The Equity Premium
and Its Behavioral Explanations

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Trier 2016

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Dissertation
am Fachbereich IV der Universität Trier

Trier, den 12 April 2016

Erstgutachter: Prof. Dr. Marc Oliver Rieger
Zweitgutachter: Prof. Dr. Tibor Neugebauer
Tag der mündlichen Prüfung: 12 Juli 2016

Acknowledgments

I would never have been able to finish my dissertation without the guidance of my committee members, funding from the Vietnam Ministry of Education and Training (MOET) and the German Academic Exchange Service (DAAD), help from other faculty members, support from my family and wife, and my beloved friends.

I would like to express my deepest gratitude to my supervisor, Prof. Dr. Marc Oliver Rieger, for his great guidance, caring, and patience, and for providing me with an encouraging atmosphere in which to undertake research. I have learned a lot beyond his excellent expertise, including his sympathy and encouragement at every stage of the process.

In addition, I would like to thank Prof. Dr. Ernst Maug, who gave me the chance to take part in the first-year Ph.D program at the University of Mannheim, where I undertook research in behavioral finance and practical issues beyond textbooks for the first time. Furthermore, for discussions of great value, I would like to thank Prof. Dr. Mei Wang, Prof. Dr. Henrik Cronqvist, Dr. Eric Duca, Dr. Dmitry Shcherbakov, and many conference participants at the 5th International Finance and Banking Society (IFABS) Conference, Nottingham, UK 2013; the Annual Meeting of the Academy of Behavioral Finance and Economics, Chicago, USA, 2013; the World Finance and Banking Symposium, Beijing, China 2013; the 21st Conference of the Multinational Finance Society, Prague, Czech Republic, 2014; and the World Finance and Banking Symposium, Singapore, 2014. Special thanks go to Prof. Dr. Tibor Neugebauer, who was willing to participate in my final defense committee and gave me the most valuable comments.

In addition, I would like to thank the MOET for funding my project with the 322 Scholarship and the University of Trier for its "Studienabschluss-Stipendien" scholarship. I would like to thank DAAD, the Vietnamese Embassy in Berlin, and the Consulate in Frankfurt for their kind support during the years I have spent in Germany. I also appreciate Dr. Nguyen Van Dung, Assoc. Prof. Dr. Pham Van Nang, and Assoc. Prof. Dr. Tran Hoang Ngan for giving me the opportunity to study abroad as part of the plan to develop the University of Economics, Ho Chi Minh City into a world-ranking institution in the near future.

My work could not have been undertaken without the attentive support of Carolina Hilgers and the diligent research assistants, Jan Rieken, Medi Tuku, Phil Wenzel, and Van Hoang. Special thanks go to Elservier for their excellent service in proofreading my English. I would like to thank Cao Ji, Shuonan Yuan, Daniel Metze, Tobias van der Neut, Minh-Tu Le and Dennis Dlugosch, who as good friends were always willing to help and give the best suggestions. I appreciate also Ms Ha Nguyen, who supported me in a great kindness as my blood relative. It would have been very lonely without them.

I would also like to thank my parents, my mother-in-law, my younger sister, Tina and Gilles. Many thanks go to my aunt's family in Berlin, Noel and Tito. They have always supported me and encouraged me with their best wishes.

Finally, I would like to thank my wife, Dang Ngoc Bao Vi, and my daughter, Ngo Bao Truc Nghi. They were always there cheering me up and stood by me through the good times and bad. All my successes are theirs.

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Zusammenfassung

Das “Equity Premium Puzzle” (Mehra und Prescott, 1985) gilt noch immer als finanzwissenschaftliches Rätsel, da nach wie vor keine überzeugenden Erklärungen für die Höhe der Eigenkapitalprämie gefunden wurden. In dieser Dissertation untersuchen wir dieses seit Langem bekannte “Puzzle” und diverse mögliche verhaltenswissenschaftliche Erklärungen. Im ersten Teil (Kapitel 2), “The fundamental equity premium”, wird ein neuer Ansatz zur Schätzung der “fundamentalen” Eigenkapitalprämie vorgeschlagen, welcher auf der Internen-Rendite-Methodik von Fama und French (1999) basiert. Dazu werden Unternehmensdaten bezüglich der Eigenkapitalprämie für $N = 28.256$ Unternehmen in 54 Ländern auf der ganzen Welt untersucht.

Der zweite Teil (Kapitel 3), “Myopic loss aversion revisited”, wirft einen genaueren Blick auf kurzsichtiges Verhalten und Verlustaversion (Benartzi and Thaler, 1995), um die jüngste historische Aktienprämie in mehr als 20 Ländern zu erklären. Wir zeigen, dass andere Bestandteile der Prospect Theory einen Effekt auf die historische Aktienprämie haben, gemeinsam mit kurzsichtigem Verhalten. Einen optimalen Anlagehorizont von einem Jahr können wir jedoch nicht bestätigen.

Im dritten Teil (Kapitel 4), “Empirical investigation on equity premia and its determinants”, werden auf Grundlage der Ergebnisse der INTRA-Studie (Rieger et al., 2014a; Wang et al., 2011) relevante Risikofaktoren zusammen mit der Zeitdiskontierung als Erklärung der Eigenkapitalprämie getestet. Wir stellen fest, dass Risikodeterminanten zusammen mit Zeitpräferenzen bessere Schätzer für die weltweite Streuung der Eigenkapitalprämien darstellen und dass Verlustaversion eine geringere Rolle spielt.

Der letzte Teil (Kapitel 5), “Ambiguity Aversion as an explanation of the Equity Premium Puzzle”, liefert umfassende empirische Evidenz dafür, dass die verhaltenswissenschaftliche Theorie der Ambiguitätsaversion einen Beitrag zur Erklärung der Eigenkapitalprämie leistet. Unsere Ergebnisse beleuchten den neuen Ansatz zur Integration von Risiko und Ambiguität (zusammen mit Zeitpräferenzen) in ein allgemeineres Asset-Pricing-Modell der Unsicherheit in welchem sowohl Risiko- als auch Ambiguitätsprämien eine Rolle spielen. In Kapitel 6 werden Schlussfolgerungen gezogen und noch offene

Forschungsfragen aufgezeigt.

Diese Dissertation leistet einen Beitrag zur aktuellen Diskussion um die Eigenkapitalprämie und liefert umfassende empirische Evidenz durch das Testen aktueller verhaltenswissenschaftlicher Modelle mit internationalen Daten auf Unternehmensebene. Der neuartige Ansatz stellt heraus, dass es notwendig ist, allgemeinere Theorien zu etablieren, welche verhaltenswissenschaftliche Faktoren und Zeitpräferenzen integrieren, um die verbleibenden Fragen beantworten zu können.

Executive Summary

The equity premium (Mehra and Prescott, 1985) is still a puzzle in the sense that there are still no convincing explanations for the size of the equity premium. In this dissertation, we study this long-standing puzzle and several possible behavioral explanations.

The first part (Chapter 2), "The fundamental equity premium," proposes a new approach in estimating the "fundamental" equity premium based on the internal rate of return methodology proposed by Fama and French (1999). This study is the first attempt to achieve large quantities of firm-level data on the equity premia for $N =$ *28,256* companies in *54* countries around the world.

The second part (Chapter 3), "Myopic loss aversion revisited," takes a closer look at myopic loss aversion Benartzi and Thaler (1995) to account for the recent historical equity premia in more than 20 countries. We document that other components of prospect theory have effects on the historical equity premium together with myopia. The ideal investment horizon of one year is however not supported.

The third part (Chapter 4), "Empirical investigation on equity premia and its determinants," uses preferences data from the International Test of Time Preferences and Risk Attitudes (INTRA) study (Wang et al., 2011; Rieger et al., 2014a) to test the relevant risk factors together with time cognition to explain the equity premium. We document that *risk determinants* together with *time preference* better estimate the globalized dispersion of equity premia while *loss aversion* plays a weaker role.

The last and important part (Chapter 5), "Ambiguity aversion as an explanation of the equity premium puzzle," provides rigorous empirical evidence to support the behavioral theory of ambiguity aversion to account for the equity premium. The observations shed some light on the new approach of integrating risk and ambiguity, together with time preferences, into a more general model of uncertainty, in which both risk premium and ambiguity premium play roles in asset pricing models. We conclude and propose some future research directions in Chapter 6.

This dissertation contributes to the equity premium debates in providing rigorous empirical evidence by testing recent behavioral models with new international firm-level data. The dissertation's novel approach highlights the need to propose more general theories to integrate behavioral factors together with time preference(s) in order to account for the remaining puzzles successfully.

Chapter 1

General introduction

1.1 State of the art and preliminary work

The equity risk premium puzzle is one of the classic puzzles in finance. Going back nearly three decades, Mehra and Prescott (1985) find that historical average returns on equity on the US stock market from 1889 to 1978 (90 years) far exceeded the average returns of short-term debt, corresponding to basically riskless assets. While the difference would be a natural consequence of risk aversion, the authors find that the sheer size of this difference could be explained only by a much higher level of risk aversion than what is usually measured in decision experiments.

This dissertation does not aim either to survey the preliminary work or to review recent theories in behavioral finance that might explain the equity premium puzzle. Given a new estimation of equity premia from accounting data of *28,256* firms in *54* countries and data on investors' preferences from an international survey (Rieger et al., 2014a,b), we conjecture the link between the equity premia dispersion and the differences in investors' preferences, which might be due to cultural traits. Prior internationally empirical evidence, such as the historical equity premia and time discounting (Rieger et al., 2013b), and the historical equity premia and ambiguity aversion (Rieger and Wang, 2012), motivates our further investigation of this "unsolved" puzzle (Mehra, 2006).

Consequently, we have to answer the following questions. (1) What is the equity premium puzzle and how is it measured? (2) Why is it a puzzle and which attempts have been tested to find a solution to this puzzle? (3) What are the advances in behavioral finance that might capture this puzzle? These topics are discussed in more detail throughout this dissertation.

1.1.1 What is the equity premium puzzle and how is it measured?

Initially, Mehra and Prescott (1985) defined the puzzle as the incapacity of the traditional consumption asset pricing model (CCAPM) based on Lucas Jr (1978)'s pure exchange model[1] to capture the equity premium from US data from 1889 to 1978. Assuming no transaction cost and efficient markets, rational investors price assets based on the equilibrium in which the utility of consumption being sacrificed at time zero matches the expected utility gain from the investment in the future. In more detail, the assumption is that the representative household maximizes its preferences over random consumption paths

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t U(c_t) \right\}, \qquad 0 < \beta < 1, \tag{1.1}$$

where c_t is per capita consumption, β is the subjective time discount factor, α measures the curvature of the utility function, and its utility function is of the constant relative risk aversion (CARA) class:

$$U(c, \alpha) = \frac{c^{1-\alpha} - 1}{1 - \alpha} \qquad 0 < \alpha < \infty. \tag{1.2}$$

The Arrow and Debreu (1954) equilibrium asset price is found when the discounted future utility balances with current utility from consumption (Mehra and Prescott,

[1]The Lucas Jr (1978) competitive pure exchange model assumes the following. (i) The economy has a single representative stand-in household that has an increasing concave utility function, which is characterized by the risk aversion parameter α. (ii) The market consists of two assets—one equity share issued by a productive unit and a risk-free bill, which are competitively traded. The firm's output (dividend payment) is constrained to be less than or equal to the household's per capita consumption. (iii) The growth rate of this endowment follows a Markov process.

1985):

$$p_t U'(c_t) = \beta E \left\{ [p_{t+1} + y_{t+1}] \, U'(c_{t+1}) \right\}, \tag{1.3}$$

where p_t, c_t, and p_{t+1}, c_{t+1} are price and consumption at time t and $t+1$, respectively.

Applying the equation (1.3) on the return from stock investment and risk-free asset investment separately, and rearranging in the form of the CCAPM formula, Mehra and Prescott (1985) propose that the equity premium predicted by the CCAPM is the following:

$$R^e_{t+1} - R^f_{t+1} = Cov_t \left[\frac{-U'(c_{t+1}), R^e_{t+1}}{E\left[U'(c_{t+1})\right]} \right], \tag{1.4}$$

where R^e_i is the equity's expected period return in the current state i, and similarly, R^f_i is the expected return on risk-free asset. If the consumption growth has a log normal distribution and follows a stochastic process with mean μ and variance σ^2, the equation (1.4) is then reformulated to

$$lnE\left[R^e\right] - lnE\left[R^f\right] = \alpha\sigma^2. \tag{1.5}$$

Given values of the average growth rate of per capita consumption (1.8% per annum), its standard deviation (3.6%), and its first-order serial correlation, Mehra and Prescott (1985) documented the inconsistency between the *observed* equity risk premium (6.18% per annum) and the equity premium estimated by this model (e.g., 14.1% - 12.7% = 1.4% in the case of $\alpha = 10$ and $\beta = 0.99$, by which the equity premium puzzle = 6.8% - 1.4% = 4.78%). This model incapacity is, therefore, named the equity premium puzzle.

