t	23.35	17.93	0.00	79.51	74,351
C_t	0.25	0.39	0.00	2.88	67,262
Country-Specific Control Variables					
Common Law Dummy	0.46	0.50	0.00	1.00	79,926
Corruption	7.09	1.80	0.00	9.40	79,926
Inflation	0.03	0.18	-0.08	7.50	75,520
Total Taxes	47.28	11.22	24.35	107.38	79,926
Behavioral Variables					
Ambiguity Aversion	0.56	0.09	0.42	0.80	80,080
Uncertainty Avoidance	61.72	25.18	0.00	112	79,200

Table II. Summary statistics for second regression model

This table presents the mean, standard deviation (STD), minimum (Min), maximum (Max) and number of observations (N) for all the company-specific control variables used in the second regression. We refrain from reporting the summary statistics for the variables that are included both in the first and second regression models. *Real size* is the value of total assets in constant 1992 dollars. The market-to-book ratio is measured as the market value of equity plus book value of debt divided by total assets (*MB-Ratio*). Net working capital is calculated without cash before being divided by total assets (*NWC/Assets*). L_t is total debt over total assets. *SG* is the sales growth defined as net sales in year t divided by net sales in year $t-1$. We also control for research and development (R&D) spending and capital expenditures, denominated by net sales (*R&D/Sales*) and total assets (*Capex/Assets*), respectively. *Dividend Dummy* assumes the value 1 (0) for company-years with above-median (below-median) levels for cash dividends to total assets. Cash flow is denominated by total book value of assets as well (*CF/Assets*). All variables listed in this table are winsorized at 1 % level.

Variable	Mean	STD	Min	Max	N
Cash/NetAssets	0.22	0.37	0.00	2.73	72,710
Company-Specific Control Variables					
Real Size	15.13	3.41	0.76	22.80	74,187
MB-Ratio	1.35	1.15	0.07	6.86	68,718
NWC/Assets	0.01	0.16	-0.49	0.44	71,361
Lt	23.35	17.93	0.00	79.51	74,351
SG	1.16	0.39	0.41	4.01	69,188
R&D/Sales	0.02	0.04	0.00	0.21	74,022
Capex/Assets	0.06	0.06	0.00	0.31	70,894
Dividend Dummy	0.53	0.50	0.00	1.00	72,983
CF/Assets	0.10	0.08	-0.15	0.35	73,431

Table III. Financial constraints and the valuation of cash as a function of ambiguity aversion

This table presents the results of regressions on the excess stock returns distinguishing between two subsamples: the financially constrained and financially unconstrained firms. The main variable of interest is the interaction term, ΔCt×Ambiguity Aversion. We use dividend payouts to assets, the value of total assets and company age as defining criteria for the level of financial constraints in Columns (1) and (2), (3) and (4) and (5) and (6), respectively. In Columns (1), (3) and (5), we report the results for financially constrained firms and in Columns (2), (4) and (6) for unconstrained firms. Robust standard errors are clustered at the firm level and we use year and industry dummies. All *t*-values are reported under the coefficient estimates. Statistical significance at the 1 %, 5 % and 10 % level are indicated by ***, **, and *, respectively.

	Dividend Dummy		Size Dummy		Age Dummy	
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
ΔC_t×Ambiguity Aversion	*-1.173***	0.878	*-1.560***	0.306	*-1.715***	0.639
	-2.395	1.350	*-2.448*	0.614	*-2.111*	1.012
ΔE_t	*0.357****	*0.350****	*0.427****	*0.295****	*0.385****	*0.268****
	9.714	*6.986*	*9.119*	*7.616*	*5.836*	*6.473*
ΔNA_t	*0.074****	*0.098****	*0.117****	*0.064****	*0.099****	*0.082****
	5.138	*5.693*	*6.291*	*4.529*	*3.868*	*4.341*
ΔRD_t	*2.216****	1.120	*4.133****	-0.369	*2.329***	-0.509
	3.288	1.603	*5.390*	-0.646	*2.013*	-0.926
ΔI_t	-0.351	*-1.194****	-0.331	*-0.962***	*-1.644****	-0.258
	-0.997	*-3.065*	-0.933	*-2.488*	*-3.214*	-0.573
ΔD_t	*-1.071***	*1.145****	*0.907****	0.159	*1.052***	0.109
	-2.050	*4.978*	*3.281*	0.485	*2.551*	0.284
NF_t	-0.010	*-0.078***	-0.048	*-0.056**	-0.020	*-0.192****
	-0.341	*-2.361*	-1.416	*-1.873*	-0.428	*-5.557*
ΔC_t	*0.696****	*0.652****	*0.768****	*0.539****	*0.941****	*0.454****
	12.401	*11.132*	*12.486*	*9.573*	*10.380*	*7.320*
L_t	*-0.002****	*-0.001****	*-0.002****	*-0.000**	*-0.001****	-0.000
	-6.545	*-4.674*	*-7.349*	*-1.720*	*-4.702*	-0.945
C_{t-1}	*0.233****	*0.182****	*0.316****	*0.183****	*0.286****	*0.155****
	9.751	*5.422*	*9.480*	*8.358*	*6.739*	*6.480*
$\Delta C_t \times C_{t-1}$	*-0.176***	*-0.301****	*-0.365****	-0.082	-0.076	*-0.117**
	-3.201	*-3.725*	*-4.291*	-1.554	-0.736	*-1.894*
$\Delta C_t \times L_t$	*-0.005***	-0.004	*-0.005***	-0.003	*-0.009***	-0.001
	-2.282	-1.285	*-2.068*	-1.389	*-2.573*	-0.405
Ambiguity Aversion	*-0.223****	-0.059	*-0.259****	*-0.174****	*-0.250****	*-0.107**
	-3.085	-1.534	*-5.082*	*-3.039*	*-3.521*	*-1.954*
Common Law Dummy	*0.068****	*0.015**	*0.068****	0.011	*0.042****	0.004
	3.900	*1.688*	*6.086*	0.874	*3.002*	0.307
Inflation	0.204	*1.038****	*1.618****	*-1.255****	*0.866***	0.453
	0.486	*3.715*	*4.343*	*-2.894*	*2.155*	1.039
Corruption	-0.008	*-0.015****	0.003	*-0.022****	*-0.012***	*-0.022****
	-1.298	*-5.108*	0.570	*-5.306*	*-2.164*	*-3.356*
Total Taxes	*-0.001*	*-0.003****	*-0.001**	*-0.006****	*-0.003****	*-0.004****
	-1.303	*-7.912*	*-1.702*	*-9.482*	*-5.064*	*-5.589*
Constant	*0.445***	*1.303***	0.351	*0.887****	*0.926****	*0.411***
	2.051	*2.119*	1.300	*6.733*	*3.870*	*2.455*
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.164	0.148	0.187	0.140	0.190	0.154
Observations	13,843	17,210	14,658	16,259	7,387	11,430

Table IV. Cash holdings and ambiguity aversion

This table presents the results of regressions of cash holdings divided by net assets (Cash/NetAssets) on various firm characteristics. The main variable of interest is our preference parameter, Ambiguity Aversion. We use dividend payouts to assets, the value of total assets and company age as defining criteria for the level of financial constraints in Columns (1) and (2), (3) and (4) and (5) and (6), respectively. In Columns (1), (3) and (5), we report the results for financially constrained firms and in Columns (2), (4) and (6) for unconstrained firms. Robust standard errors are clustered at the firm level and we use year and industry dummies. All *t*-values are reported under the coefficient estimates. Statistical significance at the 1 %, 5% and 10 % level are indicated by ***, **, and *, respectively.

	Dividend Dummy		Size Dummy		Age Dummy	
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
Ambiguity Aversion	*-0.309****	0.031	*-0.500****	*0.253****	*-0.416****	0.081
	-3.902	0.640	*-6.790*	*4.703*	*-3.592*	1.587
Real Size	-0.003*	0.001	*-0.006****	*-0.008***	0.004*	-0.001
	-1.807	0.758	*-2.936*	*-2.304*	1.646	-0.669
MB-Ratio	*0.109****	*0.068****	*0.089****	*0.087****	*0.102****	*0.058****
	13.134	*8.540*	*11.498*	*9.560*	*10.177*	*6.214*
NWC/Assets	*-0.632****	*-0.576****	*-0.647****	*-0.526****	*-0.844****	*-0.377****
	-14.452	*-14.676*	*-15.075*	*-12.236*	*-13.485*	*-8.910*
L_t	*-0.005****	*-0.005****	*-0.005****	*-0.005****	*-0.006****	*-0.004****
	-15.324	*-17.310*	*-14.767*	*-14.996*	*-14.077*	*-12.643*
SG	*0.054****	0.009	*0.061****	0.008	*0.042****	*-0.026****
	4.810	1.034	*5.401*	1.067	*2.832*	*-3.234*
R&D/Sales	*1.903****	*1.185****	*2.296****	*0.910****	*1.347****	*0.965****
	7.890	*5.770*	*9.400*	*5.325*	*4.468*	*6.706*
Dividend Dummy	.	.	*-0.022***	*-0.018***	-0.009	0.011
	.	.	*-2.469*	*-2.419*	-0.663	-1.545
Capex/Assets	*-0.757****	*-0.931****	*-0.702****	*-0.974****	*-1.113****	*-0.751****
	-10.334	*-11.947*	*-9.897*	*-11.749*	*-9.491*	*-7.852*
CF/Assets	*-0.710****	0.054	*-0.612****	0.084	*-0.358***	0.007
	-4.785	0.721	*-4.720*	1.108	*-2.174*	0.099
Common Law Dummy	*-0.026**	*-0.092****	*-0.046****	*-0.068****	*-0.056***	*-0.088****
	-1.698	*-10.757*	*-3.497*	*-6.091*	*-2.745*	*-8.441*
Inflation	*-0.397****	*-0.790****	*-0.253**	*-0.515****	*-0.722****	*-0.383****
	-3.647	-6.319	-1.939	-4.767	-4.709	-4.064
Corruption	-0.005	*-0.012****	*-0.011****	-0.003	*-0.017****	-0.005
	-1.153	*-4.053*	*-2.596*	-1.142	*-3.124*	-1.522
Total Taxes	*-0.001***	*-0.002****	*-0.002****	-0.001	0.000	*-0.001**
	-2.162	*-3.988*	*-4.643*	-1.147	-0.652	*-1.814*
Constant	*0.371****	*0.483****	*0.514****	*0.447****	*0.230****	*0.387****
	5.673	*6.919*	*7.985*	*4.992*	*2.454*	*5.746*
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	21,145	24,330	22,850	22,625	11,931	17,008

Table V. Foreign ownership and the valuation of cash as a function of ambiguity aversion

This table presents the results of the same regression model as in Table III only for companies with *Foreign Ownership* > 30 %. In Columns (1), (3) and (5), we report the results for financially constrained firms and in Columns (2), (4) and (6) for unconstrained firms. Robust standard errors are clustered at the firm level and we use year and industry dummies. All *t*-values are reported under the coefficient estimates. Statistical significance at the 1 %, 5 % and 10 % level are indicated by ***, **, and *, respectively.

	Dividend Dummy		Size Dummy		Age Dummy	
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
ΔC_t×Ambiguity Aversion	2.652	2.633	-0.833	3.065	4.045	4.522
	1.200	1.105	-0.401	1.035	1.265	0.991
ΔE_t	*0.462****	0.013	*0.408****	0.393*	0.466	*0.430***
	2.851	0.057	*2.602*	1.737	1.464	*2.387*
ΔNA_t	0.075	*0.144**	0.068	0.041	0.008	0.100
	1.457	*1.710*	0.977	0.647	0.121	1.299
ΔRD_t	-0.672	-0.094	-2.049	4.422	-3.404	-4.609
	-0.169	-0.026	-0.403	1.352	-0.396	-1.235
ΔI_t	-0.793	-3.199	*-2.948**	0.584	-2.362	-2.09
	-0.469	-1.280	*-1.735*	0.320	-1.320	-1.332
ΔD_t	-1.923	*1.538***	*1.363**	0.712	*2.499***	*2.625**
	-1.241	*2.147*	*1.914*	0.607	*2.104*	*1.844*
NF_t	0.128	0.171	-0.079	0.111	0.271	-0.117
	1.216	1.319	-0.615	0.926	1.642	-0.508
ΔC_t	0.285	0.303	*0.410***	0.258	*0.975****	0.625
	1.217	1.311	*1.994*	0.824	*2.736*	1.659
L_t	*-0.004***	-0.002	*-0.003***	*-0.004***	*-0.004***	*-0.003**
	-2.394	-1.377	*-2.408*	*-2.473*	*-2.402*	*-1.682*
C_t	*0.379****	*0.349***	*0.396****	*0.344****	*0.843****	0.052
	4.144	*2.474*	*3.697*	*3.517*	*4.498*	0.448
$\Delta C_t \times C_t$	-0.291	0.142	*-0.738****	-0.041	-0.626	*-0.683****
	-1.336	0.699	*-3.606*	-0.21	-1.018	*-2.777*
$\Delta C_t \times L_t$	-0.005	-0.007	-0.009	-0.01	-0.015	*0.053****
	-0.383	-0.405	-0.847	-0.792	-0.885	*2.656*
Ambiguity Aversion	-0.284	*0.516***	-0.084	-0.044	0.196	0.307
	-0.871	*2.182*	-0.352	-0.127	0.349	0.677
Common Law Dummy	-0.010	0.075	*0.090***	-0.025	-0.018	-0.014
	-0.146	1.538	*2.151*	-0.351	-0.284	-0.161
Inflation	3.002	-0.251	0.603	0.509	1.78	2.486
	1.559	-0.299	0.498	0.383	1.189	1.188
Corruption	-0.002	-0.011	-0.006	-0.026	-0.017	-0.006
	-0.067	-0.949	-0.367	-1.305	-0.712	-0.196
Total Taxes	*-0.005**	-0.002	0.000	*-0.006***	-0.001	-0.002
	-1.697	-1.110	0.166	*-2.424*	-0.23	-0.915
Constant	-0.272	0.261	-0.28	*0.556***	0.309	0.207
	-0.777	1.482	-1.222	*2.11*	0.809	0.495
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.354	0.262	0.28	0.342	0.506	0.363
Observations	530	864	703	661	302	283

Table VI. Cash holdings and ambiguity aversion

This table presents the results of the same regression model as in Table IV only for companies with *Foreign Ownership* > 30 %. We use dividend payouts to assets, the value of total assets and company age as defining criteria for the level of financial constraints in Columns (1) and (2), (3) and (4) and (5) and (6), respectively. In Columns (1), (3) and (5), we report the results for financially constrained firms and in Columns (2), (4) and (6) for unconstrained firms. Robust standard errors are clustered at the firm level and we use year and industry dummies. All *t*-values are reported under the coefficient estimates. Statistical significance at the 1 %, 5 % and 10 % level are indicated by ***, **, and *, respectively.