If we take a closer look at the very first critical point to define the equity premium, some confusion arises from the fact that the term "equity premium" is used to designate at least four different concepts:

1. The historical equity premium is the historical average differential return of the market portfolio over risk-free assets, usually bonds or Treasury-bills (T-bills). Since the first empirical estimate of Smith (1928) for an outperformance of eq-

uity investor over a bond investor for the most actively traded stocks from 1901 to 1922, the historical equity premia were reported in the US (Schwert, 1989; Siegel and Thaler, 1997; Siegel, 1999; Siegel and Coxe, 2002; Wilson and Jones, 2002; Ibbotson and Chen, 2003; Siegel, 2005; Goetzmann and Ibbotson, 2006; Siegel and Schwartz, 2006) and in other countries (Blanchard et al., 1993; Jorion and Goetzmann, 1999; Dimson and Marsh, 2001; Dimson et al., 2005, 2006). However, different authors, different time spans, different aggregation methodologies, and different choices of risk-free benchmarks diversify the historical equity premium estimation. Despite its wide application, the historical equity premia become meaningful only for long time series (Cornell, 1999; Dimson et al., 2005; Damodaran, 2015), which is often difficult to collect, since complete stock market data are, in most countries, available only for the most recent periods. The inclusion of only listed companies biases the estimation toward "survival" firms and markets, for instance, the US (Jorion and Goetzmann, 1999; Dimson et al., 2006).

2. The expected equity premium is the expected differential return of the stock market over risk-free asset return. This is the answer to the following question: "What would be the expectation for an excess return from stock investment over the risk-free rate in the near future?" The first simple approach is to ask this question directly to financial professors (Welch, 2000), US chief financial officers (Graham and Harvey, 2005) and clients of Goldman Sachs (O'Neill et al., 2002). The second is to regress the equity premium on some independent lagged predictors, such as dividend yield (Ball, 1978; Campbell and Shiller, 1988; Fama and French, 1988; Cochrane, 1998), the short-term interest rate (Hodrick, 1992), earnings price and payout ratio (Campbell and Shiller, 1988; Lamont, 1998; Ritter, 2005), the term spread and default spread (Campbell, 1987; Avramov, 2002), the inflation rate (Fama and Schwert, 1977; Fama, 1981; Campbell and Vuolteenaho, 2004), the interest rate and dividend-related variables (Ang and Bekaert, 2007), book-to-market ratio (Kothari and Shanken, 1997), value of high- and low-beta stock (Polk et al., 2004), consumption and wealth (Lettau and Ludvigson, 2001), and

aggregate financing activity (Baker and Wurgler, 2000; Boudoukh et al., 2007).

In this case, the historical equity premium is used as an *unbiased* estimate of the expected equity premium over the long horizon (Mehra and Prescott, 2003). Again, the issue of survival bias (Dimson et al., 2005; Brown et al., 2012) still exists. Moreover, the abovementioned models are not stable in predicting the equity premium (Goyal and Welch, 2006). As a result, this does not provide a consistent estimation of the equity premia for further research.

3. The required and/ or implied equity premium of an investor is the incremental return that she requires or expects over the risk-free rate for investing in a stock portfolio. The two concepts are often used interchangable since they are the *required* equity premia which are *implied* from some market models. This is the key to answer how much a firm or an investment project can return for its investors. In the debates, there are two widely used approaches in the valuation of a stock that matches the current market value with an estimate of the future cash flow to equity. The first approach is based on the constant dividend growth model (Gordon, 1962) and its variation: the residual income model; the second is the internal rate of return (IRR) approach, which was used by Fama and French (1999) to estimate the equity cost of capital.

- According to the Gordon (1962) model, the current price (P_0) is the present value of expected dividends discounted at the required rate of return (k). If d_1 is the dividend per share that would be distributed at time 1, g is the expected long-term growth rate of dividends, and

$$P_0 = \frac{d_1}{k - g}, \tag{1.6}$$

then,

$$k = \frac{d_1}{P_0 + g}, \tag{1.7}$$

and the equity premium is

$$R^e = \frac{d_1}{P_0} + g - R^f. \tag{1.8}$$

Similarly, if the "clean surplus" relationship holds ($d_t = e_t - (BV_t - BV_{t-1})$), with d being the dividend per share, e is the earnings per share and BV is the book value per share. In that case,

$$P_0 = BV_0 + \frac{(e - kBV_0)}{k - g}, \tag{1.9}$$

which implies (k is the required/implied rate of return from the stock investment):

$$k = \frac{e_1}{P_0} + g(1 - \frac{BV_0}{P_0}). \tag{1.10}$$

- The IRR approach (Fama and French, 1999) deals with fundamental accounting data and seems to predict a more reasonable equity premium estimation. If investment into a firm is treated as an investment project, the IRR estimated from balancing all discounted future incomes with current price is the unbiased return from equity investment. If P_0 is the current value, P_v is the future value and I_t, E_t are investments and earnings at year t, and T is the investment period, the required equity premium can be estimated via

$$P_0 = \sum_{t=1}^{T-1} \frac{(E_t - I_t)}{(1 + IRR)^t} + \frac{PV}{(1 + IRR)^T}. \tag{1.11}$$

  The Gordon (1962) approach has been used to predict the equity premium, which ranges from 3.04% (Jaganathan et al., 2000) to 5.3% (Easton et al., 2002) and 7% (Harris et al., 2003) in the US, and is less than 3% for Canada, France, Germany, and the UK (Claus and Thomas, 2001). However, one problem with all these estimates is that they depend on a subjective assumption about the values of expected growth. The second but critical issue is that many pairs (implied/expected equity premium and growth) that are consistent with market prices are found easily. An excellent survey is found in Fernandez (2006).

These divergences in choosing a consistent measure of the equity premium have caused endless arguments surrounding this puzzle. First and foremost, the historical equity premium is meaningful only in the long run as it involves collecting stock market data back to times when these data were not readily available. This alters any attempts to document the equity premium outside some "survival" markets and blames the problems on explanations for the equity premium puzzle that attempt to expand the investigation periods to as long as possible in order to capture a "meaningful" equity premium. The other drawback is the fact that the historical equity premium can be measured only at country-aggregate level from market indexes, in which only big and successful firms are included, and the selected time horizon has to be shortened. The "survival" issue is addressed also in the estimation of the equity premium using Gordon (1962)'s approach and its variations. The subjective assumption of an unknown growth rate and the choice of only major stock market indexes (e.g., Damodaran, 2015) biases the equity premium estimation and limits the investigation to only countries with long-term data availability.

If we want to understand the "fundamentals" of equity premia, that is, the return on securities instead of the return of investors in these securities, the IRR approach helps to answer directly the following question: "Does stock investment dominate risk-free investment?" In reality, individual investors with exogenous expectations do not hold a market portfolio but their own choice of "picked" stocks. With different experience and investment strategy, every individual has her own "required" equity premium, and thereby, her own "implied" equity premium because of diversified preferences. However, for the same firm during the same investment period, the IRR approach yields only one "fundamental" rate of return, regardless of different types of investors. The IRR approach works well if one wants to investigate the time series of returns, as in Dichev (2004), who computed that the US dollar-weighted return from \$1 invested on the NYSE/AMEX market over 1926–2002 would yield 1.3% in returns, and similarly, 1.5% for 19 major stock markets around the world over 1973–2004. Nevertheless, his approach is applicable only on a country-aggregated level.

We take this one step further in applying the IRR approach to large quantities of firm-level data from OSIRIS. Given the accounting data available, the formula (1.11) is applied to more than 20,000 firms around the world for the period of 10 years from 2001 to 2010. This is the first estimation of the *objective* equity premia, which is assumption-free and directly answers the question of how large the premium of equity investment is. The advantages of this approach are quite obvious. The equity premia can be estimated at individual stock level, which can include additional unlisted firms, somehow reducing the survival bias. Second, the consistency of IRR methodology helps to obtain a reliable measurement over a much shorter time period than the historical equity premium method does. Last and most important, the new measurement of the equity premium allows the inclusion of firm-level controls, which are usually bypassed in other investigations of the equity premium puzzle.

1.1.2 Related preliminary work on equity premium puzzle

In the meantime, many possible explanations for this puzzle have been proposed, for example, consumption-based generalized expected utility (Epstein and Zin, 1991, Constantinides, 1990, Abel, 1990, Campbell and Cochrane, 1999), rare and disastrous events (Rietz, 1988, Mehra and Prescott, 1988, Barro, 2005), idiosyncratic income shocks, (Constantinides and Duffie, 1996, Krebs, 2000), liquidity limitations (Bansal and Coleman, 1996, Holmström and Tiróle, 1998), borrowing constraints, (Constantinides et al., 2002), tax reasons, (McGrattan and Prescott, 2003, 2005), survivorship bias (Brown et al., 2012), relative volatility of stocks and bonds (Asness, 2000), and measurement errors and poor consumption growth proxies (Breeden et al., 1989; Mankiw and Zeldes, 1991; Ait-Sahalia et al., 2004). Further discussion is found in some excellent surveys of this work, such as Kocherlakota (1996); Cochrane (1998); Mehra and Prescott (2003); Mehra (2006). All of these approaches, however, are capable of explaining only parts of the puzzle.

Recent research has therefore concentrated on behavioral factors contributing to an explanation of the equity premium. The two most convincing theories are based on myopic loss aversion (Benartzi and Thaler, 1995, Barberis and Huang, 2006) and ambiguity aversion (Chen and Epstein, 2003, Barillas et al., 2009, Gollier, 2011).

The myopic loss aversion theory interprets the high amount of equity risk premium with loss aversion, as defined by prospect theory (Kahneman and Tversky, 1979, Tversky and Kahneman, 1992) coupled with a myopic view of an investor who evaluates the returns of his portfolio on a short-term basis (e.g., annually) while in fact investing for a long-term goal (e.g., for retirement). Since in the short-term, the loss probability of stocks is relatively high, investors request a larger risk premium.

The explanation based on ambiguity aversion starts from the observation that return distributions of stocks are not well known by investors. Therefore, not only does risk aversion but also ambiguity aversion makes stocks unattractive. However, this should be distinguished from models on uncertainty. Since the world is full of uncertainty, this additional ambiguous factor adds an extra premium over the premium for risky asset. In the debate, uncertainty can refer to model uncertainty, probability uncertainty (Camerer and Weber, 1992, Epstein and Schneider, 2010, Mukerji and Tallon, 2001, Gilboa and Marinacci, 2011), or political uncertainty (Pastor and Veronesi, 2012; Pástor and Veronesi, 2013). Additionly, information quality helps to understand the equity premium (Epstein and Schneider, 2008).

Other investors remain skeptical about the ambiguous factor. The investors' attitudes toward ambiguity, not the ambiguity itself, cause the ambiguity premium. Ambiguity aversion has been modeled as an additional behavioral factor beyond risk aversion to contribute to the equity premium (Abel, 1989, 2002; Chen and Epstein, 2003; Klibanoff et al., 2005; Barillas et al., 2009; Gollier, 2011; Ju and Miao, 2012). However, it is difficult to test this hypothesis empirically, since it is difficult to distinguish ambiguity from simple risk. An ambiguous choice of an investor could be a risky situation for another investor in the case of *a priori* known knowledge. In addition, measuring ambiguity from market data is a complicated task (Izhakian, 2012b), and so is investigation of the interaction effect of ambiguity aversion associated with ambiguity on the ambiguity premium in asset pricing models.

1.1.3 Investors' preferences, culture and the dispersion of equity premia

Recent studies show that cultural traits affect the preferences of investors in most dimensions. For instance, Asian students are believed to be more risk-tolerant and less loss-averse when facing financial risk (Fan and Xiao, 2006). However, differences in risk perception are also reported among students in China, Germany, Poland, and the US (Weber and Hsee, 1998). Divergence in probabilistic thinking style, an important component of prospect theory, has been found since the Hong Kong participants tend to assign more extreme probability estimations compared to their UK counterparts (Wright and Phillips, 1980). Yates et al. (1996) suggest that this overconfidence bias, leading to excessive trading, may be caused by a collectivist culture. Levels of reference point (framing effect), a parameter of prospect theory to measure risk-seeking attitudes, are found to have effects within the social context of China more than the social contexts in other countries (Wang and Fischbeck, 2004; Levinson and Peng, 2007).

The additional step is to link market outcomes to cultural proxies, which are hypothesized to represent investors' preferences. For example, using stock return data from 41 countries and the individualism index by Hofstede (2001), Chui et al. (2010) find that investors in individualist cultures tend to exhibit more overconfidence, and consequently, have higher trading volumes. This confirms the conjectures that the momentum returns and their characteristics (mid-term momentum and long-term reversal) can be explained partly by cultural variables. In later research, Chui et al. (2012) use the Uncertainty Avoidance Index (UAI) and Individualism Index developed by Hofstede (2001) to measure investors' attitudes toward risk and use the transaction cost index and market development measures to proxy for limits to arbitrage in data from 40 countries. The authors suggest that the value premium can be subjected to the dispersion of the attitude toward risk, which the mispricing hypothesis fails to capture. A more direct finding is found in the work by Caliskan and Hens (2014), who hypothesize that suboptimal investor behavior caused by cognitive and emotional factors lead to pricing errors, which are responsible for asset pricing anomalies in general and for value premium in particular. The authors suggest that risk aversion is positively related to the magnitude of the value profits: the higher is the compensation demanded for a given loss, the higher is the value premium. Time preference has a negative link: the value profits increase as investors are less patient.

These exploratory findings motivate us to follow the recent trends in behavioral finance. Instead of matching measurement of investor preference from psychology experiments with stock data, which always faces the joint hypothesis problem[2], we attempt to link market outcomes to investors' preferences or other proxies that might predict their behavior. Thanks to (cumulative) prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992), risk-taking behavior of investors could be determined by (1) how investors choose the reference point; (2) risk attitudes in gains and losses; (3) the degree of loss aversion; and (4) how investors judge and weight probabilities. We hypothesize that the dispersion of market outcomes, the equity premium in particular, might be explained by systematic deviations from rational decision making.

In fact, there are already empirical articles at the national level that try to capture the worldwide differences in equity risk premium. In a recent paper, Rieger et al. (2013b) find that time discounting seems to correlate with the average historic risk premium in a country. This gives a certain level of support to the myopic loss aversion hypothesis, as it can be expected that investors in countries with stronger time discounting would consider their investment more myopically, that is, their time horizons would be somewhat shorter, which makes stock investments less attractive for them, ultimately leading to the requirement of a higher equity premium. Rieger and Wang (2012) finds a similar effect of ambiguity aversion on the equity risk premium.

Up to this point, the new estimation of equity premia enables us a great chance to test alternative determinants of the equity premium with the inclusion of many feasible controls, which are usually bypassed in other country-level research. In fact, we

[2]The joint hypothesis problem refers to the fact that testing for market efficiency is problematic, or even impossible. Any attempts to test for market (in)efficiency must involve an equilibrium asset pricing model. It is not possible to measure any "abnormal" returns without expected returns predicted by this pricing model. Therefore, any anomalous evidence on market returns may reflect market inefficiency, a bad asset pricing model, or both (Fama, 1991).

could test any possible proxies of behavioral characteristics of the individual investors that are documented throughout the debates. For instance, Daniel et al. (2002) state that individuals in general account for *heuristic simplification* (salient and availability effect, framing, money illusion, and mental accounting), *self-deception* (overconfidence, biased self-attribution, confirmatory bias, hindsight bias, rationalization, and cognitive dissonance), and last but not least, *feeling or emotion-based judgments* (mood effects, attribution errors, problems of self-control, and hyperbolic discounting). Thanks to the preliminary works of Benartzi and Thaler (1995) and Barberis and Huang (2006) on the myopic loss aversion hypothesis and Chen and Epstein (2003), Barillas et al. (2009), and Gollier (2011) on the ambiguity aversion hypothesis, we test their conjectures on the integration of risk aversion and time preference (myopic loss aversion hypothesis) in Chapter 3, and the integration of risk aversion and ambiguity aversion (ambiguity aversion hypothesis) in Chapter 5 in attempts to explain the equity premium. We propose exploratory research on the effects of other prospect theory components on the equity premia dispersion in Chapter 4. We expect that our rigorous empirical evidence would set some base for further research to understand this remaining equity premium puzzle.

1.2 Main objectives and contributions

The dissertation consists of six chapters. Following this introduction, in Chapter 2, we briefly review the pros and cons of some "traditional" approaches to estimating the equity premia and describe in more detail about the data, methodology, and results of the IRR approach. We elaborate why and how data at a country level further alters investigation due to very few data points and limited availability of long-horizon time series. In addition, the advantages and disadvantages of the IRR approach are addressed in order to determine the contribution and limitations of our investigation.

Chapter 3 replicates the original calibration of Benartzi and Thaler (1995) in line with the myopic loss aversion argument using cumulative prospect theory parameters from an international survey (Rieger et al., 2014a,b) on stocks and bonds indexes in Datastream for more than 20 countries. We document that in shorter time spans and using our recent estimation of cumulative prospect theory parameters, the myopic loss aversion hypothesis suggests a shorter evaluation period. The inclusion of the full set of cumulative prospect theory parameters performs better when we expand the investigation to other countries.

Given our estimation of equity premia from "fundamental" analysis, in Chapter 4, we take one step further to analyze the explanatory powers of behavioral preferences on the dispersion of the equity premia worldwide within the setting of the myopic loss aversion hypothesis. We investigate not only loss aversion and time preference variables, but also other components of cumulative prospect theory that might account for the risk-taking behavior. Our results are robust in terms of the inclusion of many firm-level controls, which are proposed to affect equity return. In addition, cultural variables are investigated jointly using measurements that go back to the Dutch sociologist Hofstede: the so-called "Hofstede dimensions" (Hofstede, 1984, Hofstede, 2001). Since our exploratory analysis is not backed by a well-proven theory, we aim to provide some early empirical results as the first step for later research.

It has been demonstrated that such a connection between ambiguity aversion and the equity risk premium can exist in theory (Chen and Epstein, 2003; Barillas et al., 2009; Gollier, 2011). However, empirical evidence has been documented only at country-aggregate level and with the historical equity premium (Rieger and Wang, 2012). The new firm-level estimation of equity premia enables us to test empirically the joint effect of risk aversion together with ambiguity aversion in models accounting for the equity premia in Chapter 5. Thus, it is possible to conclude from a positive correlation across countries between ambiguity aversion and the equity premium that ambiguity aversion has a positive impact on equity premium, as theoretical models suggest. However, our current data are insufficient to estimate the proportion of equity premia that can be explained by it.

Finally, we conclude and want to shed some light on further research in Chapter

6. One of our additional contributions is to analyze the possible influence of cultural differences on the equity premium. It is not easy to investigate a potential mediator effect in which cultural differences influence behavioral preferences (e.g., loss aversion, time preference, and ambiguity aversion) that then by themselves influence the equity premium. We report the potential direct influence of culture on the equity premium in some specific sections in this dissertation.

Chapter 2

The “fundamental” equity premium

2.1 Introduction

In this chapter, we consider the key questions raised by Mehra and Prescott (2008): “Why have stocks been such an attractive investment relative to bonds?” and “Why has the rate of return on stocks been higher than on relatively risk-free assets?” Investigating 90 years of US stock market data (1989–1978), Mehra and Prescott (1985) find the historical average returns on equity far exceeded the average returns on short-term debt—virtually a default-free asset. While they use this historical equity premium, later research uses different concepts: in addition to the historical equity premium (HEP), also the expected equity premium (EEP), the required equity premium (REP), and the implied equity premium (IEP). We discuss the advantages and limitations of these approaches in estimating the equity premium and explain why we need another measurement of the equity premium, which we propose as a “fundamental” approach[1]. We name that “fundamental” since it is based on only fundamental accounting data.

The idea is to estimate the actual firm-level equity premium by extracting the internal rate of return (IRR) from investing in a company as if investing in a project. The new measurement of equity premia is consistent across firms and across countries over a much shorter time period than other methods are. This allows us to obtain data for a much larger number of countries than previous methods do, since in many cases, data

[1]Some of these results have been used for a working paper (?).

are available only for quite recent time periods. As a result, we can estimate equity premia in *28,256* firms from *54* countries. Because this method gives estimates at the firm level, we can also use equity firm controls, which are often bypassed in the previous literature.

Following this Introduction, Subsection 2.2 discusses the advantages and limitations of the "traditional" approach to estimating the equity premia in recent related literature in more detail. Subsection 2.3 describes our data collection and methodology, and reports also the estimated results of the "fundamental" equity premia.

2.2 Advantages and limitations of previous approaches for estimating equity premia

We first clarify the four different concepts of equity premia. First, the HEP is simply the differential return of the stock market over a risk-free asset. This is computed by taking the average difference between arithmetic/geometric returns from a stock market index over the risk-free asset, usually bonds or T-bills. The second concept is the EEP, which is the expected differential return of the stock market over a risk-free asset. EEPs are often collected via surveys. However, it is indeed difficult to determine a represent active EEP for the whole market, as different investors would have different expectations about stock returns. The REP is defined as the excess return from holding the stock portfolio over the risk-free asset as a reward for the compensation of additional risk. Finally, the IEP is actually the REP suggested by asset pricing models within the assumption of efficient market theory. For enthusiastic readers, excellent reviews can be found in Fernandez (2006); Mehra and Prescott (2008); Fernandez (2009); Damodaran (2015).

Among those methods, the original and most widely applied approach is the HEP. Many authors consider that the equity premium is a stationary process, and thus, the HEP would be an unbiased estimate of the EEP (*unconditional* average equity premium). For example, Mehra and Prescott (2003) state that "*... over the long horizon the equity premium is likely to be similar to what it has been in the past.*" This estimation also represents the required equity premium of a representative investor (Ross, 1976; Copeland et al., 1983; Stowe et al., 2002; Pratt, 2003; Goyal and Welch, 2006; Brealey et al., 2012). However, the HEP suffers from many critical drawbacks if the aim is to determine a consistent estimation of the equity premia for further research.

First, the historical equity premium is very sensitive to short-term fluctuations of stock markets, so that this approach becomes meaningful only for long time series (Cornell, 1999; Dimson et al., 2005; Damodaran, 2009). Therefore, it is necessary to extend the data analysis as far as possible, which is often difficult, since complete stock market data are, in most countries, available only for recent years. While in the US, time series can go back more than 100 years, in countries that have established financial markets only recently (e.g., countries in South East Asia, South America, and Eastern Europe), time series can be as short as 10 years. Even in the best cases in which back fillings help to create long time series, trading breaks, often in wartime, are often excluded from stock and bond data, resulting in concerns about the usefulness and accuracy of data (Fernandez, 2006). As Dimson et al. (2006) point out that "*... virtually all of 16 countries experienced trading breaks*." Such evidence is reported, for example, in UK and European exchanges at the start of World War I, in Japan after the Great Tokyo Earthquake of 1923, in Germany and Japan toward the end of World War II, in Spain during the Civil War, and in the Swiss market during mobilization.

The second concern is about a precise definition of a risk-free proxy and the choice of a representative stock market index. Neither T-bills nor bonds can exclude systematic risks[2], while the return on a single market index clearly does not represent the stock market as a whole. For instance, for the period of 1926–1957 in the US, the S&P composite weekly consisted of 228 stocks in 1927, 410 stocks in 1928, and 480 stocks in 1956, but was abandoned for the period of 1957–2006. Its alternative, the Ibbotson S&P composite daily, consisted of 90 stocks at the beginning and then in 1957 expanded to its current 500 stocks. In more detail, the market value of the S&P 500 stocks that

[2] "*... Bonds may expose an investor to one or more of the following risks: (1) interest-rate risk, (2) reinvestment risk, (3) call risk, (4) credit risk, (5) inflation risk, (6) exchange-rate risk, (7) liquidity risk, (8) volatility risk, and (9) risk risk.*" (Fabozzi, 1989)

have survived from the original 1957 list was only 31% of the 2003 S&P 500's market value, while more than 900 new stocks were added during the formulation of this index (Fernandez, 2006). Moreover, the geometric average or arithmetic average predicts different equity premia, even on the same data and investigation parameters, either in the US investigation or international research (Goetzmann and Ibbotson, 2006; Siegel and Schwartz, 2006; Damodaran, 2009).

Besides these specific forms of bias, the historical approach also has some other limits: survival bias and aggregation problem. First, only data at a country level are studied, which leads to very few data points. The selection criteria of using only data on listed companies, which show to some extent "the survival of the fittest" and tend to outperform other firms in the market, results in a positive return (Li and Xu, 2002; Brown et al., 2012). Additionly, Dimson et al. (2005) emphasize that "*... even if we have been successful in avoiding survivor bias within each index, we still focus on markets that survived."* We may add that selection bias results in the exclusion of countries with young stock markets due to the need for a long time series—another variant of survival bias. Moreover, there is still an aggregation problem in which the index has to reflect the overall returns of the whole stock market, which requires the broadest coverage and has to be weighted according to the stocks' market capitalization. The limitation only on firms that are included in market indexes alters the representativeness of these country-aggregated equity premia. Last but not least, the exogeneity of the equity premia leads to greater difficulties if we want to investigate equity premia using an international comparison. All of these problems make the simple and straightforward at-first-glance approach quite difficult, and the "art" of estimating HEP can be observed from the fact that in some instances, an HEP estimate for only one or very few countries justifies its own study (e.g., Wilson and Jones, 2002; Ibbotson and Chen, 2003; Siegel and Schwartz, 2006; Dimson et al., 2006; Damodaran, 2009).