	Dividend Dummy		Size Dummy		Age Dummy	
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
Ambiguity Aversion	-0.562	0.125	-0.324	-0.125	*-1.078***	-0.189
	-1.497	0.554	-0.902	-0.484	*-2.26*	-0.873
Real Size	-0.003	0.001	-0.001	-0.018*	-0.006	0.003
	-0.592	0.203	-0.190	-1.811	-0.917	0.797
MB-Ratio	*0.067****	*0.065****	*0.065****	*0.047****	*0.093****	0.014
	2.736	*3.331*	*2.969*	*2.659*	*3.487*	0.739
NWC/Assets	*-0.463****	*-0.564****	*-0.542****	*-0.383****	*-0.768****	*-0.475****
	-3.494	*-4.534*	*-4.271*	*-3.872*	*-3.883*	*-3.045*
L_t	*-0.006****	*-0.006****	*-0.006****	*-0.004****	*-0.008****	*-0.002****
	-5.505	*-5.347*	*-5.076*	*-4.071*	*-5.064*	*-2.946*
SG	0.033	0.086	0.086	-0.027	0.087	*-0.039**
	0.934	1.062	1.390	-1.088	0.720	*-1.992*
R&D/Sales	1.000	*1.774***	*1.889***	1.129	1.282	*2.090****
	1.090	*2.041*	*2.037*	1.215	1.161	*3.296*
Dividend Dummy	.	.	-0.006	-0.035	-0.015	0.002
	.	.	-0.213	-1.440	-0.385	0.122
Capex/Assets	*-0.623***	*-0.663****	*-0.464**	*-0.595****	*-1.305****	-0.116
	-2.448	*-2.809*	*-1.867*	*-3.146*	*-2.876*	-0.388
CF/Assets	-0.374	-0.168	-0.436	*0.713****	-0.569	*0.280***
	-1.002	-0.567	-1.357	*3.66*	-1.228	*2.013*
Common Law Dummy	0.008	-0.004	-0.013	-0.055	-0.081	-0.001
	0.163	-0.113	-0.248	-1.525	-1.155	-0.030
Inflation	0.461	0.012	-0.579	0.314	-2.067	-0.804
	0.543	0.020	-0.836	0.508	-1.571	-1.564
Corruption	-0.006	-0.003	-0.015	-0.005	-0.028	*-0.032***
	-0.381	-0.285	-1.227	-0.402	-1.446	*-2.284*
Total Taxes	*-0.003***	*-0.002***	-0.002	*-0.004****	-0.005	-0.000
	-2.037	*-2.185*	-1.436	*-3.227*	-1.595	-0.426
Constant	*0.693****	0.254	*0.471***	*0.875****	*1.320****	*0.381***
	3.048	1.882	*2.515*	*3.483*	*2.619*	*2.422*
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	21,145	24,330	22,850	22,625	11,931	17,008

Table VII. Valuation of cash holdings depending on ambiguity aversion and risk aversion

This table presents the results of regressions of the excess stock returns on changes in firm characteristics over the fiscal year. Our main variables of interest are *ΔC_t×Ambiguity Aversion* and *ΔC_t×Risk Aversion*. Robust standard errors are clustered at the firm level and we use year and industry dummies. All *t*-values are reported under the coefficient estimates. Statistical significance at the 1 %, 5 % and 10 % level are indicated by ***, **, and *, respectively.

	Dividend Dummy		Size Dummy		Age Dummy	
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
ΔC_t×Ambiguity Aversion	*-1.109**	1.030	*-1.691***	0.775	*-1.998***	1.088
	-1.889	1.512	*-2.312*	1.398	*-2.258*	1.006
ΔC_t×Risk Aversion	0.269	1.01	-0.528	*2.173***	-1.091	1.241
	0.234	0.884	-0.418	*2.053*	-0.765	0.550
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.164	0.148	0.187	0.141	0.190	0.155
Observations	13,843	17,210	14,658	16,259	7,387	11,430

Table VIII. Valuation of cash holdings depending on ambiguity aversion and risk aversion

This table presents the results of regressions of cash holdings divided by net assets (*Cash/Net Assets*) on various firm characteristics. Our main variables of interest are *Ambiguity Aversion* and *Risk Aversion*. Robust standard errors are clustered at the firm level and we use year and industry dummies. All *t*-values are reported under the coefficient estimates. Statistical significance at the 1 %, 5 % and 10 % level are indicated by ***, **, and *, respectively.

	Dividend Dummy		Size Dummy		Age Dummy	
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
Ambiguity Aversion	*-0.313****	0.068	*-0.435****	*0.317****	*-0.540****	*0.170***
	-3.423	1.149	*-5.252*	*4.875*	*-4.176*	*2.477*
Risk Aversion	-0.015	0.110	*0.245**	*0.187**	*-0.349***	*0.248***
	-0.112	1.127	*1.815*	*1.798*	*-2.282*	*2.003*
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	21,145	24,330	22,850	22,625	11,931	17,008

Framing Effects in Intertemporal Choice Tasks and Financial Implications

Wolfgang Breuer, K. Can Soypak

Abstract. In contrast to previous studies, we compare intertemporal preferences in different frames with the help of choice tasks instead of willingness-to-pay tasks. To this end, we examine differences in choice patterns between delay and speedup frames and refer to these differences as time framing effects. Time framing effects are only strong for negative outcomes. We explain this experimental result by distinguishing between out-of-pocket costs incurred by delaying a loss and opportunity costs from speeding up a gain with the latter costs being less important than the former. As a practical application of our findings, we investigate borrowing and lending decisions of private households via a panel analysis across 54 countries empirically and show that household behavior is in line with our theory.

JEL Classification: D91, E43, G00

Keywords: delay-speedup asymmetry, experimental economics, household finance, time discounting, framing effects

We would like to thank Amelie Brünn, Alexander Erler, and seminar participants at the annual meeting of the Swiss Society for Financial Market Research 2013 in Zurich and at the INFINITI Conference on International Finance in Aix-en-Provence 2013. Of course, all remaining errors are our own.

Framing Effects in Intertemporal Choice Tasks and Financial Implications

Abstract. In contrast to previous studies, we compare intertemporal preferences in different frames with the help of choice tasks instead of willingness-to-pay tasks. To this end, we examine differences in choice patterns between delay and speedup frames and refer to these differences as time framing effects. Time framing effects are only strong for negative outcomes. We explain this experimental result by distinguishing between out-of-pocket costs incurred by delaying a loss and opportunity costs from speeding up a gain with the latter costs being less important than the former. As a practical application of our findings, we investigate borrowing and lending decisions of private households via a panel analysis across 54 countries empirically and show that household behavior is in line with our theory.

JEL Classification: D91, E43, G00

Keywords: delay-speedup asymmetry, experimental economics, household finance, time discounting, framing effects

1. Introduction

Many of our decisions have consequences in the future. In such intertemporal decisions, we need to determine the weight given to future periods in order to compare multiple alternatives with temporal distance. Mostly, we attach a higher value to earlier outcomes than to later outcomes which implies positive time preferences and positive discount rates.

There are several possible explanations why we discount future outcomes with positive discount rates. Some researchers have attributed this to the lack of necessary self-control to postpone consumption and the willpower costs that follow in order to do that (Shefrin and Thaler, 1988). The necessity of willpower for deferring consumption can be attributed to many reasons including our shortsightedness, i.e., we do not care about our future selves as much as we care about our present situation (Frederick, 2006).

Still, there is much more to learn about discounting functions like their shape as well as their relationship to other factors such as outcome magnitude, sign or the description of time (Loewenstein and Prelec, 1992; Read et al., 2005a; Onculer and Onay, 2007). For instance, Loewenstein (1988) has shown in an experimental setting using willingness-to-pay (henceforth WTP) tasks that outcome framing effects are at work in intertemporal decisions as well and that we observe different decisions in different outcome frames (Thaler and Johnson, 1990).

However interesting these results are, the setting of WTP tasks (which are a specific form of matching tasks) is not very realistic and we often face choice tasks instead in real-life decisions. For instance, households have to decide for given investment opportunities whether they want to spend their income right away or invest a certain portion of this income rather than determining the premium that they request to postpone consumption, as they are usually rate-takers in capital markets with a weak bargaining hand. Similarly, if an extension or early maturation option is embedded in financial products such as extendible or putable bonds, at the exercise date, the buyer has a choice to make between consuming right away or waiting, and is not requested to specify the WTP to change the maturity of the bond or in other words, the value of the option.

Different tasks affect the choices of individuals, as Lichtenstein and Slovic (1971) have demonstrated in their study, where they compared the participants' answers in WTP and choice tasks. In choice tasks, no outcome serves as the reference point (status quo), since all possible alternatives are listed prior to the decision. Decision makers will cancel the common parts of alternatives in these tasks out and become less prone to framing effects due to this editing process as advocated in prospect theory (Kahneman and Tversky, 1979; Tversky et al., 1990). In matching tasks such as WTP tasks, this editing will not occur in general, because each alternative is evaluated separately. As a consequence, we show that framing effects are very much marginalized in choice task experiments compared to framing effects in matching tasks (see also Ahlbrecht and Weber, 1997).

In what follows, we can frame the same choice tasks differently by shifting the reference point of time instead of the reference point of outcomes. In a delay frame, the timing of the earlier outcome becomes the reference point of time, while in a speedup frame the reference point of time is the date of receipt of the later alternative. We refer to the differences in decision patterns in different frames of choice tasks without a status quo alternative as "time framing effects" and discuss how this more "realistic" form of framing affects intertemporal decisions.

In other words, our experiment extends prior literature by investigating time framing effects rather than outcome framing effects. This type of framing resembles the framing effects in real-life intertemporal decisions that we have mentioned above much more, since in reality, individuals face mostly i) choice tasks, ii) where different time frames produce framing effects rather than outcome frames. Therefore, we expect our experimental results to have practical relevance as well. In order to verify this conjecture, we investigate empirically borrowing and lending decisions of private households via a panel analysis across 54 countries and show that household behavior is in line with our theory. This way, to the best of our knowledge, we provide the first ever empirical evidence for framing effects in intertemporal choices.

To sum up, our paper contributes to the literature in several different ways. First of all, in choice tasks, we show that framing effects in intertemporal decisions are not as strong as framing effects in matching tasks, especially for positive outcomes. Secondly, we provide a theoretical justification for the observed differences between framing issues in WTP and choice tasks. Last, but not least, we demonstrate empirically that the framework of our experimental questions can indeed portray actual intertemporal decision tasks better. Hence, our experimental evidence has practical consequences as well.

In the next section, we start by drawing the outline of time framing effects and isolate them from outcome framing effects. In Section 3, we talk about the purpose and design of our experiment. In Sections 4 and 5, we present and discuss the results of our experiments, respectively. In Section 6, we seek empirical support for our findings in the field of household finance. Section 7 concludes.

2. Separating Time and Outcome Framing Effects

Standard discounted expected utility (DEU) theory does not allow our choices to be subject to framing effects, which is called the invariance principle. This means that different formulations of the same problem should not affect our decisions. Of course, this applies to intertemporal decisions under certainty as well. Let C_t stand for an individual's initial (fixed) consumption at time $t = 0, 1$ and ρ be a subjective discount factor. Then, according to DEU, in WTP tasks, if we define the delay (speedup) premium d (s) as the amount of money which we want (are ready) to receive (pay) today in order to delay (hasten) the consumption of x at time $t = 0$ (1), the delay (speedup) premium is implicitly defined as follows:

$$\frac{U(C_1 + x)}{1 + \rho} + U(C_0 + d) = U(C_0 + x) + \frac{U(C_1)}{1 + \rho}, \tag{1}$$

$$\frac{U(C_1 + x)}{1 + \rho} + U(C_0) = U(C_0 + x - s) + \frac{U(C_1)}{1 + \rho}. \tag{2}$$

According to DEU, the delay or speedup premium will be integrated with the initial consumption level C_0, and the relation between the delay and the speedup premium is given by: $U(C_0 + d) - U(C_0) = U(C_0 + x) - U(C_0 + x - s)$. For linear utility functions, there should be no difference at all between d and s, if decision makers act according to DEU theory. However, we know that utility functions are (strictly) concave. Thus, speedup premiums should be somewhat larger than delay premiums due to the concavity of utility functions, yet these differences will be negligible, if x is small relative to initial consumption level C_0.

Some studies challenged the descriptive quality of DEU in terms of explaining delay and speedup premiums observed in experiments, since experimental studies demonstrated that delay premiums are more than twice as large as speedup premiums. This ratio between the delay and the speedup premium is by no accident almost as large as the typical value of the loss aversion parameter known from prospect theory (Loewenstein, 1988; Benzion et al., 1989). Therefore, these studies ascribe this large difference between inferred discount rates in delay and speedup frames to prospect theory aligned preferences.

The explanation is as follows: In the delay frame, the sooner consumption of x is presented as the status quo, which defines the dynamic reference point (x, 0) (with x being valid as reference for $t = 0$ and 0 being valid for $t = 1$) and test subjects are asked to state the delay premium d they would require in order to delay the initial reward x. Prospect theory investors evaluate outcomes relative to a reference point and segregate the delay premium from the initial amount x due to the specific formulation of the WTP tasks. Hence, the delay premium will be determined according to the following formula, with v denoting the value function according to prospect theory:

$$v(-x) + v(d) + \frac{v(x)}{1 + \rho_d} = 0. \qquad (3)$$

On the other hand, if the same reward x is supposed to be received later in a speedup frame, the reference point shifts to $(0, x)$. In this case, indifference between the later and the sooner alternative is ensured for:

$$v(x) + v(-s) + \frac{v(-x)}{1 + \rho_s} = 0. \qquad (4)$$

Due to outcome framing effects, the delay premium will be higher than the speedup premium in absolute value even when the delay discount rate ρ_d is equal to the speedup discount rate ρ_s. The future (present) consumption becomes more valuable in a speedup (delay) frame as a consequence of a decision maker's loss aversion and the resulting reluctance to change an established behavior, which is labeled as the status quo bias. Loewenstein (1988) named this observation the delay-speedup asymmetry and many researchers have later confirmed his results in different contexts (see Frederick et al., 2002, for a review).

Benzion et al. (1989) repeated the same experiment with a similar matching task without segregating the delay or speedup premium from the initial reward x and they were able to confirm the findings of Loewenstein (1988). Moreover, for negative payments, Benzion et al.

(1989) found evidence for a reversed delay-speedup asymmetry which is again in line with the outcome framing story.

Yet, decision makers do not encounter matching tasks in reality often and it is more interesting to analyze framing effects in choice tasks. Thus, the practical relevance has motivated us to investigate the impact of framing effects in choice tasks. In such tasks, no alternative is tagged as the status quo, therefore we refer to these frames as neutral (outcome) frames following Shelley (1993) who investigated sign effects in a similar setting.

Even with choice tasks, the same intertemporal decision problem is going to be perceived either in a delay (the reference point of time is the timing of the early alternative and the later alternative is described by "*m* months later") or in a speedup frame (the reference point of time is the timing of the later alternative and the sooner alternative is described by "*m* months earlier") because of differing descriptions of temporal distance. However, compared to matching tasks, in choice tasks framing effects are marginalized due to a different editing process which we discuss further in Section 5.

In the absence of framing effects, decision makers would exhibit the same preferences in delay and speedup frames in choice tasks. Hence, they would choose the same consumption path in both time frames. In the following experiment, we now want to look closely at this prediction and try to understand whether framing effects can be eliminated entirely in choice tasks. To the best of our knowledge, this is the first attempt to understand framing effects in choice tasks or time framing effects, as we refer to them.

3. The Experiment

3.1 Hypotheses

As we have mentioned in the previous section, our experiment is devised to examine framing effects in neutral outcome frames, which we define as time framing effects. For this purpose, we want to conduct an experimental analysis with choice tasks which also emulates intertemporal decisions generally much better. We argue that choice tasks marginalize framing effects, hence our null hypothesis is that time framing effects are not existent. Thus, we conjecture the following:

Hypothesis 1: *On average, decisions are consistent in the delay and the speedup frame in choice tasks (no time framing effects).*

Moreover, we repeat our experiment in different scenarios to investigate the relationship between time framing and other possible determinants of time discounting. Usually, factors such as sign, size, or timing of the outcomes are found to be relevant for discount rates (Frederick et al., 2002). Therefore, we want to examine the impact of these factors on time framing effects. We do not expect to observe any correlation between those factors and time framing effects. In other words, we argue that time framing effects should be always negligible regardless of the timing, size or sign of the outcomes. Hence, we predict the following hypothesis:

Hypothesis 2: *In addition to being non-existent on average, there are also no time framing effects for certain scenarios distinguished by timing, size or sign of the outcomes.*

3.2 Design of the Experiment

To start the experiment, we have informed as many students as possible (probably more than 2,000 students) via the online learning portals of different courses of RWTH Aachen University in Germany and via e-mail newsletters of student unions about a scientific study on discounting preferences. The survey was available online and was accessible for all students. Overall, 229 participants responded. In order to assure that each student participates in the questionnaire only once, each participant was required to register with an e-mail account with RWTH domain. After the completion of the questionnaire, we sent each registered account an e-mail which had to be confirmed; otherwise the respective answers were not evaluated. This confirmation was also necessary in order to participate in the raffle which rewarded the winners with 3 iPods. We eliminated participants who have failed to provide consistent answers (see explanation later on) or have not confirmed their identity. After this correction, we are left with 178 students in our sample, 100 in the basic scenario with immediate (sooner) outcomes (54 with delay frame, 46 with speedup frame) and 78 in the delayed scenario with delayed (sooner) outcomes (three months delay) (44 with delay frame, 34 with speedup frame), respectively.

Each participant in both basic and delayed scenarios faced three question sets in their questionnaire with small (100 € vs. 105 €), negative (−100 € vs. −105 €) and large outcomes (1,000 € vs. 1,050 €) either in the delay or the speedup frame. Hence, for each participant, we elicit three potentially different discount rates. This way, we can analyze time framing effects (the difference between choices in delay and speedup frames) in different settings in order to control for the link between time framing and outcome timing, size and sign and thus to elaborate on the second hypothesis. Moreover, this will also enable us to control for delay, size and sign effects in our setting (see Frederick et al., 2002, for a definition of these effects).

The questionnaires consist of choice tasks where subjects have to decide between a later larger and a sooner smaller reward, while the temporal distance between the two alternatives is increased among questions of the same question set (Coller and Williams, 1999). Each question set consists of seven questions and the shift from a later to a sooner alternative marks the interval for discount rates of each participant (for negative outcomes, it is the other way around). Participants are divided into two groups in both the basic and the delayed scenario; each group receives the same question set, but in different time frames, i.e. either in a delay frame or in a speedup frame. We are going to trace different choices in different frames back to time framing effects, as mentioned above. A sample question set in the delay frame will have the following general form:

Imagine that you are creditor and your borrower offers you two alternative repayment plans for the money he/she owes you. Which alternative would you choose?

a) *Receive 100 € on 01.12.2012,*
b) *Receive 105 € 6 months after 01.12.2012.*

Correspondingly, in the speedup frame, the reference calendar date and the description of the time interval between the alternatives are modified and alternatives are formulated as follows:

a) *Receive 105 € on 01.06.2013*
b) *Receive 100 € 6 months before 01.06.2013.*

In each question set, the same alternatives are separated simply by seven different time intervals (1, 2, 3, 4, 6, 9, or 12 months) holding the date of the sooner alternative always constant. For the basic scenario in the delay frame, it is the first day of the following month in which the questionnaire has been filled. For the delayed scenario in the delay frame, the sooner alternative is to be received on the first day of the fourth following month. We thus have to distinguish clearly between the delayed scenario and the delay frame. The delayed scenario simply refers to choice tasks where even the sooner outcome is not available immediately, but it is to be received three months after the decision is made. On the other hand, the delay frame is the label for the question sets where the calendar date of receipt is declared for the sooner of two outcomes between one has to choose. Hence, both the basic scenario and the delayed scenario can be utilized for an investigation of potential differences in the speedup and the delay frame.

We have excluded all participants who switched either twice or who switched from sooner smaller to later larger alternatives with increasing temporal distance, exhibiting negative time preferences in one of the question sets in the questionnaire. Both indicate an inability to understand our questions.

>>>>*Insert Table 1 here*<<<<

We have also asked our participants for some demographic information. Table 1 presents some descriptive statistics regarding demographics of our participants. We have utilized binary dummy variables for participants' gender (*Gender;* male = 0, female = 1) and major (*Major*; non-economics students = 0, economics students = 1), while age (*Age*) is measured by integers describing the age of participants in years.

4. Results

4.1 Direct and Indirect Effects of Time Framing

Now we can evaluate the results of our experiments and compare choices of our participants in the delay and the speedup frame in different scenarios. We categorize our participants into groups depending on where they start to prefer earlier to later rewards (or later to earlier payment obligations), as interval lengths grow. Since we have seven questions in each set, participants are divided into eight groups, with 1 being the most patient group (chooses the later reward (earlier payment) in every question) and 8 being the least patient group (chooses the earlier reward (later payment) alternative in every question). As we cannot determine the exact value of discount rates in choice tasks, the discount rates can either be defined as an ordinal variable or in ranges as explained in more detail below. On the other hand, time framing effects are represented by a dummy variable, *TimeFraming*, which assumes the value of zero in the delay frame and the value of one in the speedup frame.

We want to explore the relationship between the discount rates and *TimeFraming*. Interval regressions allow us to work with censored dependent variables while controlling for the impact of multiple factors on the dependent variable simultaneously. As mentioned above, we want to control for the other discounting anomalies such as delay, size and sign effects as well as for demographic factors, including age, gender (Harrison et al., 2002), or familiarity with the present value concept (Matsumoto et al., 2000) together with time framing effects on time preferences.

In order to utilize interval regressions, we have to define a lower bound and an upper bound for each category of discount rates. We denote this form of the dependent variable as *Discounting_Interval* and the range for each category can be seen in Column (1) of Table 2. We refer to these discount rates as "linear", since we have assumed linear utility functions in order to calculate these ranges. In the next section, we also discuss the sensitiveness of our results to this assumption with the help of ordinal regressions.

>>>>Insert Table 2 here<<<<

Furthermore, in order to check our second hypothesis, we include interaction terms in our regression models between time framing and delay, size and sign effects to gauge whether time framing effects are correlated with these effects. Similar to time framing effects, delay, size and sign effects are also represented by binary dummy variables. The dummy variable for delay effects (*Delay*) assumes the value 0 in the basic scenario and 1 in the delayed scenario.

The dummy for size (sign) effects, *Size* (*Sign*) assumes the value 1 for larger (negative) outcomes and 0 for smaller (positive) outcomes.

As we have mentioned above, there are 178 participants combined in the basic and the delayed scenario and all of them have answered three question sets in their questionnaire which yields three different discounting results for small, negative and large outcomes, respectively. Therefore, we have a sample of 534 observations in our regressions. The outcomes of our regressions are demonstrated in the first column of Table 3 where the standard errors are clustered by participants in order to account for the correlation between the answers of each participant.

>>>>Insert Table 3 here<<<<

The estimates of *Sign* and *Size* are highly significant at a 1 % significance level, but *Delay* is insignificant, as demonstrated in Column (1) of Table 2. This suggests that sign and size effects are also statistically significant in choice tasks with neutral outcome frames, which contradicts Shelley (1993), but is in line with a more recent study of Abdellaoui et al. (2009). Thus, the underlying reasons for these effects are open to further discussion. Moreover, the absence of delay effects indicates that there is no significant difference between decision patterns in the basic and the delayed scenario, i.e. there is no significant present bias, which contradicts other studies pledging the relevance of this bias. However, recently, a body of work has found that decreasing impatience is not as robust as it was previously believed, especially in choice tasks such as ours (Read et al., 2005b; Sayman and Öncüler, 2009).

Now, we want to turn our attention to our main hypotheses. In line with our first hypothesis, the results in Column (1) show that *TimeFraming* is not significant in our interval regression model which disagrees with earlier experiments focusing on framing effects in matching tasks. Choice tasks (neutral outcome frames) thus seem to countervail outcome framing effects.

Yet, the estimate for the interaction term between time framing and outcome sign presents an interesting link between time framing effects and sign effects which conflicts with our second hypothesis. The interaction term *Sign*TimeFraming* is significant at the 5 % level with a positive sign which suggests that differences between discount rates in the speedup and the delay frame are significantly more pronounced for negative outcomes. This result is also consistent with earlier studies investigating outcome framing effects which find that the speedup premium is larger than the delay premium for negative outcomes. Hence, this implies that framing effects cannot be eliminated completely even in neutral (outcome) frames. We discuss this issue in detail in Section 5.

On the other hand, the other interaction terms between delay and time framing or size and time framing are insignificant. To sum up, we have not found strong enough evidence for time framing effects *on average* which agrees so far with our first hypothesis. However, there seems to be some interaction between time framing and sign effects, but not between time framing and the timing or the size of the outcomes. Thus, our results are less affirmative regarding our second hypothesis. In order to elaborate on this correlation between time framing and outcome sign, we now want to analyze time framing effects separately for negative and positive outcomes in the next subsection.

4.2 Time Framing Effects for Different Outcome Signs

The results of our first regression model suggest that Hypothesis 2 can be rejected with respect to the relation between time framing and outcome signs. This implies that although time framing effects are not significant on average, they are correlated with the outcome sign, as the outcome sign seems to affect time preferences differently in the delay and the speedup frame.

This also means that framing effects can be powerful to varying degrees for positive and negative outcomes. Therefore, we want to analyze the significance of time framing effects for different outcome signs separately and for this purpose, we first take a look at the choices in question sets with negative outcomes. The results in Column (2) of Table 3 demonstrate that *TimeFraming* is indeed statistically significant (p = 0.042) and positive when we only analyze preferences for negative outcomes. Thus, our participants are significantly less patient in the speedup frame compared to the delay frame for negative outcomes. In other words, time framing effects are statistically significant for choices involving negative outcomes. Further-more, the interaction between delay and time framing is not significant, implying that time framing effects are equally strong both in the basic and the delayed scenario for negative out-comes. Time framing effects for negative outcomes are also economically significant, as line-ar discount rates are ceteris paribus on average 11.4 percentage points higher in a speedup frame than in a delay frame.

After that, we also analyze results for positive outcomes separately, in a similar fash-ion. Time framing effects are insignificant for positive outcomes. In addition, the interaction between time framing and delay or size effects is not substantial, confirming the results in Column (1) and Column (2).

Summing up, our results are in line with Hypothesis 1, but Hypothesis 2 can be reject-ed to a certain degree. Time framing effects become stronger and significant, as we consider negative outcomes regardless of the timing of the outcomes, which contradicts Hypothesis 2. On the other hand, although time framing effects correlate with the sign of the outcomes, the same relation does not exist between time framing and delay or size effects. These interaction terms are insignificant.

Just like outcome framing effects, time framing effects imply inconsistent behavior, too. Our results allege that decision makers arrive at different decisions in delay and speedup frames for negative outcomes, while this problem is less accentuated for positive outcomes. This suggests that people might hesitate to exercise both early termination and delay options for two identical choice tasks, if they are framed differently.

In order to demonstrate this with an example, we consider a decision problem where it is assumed that a decision maker has an (linear) annual delay discount rate of 6.95 % and (due to higher impatience) an (linear) annual speedup discount rate of 14.25 %, and this individual has to choose between a negative payment of −100 € today or −105 € six months later. Then, in a delay frame, we arrive at $-105/1.0695^{6/12} = -101.353 < -100$ so that the delay option will not be exercised. However, in the speedup frame we have $-105/1.1425^{6/12} = -98.23 > -100$. Consequently, the speedup option will not be exercised, either. In the first situation, the individual will prefer not to delay the payment and end up consuming less today. On the other hand, in the second scenario she chooses not to expedite her payments, and, hence, consumes more today. Therefore, she exhibits inconsistent behavior in delay and speedup frames. Hence, our results revealing different choices in delay and speedup frames imply that decision makers might tend to have a hard time exercising maturity options and this inconsistency is only strong for negative outcomes.

4.3 Discussion

Now we want to further circumstantiate the quality of our results with some robustness tests. For this purpose, we first estimate ordinal logistic regressions instead of interval regressions. Secondly, we also debate the relevance of a potential selection and non-response bias for our results.

4.3.1 Ordinal Regressions

Our original dependent variable consists of eight categories. An ordinal regression is another empirical method to analyze ordinal variables with unknown exact values. Interval regressions allow us to predict the exact value of the dependent variable even when it is censored, while ordinal regressions can only predict the likelihood that a variable falls into one of these eight categories. Therefore, the results of interval regressions are more informative and we prefer interval regressions to ordinal regressions initially. Yet, since we cannot specify the shape of utility functions, we cannot exactly calculate the upper and lower bounds for each category in our example. Due to this problem, the results of ordinal regressions actually are more robust, since this specification becomes irrelevant.

In this case, we have to define our dependent variable as an ordinal variable. We refer to this version of the dependent variable as *Discounting_Ordinal* and it can assume integer values between 1 and 8. Yet, when we use *Discounting_Ordinal* as our dependent variable in ordinal regressions, two assumptions underlying ordinal logistic regressions are violated. First, a simple crosstab analysis shows that there are too many empty or extremely small cells. Another critical assumption of the ordinal logistic regression model is the proportional odds assumption. We find that this assumption is violated, too.

Both of these problems can be solved by reducing the number of categories of our dependent variable. With four categories or more, the proportional odds assumption is still violated, which is why we have to reduce the number of categories to three in ordinal logistic regressions. This is also a reason why we prefer interval regressions to ordinal logistic regressions to begin with.

We only report here the results for the recoding, which we define as “3 Group (3)”. The details for the definitions of the categories can be found in Table 2. In any case, our findings remain qualitatively unchanged for the other category definitions listed in Table 2. Hence, results of the ordinal logistic regressions are also robust with respect to the definition of categories. Moreover, as Table 4 demonstrates, these results are also very similar to the results of the interval regressions and fortify our earlier conclusions.

>>>>Insert Table 4 here<<<<

4.3.2 Robustness Test: Non-Response (Selection) Bias

One possible concern regarding our findings is a potential non-response bias, as only about 10 % of all students who had been contacted eventually participated in our study. Following Armstrong and Overton (1977), we control for this issue by comparing the answers of early and late respondents. We implicitly assume that late respondents should generally be more similar to non-respondents than early respondents. However, we find no significant differences between the choices of these two groups based on χ^2-tests. In particular, neither in the basic nor in the delayed scenario, the null hypothesis that the choices are identical for early and late respondents, can be rejected. Hence, we can rule out a potential selection bias in our experiments.