The second widely accepted approach is the EEP from surveys. Intuitively, it seems natural to ask investors directly about the expected returns they demand when investing in stocks. The survey subjects include range from individual investors (Shiller, 2000), institutional investors, professionals, and managers (Graham and Harvey, 2012) to academics (Welch, 2000, Fernandez et al., 2012). However, a challenge is to find a subset of investors that best represents the aggregate market. First, many investors do hot hold the market portfolio but rather a subgroup of stocks and/or bonds. Second, they do not share "homogeneous expectations" (Brennan, 2004). Even if such a representative investor were to exist, there would be no social welfare function that leads to a normative representative expectation (Mas-Colell et al., 1995).

Another problem of this expected equity premium is due to the well-documented prediction bias of survey subjects[3]. Usually, a specific investor/fund manager or other individual in charge of investment decisions has their own knowledge, previous experience, and of course, some private information. This means that their actions might be driven by preference errors, thereby leading to disagreements in the subjectively expected equity premia. For instance, survey equity premia are responsive to recent stock price movements, that is, estimated values increase after bullish periods and decrease after recessions. Historical values, such as: average historical high and low peaks, yesterday's closing prices, and previous predictions about the market index, are often used as anchors for estimation about the future. For example, substantial differences have been found between the EEP and HEP (Booth, 1999; Mayfield, 2004).

The other issue is the fact that survey premia are sensitive not only to whom the question is addressed but how the question is delivered. Individual investors tend to predict higher expected returns on equity, and obviously positive numbers. Professional traders, who are subjected to be more overconfidence and are experienced, provide a lower anchored estimation of the equity premium (Kaustia et al., 2008). In addition, the framing effect plays a role in accounting for bias in survey results (Damodaran, 2015)[4]. As a result, the aggregation of those responses might not be particularly reliable in the

[3]Behavioral bias is discussed further in the next chapters. In brief, investors usually overvalue themselves (overconfidence), pay more attention to the recent fluctuations of some specific stocks in their portfolio (narrow framing), and use past information as reference points (anchoring effect). This explains the common positive magnitudes of the required equity premia and the tight bounds of those estimations in the cited references.

[4]The author argues that asking the question "What do you think stocks will do next year?" would generate different numbers than asking "What should the risk premium be for investing in stocks?"

case in which its components are estimated inaccurately.

Another EEP estimation approach is to regress the equity premium on some independent lagged predictors within the following formula (Fernandez, 2006):

$$Equity\ premium = a + bX_{t-1} + \varepsilon_t, \tag{2.1}$$

where X_{t-1} are the lagged predictors of which many have been suggested in the past, such as dividend yield (Ball, 1978; Campbell and Shiller, 1988; Fama and French, 1988; Cochrane, 1998), the short-term interest rate (Hodrick, 1992), earnings price and payout ratio (Campbell and Shiller, 1988; Lamont, 1998; Ritter, 2005), the term spread and default spread (Campbell, 1987; Avramov, 2002), the inflation rate (Fama and Schwert, 1977; Fama, 1981; Campbell and Vuolteenaho, 2004), the interest rate and dividend-related variables (Ang and Bekaert, 2007), the book-to-market ratio (Kothari and Shanken, 1997), value of high- and low-beta stock (Polk et al., 2004), consumption and wealth (Lettau and Ludvigson, 2001), and aggregate financing activity (Baker and Wurgler, 2000; Boudoukh et al., 2007). This method is based on the strong assumption that the stock prices perform as well as the models predicted, thereby facing the tests of a joint hypothesis of market efficiency and perfect asset pricing models.

In a similar vein, this would be the case when the historical equity premia are used as an *unbiased* estimate of the expected equity premium over the long horizon (Mehra and Prescott, 2003). Still, the issue of survival bias (Dimson et al., 2005; Brown et al., 2012) does exist, and the abovementioned models are not stable in predicting the expected equity premium (Goyal and Welch, 2006). For all of these reasons, this method cannot yield a concise prediction of the equity premium satisfying our research question.

Finally, we discuss the REP and the IEP—two closely related methods whose names are often used interchangeably. The REP is the incremental return that a representative investor requires or expects over the risk-free rate for investing in a stock portfolio, while the IEP is the required equity premium that arises from a pricing model and assuming that the market price is correct. In an ideal portfolio of only one stock and one risk-free asset, the REP of the representative investor is also the IEP suggested by any asset pricing formula under the settings of Lucas Jr (1978)'s pure exchange economy, given the EMH (Malkiel and Fama, 1970).

Within this setting, the REP is defined as the excess return that investors require for their additional risk bearing. In a world of only risk–return relationship, efficient asset pricing models and historical data can estimate this equity return precisely, and consequently, the equity premium over any risk-free asset. This viewpoint is widely accepted in textbooks and papers, and the equity premia are suggested in a range from 4% to 10% per annum. Examples from US data are REP = EEP = geometric HEP vs. T-bonds = 6% (Copeland et al., 1983); ERP = EEP = geometric HEP vs. T-bonds = 5.5% (Damodaran, 1996); REP = EEP = arithmetic HEP vs. T-bills = 8.5% (Ross et al., 2008); REP = EEP = arithmetic HEP vs. T-bills = 8% (Brealey et al., 2012); and many other similar suggestions (Stowe et al., 2002; Pratt, 2003; Arzac, 2004; Bruner, 2004). However, it is difficult to distinguish between diversifiable and undiversifiable risks (Ben-Horim and Levy, 1980). Furthermore, the choices of risk factors that cause the risk premium in neoclassical asset pricing models still face the chicken-and-egg problem of whether the stock prices perform as the asset pricing models predicted or the precise group of risk determinants have to be collected before expecting a reasonable model of asset pricing. Eventhough, an international risk-based asset pricing model is difficult to find due to the strong assumption that risks are well diversified across countries, which is proved to be practically unattainable (Karolyi and Stulz, 2003; Stulz, 1994; Goyal, 2012).

Damodaran (2015) undertakes the challenge of finding a "representative" equity premium, which can be estimated using shorter time spans and would be the base for further research on the equity premium and its potential determinants. The equity premium, in his view, is the price attached to risk. A risk-averse investor would pay a lower price for risky cash flows than for riskless cash flows with the same expected value. In a global context, assuming that investing in the US would yield the best estimation of equity premium due to the maturity of its equity market, the country specific equity premium can be decomposed as

$$Equity\ risk\ premium = Base\ premium + country\ risk\ premium, \tag{2.2}$$

where the country premium represents the excess undiversifiable risks and the base premium represents the equity risk premium in a mature market, here, the US. If this country risk can be measured, it is feasible to convert this measure into a country risk premium applying the formula (2.2). Alternative methodologies to measure the country risk are applied. The first is the sovereign rating attached to a country by rating agencies. The second is the use of country risk reports computed by various factors in the economic, political, and legal environment. The third is the volatility in the country's currency or markets, such as bond default spreads, credit default swap spreads, and market volatilities. Damodaran (2015) implies that "*... the equity risk premium, using different approaches, yields a range, with the lowest value being 2.80% and the highest being 5.78%.*" However, beyond its convenience, this approach excludes out the US's undiversifiable risks, and can not embrace idiosyncratic risks such as natural disasters or shocks from rare and disastrous events.

Up to this point, these estimations of the equity premium, except the EEP from surveys, all face another the same problem of backward looking. Given that "*... the future will not necessarily be like the past*" (Shiller, 2000), it seems more practical to consider other approaches that are more forward looking. There are two widely used approaches in the valuation of a stock that matches the current market value with an estimate of the future cash flow to equity. The first approach is based on the constant dividend growth model (Gordon, 1962) and its variation (residual income model), and the second is the IRR approach, which has been used by Fama and French (1999) to estimate the equity cost of capital. The equity premium estimated by this approach is therefore named the implied equity premium[5] (Damodaran, 2015).

[5] In our viewpoint, this is better addressed as the required equity premium because investors expect certain values of returns based on their subjective predictions about future cash flows, regardless of any assumption about the underlying asset pricing models. While Gordon (1962)'s model and its similarities have to assume some hypothetical values to capture the future expected returns, the IRR approach implies equity return from periodic firm performance, and hence, results in more objective

According to the Gordon (1962) model, if the current price (P_0) is the present value of expected dividends discounted at the required rate of return (k), d_1 is the dividend per share distributed at time 1, and g is the constantly expected long-term growth rate of dividends, the condition of a match between future cash flows to equity and current value is

$$P_0 = \frac{d_1}{k-g}, \tag{2.3}$$

which implies

$$k = \frac{d_1}{P_0 + g}, \tag{2.4}$$

and yields the equity premium

$$R^e = k - R^f = \frac{d_1}{P_0} + g - R^f. \tag{2.5}$$

Similarly, the abnormal return method assumes that all possible firm returns are included in d_t, that is, $d_t = e_t - (BV_t - BV_{t-1})$, where d is the dividend per share, e is the earnings per share, and BV is the book value per share. Then, we obtain

$$P_0 = BV_0 + \frac{(e - kBV_0)}{k-g}, \tag{2.6}$$

which implies

$$k = \frac{e_1}{P_0} + g(1 - \frac{BV_0}{P_0}), \tag{2.7}$$

where k is the required/implied rate of return from stock investment.

Excluding the risk-free return from the abovementioned equity return would yield the equity premium, as in equation (2.5).

Damodaran (2015) assumes a two-stage valuation model in which growth continues at 5% for 5 years and then, lowers to 4.02% (the risk-free rate) later on. Given the data of dividend yield on the index were approximately 1.89%, the implied equity risk

estimations of the equity premia

premium estimated for the period from 2008 to 2015 is computed by

$$1468.36 = \frac{29.12}{(1+r)} + \frac{30.57}{(1+r)^2} + \frac{32.10}{(1+r)^3} + \frac{33.71}{(1+r)^4} + \frac{35.39}{(1+r)^5} + \frac{36.81}{(r-0.0402)(1+r)^5}, \tag{2.8}$$

where the left-hand side value is the S&P 500 Index closed on December 31, 2007, the numerators in these right-hand side fractions are the estimated dividends, and the last term in the equation is the terminal value of the index. Subtracting out the 10-year T-Bond rate suggests an IEP of 2.02%. Adjusted for dividend cutoffs and stock buybacks during the global financial crisis, the estimation of IEP increases to 5.78% at the start of 2015.

Gordon (1962)'s approach and its variations have been used to predict the equity premium, which ranges from 3.04% (Jaganathan et al., 2000) to 5.3% (Easton et al., 2002) and 7% (Harris et al., 2003) in the US, and is less than 3% for Canada, France, Germany, and the UK (Claus and Thomas, 2001). However, critical limitations remain regarding subjective assumptions of future growth rates and its inconsistency in application to stock market prices, since many pairs of implied equity premia and growth can satisfy any assumption of market movements (Fernandez, 2006).

In more detail, regardless whether this approach yields a *safe* estimation (relatively similar to former suggestions) of the equity premium, and aims to be a forward-looking prediction, historical values are used again as an *unbiased* predictor for the future. For instance, even both the subjective value of a growth rate of 5% for the period of 2008–2015 and the assumption of a constant growth rate of 4.02% (the risk-free rate) after 2015, Damodaran (2015) might suggest an *acceptable* value of the implied equity premium. Because these smooth assumptions for future cash flows would have already excluded catastrophe risks, such as financial crisis, political turmoil, or natural disasters, by which the equity premium is believed to be the compensation for such undiversifiable risks (Rietz, 1988; Barro, 2005). Moreover, the choices of a set of parameters to estimate reasonable equity premia are in part based on subjective feelings toward an uncertain future, and thus, limit the applicability of this method.

Another technical issue is the fact that given the future dividend growth path performs as the Gordon model assumes, there are intuitively many pairs (IEP, g) that satisfy the condition of a surplus clearance in equation (2.6). This would be the case when heterogeneous investors do not hold the same portfolio of risky assets, that is, different expectations for the future cash flow rate g. Intuitively, the task of predicting a unique IEP regarding the assumption of homogeneous expectation, or a representative investor, representing the whole population of investors seems to be impossible.