5. Theoretical Discussion

There are two important findings of our experimental analysis:

- Our results show that choice tasks indeed counteract framing effects to a certain extent, as these effects are not significant on average in neutral frames.

- However, time framing effects are correlated with the outcome sign. Changes in the outcome sign affect the magnitude of time framing effects.

Taken together, these results indicate that the status quo bias can be alleviated, but cannot be eliminated completely in choice tasks. As we have discussed above, previous experimental studies advocate that people edit the outcomes in a way that they only focus on the differences between different alternatives in choice tasks in contrast to matching tasks. Hence, decision makers are likely to segregate the difference between alternatives from the common part in choice task based experiments (Tversky et al., 1990; Ahlbrecht and Weber, 1997). This obviously reduces the impact of the status quo bias resulting from loss aversion, since common parts are evaluated identically in both frames. Only the differences between alternatives are going to be treated differently depending on the framing of the question.

If the difference between alternatives is defined according to time frames, delaying a positive outcome yields an additional return $y–x$ which is the difference between the later payment y and the (smaller) sooner payment x and this is perceived as a gain. In contrast, speeding up a reward results in a reduced payment (from y to x with $x < y$) and this small difference $x–y$ is understood as a loss after canceling out the common part of both alternatives. On the other hand, after a delay, financial obligations will be higher in absolute terms, and this is going to be perceived as an additional loss. In a similar vein, speedups are rewarded with a smaller (absolute) obligation which will be perceived as a gain as well.

Summing up, we think that the intertemporal decision problem for choice tasks in neutral outcome frames can be modeled in the following way in delay and speedup frames, respectively:

$$v(x) \gtreqless \frac{v(y-x)+v(x)}{(1+\rho_d)^t}, \qquad (5)$$

$$v(y) + v(x - y) \gtreqless \frac{v(y)}{(1 + \rho_s)^t}. \tag{6}$$

Clearly, for linear value functions and identical discount rates $\rho_d = \rho_s$ in the delay and the speedup frame, people choose the same option regardless of the framing of the question or time. Yet, experimental studies have demonstrated that value functions are not linear, but s-shaped (convex-concave) with a kink implied by loss aversion (Kahneman and Tversky, 1979; Tversky and Kahneman, 1990). A typical value function with such features is the following one with a loss aversion parameter $\lambda \geq 1$:

$$v(x) = \begin{cases} x^\alpha & (x \geq 0) \\ -\lambda \cdot (-x)^\alpha & (x < 0). \end{cases} \tag{7}$$

It is possible to compute critical values t_d and t_s that equate both sides of (5) and (6):

$$(1 + \rho_d)^{t_d} = \frac{v(y - x) + v(x)}{v(x)}, \tag{8}$$

$$(1 + \rho_s)^{t_s} = \frac{v(y)}{v(y) + v(x - y)}. \tag{9}$$

First assume y, $x > 0$ with $y > x$. A finite positive solution for t_s requires $v(y)+v(x-y) > 0$. In this case, a larger loss aversion parameter implies smaller (negative) values of $v(x-y)$ and thus higher values of t_s in (9) with t_s approaching infinity for $v(y)+v(x-y) \to 0$. On the other hand, loss aversion is irrelevant for t_d, as each term in equation (8) is positive. Therefore, loss aversion leads to ceteris paribus greater differences between t_s and t_d and eventually to $t_s > t_d$, i.e., for positive outcomes people prefer to wait longer in a speedup frame if loss aversion is sufficiently high.

For negative outcomes y, $x < 0$ with $y < x$ and a value function according to (7), the right-hand side of (8) becomes independent of λ, while the right-hand side of (9) is a decreasing function of λ approaching 1 with t_s converging towards zero for increasing loss aversion parameter. Summarizing, an increase in the loss aversion parameter eventually implies $t_d > t_s$ for negative outcomes.

In addition, we may utilize these critical values t_d and t_s to calculate corresponding "linear" discount rates $\rho_d^{(lin)}$ and $\rho_s^{(lin)}$ under the fictitious assumption of linear utility functions. These "linear" discount rates obey the following equations:

$$\frac{y}{\left(1+\rho_d^{(lin)}\right)^{t_d}} = x, \qquad \frac{y}{\left(1+\rho_s^{(lin)}\right)^{t_s}} = x \tag{10}$$

As these critical linear discount rates are negatively correlated with t_d and t_s, we can conclude $\rho_d^{(lin)} > \rho_s^{(lin)}$ for positive and $\rho_d^{(lin)} < \rho_s^{(lin)}$ for negative outcomes. If loss aversion is sufficiently strong, we should therefore observe time framing effects even in our neutral (outcome) frames and even when the decision maker applies the same discount rate for both the delay and the speedup frame ($\rho_d = \rho_s$). However, our experimental study also shows that time framing effects are in fact too small to be statistically significant for positive outcomes which cannot be explained with the arguments until now.

In order to understand the absence of time framing effects for positive outcomes, we need to distinguish between different loss aversion parameters λ^+ and λ^- for positive and negative outcomes. In fact, going back to as far as Thaler (1980), it is clear that decision makers treat out-of-pocket costs and opportunity costs differently and opportunity costs tend to be undervalued compared to out-of-pocket costs. Therefore, we think that the relevant loss aversion parameter is much smaller for the opportunity costs resulting from speeding up positive outcomes compared to the loss aversion parameter for the delay costs y–x for negative outcomes as well as for the original payment obligations, since they constitute out-of-pocket costs. As we discussed above, the differences between $\rho_d^{(lin)}$ and $\rho_s^{(lin)}$ for positive outcomes are driven by the loss aversion parameter of opportunity costs of speeding up positive outcomes and this difference is increasing in the loss aversion parameter. Consequently, if this loss aversion parameter is small, the imputed linear discount rates in the delay and the speedup frame will be less distinguishable.

These general conclusions can also be highlighted by a numerical example. We additionally assume the discount rates ρ to be smaller for negative outcomes in order to justify sign effects, for which there is extensive evidence even after controlling for the shape of utility functions (Abdellaoui et al., 2009). This is also in line with our experimental findings.

To be more precise, for positive outcomes, we have on average a critical value of t that is about two to three months for delay as well as speedup frames in our experimental study. In contrast, for negative outcomes, participants are more patient with a critical value for t_d of about six to nine months in the delay frame and for t_s of about four to six months in the speedup frame.

In order to replicate these results based on (8) and (9), we set α = 0.88 (Kahnemann and Tverksy, 1979) and loss aversion parameters $\lambda^+ = 1$ and $\lambda^- = 2$. Hence, we work with a typical loss aversion parameter for out-of-pocket costs, but assume also that participants exhibit no feeling of loss aversion at all regarding opportunity costs. With these parameters and discount rates $\rho_d = \rho_s = 0.35$ for positive outcomes and $\rho_d = \rho_s = 0.10$ for negative outcomes, we arrive at critical values t_d and t_s (in months) amounting to $t_d = 2.77$ and $t_s = 2.84$ for positive outcomes and to $t_d = 8.71$ and $t_s = 4.40$ for negative outcomes in line with our experimental findings. This numerical example visualizes also clearly that time framing effects are of an extent that is worth to be mentioned only for large loss aversion parameters.

Moreover, these critical values for t_d and t_s correspond to (annual) calculated critical linear discount rates for fictitious linear utility of $\rho_d^{(lin)} = 6.95$ % and $\rho_s^{(lin)} = 14.25$ % for negative outcomes and are hence identical to those discount rates which we have assumed in our numerical example of the preceding section. Corresponding critical discount rates for positive outcomes are $\rho_d^{(lin)} = 23.57$ % and $\rho_s^{(lin)} = 22.87$ % and are thus almost indistinguishable. Such linear discount rates (approximately) in the range between 20 % and 25 % for positive outcomes are also in line with the results of a more comprehensive survey of Andersen et al. (2006). Since Andersen et al. (2006) have also elicited the discount rates in their study with the help of the multiple price list method, this similarity also endorses the quality of our results. To sum up, our model can explain the results in our experiments with reasonable parameter values.

To recap, even when choice tasks can eliminate the status quo bias for the common parts of the alternatives, the perception of the differential amount between sooner and later alternatives depends on the definition of time frames. Therefore, we might observe delay-speedup asymmetries even in neutral (outcome) frames for loss averse investors. However, the time framing effect is not expected to be strong for positive outcomes, since speeding up a receipt causes only opportunity costs which is not connoted with the same negative associations as out-of-pocket costs following delaying payment obligations.

6. Practical Implications of Time Framing Effects

Our results reveal that people exhibit greater consistency in choice tasks and framing effects are less significant. Yet, we observe consistent exercise of delay and speedup options, only for decisions involving positive outcomes. Otherwise, decision makers are prone to errors and make inconsistent decisions even in neutral outcome frames and we describe this inconsistency as time framing effects.

As we have already mentioned, these results are important, because real-life intertemporal tasks resemble choice tasks usually more than matching tasks. Therefore, in this section, we try to verify the applicability of our findings for real-life decisions with the aid of an empirical analysis which addresses households' portfolio decisions.

We can first demonstrate the meaning of our experimental results with the aid of our earlier numerical example. As a starting point, we keep the parameters of the preceding section. This means, we assume $\alpha = 0.88$, $\lambda^{+} = 1$, $\lambda^{-} = 2$, $\rho_d = \rho_s = 0.35$ for positive outcomes and $\rho_d = \rho_s = 0.10$ for negative outcomes. In a choice task with negative outcomes, for an individual with these preference parameters, we observe a personal critical (linear) discount rate of $\rho_s^{(lin)} = 14.25$ % so that speedup options for negative payments will only be exercised for borrowing rates beyond 14.25 %. Similarly, the corresponding critical (linear) personal discount rate $\rho_d^{(lin)}$ amounts to 6.95 % for decisions involving delay options. Only for smaller interest rates, payments will be delayed by taking on a credit. Thus, an individual would exercise neither the delay nor the speedup option embedded in (potential) credits for market interest rates between 6.95 % and 14.25 %. If an individual exercises neither of these options, her answers are clearly inconsistent in different time frames. Analogously, for the same parameters and for positive outcomes, an individual hesitates to exercise both speedup and delay options for market interest rates between 22.87 % and 23.57 %. Hence, (only) for interest rates between 22.87 % and 23.57 %, time framing effects impact an individual's choice. Apparently, we observe a stronger inertia regarding payment obligations, since for given parameters, people forgo both delay and speedup options embedded in payment obligations for a larger interval of market interest rates.

Once again, this example demonstrates that framing effects are not only less significant in choice tasks, but they are also much stronger for negative outcomes. Until now, research has focused on the magnitude of framing effects in intertemporal decisions, but left the question out when framing effects are going to be stronger. The reason for this inattention is probably the fact that previous studies have conducted experiments via matching tasks and this aggravated framing effect. Owing to matching tasks, framing effects were very strong even for positive outcomes in previous experiments (Benzion et al., 1989), although a deviation from the status quo entails only opportunity costs in this case. Since our methodology in general reduced the impact of framing effects, we have been able to observe that the outcome sign also plays an important role for the magnitude of framing effects in intertemporal decisions.

Now, we want to discuss the potential empirical consequences of our theory. As mentioned above, decision makers encounter time framing effects in many decisions. For instance, after an income shock, households have to decide about the optimal consumption stream. In this case, the desired consumption path might deviate from the given income stream, but households can turn to capital markets. For instance, after a positive income shock, if a household wants to consume less than its income in a given period (saver household), it can either invest this difference in deposits which is going to affect household's total assets or it can redeem existing loans which is going to reduce its debt stock. Analogously, borrower households can either raise credits or terminate investments after a negative income shock to reach to the same consumption path. In a related analysis, Gilkeson et al. (1999) found that time deposit portfolios experience early withdrawals at economically significant levels, but they have not contrasted the changes in asset and liability sides with each other.

These transactions have the same influence on the consumption stream and the discounted expected utility in perfect capital markets. Hence, they are perfect substitutes in perfect capital markets with equal lending and borrowing rates. Yet, our numerical example above demonstrates that people are neither going to delay nor expedite their payment obligations for a large range of interest rates, while this status quo bias is effective only for a smaller range in the asset account. Hence, the differences between consumption and income are going to be reflected mainly in the asset account.

In order to demonstrate this, let us assume that borrowing and lending interest rates are both equal to 10 %. In this case, the decision maker of our numerical example with critical linear discount rates of $\rho_s^{(lin)}$ = 14.25 % (speedup options) and of $\rho_d^{(lin)}$ = 6.95 % (delay options) for debt payments is prone to time framing effects, because for an interest rate of 10 % she will – at the same time – neither be willing to repay (existing) debt prematurely nor to postpone debt obligations to the far future. Yet, according to our previous computations, the same household will choose to actively increase current consumption by liquidating (or not prolonging) investments with a 10 % interest rate, since framing effects for positive outcomes are only effective for a smaller range of discount rates.

Hence, the existence of time framing effects entails a more proactive reaction on the asset side and predicts that households experience difficulties exercising delay or speedup options embedded in (potential) credits compared to the same options embedded in investment plans, although these decisions have the same consequences in perfect capital markets. Thus, we state the following hypothesis:

Hypothesis 3: *Changes in the households' net financial position are driven more by changes in total assets than in total liabilities even in perfect capital markets due to time framing effects.*

6.1 Data and Methodology

In order to test this prediction, we need a data set on households' financial wealth which has to be representative of the total population and features a high level of accuracy.

Such a data set on households' total assets and total liabilities in a country is made available by the Economist Intelligence Unit (EIU) World Data panel. The EIU World Data is a panel data set that provides information on the country level about the household population in 54 countries (partially) available for the period between 2003 and 2013 with data for 2012 and 2013 being forecasts.

For our empirical analysis, we use difference in differences (henceforth, DiD) estimators. Obviously, for our analysis, DiD is well suited, as we want to examine the changes in households' liability (control group) and asset accounts (treatment group) for a country *i*, after a change in net financial wealth from year $t-1$ to t. Since we compare the changes in asset and debt accounts in the same country, these changes are perfect substitutes, provided that markets are perfect. Hence, in a perfect capital market, no factor should be able to explain systematically whether households should prefer to raise a new credit or liquidate an asset to adjust consumption.

In order to test our Hypothesis 3 empirically, we disaggregate changes in (US-Dollar denominated) net financial wealth of households, ΔNFW_{it}, into two parts, namely changes in the asset and in the liability account. Hence, for each country *i*, we have two accounts, the total assets and the total liabilities account. The aggregate changes in both accounts make up ΔNFW_{it} in a country *i* for a certain year *t*. The treatment dummy *Asset* assumes the value of 1 for changes in the asset account and the value of 0 for changes in the debt account. Therefore, we get two values for each country-year net financial wealth change. In other words, half of the sample of our dependent variable refers to changes in the asset account and thus coincides with *Asset* = 1, and the other half refers to changes in the debt account where *Asset* takes the value of 0. It should be noted that ΔNFW_{it} is always considered in absolute values, since we compare the amount of value changes in debt or asset accounts and not their signs. Therefore, we work with $|\Delta NFW_{it}|$ instead of ΔNFW_{it} as our dependent variable.

According to our hypothesis, the coefficient for our treatment dummy *Asset* should be positive, as this suggests that changes in net financial wealth, $|\Delta NFW_{it}|$, are mainly driven by changes in the asset account for year t, i.e., if *Asset* assumes the value 1.

In order to control for the correlation between standard errors across country and time, we prefer robust standard errors clustered by both country and time (Petersen, 2009). This method yields estimates robust to the correlation of standard errors in both dimensions and is particularly recommendable for panel data, since this way, we can capture the impact of country- and time-specific factors that might affect our results, such as institutional and legal differences. Moreover, the t-statistics are very conservative in this approach, therefore a validation of our hypothesis would be even more convincing with this method (Thompson, 2011). Since the value range of our dependent variable is limited (non-negative), we have also estimated a Tobit regression again with double clustering as a robustness check. We do not report these results here, since they are completely in line with the findings for ordinary least squares regressions with double-clustered standard errors. Our model is of the following form:

$$|\Delta NFW_{it}| = \alpha + \beta \cdot Asset_{it} + \varepsilon_{it} \tag{11}$$

6.2 Results

As mentioned above, a positive estimate for the regression coefficient β would support our theory, since it suggests that households accumulate or liquidate assets faster than they redeem their loans or take on new debt. Indeed, our t-statistics demonstrate that there is a significant difference between $|\Delta NFW_{it}|$ in the asset and the liability account in favor of the asset side. The DiD estimator for the treatment dummy *Asset* is significantly positive even for this very conservative measure (t-statistic = 3.14, p-value = 0.002). This result is also economically significant: An absolute change in net financial wealth of $ 1 coincides on average with an absolute change of $ 0.7637 in the asset account and of only $ 0.2363 in the liabilities account. Moreover, according to Table 5, we can also reject the null hypothesis that the mean on the asset side is smaller than on the liability side for $|\Delta NFW_i|$ at least at a 6 % level, for each year between 2003 and 2013, separately.

>>>>Insert Table 5 here<<<<

This means that our results are in line with our third hypothesis and show that if the optimal consumption stream deviates from the income stream, these differences concern households' assets more than their liabilities. Thus, households prefer to adjust consumption with the help of asset rebalancing in line with our third hypothesis (see also Gilkeson et al., 1999). This result is also somehow in line with the so-called "refinancing puzzle", an empirical finding demonstrating the reluctance of households to clear their debts earlier and to take on new credit (for the same remaining term of maturity) with more favorable conditions (see Agarwal et al., 2007, for a discussion of the "refinancing puzzle").

6.3 Discussion

Up until here, we have emanated from perfect capital markets and neglected the possibility that capital market frictions may also explain households' portfolio decisions. For instance, lenders might ask for extra payments to dissolve a credit relationship earlier than the maturity date. Similarly, penalties might be attached to liquidating a time deposit before maturity, as well. Therefore, in order to control for the possible impact of these capital market frictions on our results, we repeat our DiD analysis for a subsample of country-years with negative changes in net financial wealth in a certain year (negative ΔNFW_{it}). If the mean for $|\Delta NFW_{it}|$ is larger for the asset side in this subsample, this insinuates that even if households need to decide between taking on new debt and withdrawing their assets before maturity, they prefer to liquidate their assets. Obviously, transaction costs involving this decision would work against that, since households face higher transaction costs and penalties if they want to withdraw their time deposits before maturity. As a consequence, households would be encouraged to take on new debt instead of withdrawing their deposits.

In line with our third hypothesis, we can reject the null hypothesis of equal means at a 5 % level (p-value < 0.001), and the t-statistic (3.65) is even larger for the subsample consisting of negative ΔNFW_{it} again for double-clustered standard errors. Hence, even in periods of negative savings, households prefer to liquidate their assets instead of raising new credits hazarding the resulting penalties, which contradicts the transaction costs story.

However, this result could also be attributed to the credit supply of banks rather than to the credit demand of households. Banks seem to reduce credit supply in crisis times (see e.g., Adrian and Shin, 2010). In this case, households without credit access are obliged to liquidate their assets in order to make the ends meet. Consequently, even with large transaction costs, households are forced to sell assets in crisis times. To account for this alternative explanation for the invalidity of the transaction costs story, we add private lending (credit amount to the private non-financial sector) divided by GDP as a proxy for credit rationing in a certain country in a given year. If the credit supply measured by *Private lending to GDP* is high for the private sector in aggregate, this would imply that households have easier access to credits. If the transaction costs story is valid, after controlling for *Private lending to GDP*, our treatment dummy *Asset* should not remain significant for the subsample with negative ΔNFW.

However, we find that credit rationing cannot explain the preference of households to liquidate assets rather than taking on a new credit, as *Asset* is still significant at a 5 % level after adding *Private lending to GDP* in our regression models (t-statistic = 3.47). Furthermore, we added the interaction term between *Asset* and *Private lending to GDP* in order to see whether the impact of *Asset* is at least significantly diminished for increasing lending opportunities. But the interaction term is not significant either (t-statistic = −0.29), hence we can conclude that our results are driven by household credit demand and not by bank credit supply.

An alternative explanation for this seemingly puzzling decision pattern of households might be the discrepancy between borrowing and lending interest rates. On imperfect capital markets, borrowing rates r_b are usually higher than lending rates r_l for households. Due to higher borrowing interest rates, borrower households might be financially better off terminating their deposits instead of taking out a new loan in periods of negative savings even in the case of transaction costs c (as percentage of initial capital) for premature liquidation. This means we may explain our empirical finding for the subset of negative values of negative ΔNFW_{it} by cost-earnings considerations with $r_b > r_l + c$.

In practice, c is the compensation of a household's contractual partner for searching a new creditor or a new debtor as a substitute for the withdrawing household under possibly less favorable conditions due to changes in current market interest rates. This means that for stationary interest rate processes over time, one may reasonably assume similar average transaction costs c for premature liquidation of assets and liabilities. As a consequence, if $r_b > r_l + c$ for negative ΔNFW_{it}, the difference between borrowing and lending interest rates is a bigger concern than penalties involving exercising call options for liabilities, too. This would imply that households would also prefer to redeem their loans earlier instead of tying up their money elsewhere for investment purposes in periods of positive savings ($\Delta NFW_{it} > 0$).

To check the relevance of this theory, we calculate DiD estimators for *Asset*, this time for the subsample of country-years with $\Delta NFW_{it} > 0$. Again, we find that saver households prefer to invest their savings in their deposits rather than to pay down debt with them (t-value = 3.21 with double-clustered standard errors, p-value = 0.001). Hence, the discrepancy between lending and borrowing interest rates cannot explain our results for this subsample. More formally, our empirical results for positive values of ΔNFW_{it} would require a cost-earnings consideration with $r_b - c < r_l$. This apparently contradicts our previous finding concerning the subset for negative values of ΔNFW_{it} which requires $r_b > r_l + c$.

To sum up, neither the transaction costs nor the uneven interest rate story can accommodate the fact that both saver and lender households choose to forgo the options embedded in their credit agreements rather than in their investment plans. However, our time framing story can explain our findings in both sides, since it conjectures that if the income stream is not identical with the preferred consumption stream, these differences are reflected in the asset account.

7. Conclusion

We can now sum up the findings of our paper briefly. Our main purpose is to explore framing effects in choice tasks with neutral (outcome) frames. It is easy to imagine that decision makers encounter such decision tasks more often than matching tasks; still experimental studies have ignored this more realistic setting before our study. With our experiment, we are able to compare subjective discount rates in the delay and the speedup frame in choice tasks. We reveal that framing effects are still at work to a certain extent even in this setting and we refer to this specific form of framing effects as time framing effects. Moreover, we observe that framing effects are only relevant for negative outcomes.

In order to explain this correlation between framing effects and outcome sign, we have developed a theory based on the different perception of out-of-pocket and opportunity costs. As a result of their different treatment, the opportunity costs incurred by speeding up a gain do not disturb decision makers as much as costs incurred by delaying a loss. For this reason, exercising options related to positive outcomes becomes less difficult than exercising options related to negative outcomes for decision makers.

Since we argue that choice tasks are more likely to be encountered in real-life decisions than willingness-to-pay tasks, we expect our results regarding time framing effects to bear also practical implications. A general aversion to exercise options involving transactions with negative cash flows implies that people prefer to adjust their consumption by dipping into their savings or by accumulating wealth. We have been able to find supporting empirical evidence for this prediction which cannot be explained with the aid of other market imperfections.

Summarizing, our paper contributes to the existing literature both in the field of household finance and in the field of experimental economics. First, we have conducted an experiment investigating framing effects in intertemporal decisions in a much more realistic setting using choice tasks. The result of this experiment helped us to identify and to explain a very interesting puzzle regarding households' borrowing and lending behavior. Furthermore, our empirical analysis of household behavior is to our knowledge the first one to explore the influence of framing effects in intertemporal decisions empirically, although the first experimental evidence in this regard goes back to Loewenstein (1988).

References

Abdellaoui, M., Attema, A., Bleichrodt, H. (2009) Intertemporal tradeoffs for gains and losses: An experimental measurement of discounted utility. Economic Journal 120, 845-866.

Adrian, T. Shin, H.S. (2010) Liquidity and leverage. Journal of Financial Intermediation 19, 418-437.

Agarwal, S., Driscoll, J.C., Laibson, D. (2007) Optimal mortgage refinancing: A closed form solution. Unpublished working paper.

Ahlbrecht, M., Weber, M. (1997) An empirical study on intertemporal decision making under risk. Management Science 43, 813-826.

Andersen, S., Harrison, G.W., Lau, M.I., Rutström, E.E. (2006) Elicitation using multiple price list formats. Experimental Economics 9, 383-405.

Armstrong, J.S., Overton, T.S. (1977) Estimating nonresponse bias in mail surveys. Journal of Marketing Research 14, 396-402.

Benzion, U., Rapoport, A., Yagil, J., (1989) Discount rates inferred decisions: An experimental study. Management Science 35, 270-284.

Coller, M., Williams, M.B. (1999) Eliciting individual discount rates. Experimental Economics 2, 107-127.

Frederick, S. (2006) Valuing future life and future lives: A framework for understanding discounting. Journal of Economic Psychology 27, 667-680.

Frederick, S., Loewenstein, G., O'Donoghue, T. (2002) Time discounting and time preference: A critical review. Journal of Economic Literature 40, 351-401.

Gilkeson, J.H., List, J.A., Ruff, C.K. (1999) Evidence of Early Withdrawal in Time Deposit Portfolios. Journal of Financial Services Research 15, 103-122.

Harrison, G.W, Llau M., Williams M.B. (2002) Estimating individual discount rates in Denmark: A field experiment. American Economic Review 92, 1606-1617.

Kahneman, D.,Tversky, A. (1979) Prospect theory: An analysis of decision under risk. Econometrica 47, 263-291.

Lichtenstein, S., Slovic P. (1971) Reversals of preference between bids and choices in gambling decisions. Journal of Experimental Psychology 89, 46-55.

Loewenstein, G. (1988) Frames of mind in intertemporal choice. Management Science 34, 200-214.

Loewenstein, G., Prelec, D. (1992) Anomalies in Intertemporal Choice: Evidence and an Interpretation. Quarterly Journal of Economics 107, 573-597.

Matsumoto, D., Peecher, M.E., Rich, J.S. (2000). Evaluations of outcome sequences. Organizational Behavior and Human Decision Processes 83, 331-352.

Onculer, A., Onay, S. (2007) Intertemporal choice under timing risk: An Experimental Approach. Journal of Risk and Uncertainty 34, 99-121.

Petersen, M.A. (2009) Estimating standard errors in finance panel data sets: Comparing approaches. Review of Financial Studies 22, 435-480.

Read, D., Airoldi, M., Loewe, G. (2005) Intertemporal tradeoff priced in interest rates and amounts: A study of method variance. Unpublished working paper.

Read, D., Frederick S., Orsel, B., Rahman, J. (2005) Four Score and Seven Years from Now: The Date/Delay Effect in Temporal Discounting. Management Science 51, 1326-1335.

Sayman, S., Onculer, A. (2009) An investigation of time inconsistency. Management Science 55, 470-482.

Shefrin, H. H., Thaler, R. H. (1988) The behavioral life-cycle hypothesis. Economic Inquiry 26, 609-643.

Shelley, M. (1993) Outcome signs, question frames and discount rates. Management Science 39, 806-815.

Thaler, R.H. (1980) Toward a positive theory of consumer choice. Journal of Economic Behavior and Organization 1, 39-60.
Thaler, R.H., Johnson, E.J. (1990) Gambling with the house money and trying to break even: The effects of prior outcomes on risky choice. Management Science 36, 643-660.
Thompson, S.B. (2011) Simple formulas for standard errors that cluster by both firm and time. Journal of Financial Economics 99, 1-10.
Tversky, A., Slovic, P., Kahneman, D. (1990) The causes of preference reversal. The American Economic Review 80, 204-217.

Table I. Summary statistics for the demographic variables in our regression model

Dummy variables are utilized to describe participants' gender (male = 0, female = 1) and major (non-economics students = 0, economics students = 1), while age is represented by an integer characterizing the age of participants. In the basic scenario, the sooner of the two eligible outcomes is to be received immediately, in the delayed scenario the sooner of the two eligible outcomes is to be received three months later.

Variable	Mean	S.D.	Median	N
Basic Scenario				
All Answers				
Gender	0.23	0.42	0	121
Age	21.60	2.39	21	121
Major	0.81	0.39	1	121
Consistent Answers				
Gender	0.24	0.43	0	100
Age	21.69	2.52	21	100
Major	0.80	0.40	1	100
Delayed Scenario				
All Answers				
Gender	0.32	0.47	0	108
Age	23.54	2.51	23	108
Major	0.71	0.45	1	108
Consistent Answers				
Gender	0.36	0.48	0	78
Age	23.44	2.43	23	78
Major	0.74	0.44	1	78

Table II. Coding of subjective discount rates in different ways

$\rho^{(lin)}$ stands for a participant's subjective "linear" discount rate computed under the fictitious assumption of a linear value function.

	No Grouping	3 Groups (1)	3 Groups (2)	3 Groups (3)
Group 1	0 % < $\rho^{(lin)}$ < 5 %	0 % < $\rho^{(lin)}$ < 16 %	0 % < $\rho^{(lin)}$ < 10 %	0 % < $\rho^{(lin)}$ < 10 %
Group 2	5 % < $\rho^{(lin)}$ < 7 %	16 % < $\rho^{(lin)}$ < 34 %	10 % < $\rho^{(lin)}$ < 22 %	10 % < $\rho^{(lin)}$ < 34 %
Group 3	7 % < $\rho^{(lin)}$ < 10 %	34 % < $\rho^{(lin)}$	22 % < $\rho^{(lin)}$	34 % < $\rho^{(lin)}$
Group 4	10 % < $\rho^{(lin)}$ < 16 %			
Group 5	16 % < $\rho^{(lin)}$ < 22 %			
Group 6	22 % < $\rho^{(lin)}$ < 34 %			
Group 7	34 % < $\rho^{(lin)}$ < 80 %			
Group 8	80 % < $\rho^{(lin)}$			

Table III. Results of the interval regressions

This table presents the results of interval regressions of the subjective discount rates on various independent variables combining the answers of the basic and the delayed scenario. *TimeFraming* is a binary dummy variable assuming the value of 1 for the speedup frame and a value of 0 for the delay frame. *Delay, Size*, and *Sign* are additional binary dummy variables characterizing the delayed scenario, large outcomes, or negative outcomes, respectively. Cluster adjusted *z*-values are reported below the regression coefficients. *** $p \leq 1$ %, ** $p \leq 5$ %, * $p \leq 10$ %.