Is there another approach that overcomes the constraints of time spans, survival, subjective assumptions, and limitations on country-level estimates, and is consistent across investigated subjects? The IRR method (Fama and French, 1999) deals with fundamental accounting data and seems to accomplish that. Generally, if P_0 is the current value, P_v is the future value, and I_t, E_t are investments and earnings at year t, and if T is the investment period, the required equity premium can be estimated via

$$P_0 = \sum_{t=1}^{T-1} \frac{(E_t - I_t)}{(1 + IRR)^t} + \frac{PV}{(1 + IRR)^T}. \tag{2.9}$$

The formula (2.9) is the standard IRR estimate of investment return from any financial asset. Given a concise time span and data availability, this helps to predict *objective* and *assumption-free* returns from every equity investment project. The IRR approach differentiates between security returns and the returns of investors, since the returns of stock investors depend not only on the returns of the securities they hold, but also the timing of their capital flows into and out of these securities, which captures both the cross-sectional and time-series characteristics of equity returns (Dichev, 2004). The return from an equity investment project can be computed within formula (2.9), in which initial market values and contributions from investors enter with negative signs (e.g., buying stocks), and distributions to investors (e.g., dividends and stock repurchases) and final market values enter with positive signs. It can be argued that the equity returns estimated by IRRs are meaningful only in mature stock markets that have long time-series data available, in which the positive effects of good time and the negative effects of bad time are canceled out, yielding more reasonable equity premia. However, the consistency of these IRR estimates, even in short periods and in bad times, suggests reliable equity returns that might be useful for comparison with risk-free asset returns observed from the same time spans. One reason is that it is possible to estimate returns on the level of individual stocks and that there are always overperforming and underperforming stocks on the market at the same time. For comparative research, such as explaining the differences of equity premia by variations of their potential determinants, the IRR approach seems to be a good choice in terms of its consistent applicability and its freedom from any subjective assumption.

Therefore, we decide to apply the IRR method to firm-level data to estimate equity returns. One advantage is that it allows the inclusion of various firm-level controls that are otherwise missing, especially in a countrywide comparison. In more details, we follow the empirical work of Fama and French (1999) for a similar purpose[6]. Technically, the equity returns are computable at a firm level and for shorter time series. However, this approach is in one respect rather demanding because, in order to obtain a worldwide sample, accounting data of good quality are needed for a sufficiently large number of companies. Fortunately, this latter point is no longer an issue nowadays, since, for example, the Osiris database provides exactly such data[7].

The IRR method is then applied to the OSIRIS database for the period of 2001–2010 (10 years). Even though our country-level equity premia aggregated from firm-level estimations are in the *reasonable* range from 0.94% (Denmark) to 7.75% (Netherlands)

[6]They use accounting and stock data in the US for the period of 1950–1966. Their measurements of equity returns are in the order of 6% to 7% in real terms, which is close to the compound year returns of stocks for the same period.

[7]OSIRIS is a fully integrated public company database and analytical information solution. The database provides financial, ownership, news, ratings, earnings, and stock data for the world's publicly listed companies. The industrial company financial data on OSIRIS is provided by World'Vest Base and five regionally specialized providers: Korea Information Service (KIS), Teikoku Databank (Japan), Huaxia International Business Credit Consulting Company (China), Reuters (US), and Edgar Online (US). OSIRIS has the unique advantage of providing firm-level fundamental data with large coverage around the world. There has been recent growth in the use of the OSIRIS database by high-ranking quality journals, such as the *Journal of Finance (*John et al., 2008)*, Journal of Financial Economics* (Carney and Child, 2013)*, The Review of Financial Studies* (Masulis et al., 2011, Lins et al., 2013), *Journal of Financial and Quantitative Analysis* (Li et al., 2011)*, Journal of Banking and Finance* (Agusman et al., 2008, Białkowski et al., 2012)*, Journal of Empirical Finance* (Bartram and Karolyi, 2006), and many others.

in Europe; 4.46% (Argentina) to 13.82% (Cayman Islands) in the Americas; 4.14% (Jordan) to 11.86% (United Arab Emirates) in the Middle East; 3.04% (Indonesia) to 15.05% (Vietnam) in Asia; and 9.55% (Morocco) to 16.33% (South Africa) in Africa, we do not aim to suggest representative equity premium values. Since these values may change accordingly to different time spans, the existence of a unique implied equity premium is still unclear (Fernandez, 2006).

We acknoledge that the other considerations would be about the 10-year evaluation period and the period of 2001–2010. First, why 10 years? Beyond the fact that choosing a 10-year period results in the largest data coverage from OSIRIS, the hypothetical 10-year evaluation period is backed up by a suggestion from recent research: Ljungqvist and Richardson (2010) investigate the performance of private equity funds and document that it would take at least 10 years for capital to be returned to generate excess returns. Second, why select 2001–2010? Note that the period from 1995 to 2010 was not a "normal" period, since it contained the dotcom bubble, the global financial crisis, and the 12-year lows of stock indexes in 2009; thus, the estimated equity premia might not be representative at all. This would be the case for country-level aggregation. However, at the firm/individual-investor level, the requirement of a representative investment period becomes meaningless. Because noise traders follow the trends while value investors take the opposite positions[8]. Even in bad times, our approach suggests a consistent measurement of equity returns, which enables further investigation on its determinants, both at the firm-specific level and other countrywide potential. However, the law of large number and our large data suggest a reasonable range of equity premium on country aggregation.

After the exclusion of firms in the banking and finance sectors, as is standard in this field, this gives a total of N = *28,256* companies in *54* countries for our final investigation, which is the largest sample for equity premium estimates to date and enables us to investigate the famous equity premium puzzle further.

[8] "*We simply attempt to be fearful when others are greedy and to be greedy only when others are fearful.*" Warren Buffett (http://www.berkshirehathaway.com/letters/1986.html)

2.3 Methodology and results: the "fundamental" equity premium

To estimate the equity premium with the fundamental approach, we treat every firm as a project. In other words, we consider the investment as buying the firm by acquiring all its assets at the beginning, subsequently retrieving earnings, and funding outflows. At the end, we sell the firm to realize returns. The IRR from this investment is the *objective* return of investors, given the condition that investors had enough initial money to buy the whole company at first and to sponsor all the outcomes (e.g., investments and operational costs). The equity premia aggregated at country level can then be used as a proxy for the required equity premia under the assumptions of the law of large numbers.

More precisely, we use the following accounting items to estimate the IRRs: the book capital of a firm in year t is defined as the sum of long-term debt (item D:14016 in the OSIRIS global detailed format) plus short-term debt (D:21030) and book equity, where book equity is the sum of total assets (D:13077) minus total liabilities (D:14022) plus deferred tax (D:21100). The cash earnings in year t are computed by adding earnings before extraordinary items and depreciation (D:12037). Investment in year t is measured as the change in book capital of the firm between year $t-1$ and t. To increase the number of observations, we set the value of long-term debt, short-term debt, and the value of net cash flow to zero when there are missing values[9]. This modification is suggested by Fama and French (1999) and has been proven to work well for real-life data.

A natural concern is the potential problems due to different accounting regulations between the investigated countries, but this has been addressed by the *global detailed* format in Osiris. Raw data are presented in the company's country-specific and regional accounting standards. The accounts are further condensed and the format presentations

[9] We have to replace 2,438 observations of deferred tax, 5,196 observations of extraordinary items, 1,921 observations of short-time debt, and 1,162 observations with long-term debt with zero. This constitutes in total less than 7% of the overall observations. This trade-off makes sense, since we can include more firms but our methodology still maintains the consistency of the estimated IRRs.

are synchronized across the different templates in the *global detailed* and *global* formats. These standardized formats enable users to follow the account logic while maintaining a high level of data transparency and accuracy[10].

Technically, the IRRs[11] are the discount rates r_c, which solve the following formula:

$$0 = -IC_0 + \sum_{t=1}^{T-1} \frac{X_t - I_t}{(1+r_c)^t} + \frac{FC_T + (X_T - I_T)}{(1+r_c)^T}, \tag{2.10}$$

where

IC_0: book value of a firm's assets at the beginning of the investment period.

X_t: cash earnings of a firm in year t,

I_t: gross investment of a firm in year t,

FC_T: book value of a firm's assets at the end of the investment period,

T: the number of years of the investment period. c denotes book values and t is the summation index.

The formula (2.10) is the standard expression of the *IRR* of an investment project. The ideal cases in which we have all the accounting variables for the whole period of 10 years for those firms from OSIRIS are infrequent, while the case in which firms entering and exiting the data in durations of less than 10 years are more frequently observed. Thus, the time indexes of the IRR formula have to be adjusted to match these time spans.

[10]"The industrial financials on Osiris from World'Vest Base, Multex, KIS, Teikoku and Huxia are collected through direct company contact and directly from the original annual reports issued by the companies. The regional accounting practices are retained with the use of the *Anglo* (mostly used for American, English and Nordic companies), *Hybrid* (mostly used for European companies) and *Continental* (mostly used for Asian and Australian companies) templates, which present differing *Spreadsheet* formats. Accuracy is retained in the *Global detailed* and *Global* formats as the accounts are further condensed and the format presentations are synchronized across the three industrial templates" [Osiris dataguide] (http://www.otago.ac.nz/library/pdf/OSIRISDataGuide.pdf)

[11]Fama and French (1999) propose two concepts: IRRs on costs and IRRs on values. In the first term, the initial investment is to acquire the firm at its market value, while booked costs are used in the second. The same argument is applied to the values at the end of the investment period. In this research, we apply only nominal values following the "Money Illusion" assumption in which investors usually deal with nominal values in practice (Benartzi and Thaler, 1995). Consequently, the use of book values better captures the "fundamental" corporate returns by excluding all trading risks in stock markets. Thus, such data perfectly fit our international comparison.

Table 2.1: Numerical examples of IRR methodology

The cash flows to estimate IRRs are formed as follows: the initial value of each run equals the book capital of the firm and starts with a negative value, the middle terms are net cash flows (i.e., earnings minus investments), and the end-run value equals the book capital of the firm plus the net cash flow of the end-run year. The currency unit is US dollars. These values are extracted from real data but company names are hidden.

	Company A	Company B	Company C	Company D
December 31, 2001	-1,104,830			-183,174
December 31, 2002	203,821			-5,310
December 31, 2003	-197,944		-3,022,000	142,967
December 31, 2004	-490,045		-252,000	
December 31, 2005	-662,773		628,000	
December 31, 2006	435,908	-73,653	252,000	
December 31, 2007	-38,688	1,975	4,627,000	
December 31, 2008	-511,806	2,218		
December 31, 2009	462,479	-8,246		
December 31, 2010	4,591,151	107,112		
IRR	12%	9%	15%	-13%

We have to apply the following method to utilize the best information available from OSIRIS: first, the IRR formula requires firm values at time zero, firm values at time T (the end of an investment period), and information about incomes and investments yearly. Firms with at least 2 consecutive years of data availability are then selected. An investment subperiod is named as a run from year t to year $t+i$, which i is the number of consecutive years. The firm value at the beginning of a run IC_t equals the book capital of this firm in that year, while the firm value at the end of the run FC_{t+i} has to be adjusted by the net cash flow (i.e., earnings minus investments). The largest number of years in a run is 9 and the smallest number is 2. Numerical examples of the IRR methodology are illustrated in Table 2.1.

The next step is to create a 10-year investment period from year 2001 to year 2010 to apply the IRR formula to estimate the equity premia[12]. After computing the IRR for a large number of companies, we then remove outliers[13]. And we check the consis-

[12] We attempt to increase the IRR estimates by assuming that a firm with data that have missing values during the investigation period can be disparted into a maximum of three runs (consecutive years). The IRRs from these runs are then aggregated to estimate an IRR for a specific firm. However, this does not work since the IRRs cannot yield estimated results due to lack of data points.

[13] We drop the top and bottom 1% percent of observations, as is standard in this field (Ramsey and Ramsey, 2007) for each variable in our sample. In addition, we remove countries that have less than 30 companies in order to improve the representativeness of sampling, thereby excluding *64* countries

tency of our results by comparing the country-aggregated IRRs with the equity premia approximated by other methodologies (Table 2.2)

Table 2.2: Equity premia around the world

No.	Country	# of firms	Obs	Equity Premium	Standard Deviation
Western Europe					
1	Austria	58	468	5.57%	120.1%
2	Belgium	96	705	5.88%	16.9%
3	Switzerland	119	847	6.04%	12.5%
4	Cyprus	78	360	7.23%	215.8%
5	Germany	489	3,465	3.26%	13.3%
6	Denmark	58	391	0.94%	9.6%
7	Spain	98	603	4.75%	11.1%
8	Finland	101	866	5.83%	8.8%
9	France	564	3,976	6.63%	25.5%
10	UK	1,075	6,449	6.30%	49.6%
11	Greece	200	1,303	1.66%	8.7%
12	Ireland	50	336	6.98%	12.3%
13	Italy	197	1,319	3.29%	9.5%
14	Netherlands	98	747	7.75%	9.8%
15	Norway	98	564	5.65%	9.9%
16	Portugal	38	274	1.46%	8.3%
17	Sweden	265	1,604	7.29%	20.1%
18	Turkey	228	1,108	5.16%	15.1%
South and Central America					

and $N = 491$ companies from the sample.