Independent Variables	(1) All Outcomes	(2) Only Negative	(3) Only Positive
Delay	0.070	*0.145*	0.029
	1.18	*2.23***	0.41
Size	*-0.188*		*-0.189*
	*-6.31****		*-6.31****
Sign	*-0.319*		
	*-7.83****		
TimeFraming	-0.039	*0.114*	-0.054
	-0.61	*2.03***	-0.81
*Delay*TimeFraming*	-0.027	-0.095	0.010
	-0.30	-0.88	0.09
*Size*TimeFraming*	0.002		0.002
	0.05		0.05
*Sign*TimeFraming*	*0.128*		
	*2.24***		
Gender	-0.018	-0.039	-0.008
	-0.39	-0.65	-0.14
Age	0.006	0.009	0.005
	0.66	0.95	0.37
Major	*0.101*	*0.127*	0.087
	*1.73**	*2.11***	1.17
Constant	0.305	-0.132	0.370
	1.29	-0.55	1.19
Likelihood-Ratio χ^2	119.53	73.80	16.91
	0.000***	0.000***	0.010***
Observations	534	178	356

Table IV. Results of the ordinal logistic regressions

This table presents ordinal logistic regression results of the subjective discount rate (with three categories) on various independent variables combining the answers of the basic and the delayed scenario. *TimeFraming* is a binary dummy variable with a value of 1 for the speedup frame and a value of 0 for the delay frame. *Delay, Size*, and *Sign* are additional binary dummy variables characterizing the delayed scenario, large outcomes, or negative outcomes, respectively. Cluster adjusted *z*-values are reported below the regression coefficients. *** $p \leq 1$ %, ** $p \leq 5$ %, * $p \leq 10$ %.

Independent Variables	(1) All Outcomes	(2) Only Negative	(3) Only Positive
Delay	0.231	*0.837*	-0.061
	0.68	*2.03***	-0.15
Size	*-1.012*		*-1.045*
	*-6.20****		*-6.20****
Sign	*-2.100*		
	*-8.10****		
TimeFraming	-0.310	*0.777*	-0.409
	-0.90	*2.11***	-1.12
*Delay*TimeFraming*	-0.284	-0.860	-0.010
	-0.59	-1.41	-0.02
*Size*TimeFraming*	-0.054		-0.070
	-0.23		-0.29
*Sign*TimeFraming*	0.924		
	2.69***		
Gender	-0.150	*-0.706*	0.105
	-0.57	*-1.82**	0.35
Age	0.012	0.056	-0.009
	0.19	0.96	-0.11
Major	*0.631*	*0.961*	0.486
	*1.99***	*2.36***	1.26
Likelihood-Ratio χ^2	*122.52*	*15.17*	*73.25*
	*0.000****	*0.019***	*0.000****
Pseudo R^2	0.070	0.041	0.047
Observations	534	178	356

Table V. Univariate analysis of changes in households' net financial wealth

This table presents the results of *t*-statistics (accounting for unequal variances) for the null hypothesis that the mean value of changes $|\Delta NFWit|$ in households' net financial wealth is smaller for the asset side than for the liabilities side. *p*-values are below the *t*-statistics. *** $p \leq 1$ %, ** $p \leq 5$ %, * $p \leq 10$ %.

Year	Dif < 0
2003	*1.954*
	*0.028***
2004	*1.684*
	*0.049***
2005	1.633
	0.054*
2006	*2.127*
	*0.019***
2007	*2.313*
	*0.012***
2008	*1.861*
	*0.034***
2009	1.524
	0.067*
2010	*1.661*
	*0.051**
2011	*1.900*
	*0.031***
2012	*1.870*
	*0.033***
2013	*1.763*
	*0.041***

Size Effects and Implications for P2P Credit Markets

Wolfgang Breuer, K. Can Soypak

Abstract. Previous literature has shown that in choice tasks with disclosed effective interest rates, some discounting anomalies such as hyperbolic discounting might disappear. In the following paper, we show that another discounting anomaly called size effect is still persistent in a similar experimental task. Subsequently, we discuss the empirical implications of our experiments for decisions in internet credit markets for the example of Germany where the decision tasks resemble our experimental tasks to a very large degree. This also provides first evidence regarding the empirical implications of the size effect.

JEL classification: D91, G02, G12

Keywords: credit spreads, online credit markets, discounting anomalies, experimental economics.

We would like to thank Victoria Galsband, and seminar participants at the INFINITI Conference on International Finance in Aix-en-Provence 2013. Of course, all remaining errors are our own.

Size Effects and Implications for P2P Credit Markets

Abstract. Previous literature has shown that in choice tasks with disclosed effective interest rates, some discounting anomalies such as hyperbolic discounting might disappear. In the following paper, we show that another discounting anomaly called size effect is still persistent in a similar experimental task. Subsequently, we discuss the empirical implications of our experiments for decisions in internet credit markets for the example of Germany where the decision tasks resemble our experimental tasks to a very large degree. This also provides first evidence regarding the empirical implications of the size effect.

Keywords: credit spreads, online credit markets, discounting anomalies, experimental economics.

JEL classification: D91, G02, G12.

1. Introduction

According to traditional neoclassical theories, decision makers are forward-looking and they maximize the aggregate lifetime utility in intertemporal decision settings using backwards induction (Samuelson, 1937; Samuelson, 1969). Time preferences are very decisive to solve such problems, since they determine the weight given to future utility compared to today's utility.

Therefore, it is essential to define discounting functions and discounting behavior in order to understand how investors determine their consumption path (Shefrin and Thaler, 1988). For this reason, it is not very surprising that numerous researchers have attempted to identify the shape and the determinants of discounting functions both with the help of experimental studies (see e.g., Thaler, 1980; Kirby and Herrnstein, 1995; Andersen et al., 2006) and field studies (see e.g., Hausman, 1979; Viscussi and Moore, 1989; Warner and Pleeter, 2000).

In experimental studies, which are designed to explore the discount rates, the subjects mostly have to choose between two mutually exclusive (predefined) monetary outcomes (Example: 100 € today or 102.47 € in 6 months) and the implicit interest rate between the sooner and later alternatives (for our example: 5%) is not revealed by experimenters. These experiments sometimes even work deliberately with complicated numbers to make it difficult for the participants to calculate the interest rates on their own. As a result, the elicited discount rates are usually unrealistically large, which exceed 100% in some scenarios (see Frederick et al., 2002, for a review). On the other hand, when disclosing the internal interest rates of alternative payments, personal discount rates assume smaller and more realistic values (Coller and Williams, 1999; Harrison et al., 2002; Andersen et al., 2006). In the rest of this paper, we refer to the former question frame as the money frame and the latter question frame as the interest rate frame, respectively.

Although there has been only a handful of attempts to investigate time preferences in the interest rate frame, Read et al. (2005) demonstrate further that besides the magnitude of discount rates, time discounting functions exhibit a generally different shape if effective interest rates are disclosed. Their experimental results have been able to reject the prevalence of hyperbolic discounting functions in interest rate frames. Furthermore, again in contradiction with other studies utilizing money frames (see e.g., Read and Roelofsma, 2003), they have found evidence for reversed interval effects. This means that discount rates are not larger, but smaller if the delay between sooner and later outcomes is divided into subintervals.

These differences between discounting functions in experiments utilizing different frames frame can be attributed to the obvious simplicity of the decision tasks in interest rate frames due to disclosure of effective interest rates. In interest rate frames, the participants are not obliged to calculate the present value of a later outcome themselves. Clearly, this would help participants to avoid miscalculations and increases the likelihood that the answers in such experiments reveal actual preferences much better. As previous studies witness, the complexity of the discounting/compounding principle might lead to mistakes (see e.g., Stango and Zinman, 2009). Hence, we can argue that discounting anomalies such as excessive discounting or hyperbolic discounting arise from simple miscalculations, as well.

Other discounting anomalies might also be traced back to the inability of individuals to work with exponential functions. The size effect poses such an example. It refers to the experimental evidence showing that discount rates are decreasing in outcome size. Considering the degree of difficulty to discount or compound numbers exponentially, decision makers are bound to make mistakes without calculators in simple experimental settings. Instead, revealing the effective interest rate between two alternatives, we can avoid these mistakes and eliminate size effects if these are due to miscalculations.

Yet, there are also alternative theories that can entail size effects. For instance, Benzion et al., (1989) advocate in their paper that individuals solve intertemporal decision problems based on a heuristic, which they refer to as the added compensation approach. According to this theory, an individual asks for compensation (is willing to pay a premium) if he is requested to delay (expedite) consumption. This amount, which the authors refer to as the added compensation component is fixed and independent of the underlying question. Hence, with this additional fixed amount, the relation between the sooner smaller (x) and the equally attractive later larger reward (y) is going to look as follows:

$$v(y) \cdot \varphi(t) = v(x) + B. \quad (1)$$

B is the fixed amount required to delay the rewards or the payments and it is positive if $x > 0$ (delaying a receipt) and negative otherwise. $\varphi(t)$ is the discounting function that decision makers use to compare the later outcomes with the sooner outcomes. If that approach describes the discounting process more accurately, it can also entail size effects even when miscalculations are avoided, as we show later. Thus, we would expect to observe size effects even in interest rate frames. Therefore, with our new experimental design, we can also seek validation for the added compensation approach.

Furthermore, the practical relevance of interest rate frames is another reason, why it is essential to understand time preferences in this setting. Intertemporal decisions are presented to decision makers in interest rate frames more often than not in real life. It is easy to imagine that the borrowers compare the effective interest rates of different loan agreements, rather than their annuities. In some countries, including Germany, it is even obligatory for the financial institutions to inform investors (creditors) about the effective interest rates of their time deposits (loans).

We also investigate the practical relevance of our experimental results in interest rate frames, since we argue that we are more likely to be encounter this question type in real life decisions. For this purpose, we investigate the relationship between credit spreads and credit size for the borrowing applications listed on the German peer-to-peer (henceforth, P2P) lending platform "Smava". We focus on electronic credit markets, since both parties involved are more likely to be less informed naïve investors in such transactions who are more prone to discounting anomalies. In traditional lending relationships involving sophisticated financial institutions (like banks or other financial intermediaries), standard mathematical formulas are utilized more often than rule of thumbs (Barber et al., 2009; Chiang et al., 2011). Moreover, as we discuss later, the decision problems in online credit markets resemble the question types in our interest rate frame almost perfectly.

In sum, repeating the usual intertemporal decision experiments in an interest rate frame can help us gain more insight about time preferences and the underlying principles of time discounting. This way, we can also question the accuracy of added compensation approach (Benzion et al., 1989) and whether a fix premium is involved in intertemporal tradeoffs besides the discounting component. The fact that discounting anomalies like hyperbolic discounting cannot be reproduced in interest rate frames has motivated us to put size effects in this setting in perspective as well. Moreover, interest rate frames are worthy of being investigated, as they can replicate actual choice tasks in real life much better and we query the relevance of our experimental findings for actual decision process with the help of an empirical analysis.

We start our paper by contrasting the possible explanations for the size effect. In Section 3, we investigate these contrasting hypotheses with the help of an experiment and evaluate the results of our experiments. In Section 4, we seek empirical support for our findings focusing on loan requests carried out on the internet credit platform “Smava”. Section 5 concludes.

2. Hypothesis Development

The size effect is one of the first discounting anomalies which was discussed in experimental studies. Simply put, it describes the tendency of decision makers to wait more patiently for larger outcomes. Thaler (1981) was the first researcher who illustrated the effects of the outcome magnitude on intertemporal decisions. After that, different studies have confirmed these results repeatedly and the size effect is considered to be a very robust phenomenon (Frederick et al. 2002, for a review).

Like we mentioned above, there are two potential explanations for size effects that we like to contrast here. Either size effects are due to miscalculations of present value of the later larger outcome in the money frame or the simple discounting concept advocated by Samuelson (1937) is not completely accurate to describe the decision making process in intertemporal decisions.

In choice tasks formulated in the money frame, decision makers are required to calculate the present value later outcomes to compare this with the present value of the sooner alternative. On the other hand, in the interest rate frame, effective interest rates are already given and decision maker can simply compare this rate with her own subjective discount rate to make her decision. Therefore, we argue:

Hypothesis 1a: *Size effects disappear in the interest rate frame, since true effective interest rates are given and potential present value miscalculations are avoided.*

Yet, if decision makers act according to the added compensation approach, the size effect should be present even in the interest rate frame. The added compensation premium is more important in decisions involving smaller outcomes, since the magnitude of this component is not related to the outcome size according to Benzion et al. (1989). Hence, assuming (1) holds, for $\alpha > 1$:

$$v(\alpha \cdot y) \cdot \varphi(t) > v(\alpha \cdot x) + B. \quad (2)$$

Even if discounting functions are not related to the magnitude of the outcome and $v(\alpha \cdot y)/v(\alpha \cdot x) = v(y)/v(x)$ (Kahneman and Tversky, 1979), the later larger reward becomes more attractive if both outcomes are multiplied with the same factor. As a result, added compensation approach implies:

Hypothesis 1b: *Size effects are significant even in the interest rate frame, since the comparisons between the sooner and the later outcome involve an added compensation premium.*

3. Experiment

In the previous two sections, we have discussed the potential importance of an interest rate frame especially concerning its influence on discounting anomalies. The primary focus of this paper is on the size effect, since this has not been investigated in an interest rate frame unlike other discounting anomalies such as hyperbolic discounting or interval effects.

3.1 Design

At the beginning of the experiment, we have informed as many students as possible (probably more than 2,000 students) via the online learning portals of different courses of RWTH Aachen University and via e-mail newsletters of student unions about our online survey. The survey was accessible for all students. Overall, 231 students have responded. In order to assure that each student participates in the questionnaire only once, each participant had to register with an e-mail account with RWTH domain. After the completion of the questionnaire, each participant received an e-mail sent to their registered account, which they had to confirm; otherwise the respective answers were not evaluated. This confirmation was also necessary in order to participate in the raffle which rewarded the winners with 3 iPods. We eliminated participants who have not confirmed their identity. After that, we are left with 222 students in our sample. Furthermore, we have excluded from our analysis about 3 % of all answers that revealed unrealistic discount rates larger than 100 %.

In order to analyze size effects, we requested each participant to make a decision between two alternatives in each question set. Participants are assigned to one of three potential groups. In each group, participants are requested to answer identical questions, which differed only in outcome size of the sooner outcome (14 €, 390 €, 7700 €). Moreover, we have one additional group which had to answer same questions for two different outcome magnitudes (14 € and 390 €). With this group, we want to control the existence of size effects for within subject designs.