Table 2.2: Equity premia around the world

No.	Country	# of firms	Obs	Equity Premium	Standard Deviation
19	Argentina	81	549	4.66%	15.1%
20	Bermuda	543	4,057	7.12%	17.1%
21	Brazil	303	1,848	6.35%	58.6%
22	Chile	69	366	4.73%	136.3%
23	Cayman Islands	657	3,793	13.82%	47.5%
24	Mexico	83	518	5.43%	13.6%
25	Peru	123	737	5.54%	33.5%
26	Virgin Islands (British)	58	194	8.80%	18.4%
North America					
27	Canada	2,596	13,596	1.50%	383.5%
28	US	5,727	36,089	9.93%	249.1%
Middle East					
29	United Arab Emirates	35	217	11.86%	17.3%
30	Israel	364	1,896	5.68%	11.1%
31	Jordan	121	892	4.14%	8.3%
32	Kuwait	90	556	11.21%	50.4%
33	Oman	92	719	8.19%	96.5%
34	Saudi Arabia	70	442	8.98%	11.6%
Far East and Central Asia					
35	Bangladesh	99	294	10.20%	23.2%
36	China	2,236	14,548	6.36%	12.4%

Table 2.2: Equity premia around the world

No.	Country	# of firms	Obs	Equity Premium	Standard Deviation
37	Hong Kong	123	856	7.34%	8.6%
38	Indonesia	72	278	3.04%	6.9%
39	India	2,756	14,583	5.01%	11.4%
40	Japan	2,435	17,769	3.02%	6.1%
41	Korea (South)	1,288	8,143	7.48%	19.4%
42	Sri Lanka	158	835	7.14%	12.3%
43	Malaysia	672	4,865	5.48%	9.2%
44	Philippines	126	713	6.79%	12.7%
45	Pakistan	347	1,697	6.16%	136.6%
46	Singapore	527	3,256	9.02%	11.1%
47	Thailand	409	2,771	7.78%	9.1%
48	Taiwan	1,413	9,104	6.86%	11.7%
49	Vietnam	155	417	15.06%	18.2%
Africa					
50	Egypt	154	1,065	13.77%	12.0%
51	Kenya	34	181	12.23%	20.4%
52	Morocco	34	233	9.55%	9.2%
53	Nigeria	84	399	11.25%	115.6%
54	South Africa	212	1,366	16.33%	13.4%

Applying this method yields reasonably sized estimates for the equity premium. The median equity premia range from 0.94% (Denmark) to 7.75% (Netherlands) in Europe; 4.46% (Argentina) to 13.82% (Cayman Islands) in the Americas; 4.14% (Jordan) to 11.86% (United Arab Emirates) in the Middle East; 3.04% (Indonesia) to 15.05% (Vietnam) in Asia; and 9.55% (Morocco) to 16.33% (South Africa) in Africa. Interestingly, the equity premium in the US is 9.93%, which is very close to some recent estimations of the equity premia (reviews can be found in Damodaran, 2015, Rieger et al., 2013b and references therein). Intuitively, the equity premium that we measure for a single country is, strictly speaking, not an equity premium but just one instance of a required return by investors. On average, however, this corresponds to the equity premium.

To the best of our knowledge, this is the first international estimation of firm-level equity premia. The results confirm that the equity premium exists and is not merely an artifact of previously applied country-level methods. In the next sections, we use these unique data to test alternative explanations for the equity premium puzzle.

Chapter 3

Myopic loss aversion revisited

3.1 Introduction

This chapter focuses on one of the most influential potential explanations of the equity premium: the hypothesis of myopic loss aversion (Benartzi and Thaler, 1995). The key idea is to apply two concepts from the psychology of decision making to capture the behavior of investors in their asset allocation decisions: First, *loss aversion* relates to the empirical observation that losses have more impact than corresponding gains, playing the key role in prospect theory (Kahneman and Tversky, 1979) and its updated version cumulative prospect theory (Tversky and Kahneman, 1992). In financial contexts, changes in wealth relative to the status quo yield different utilities, according to whether the investor considers them as surplus or reduction. The larger are the volatilities of stock returns, the more frequently do investors observe losses, which makes stocks less attractive. The second is *mental accounting* (Kahneman and Tversky, 1984; Thaler, 1985; Thaler et al., 1997), this term refers to the inherent methods investors apply to code and evaluate financial outcomes in separate mental accounts rather than in broader contexts. This term is captured by the suboptimal aggregation rules by which investors tend to make short-term decisions and bypass long-term policies in their portfolio choices.

These ideas have been used to explain the equity premium puzzle in US historical data (1926–1990). Benartzi and Thaler (1995) document that the two factors result in an investor being unwilling to bear risks. The combination of loss aversion and short-term decisions is referred to as *myopic loss aversion*. The authors report that the ideal cases are found by a combination of a level of loss aversion of around two, and investment horizons of approximately 1 year, where investors feel indifferent between the prospective utilities of holding either stocks or bonds. This reflects the usual references of investors to evaluate their portfolios corresponding to frequency of annual financial reports, regardless of whether their planning horizons are much longer[1].

These results seem to fit perfectly with the US historical data, but also raise interesting questions about the applicability of myopic loss aversion to other timeframes and markets. Thanks to an international survey on investors' preferences (Rieger et al., 2013a, 2014b,a) and recent data availability, we have a great chance of replicating Benartzi and Thaler (1995)'s work on a recent group of stocks and bond series from Datastream. Our calibrations document the same results for the existence of equity premia in 20 major stock markets, confirming the predictive powers of *loss aversion* and *myopia* on the recent historical equity premia. However, when using the full version of cumulative prospect theory and myopia, that is, calibrating all five parameters of cumulative prospect theory, the effect of loss aversion is reduced, which suggests an effect of the concavity/convexity of the cumulative prospect theory value function. This is therefore a good starting point for us to take a closer look at the approach of integrating alternative behavioral dimensions to account for the equity premia in Chapter 4, given the unique empirical firm-level data we estimate before (Chapter 2).

This chapter is organized as follows. In the next section, we discuss recent equity premia, the theoretical background of myopic loss aversion, and our key research questions, similarly to Benartzi and Thaler (1995). Section 3.3 reports our empirical investigation of myopic loss aversion on data in the US, using the longest stock and bond series available in Datastream from December 31, 1988 to December 31, 2015. Section 3.4 expands

[1]Benartzi and Thaler (1995) assumes, with some evidence, that organizations, such as pension funds, foundations, and university endowments, have on average the same preferences as individual decision makers.

the investigation to other countries and Section 3.5 concludes.

3.2 Related literature

3.2.1 Do equity premia still exist?

Much time has passed since Mehra and Prescott (1985) challenged scholars to find a reasonable model to explain the considerable difference between the return from stock investments and the return from fixed income securities. The authors show that investing in stocks can bring an annual real return of around 7% but less than 1% on bonds or T-bills for the period from 1926 to 1985 in US data. Since stocks are more risky, investors require this excess return as compensation for bearing additional risk(s). However, without assuming an unreasonably high degree of risk aversion, the traditional Lucas Jr (1978) framework and the consumption-based capital asset pricing model cannot fully explain this return difference of at least 6% a year. This is the famous *historical* "equity premium puzzle."

Along that line of research, Mehra and Prescott (1985)'s approach has been replicated to report the equity premia across timeframes and markets (excellent summaries can be found in Fernandez, 2006, 2009; Mehra, 2011; Damodaran, 2015). In more recent data, the equity premium seems to decrease (Jaganathan et al., 2000, Lettau et al., 2008), but still exists all over the world (Dimson et al., 2005, 2006; Fernandez et al., 2011; Damodaran, 2015). As discussed in Chapter 2, the historical equity premium is often criticized for its limited applicability to only longitudinal historical data (Cornell, 1999), which are available only in some *survival* markets.

We expect to figure out the equity premia in recent data. To maintain consistency, we choose the total market return series and 10-year benchmark bond series from Datastream for the period December 31, 1994 to December 31, 2015 for our research. We imply an additional test with data in the US, where the longest stock and bond return series can date back to December 31, 1988, with aims to estimate the equity premium from the best data coverage recently. The equity premia are positive in some countries

Table 3.1: Historical equity premia worldwide (December 31, 1994–December 31, 2015)

Country	Arth.Equity Premia	Geo.Equity Premia
Australia	1.83%	1.21%
Austria	0.03%	-1.54%
Belgium	3.55%	2.27%
Canada	2.55%	1.65%
Denmark	6.68%	5.11%
Finland	6.82%	3.01%
France	3.27%	1.77%
Germany	-3.28%	-1.05%
Ireland	2.68%	1.12%
Italy	-0.94%	-2.80%
Japan	-0.56%	-2.02%
Netherlands	2.36%	0.69%
New Zealand	1.38%	0.79%
Norway	4.13%	2.14%
Portugal	-3.01%	-4.08%
Spain	2.25%	0.48%
Sweden	5.46%	3.42%
Switzerland	4.13%	3.07%
UK	1.03%	0.22%
US	4.33%	3.36%

and negative in others, where both arithmetic and geometric formulas were applied[2] (Table 3.1). Of course, the time span is too short to expect values close to long-term averages, particularly given the impact of the 2008/2009 financial crisis.

Data availability causes *a selection issue*, since positive equity premia are mostly reported in developed markets. This initiates the *biased* common knowledge by which stock investments always dominate bond or T-bill investments on aggregation if we expand the investigation periods long enough. Our results for a shorter horizon (20 years) can show only that stock investments are more volatile. It was possible to sustain losses at a rate from 1% to more than 4% per year if investors had invested in stocks in Australia, Germany, Japan, or Portugal during the last 20 years. However, equity investing could still bring yearly premia of up to 6% per annum in other markets. It means, in a global context, investing in stock markets increases the chances of making

[2]The monthly average equity premia are then annualized by the formula $annual\ equity\ premium = (1 + monthly\ equity\ premium)^{12} - 1$. We check for robustness by using yearly data and document the similar results

losses but yields still positive returns on aggregation. Impatient investors might experience these losses more often, thereby demanding larger required premia (Benartzi and Thaler, 1995; Barberis and Huang, 2006). In the next sections, we discuss these interesting observations in more detail in line with the myopic loss aversion hypothesis.

3.2.2 Theoretical background of myopic loss aversion

Beyond traditional risk-based attempts, behavioral approaches focus more on investors' preferences for behavior that tends to cause an additional premium over the normal risk premium. The first endeavor in this line of research is to modify the original preference structure of Mehra and Prescott (1985) to achieve a more reasonable risk aversion measurement, for instance, the generalized expected utility (Epstein and Zin, 1991). The model separates the risk aversion coefficient from the elasticity expression, and hence, consumption changes and wealth deviations can both contribute to account for the equity premium. However, a relative risk aversion coefficient larger than 45 and the overweights on this overestimated relationship between preferences limit the explanatory power of this argument (Kocherlakota, 1996; Mehra, 2003).

Other researchers have attempted to disentangle intertemporal substitution and risk aversion in order to generalize the atemporal non-expected utility theories into a temporal framework (the habit formation models developed by Constantinides, 1990, Abel, 1990, and Campbell and Cochrane, 1999). In these settings, the agent is not only risk averse on average but also prefers a lower (but stable) level of consumption that can be sustained in the long term. A small deviation in consumption level changes the marginal utility significantly. Therefore, additional aversion toward consumption deviation leads to a higher magnitude of equity risk premia.

Advances in psychology enable further exploration of applying decision-making theories to the field of finance and promise more reasonable results. Such an influential innovation is the prospect theory of Kahneman and Tversky (1979) and its updated version of cumulative prospect theory (Tversky and Kahneman, 1992). In brief, the four key ingredients of prospect theory are the following.

- Prospect Theory agents evaluate outcomes in term of gains and losses relative to a reference point[3].

- Investors have asymmetric risk aversion, since their value functions are S-shaped with a turning point at the origin.

- Investors dislike losses by a factor of around two times compared to their like of gains (loss aversion)

- Investors' probability assessments are biased in the way that extremely small (high) probabilities are over(under)-valued.

Technically, the preferences of an agent under cumulative prospect theory (Tversky and Kahneman, 1992) are characterized by the following parameters.

- The value function takes the form

$$v(x) = \begin{cases} x^{\alpha} & for \quad x \geq 0 \\ -\lambda(-x)^{\beta} & for \quad x < 0 \text{ with } \lambda > 1 \end{cases}, \tag{3.1}$$

  where α, β capture the marginally decreasing slope of the function, and the coefficient λ captures the difference in slopes of the positive and negative arms of the value function, that is, loss aversion. x is a change measured as the difference in wealth with respect to its lagged value, which means that the status quo moves over time.

- The "prospective utility" of a prospect (x_i, p_i) is given by:

$$V(x,p) = \sum_{i=1}^{N} \pi(p_i)v(x_i), \tag{3.2}$$

where $v(x_i)$ is a monotonic value function as in prospect theory. If w is a weighting function, which uses γ and δ as parameters for the subjective weights in isolated domains,

[3] These reference points can be the current level of assumption or wealth. Similar to habit formation or keeping up with the Joneses, these reference points can be a neighbor's consumption, or a past level of consumption. Temporally, these reference points refer to the status quo of the agent's wealth or consumption, which changes relatively with the marginal increase/decrease of its former values.

the decision weight of an outcome in isolated domains is described as

$$\pi_i^{\pm} = w^{\pm}(p) - w^{\pm}(p^*), \tag{3.3}$$

where $p = (p_i + ... + p_n)$ and $p^* = (p_{i+1} + ... + p_n)$ are the probability of receiving at least as good (bad) as or better (worse) than $v(x_i)$, and strictly better (worse) than $v(x_i)$, respectively. This means the decision weights $\pi(p_i)$ depend on the cumulative distribution of the prospect, not only on its probability p_i.

- Tversky and Kahneman (1992) suggest the weighting function as

$$w(p) = \frac{p^{\gamma}}{(p^{\gamma} + (1-p)^{\gamma})^{\frac{1}{\gamma}}}, \tag{3.4}$$

  with different values of γ in isolated domains while judging probabilities of a prospect ($\gamma+$ in a gains domain and $\gamma-$ in a loss domain, or γ and δ in some other publications). p represents probability.

- To capture loss aversion better, Tversky and Kahneman (1992) proposes a neutral loss-aversion parameter θ, which is defined as the ratio between a gain X and a loss L, such that a 50–50 lottery between X and L is as attractive as an outcome of zero. In the above value function and weighting function, other prospect theory parameters $(\alpha, \beta, \gamma, \delta)$ would then be equal to 1.

The idea of myopic loss aversion was proposed by Benartzi and Thaler (1995) and then generalized by Barberis and Huang (2006) to explain the equity premium puzzle. Generally, investors are loss averse. Together with shortsightedness, their aggregation rules are biased in two dimensions: cross-sectionally and intertemporally toward suboptimal decisions. Cross-sectionally, investors place more weights on stocks that receive most of their attention; for example, stocks with abnormal price fluctuations and stocks with news recently presented in the media. Intertemporally, investors tend to consider stocks less risky in the long term due to mean reversion and observed historical traits. This is illustrated in the example of Samuelson (1963), where his friend refused a risky choice at first, but accepted a combination of 100 repetitions of the same lottery. In market situations, investors are more willing to take risks if they evaluate their performance less frequently due to less experience of loss probabilities.

In more detail, investors' preferences are captured by all five parameters of cumulative prospect theory, but loss aversion plays an important role in driving their decisions. A myopic investor, that is, one with a short planning horizon, is more likely to experience potential losses, since the probability of a loss is higher in the short run. By contrast, a nonmyopic investor, that is, one with a long-term expectation, rebalances her portfolio less often. The latter investor expects a lower but stable return from equity while the former demands additional premia due to observing "more" risk. As a result, the required equity premium comes from the joint effect of the degree of loss aversion and the inherent evaluation horizon.

In their analysis, Benartzi and Thaler (1995) use historical data (1926–1990) of monthly returns on stocks, bonds, and treasury bills from the Center for Research in Security Prices (CRSP) to answer the following two questions. (1) If investors have prospect theory preferences, how often would they have to evaluate their portfolios to make their *"prospective utilities"* indifferent between stocks and bonds? (2) If investors maximize their *"prospect utilities"* with a hypothetical 1-year evaluation period, what mix of stocks and bonds would be their optimal combination? The questions are answered by empirical simulation, which suggests an ideal evaluation period of around 1 year and an optimal asset allocation of approximately 50%–50% each. This prediction at the individual level can be implied for institutional investors. Managers investing others' money must often align their interests with those of their clients, that is, they show the same myopic behavior (Eriksen and Kvaløy, 2010), and this effect is even stronger with professional traders (Haigh and List, 2005). An acceptable level of "risk" perception is reached when the 1-year frequency of portfolio balancing and the degree of aversion toward potential losses coincide.

Table 3.2: Some representative estimates of cumulative prospect theory parameters

Authors	α	β	λ	γ^+	γ^-
Tversky and Kahneman (1992)	.88	.88	2.25	.61	.69
Camerer and Ho (1994)	.22			.56	.56
Wu and Gonzalez (1996)	.5			.71	.71
Abdellaoui (2000)	.89	.92		.60	.70
Donkers et al. (2001)*	.61	.61		.413	.413
Schmidt and Traub (2002)			1.43		
Etchart-Vincent (2004)		.97		1.10	.84
Anderson and Galinsky (2006)	.81	.80	1.07		
Harrison and Rutström (2009)		.97		1.10	.84

* *The author uses Prelec (1998)'s function for the weightings:* $w(p) = exp(-(-lnp)^{\gamma})$

3.2.3 Representative parametric estimations of cumulative prospect theory

The specifications of cumulative prospect theory reviewed in the Subsection 3.2.2 have five parameters: the risk aversion coefficient α, the risk-seeking coefficient in losses β, the loss-aversion coefficient λ, and $\gamma^{\pm}$ for the probability weighting function[4]. Generally, these parameters are estimated from surveys based on Allais paradox[5] type of questions. Several studies provide estimates of the parameters associated with different functions, which causes some degree of divergence in their results. We provide a summary in Table 3.2 of some parameterizations applying the power value function and weighting function, as proposed by Tversky and Kahneman (1992). We do not intend to cover all studies that report parametric measures of utility curvature, loss aversion, and/or probability weighting under cumulative prospect theory, but this table can be used as a comparative reference of a reasonable range in the estimations of cumulative prospect theory, which capture the broadest dimensions of investors' preferences in a systemic manner. More detailed discussions can be reffered to Neilson and Stowe (2002); Booij et al. (2010).

[4] We use (γ & δ) and ($\gamma^{\pm}$) interchangeably in this research, while ($\sigma^{\pm}$) is used in other publications

[5] In the Allais paradox, subjects typically prefer lottery A= \$1 million for sure over lottery B = (\$0, \$1 million, \$5 million, 0.01, 0.89, 0.10), and prefer D = (\$0, \$5 million, 0.9, 0.1) over C = (\$0. \$1 million, 0.89, 0.11), which violates the prediction of expected utility (Allais, 1953).

3.2.4 International estimations of cumulative prospect theory values

Prospect theory parameters have been estimated recently from the international survey of risk attitudes and time preferences (INTRA) (see Rieger et al., 2014b). This survey was conducted in *53* countries worldwide with a total of $N = 6{,}912$ participants. Investors' choices were measured based on lottery-type questions, distributed among an internationally homogeneous group of subjects. The variables were then aggregated at country level to determine proxies of individual investors' preferences.

Generally, Rieger et al. (2014b) report that the values are mostly reasonably close to other previous estimates (see Table 3.3): α and β are always less than 1, which is in line with the prediction of a convex–concave value function in prospect theory (α, on average, is smaller than β). Another important feature is that investors overweight small probabilities (γ and δ are strictly smaller than 1). Those are documented in both gains and losses. The average value of γ is strictly lower than δ, which implies that the participants underweight moderate probabilities of gains more than the corresponding probabilities of losses, although the authors are cautious about this interpretation, given the small number of lotteries in losses in this study.

In addition, we use the neutral loss aversion parameter θ. This is defined by Tversky and Kahneman (1992) as the ratio between a gain X and a loss L, such that a 50–50 lottery between X and L is as attractive as an outcome of zero.

3.2.5 Test of myopic loss aversion on recent historical equity premia

Even though Benartzi and Thaler (1995)'s results fit perfectly with historical data in the US, the myopic loss aversion hypothesis has not been tested in more recent data or outside the US. One possible reason is that accurate estimates of the HEP require very long historical datasets (Cornell, 1999). However, there is no quick rule of thumb on how many years should be considered to be a fairly long time series (Nada, 2013).

Table 3.3: Prospect theory parameters from INTRA (Rieger et al., 2014a,b) for countries for which there are sufficient data on the equity premium

Country	Alpha	Beta	Gamma	Delta	Lambda	Theta
Australia	0.41	0.45	0.62	1.00	0.90	1.24
Austria	0.43	0.49	0.57	0.98	0.95	1.83
Belgium	0.44	0.55	0.64	0.94	0.86	1.96
Canada	0.42	0.47	0.44	1.00	1.04	2.00
Denmark	0.51	0.90	0.57	0.73	0.28	2.00
Finland	0.45	0.51	0.50	0.70	0.91	2.00
France	0.42	0.49	0.44	0.98	1.00	2.00
Germany	0.42	0.49	0.44	0.71	1.00	2.00
Ireland	0.39	0.49	0.42	0.71	0.83	2.00
Italy	0.42	0.55	0.44	0.94	0.78	2.46
Japan	0.36	0.49	0.48	0.71	0.75	2.00
Netherlands	0.47	0.90	0.82	0.73	0.20	1.46
New Zealand	0.44	0.33	0.51	0.76	1.75	1.50
Norway	0.39	0.45	0.55	1.00	1.00	1.83
Portugal	0.43	0.60	0.60	0.88	0.62	1.83
Spain	0.44	0.68	0.47	0.96	0.52	2.38
Sweden	0.39	0.82	0.60	0.80	0.22	2.00
Switzerland	0.41	0.49	0.48	0.98	0.95	2.00
UK	0.44	0.61	0.47	0.64	0.52	1.38
US	0.42	0.49	0.44	0.98	0.98	1.65

Given the recent data availability, we select the monthly data of the Global Equity Indices and the 27-year Benchmark Bonds Indices from Datastream for our replication in the US. In addition, the equity premia are computed from the same source for a period of 20 years (1995–2015) for our research expansion to other countries. Our data choice differs from the initial research in the following manners. (1) The most recent data, from 1995 to 2015, including the global financial crisis of 2007–2008, are used. Even though this period seems to be not a "normal" period owing to the dotcom bubble, the crisis period, and stock indexes reaching a 12-year low in 2009, our computed equity premia are distributed in a reasonable range (Table 3.1). (2) All data terms are nominal, since in reality, investors deal only with financial reports that are usually represented in nominal terms (Benartzi and Thaler, 1995). (3) No simulation process is applied with the aim of reducing any concern about data creation issues[6]. Last but not least, the consistency of data quality in Datastream promises more precise results for our international comparison of myopic loss aversion in the setting of international research.

Up to this point, Datastream data[7] and the INTRA survey enable us to investigate the same questions as Benartzi and Thaler (1995) with confidence, however within a broader context.

[6]Obviously, there would be a certain trade-off in this data choice, since simulation at first glance helps to create a smoother and econometrically significant dataset. However, using only objective data points enables us to capture the actual behavior of investors better, which is economically more meaningful. This methodology has previously been applied in a replication of myopic loss aversion on recent data for nine European countries, providing empirical evidence supporting the myopic loss aversion hypothesis (Isager-Nielsen, 2009; Frank Christensen, 2012). However, the use of only Benartzi and Thaler (1995)'s set of cumulative prospect theory parameters for all countries limited the explanation power of these attempts.

[7]We believe our data choice to be of better quality since it provides 240 monthly observations (20 years), and 324 observations (27 years) in the US compared to Mehra & Prescott (1985), who use 89 observations, and Dimson, Marsh & Staunton (2011), who use 111 observations,

3.3 Myopic loss aversion and recent historical equity premia in the US

3.3.1 How often are portfolios evaluated?

The basic approach is to calibrate the investment horizons from 1 to 36 months to find the ideal evaluation period for which investors feel indifferent in their *prospective utilities* from investing either 100% in stocks or 100% in risk-free assets. To achieve this, we need the following components: equity return series, risk-free (bonds) return series, cumulative prospect theory parameters, together with corresponding investment horizons. Three sets of cumulative prospect theory values are then calibrated. The first two are the original set of Benartzi and Thaler (1995) ($\alpha = 0.88,\ \beta = 0.88,\ \gamma = 0.61,\ \delta = 0.69$, and $\lambda = 2.25$) and the set of neutral loss aversion ($\alpha = 1.0,\ \beta = 1.0,\ \gamma = 1.0,\ \delta = 1.0$, and $\theta = 1.65$). These are applied following the suggestions of myopic loss aversion with a heavier weight on loss aversion. The other set using all cumulative prospect theory values estimated from INTRA ($\alpha = 0.42,\ \beta = 0.49,\ \gamma = 0.44,\ \delta = 0.98$, and $\lambda = 0.98$) is then used as a benchmark for comparison.