For each group, we have questions with different delays to sooner outcomes (sooner outcome is delayed one year or is to obtained immediately) or with larger time intervals between the sooner and the later alternative (2 years instead of 1 year). Hence, each participant in the first three groups had to answer three questions, while subjects in the fourth group had to provide answers for six relatively similar intertemporal choice tasks. Choice tasks with different delays and interval lengths makes it possible to control whether our results are in agreement with the earlier results of Read et al. (2005). Delaying the sooner alternative and increasing the interval length allows us to analyse hyperbolic discounting and interval effects, respectively. Moreover, this will also enable us to control for size effects in different scenarios.

As mentioned above, the questionnaires consist of choice tasks where subjects have to decide between a later larger and a sooner smaller alternative, while the personal discount rate is determined by using iterative multiple price list method which will also alleviate anchoring effects, i.e., decision makers' tendency to rely too heavily on the first piece of information offered (Frederick et al., 2002; Andersen et al., 2006). Moreover, we want to make sure that the participants understand the concept of compound interest. For this purpose, we start the experiment with an example. In this example, we explain how compounding principle works and what different annual interest rates yield for different maturities. After that, students start with the questionnaire and our iterative multiple price list tasks have the following basic form in general:

In the following questions you assume the role of an employee who earned a bonus payment for his dedicated work. You can receive this bonus in two different ways. Which alternative would you choose?

a) 390 € today,

b) Investing 390 € today in a corporate bond for a year for a yearly interest rate of 10%.

c) I am indifferent between these alternatives.

Depending on the answer provided by the participant, in the next question, we are going to increase or decrease the interest rate, until the participant chooses option c) or the tolerance interval for the lower and upper bound of personal discount rates falls within 1.25 %. Moreover, we warn our subjects that both the early and later alternative is to be received with certainty, in order to counteract the perception that future outcomes are inherently uncertain (Halevy, 2008). Obviously, this issue is going to be a major problem for larger outcomes rather than for smaller outcomes (in our example for 7700 € rather than for 14 €) and therefore, this perception should work against the size effect.

We have also asked our participants for some demographic information. Table 1 presents some descriptive statistics regarding demographics of our participants. We have utilized binary dummy variables to record participants' gender (*Gender;* male = 1, female = 0) and major (*Major*; non-economics students = 0, economics students = 1), while age (*Age*) is measured by integers describing the age of participants in years.

>>>>*Insert Table 1 here*<<<<

3.2. Results

We now want to discuss the results of our experiments. As we have mentioned already, the main purpose of this experiment is to investigate size effects and we contrast the contradicting explanations for size effects.

In an interest rate frame, participants do not need to rely on their math skills to calculate the present value of the delayed alternatives, as effective interest rates are already disclosed. Therefore, we have stated in our null hypothesis H1a that size effects might be avoided in an interest rate frame. However, our univariate analysis disagrees with this prediction. We have employed both parametric (Welch and Brown-Forsythe tests, p-value < 0.001 for both tests) and non-parametric tests (Kruskal-Wallis, p-value < 0.001) for the answers in the first three groups and results show that the discount rates are decreasing in outcome size. Our dependent variable is the mid-point of the interest rate tolerance interval that we have elicited with our titration procedure, denoted as *Interest Rate*. Since *Interest Rate* has a tolerance interval of 1.25 %, we have a margin of error of plus/minus 0.625 %, which is negligible.

Moreover, we also performed a paired-samples t-test for the last group that answered two question sets with two different outcome magnitudes. This way, we can control whether our results can be confirmed if we analyze the size effect eliminating the potential impact of other characteristic differences that cannot be controlled for in a between subjects design. The equality of discount rates can be rejected here at a 1 % level as well (t-statistic = −3.700, p-value <0.001). This result can also be confirmed with a non-parametric Wilcoxon signed rank test (Z-statistic = −3.884, p-value <0.001). Hence, parametric and non-parametric univariate tests for independent or paired samples reject our null hypothesis H1a. In other words, miscalculations do not seem to be responsible for size effects alone and we observe size effects in a systematical manner in interest rate frames as well.

Still, for experiments utilizing between subjects design, we have to account for demographic factors (Harrison et al., 2002), although paired-samples tests can rule out that these differences are responsible for our results. Hence, in the next step, we also carry out a multivariate test where we control for the demographic factors that we have mentioned above in addition to other discounting anomalies. Since we want to detect size effects, the main variable of interest is the size of underlying outcomes in a question set. As the outcome size can assume three different values, we need to use two category dummies, *Size1 and Size2*. Hence, *Size1* (*Size2*) assumes the value1, if the sooner smaller outcome is worth 390 € (7700 €), otherwise it assumes the value zero.

We have already defined the demographic factors that we intended to analyze in the previous section: *Gender*, *Age* and *Major*. In addition, we analyze hyperbolic (sooner alternative is to be received immediately or a year later) and subadditive discounting (different interval lengths) using dummy variables as well. This way, we can investigate all discounting anomalies simultaneously in interest rate frame. Since we only have two different delays and interval lengths, dummy coding requires only one variable for each. *Interval* assumes the value 1 for longer intervals (two years) and 0 for shorter intervals (one year). Similarly, *Delay* is coded with 1, if the sooner outcome is delayed and coded with 0 otherwise. *Interval* and *De-*

lay allows us to examine interval effects and hyperbolic discounting in interest rate frames as well (Read and Roelofsma, 2003; Read et al., 2005).

Our multivariate linear regressions with robust standard errors clustered by participants affirm our univariate tests. The results are reported in Table 2. Both *Size1 and Size2* are significant at the 1 % level with negative signs even after controlling for other discounting anomalies and demographic factors. Moreover, the estimate for *Size2* is larger than the estimate for *Size1*. Hence, we have found evidence for size effects in interest rate frames in our multivariate analysis as well. In sum, we cannot reject H1b neither with univariate nor with multivariate tests and this implies that simple miscalculations cannot solely explain size effects. On the other hand, added compensation approach seems to describe the actual discounting process better than Samuelson (1937).

Furthermore, we observe a reversed interval effect, as a positive and significant estimate for *Interval* indicates larger yearly discount rates for undivided intervals. This result is in line with the previous results of Read et al. (2005). Moreover, *Delay* has a negative and significant impact on discount rates. Hence, unlike Read et al. (2005), our experiment confirms hyperbolic discounting in an interest rate frame. This may be due to our more comprehensive empirical analysis, as Read et al. (2005) only rely on comparisons of median discount rates in different groups. Furthermore, no demographic variable seems to play a major role with respect to time preferences.

Lastly, we wanted to remove concerns regarding a potential non-response bias, as only about 10 % of all students who we have contacted participated in our study. Armstrong and Overton (1977) argue that in the case of a non-response bias, late respondents' answers should also be biased and more similar to non-respondents'. We classify half of our participants as early respondents and the other half as late respondents depending on the time they start answering our questionnaire. We find no significant differences between the choices of these two groups based on Mann-Whitney-tests (p-value = 0.818). Thus, we can rule out a potential selection bias in our experiments.

>>>> *Insert Table 2 here*<<<<

4. Empirical Analysis

As we have stressed above, we believe that the interest rate frame is encountered in real life decisions more often. We value this as one of the strengths of our experiment, since this would imply that our results should explain choice patterns in actual intertemporal decisions better which is the main goal of any experimental work. Now, we seek support for this claim with the help of an empirical analysis.

We investigate in our empirical analysis the relation between the credit spread and the credit size (size effects) in the lending platform "Smava". Theoretically, credit size is not a risk factor on its own and, therefore, it should not be correlated with credit spreads. Indirectly, larger credits are going to increase the level of indebtedness of a household. This justifies a positive correlation between credit size and credit spread. Yet, we have to admit that this relation is far from being conclusive, since there might be a selection bias, as richer households are more likely to raise larger credits. However, there is absolutely no reason to believe that we should observe a negative correlation between credit size and credit spreads even under uncertainty in P2P markets. Hence, if we observe a negative relationship between credit spreads and credit amount, it is safe to infer that this is a consequence of the discounting anomaly, size effects, as we discuss later.

The reasons why we choose P2P lending markets rather than corporate bonds markets for our analysis are twofold. First of all, borrowers and lenders are more likely to be unsophisticated investors in P2P markets. Conversely, institutional investors dominate the bond markets. Since naïve investors apply usually heuristics for complex decisions, while institutional investors or banks prefer to work with standardized solutions, naïve investors are more prone to decision anomalies. For this reason, the P2P credit market participants are more interesting subjects for our analysis.

Secondly, Longstaff et al. (2005) revealed a negative relationship between the principal amount of the credit and credit spreads in corporate bond markets as well, and they attributed this result to higher bond liquidity for larger issue sizes. Hence, in corporate bond markets, we cannot distinguish between liquidity and boundedly rational investor stories, if we observe a negative correlation between credit issue size and credit spread. However, the liquidity argument does not apply to internet banking platforms, since we do not have secondary market for P2P credits. Therefore, the relation between credit size and credit spreads can be indisputably attributed to size effects in our analysis.

In addition to that, the framing of the borrowing/lending decision in P2P platforms resembles the decision problem of our experiments very much. A loan application in the P2P lending market "Smava" looks as follows: First, a potential borrower submits a loan application for a certain amount of money and also sets the interest rate along way, which is nonnegotiable. After that, all members of the credit platform are notified about this loan application and each can decide whether they want to contribute to this project and how much they want to contribute. Hence, both the borrower and the lender make their decisions based on the provided information regarding interest rates and not the annuity payments. Thus, the framework of the lending or borrowing decisions resembles the interest rate frame more than the money frame in P2P credit markets.

In sum, P2P credit markets are better suited to analyze the impact of size effects in real life decisions compared to bond markets. Before we start presenting our results, we want to elaborate on the theoretical determinants of the credit spread.

4.1 Literature Review: Theoretical Determinants of Credit Spread

According to standard theoretical bond pricing literature, the value of a debt claim is defined through its contractual cash flows, which is discounted by an appropriate risk-free rate based on the risk-neutral measures (Merton, 1974, Cox and Ross, 1976). The difference between the interest rate on the debt claim and this risk-free rate is defined as the credit spread. Thus, credit spreads are a function of the probability of default and the expected recovery rate.

The existing literature has discussed the role of several macroeconomic and firm-specific factors on the default probability and recovery rate. For instance, Longstaff and Schwartz (1995) demonstrated that a higher risk-free interest rate increases the drift in the risk-neutral process for the market value of a company over time. Thus, it reduces the probability of default and the credit spread (see also Duffee, 1998).

For the same reasons, an increase in the slope of the term structure of interest rates leads to a reduced probability of default as well, since this implies larger interest rates in future (Litterman and Scheinkman, 1991). Furthermore, as Fama and French (1989) revealed, the yield curve slope increases with improving macroeconomic conditions. Since improving macroeconomic conditions imply both reduced default risk and higher recovery rates, the yield curve slope should be negatively correlated with the credit spread. Similarly, the equity market returns are also an indicator for the market sentiment as higher stock returns have the same implications as an increasing yield curve slope (Collin-Dufresne et al., 2001).

On the other hand, the most commonly referred firm-specific determinates of credit spreads are leverage ratio and equity return volatility. Empirical work suggests that the probability of default is positively linked to both of these factors (Ericsson et al. 2009). As a consequence, credit spreads should increase with these factors.

Furthermore, research also suggests that the corporate bond markets are not completely perfect and that the entire credit spread cannot be attributed to the default premium. Longstaff et al. (2005) find that both bond-specific (such as bid-ask spreads) and market specific illiquidity measures (such as flows into money market mutual funds) are related to the non-default component of credit spreads and conclude that liquidity is an important determinant for the credit spread even after controlling for default risk.

4.2 Credit Size and Spreads

The main purpose of this empirical analysis is to discuss the relationship between credit size and credit spread based on our experimental analysis which found a clear negative correlation between interest rates and credit size under certainty. Although credit size is not a risk factor by itself, one might argue that there should be a positive link between leverage and credit size, which should be reflected in larger credit spreads for larger credit amounts. Still, this might not be necessarily the case, as richer households are more likely to borrow larger amounts. Yet, empirical studies clearly demonstrate that the risk of default in internet credit markets is increasing in credit size even after controlling for the debt to income ratio of the applicants or other determinants of default risk and recovery rate (see Miller, 2011; Faßbender, 2012). Therefore, we should expect that:

Hypothesis 2a: *Credit spreads are increasing in credit size due to increasing default risk.*

On the other hand, according to our experimental study, credit size and required interest rates are negatively associated. Hence, our experimental framework emanating from boundedly rational lenders and borrowers predicts that:

Hypothesis 2b: *Credit spreads are decreasing in credit size due to the discounting anomaly called size effect.*

4.3 Data

In order to investigate these contradicting hypotheses, we have handpicked the necessary data for commercial credit applications on the platform "Smava" submitted between August 2007 and November 2010, which comprises 1,213 credit requests. First, we obtain the data on annual interest rate and size of each credit (*Credit Size*). We assume that the returns on German government bonds are risk free. Consequently, we define the difference between the nominal interest rate of the credit and yield to maturity of *Deutscher Rentenindex* (henceforth, REX) as *Credit Spread*. REX is a bond index reproducing the performance of a portfolio consisting of standard German government bonds.

In theory, the main challenge for lenders before deciding on an appropriate credit spread is the estimation problem concerning the (remaining) expected cash flows of any debt claim. This depends both on the probability of default and the expected recovery rate and these parameters are not easy to predict. Unfortunately, neither we nor the lenders have information regarding the leverage ratio of the borrower household to assess the probability of default, which is usually utilized to estimate the default probability in corporate bond markets.

Instead, lenders have to rely on *Schufa Rating* or *KDF Indicator* in P2P markets as risk indicators, which are shown to predict the probability of default quite precisely in these markets (Faßbender, 2012). Both *Schufa Rating* and *KDF Indicator* of applicants are available to lenders for each credit request. Schufa is a rating company which issues ratings regarding the creditworthiness of individuals based on their current accounts, credit card debts, mobile phone contracts, leasing contracts, loans and mail order purchases. In other words, several determinants of an individual's leverage ratio are indeed taken into account. Schufa assigns each individual to a category between A and H based on this information. While A stands for the highest creditworthiness and H stands for the lowest. Similarly, Smava provides itself a self-issued rating which is called a borrower's *KDF Indicator*. This score intends to quantify the ability of an individual to fulfill his credit obligations. For this purpose, Smava calculates the free net disposable income of the borrower and transforms the ratio of this disposable income to the interest payments to grades between 1 and 5, with 1 being the best and 5 being the worst grade. Borrowers are not allowed to apply for credits, if their KDF grades are 5. Since both *Schufa Rating* and *KDF Indicator* are categorical variables, we recode them using the worst grades as reference points.

Furthermore, we account for the macroeconomic determinants of credit spreads. As we discussed above, the risk free rate also affects the default risk. Therefore, we are going to control for this aspect in our empirical analysis by including the (monthly) internal rate of return for 10-year REX index, denoted as *10 Year Treasury Yield*. Furthermore, we add *Yield Curve Slope*, defined as the difference between the (monthly) internal rate of return of 10-year and 2-year REX index benchmarks following Collin-Dufresne et al. (2001). Similarly, we also control for the (monthly) returns of German DAX index, r^{DAX} as a proxy for the market sentiment.

In addition, previous empirical research demonstrated that the default premium cannot explain credit spreads alone and liquidity is also an important determinant of credit spreads. Bid-ask spread is the most commonly used measure for bond liquidity, but in P2P credit markets, this spread equals zero and we have to use other proxies that are shown to be correlated with bid-ask spread. *Maturity* is one such measure, which is shown to be positively correlated with the bid-ask spread. Therefore, we include credit maturity in our regressions in order to account for a liquidity premium in our regressions.

4.4 Results

As we have mentioned above, our main goal is to analyze the applicability of our experimental findings in real life intertemporal decision processes. For this purpose, we are going to investigate the relevance of the size effect for the actual credit spread in P2P credit markets. At the same time, we control for other theoretical determinants of credit spreads that we have listed above.

However, the simple OLS regression models are not suited to investigate this relationship between credit spread and credit size, as an applicant determine interest rates and credit size simultaneously herself. Hence, we have a feedback relationship between *Credit Spread* and *Credit Size* and this causes a simultaneous causality problem between these factors. In this case, we estimate a two stage least squares model (2SLS) which is the most commonly utilized approach to tackle this simultaneity bias.

In the first stage of our regression model, we need to find "excluded" instruments that are correlated only with the *Credit Size* and not with the *Credit Spread*. We have identified two instruments that satisfy this condition. The first instrument is a dummy variable, which we refer to as *Purpose of Use.* In Smava*,* borrowers also need to provide information regarding the purpose of the credit request, where they can choose one motive for their credit application from a possible list including capacity expansion, liquidity, acquisition or replacement of a plant. We create a dummy variable, *Purpose of Use*, which assumes the value of 1, if a lender states liquidity as the reason for credit application. We believe that the issued credits are going to be smaller, if a lender only needs funding to make ends meet rather than to acquire a new plant. Indeed, *Purpose of Use* is negatively correlated with *Credit Size* and it does not seem to be related to *Credit Spread*.

Moreover it is advised to use lag variables in time series analysis as instruments, which is why we include *Sum of Debt* as our second instrument in the first stage regression. This instrument is equal to the amount that is raised by the same borrower before any particular credit. Predictably, this variable is significantly negatively correlated *Credit Size*.

In sum, our 2SLS regression model has the following form:

$$Credit\ Size_i = \alpha_0 + \alpha_1 \times Purpose\ of\ Use_i + \alpha_2 \times Sum\ of\ Debt_i + \sum_{i=3}^{I} \alpha_i \times Control_i + v_i. \quad (1)$$

$$CreditSpread_i = \beta_0 + \beta_1 \times \widehat{Credit\ Size_i} + \sum_{i=2}^{I} \beta_i \times Control_i + \varepsilon_i. \quad (2)$$

Furthermore, we also adjust standard errors for correlation across time clusterijg standard errors by the month of credit application. Before we can interpret our results, we have to examine the assumptions underlying 2SLS models. First of all, the equation in the first stage should not be weakly identified. Both according to the Cragg-Donald (Wald F-statistic: 10.800) and Kleinbergen-Paap (Wald F-statistic: 8.038) tests, we can reject the weak identification null hypothesis at a 1 % level. Furthermore, the F-statistic of the first stage regression is larger than 10 suggesting a high overall significance of the model in the first stage.

After that, we control whether the underlying overidentifying restrictions are valid with the help of Hansen J-test. We cannot reject the null hypothesis that the excluded instruments are not correlated with the error terms in the second stage (*p*-value: 0.4079). Finally, we have to control whether *Credit Size* is indeed an endogenous variable. According to Sargan-Hansen statistics (p-value: 0.0075), we can reject the exogeneity of *Credit Size*. Hence, all three model assumptions of 2SLS models are satisfied.

Now, after verifying model assumptions, we can interpret our results. The main variable of interest is *Credit Size*. Column (2) of Table 3 shows that *Credit Size* has a negative and significant impact on *Credit Spread* even after controlling for the default risk proxies. Since – as already pointed out above according to the empirical literature – the default risk is actually increasing with *Credit Size* and *Credit Size* is not related to liquidity in P2P capital markets in the absence of secondary markets, this relationship can only be explained by the discounting anomaly size effect which seems to be effective even in the interest rate frame.

Moreover, in line with previous studies, we find that both *10 Year Treasury Yield* and *Yield Curve Slope* lead to significantly lower credit spreads (Litterman and Scheinkman, 1991). Besides, all seven Schufa dummies are significant. This means that a rating increase from H to another rating level reduces the credit spreads. In a similar way, two of the three KDF indicator dummies are significant with a negative sign as well. Hence, market participants indeed welcome the credit ratings provided by the internet platform as useful indicators for default risk. On the other hand, we have to admit that *Maturity* is a weak indicator for credit liquidity especially considering that all credits have either a 3-year or a 5-year maturity. Therefore, the insignificant estimates for *Maturity* are not very surprising. Moreover, the German stock market index return r^{DAX} does not have a significant impact on credit spreads, either.

>>>> Insert Table 3 here<<<<

5. Conclusion

We can now sum up the findings of our paper briefly. Our main goal is to investigate size effects in interest rate frames. This setting allows us to discuss the descriptive power of the "added compensation approach" as an intertemporal decision model (Benzion et al., 1989, Loewenstein and Prelec, 1992). Furthermore, the elicited discount rates reveal individuals' actual preferences a lot better in this question frame, because present value miscalculations should be avoided under the disclosure of interest rates.

Although there are reasons to expect a reduced proneness to size effects in interest rate frames, we have observed very strong size effects here as well. Furthermore, (reversed) interval effects and hyperbolic discounting is proven to be very significant in interest rate frames, too.

Moreover, it is more likely that decision makers encounter intertemporal decision tasks in interest rate frames. As a result, we should find empirical support for our experimental results regarding size effects. For this purpose, we analyze the relationship between credit spreads and credit size in P2P credit markets. Other determinants of credit spreads such as default risk, recovery rate (indirectly measured via, e.g., the yield curve slope) or liquidity issues cannot justify the negative relationship between credit spreads and credit size in these markets. This leaves bounded rationality of investors and resulting size effects as the only possible reason to explain the negative relation between credit size and credit spreads in P2P credit markets.

Summarizing, our paper contributes to the existing literature both in the field of experimental economics and in the field of household finance. To our knowledge, we conduct the first experiment investigating size effects in intertemporal decisions in a more realistic setting using interest rate frames. Based on these results, we explore size effects empirically and find that they are an important determinant for credit spreads in P2P markets.

References

Andersen, S., Harrison, G.W., Lau, M.I., Rutström, E.E. (2006) Elicitation using multiple price list formats. Experimental Economics 9, 383-405.

Armstrong, J.S., Overton, T.S. (1977) Estimating nonresponse bias in mail surveys. Journal of Marketing Research 14, 396-402.

Barber, B., Lee, Y., Liu, J., Odean, T. (2009) Just How Much Do Individual Investors Lose by Trading? The Review of Financial Studies 22, 2, 609-632.

Benzion, U., Rapoport, A., Yagil, J. (1989) Discount rates inferred decisions: An experimental study. Management Science 35, 270-284.

Chiang, Y., Hirshleifer, D., Qian, Y., Sherman, A.E. (2011) Do Investors Learn from Experience? Evidence from Frequent IPO Investors. Review of Financial Studies 24, 1560-1589.

Coller, M., Williams, M.B. (1999) Eliciting individual discount rates. Experimental Economics 2, 107-127.

Collin-Dufresne, P., Goldstein, R.S., Martin, S.J. (2001) The determinants of credit spread changes. Journal of Finance 56, 2177-2207.

Cox, J.C., Ross, S.A. (1976) The valuation of options for alternative stochastic processes. Journal of Financial Economics 3, 145-166.

Duffee, G. R. (1998) The relation between treasury yields and corporate bond yield spreads. Journal of Finance 53, 2225-2241.

Ericsson J, Jacobs K., Oviedo, R. (2009) The determinants of credit default swap premia. Journal of Financial and Quantitative Analysis 44, 109-132.

Fama, E.F., French, K.R. (1989) Business conditions and expected returns on stocks and bonds. Journal of Financial Economics 25, 23-49.

Fassbender, D. (2012) P2P-Kreditmärkte als Finanzintermediäre: Eine Empirische Analyse Deutscher P2P-Kreditmärkte zur Beurteilung der Eignung als Finanzintermediäre. Grin Verlag GmbH, Munich.

Frederick, S., Loewenstein, G., O'Donoghue, T. (2002) Time discounting and time preference: A critical review. Journal of Economic Literature 40, 351-401.

Halevy, Y. (2008) Strotz meets Allais: Diminishing impatience and the certainty effect. American Economic Review 98, 1145-1162.

Harrison, G.W, Llau M., Williams M.B. (2002) Estimating individual discount rates in Denmark: A field experiment. American Economic Review 92, 1606-1617.

Hausman, J. (1979) Individual discount rates and the purchase and utilization of energy-using durables. Bell Journal of Economics 10, 33-54.

Kahnemann, D., Tversky, A. (1979) Prospect theory: an analysis of decision under risk. Econometrica 47, 263-291.

Kirby, K. N., Herrnstein, R. J. (1995). Preference reversals due to myopic discounting of delayed reward. Psychological Science 6, 83-89.

Litterman, R., Scheinkman, J. (1991) Common factors affecting bond returns, Journal of Fixed Income 1, 54-61.

Loewenstein, G., Prelec. D. (1992) Anomalies in intertemporal choice: Evidence and an interpretation. Quarterly Journal of Economics May, 573-97.

Longstaff, F.A., Mithal, S., Neis, E. (2005) Corporate yield spreads: Default risk or liquidity? New evidence from the credit-default swap market, Journal of Finance 60, 2213-2253.

Longstaff, F.A., Schwartz, E.S. (1995) A simple approach to valuing risky fixed and floating rate debt. Journal of Finance 50, 789-819.

Merton, R. C. (1974) On the pricing of corporate debt: The risk structure of interest rates, Journal of Finance 29, 449-470.

Miller, S. (2011) Information and default in consumer credit markets: Evidence from a natural experiment. Unpublished working paper.
Read, D., Airoldi, M., Loewe, G. (2005) Intertemporal tradeoff priced in interest rates and amounts: A study of method variance. Unpublished working paper.
Read, D., Roelofsma, P.H.M.P. (2003) Subadditive versus hyperbolic discounting: A comparison of choice and matching. Organizational Behavior and Human Decision Processes 91, 140-153.
Samuelson, P. A. (1937) A note on measurement of utility. The Review of Economic Studies 4, 155-161.
Samuelson, P. A. (1969) Lifetime portfolio selection by dynamic stochastic programming. Review of Economics and Statistics 51, 239-246.
Savage, L.J. (1954) Foundation of Statistics. New York, Wiley.
Shefrin, H.H., Thaler, R.H. (1988) The behavioral life-cycle hypothesis, Economic Inquiry 26, 609-643.
Stango, V., Zinman, J. (2009) Exponential Growth Bias and Household Finance, Journal of Finance 64, 2807-2849.
Thaler, R.H. (1981) Some empirical evidence on dynamic inconsistency. Economics Letters 8, 201-207.
Viscusi, W.K., Moore, M.J. (1989) Rates of time preference and valuation of the duration of life. Journal of Public Economics 38, 297-317.
Warner, J.T., Pleeter, S. (2001) The personal discount rate: Evidence from military downsizing programs. American Economic Review 91, 33-53.

Table I. Summary statistics for the demographic variables in our regression model

Dummy variables are utilized to describe participants' gender (male = 0, female = 1) and major (non-economics students = 0, economics students = 1), while age is represented by integers characterizing the age of participants. In the basic scenario, the sooner of the two eligible outcomes is to be received immediately, in the delayed scenario the sooner of the two eligible outcomes is to be received three months later.

Variable	Mean	S.D.	Median	N
All Participants				
Gender	0.73	0.45	1	222
Age	22.36	2.31	22	222
Major	0.72	0.45	1	222
Groups 1-3				
Gender	0.72	0.45	1	162
Age	22.41	2.31	22	162
Major	0.71	0.46	1	162
Group 4				
Gender	0.63	0.49	1	60
Age	22.55	2.35	22	60
Major	0.78	0.42	1	60

Table II. Results of OLS regressions

This table presents the results of least square regressions of *Interest Rate* on various independent variables. *Size 1* (*Size 2*) is a binary dummy variable assuming the value of 1 for outcome magnitudes equal to 390 € (7,700 €). *Interval* and *Delay* are additional binary dummy variables characterizing longer intervals and delayed outcomes, respectively. *Z*-values are clustered by subjects and reported below the regression coefficients. *** $p \leq 1$ %, ** $p \leq 5$ %, * $p \leq 10$ %.

Independent Variables	
Size 1	*-11.705*
	*-6.04****
Size 2	*-15.090*
	*-6.60****
Interval	*1.695*
	*2.06***
Delay	*-2.890*
	*-2.91****
Gender	-3.218
	-1.43
Age	0.439
	1.25
Major	0.798
	0.33
Constant	*14.270*
	*1.70**
R^2	0.138
F	*10.94****
Observations	815

Table III. Results of the 2SLS regressions

This table presents the results of two stage least square regressions. *Credit Size* is the instrumental variable. *Credit Spread* is the dependent variable in the second stage. *Z*-values are clustered by month and reported below the regression coefficients. *** $p \leq 1$ %, ** $p \leq 5$ %, * $p \leq 10$ %.

	1st stage	2nd stage
Credit Size		*-0.000*
		*-2.14***
10 Year Treasury Yield	*-241898.800*	*-0.445*
	*-3.99****	*-1.68**
Yield Curve	-119792.000	*-22.616*
	-0.16	*-4.12****
r^{DAX}	-6195.023	-0.026
	-1.25	-0.61
Maturity	*3514.805*	-0.004
	*5.64****	-1.10
Schufa Rating A	*2970.249*	*-0.062*
	*3.33****	*-13.19****
Schufa Rating B	1128.484	*-0.053*
	0.99	*-7.32****
Schufa Rating C	*1610.980*	*-0.050*
	*1.70**	*-11.70****
Schufa Rating D	1.078.507	*-0.047*
	0.98	*-12.25****
Schufa Rating E	96.852	*-0.038*
	0.10	*-9.91****
Schufa Rating F	1341.544	*-0.028*
	1.14	*-7.35****
Schufa Rating G	659.329	*-0.012*
	0.58	*-2.91****
KDF Indicator 1	1014.272	*-0.011*
	0.98	*-3.50****
KDF Indicator 2	352.309	-0.001
	0.48	-0.19
KDF Indicator 3	*1084.312*	*-0.004*
	*2.19***	*-2.05***
Purpose of Use	-668.743	
	-1.26	
Sum of Debt	*-0.150*	
	*-3.89****	
Constant	*17428.660*	*0.173*
	*6.46****	*11.50****
R^2	0.102	0.220
F	*10.69****	*112.87****
Observations	1,213	1,213