The implied evaluation horizons are found by computing the prospective utility of investing in bonds and stocks over the periods. Technically, the steps to achieve this are described as follows.

At the first step, we have to form the two monthly series of stock returns and bond returns from December 31, 1988 to December 31, 2015 (324 months) using December 31, 1988 as the base day. We estimate the *prospective utility* using the above three sets of cumulative prospect theory parameters of 36 portfolios, which have an investment horizon increasing from 1 to 36 months. Denoting the monthly returns as r_i, the compound return x_i over the H month horizon is computed as

$$x_i = \prod_{i=1}^{i=H} (1 + r_i) - 1. \tag{3.5}$$

These compound horizon returns are then inserted into the value function (formula

3.1) together with other parameters (α, β, and the loss aversion λ or θ) to find the perceived returns $v(x_i)$.

In the next step, the corresponding decision weights are determined by subtracting the cumulative probabilities, as in formula (3.3). To achieve this, the returns have to be sorted in ascending order. We assign ranks to them: 0 for the worst return and $n-1$ for the best return. The ranked prospects from $i = -m \; to \; n$ are denoted as (x_i, p_i), where the subscript represents the rank and the nature of the prospect, that is, strictly negative prospects are in the domain $-m \leq i < 0$ and strictly positive prospects are in the domain $0 \leq i < n$. The probabilities (p) of these returns are computed from the cumulative distribution based on this ranking. If the probability of experiencing an equally good or better return is denoted as p_i, and as p_i^* for the probability of experiencing a strictly better return, these probabilities can be computed using the ranking in isolated domains as

$$\begin{aligned} &\textit{Equally good or better}: \; p_i^+ = \frac{(n-i)}{n}, && \textit{Strictly better}: \; p_i^{*+} = \frac{(n-i-1)}{n}, \\ &\textit{Equally bad or worse}: \; p_i^- = \frac{(i+1)}{n}, && \textit{Strictly worse}: \; p_i^{*-} = \frac{i}{n}, \end{aligned} \tag{3.6}$$

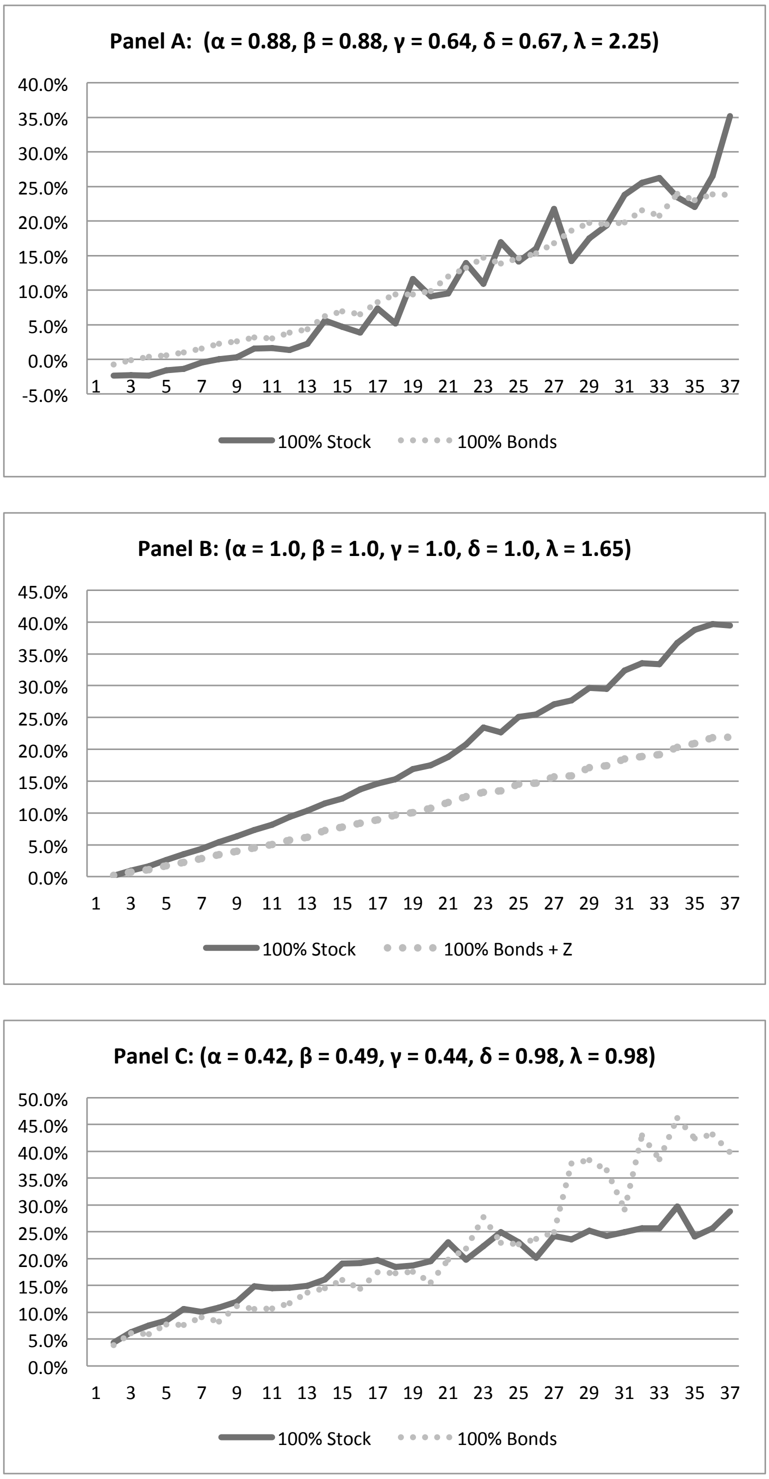
The decision weight given with every return $v(x_i)$ is then estimated using formula (3.4) with parameters γ and δ in separate domains. Then, the *prospect utility* of a portfolio associated with each evaluation horizon is

$$V = \sum_{i=-m}^{n} \pi_i v(x_i). \tag{3.7}$$

Finally, these prospect utilities are calculated for the stock-only portfolio and the risk-free portfolio (bonds only) across the increasing evaluation horizons (1-month steps). These prospective utilities are then plotted against the planning horizons. The intersection of the two series indicates the implied evaluation horizon where investors feel indifferent between the prospect utilities of holding either stocks or risk-free assets. These are expected to be from 10 to 14 months, as suggested by Benartzi and Thaler (1995), for evaluation periods of around 1 year. (Figure 3.1).

Figure 3.1: Implied investment horizons as a function of evaluation period

- The X-axis represents the time spans of the evaluation periods. The Y-axis is the prospective utility, the dotted line is the prospective utility of the portfolio of investing 100% in bonds, and the dark line is the prospective utility of investing 100% in stocks. The intersection of the two series is the fitted evaluation period, since investors feel indifferent between the prospective utility of either stocks or bonds at this point.



At first glance, loss aversion itself has effects on the implied *prospective utilities*. Panel A in Figure 3.1 indicates that investors have to smooth out their evaluation periods from around 14 months or more in order to feel indifferent between the *prospective utility* of investing in "risky" assets (stocks) and the alternative of "risk-free" assets. This is similar to the original finding of the same timeframes in Benartzi and Thaler (1995). Panel B puts more weights on the loss-aversion parameter by neutralizing the effects of other cumulative prospect theory values then suggests however a much shorter evaluation period (*2* months). One intuitive cause would be the lower recent estimation of the loss-aversion parameter from INTRA compared to Benartzi and Thaler (1995) ($\theta = 1.65 < \lambda = 2.25$). Furthermore, another possible explanation is that investors nowadays evaluate their portfolio more frequently given the ease of accessing portfolio data, for example, via online internet services. Panel C applies the full set of recent values of cumulative prospect theory from INTRA, documenting similar results.

To gain a better insight, we take one further step to the second question: "If investors have the preferences as myopic loss aversion predicted, what do their implied equity premia look like?"

3.3.2 Recent implied equity premia

The estimation of the implied equity premia is a reverse engineering of the computation of the prospective utility. First, we have to compute all the prospect utilities of holding either stocks or bonds in every investment horizon. The technique is to add an increasing small amount (a return premium) to the risk-free return to yield the assumed equity return, which is used consequently in the prospective utility formula. This calibration is then repeated until investors feel indifferent in terms of prospective utilities between those portfolio returns. Benartzi and Thaler (1995) report that the implied equity premia fall from 6.5%/ year (1-year evaluation period) to 4.65%/ year (2-year evaluation period) and to 3%; 2% and 1.4% for the evaluation periods of 5, 10, and 20 years, respectively.

The implied equity premia are then plotted against the evaluation periods (Figure

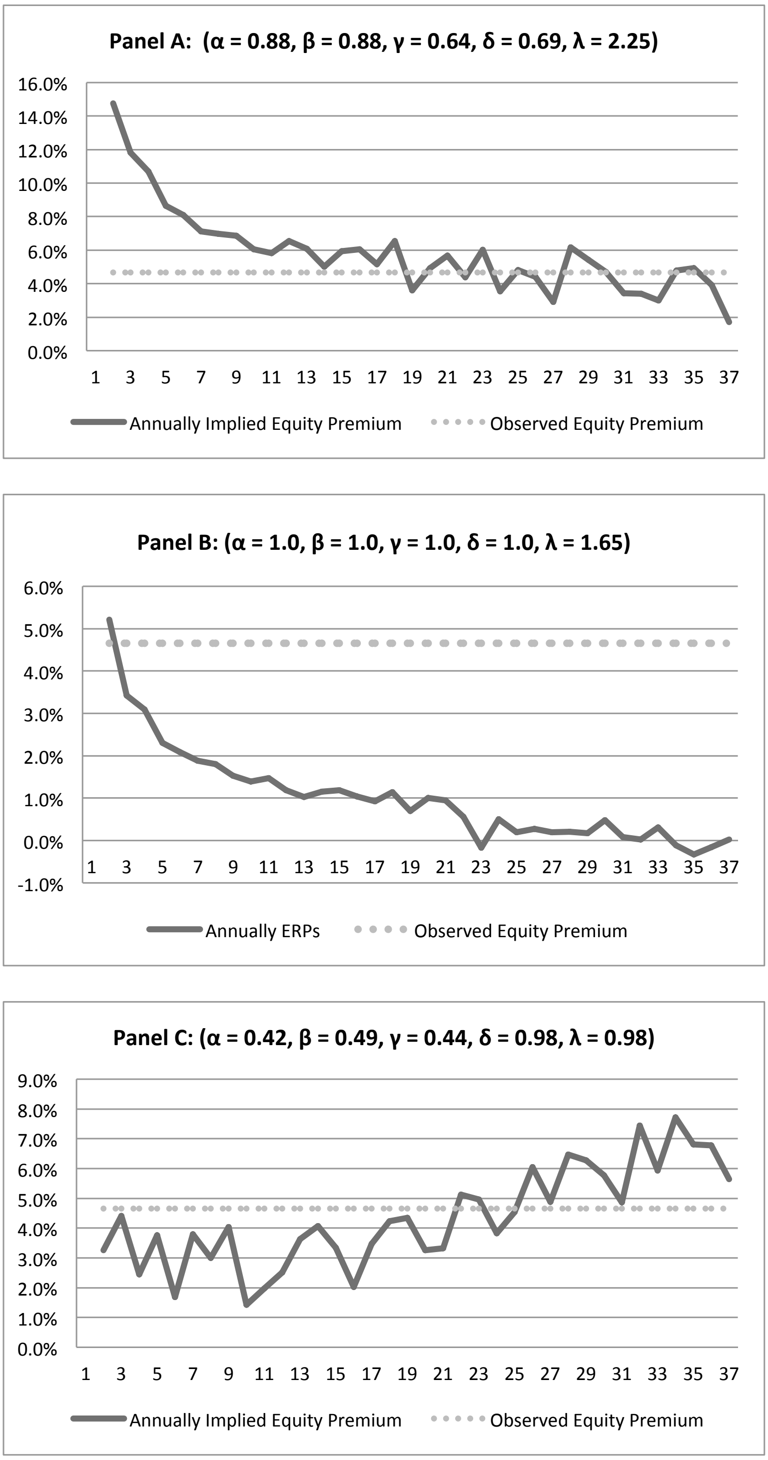
3.2). Panel A reports the calibration using the original set of cumulative prospect theory parameters from Benartzi and Thaler (1995), like the set of neutral loss aversion in Panel B and the set of recent cumulative prospect theory values from INTRA. If we take a closer look at Panels A and B, the implied equity premia with the parameters from Benartzi and Thaler (1995) are, interestingly, from 4.5% to 7% a year if investors have an evaluation period of around 1 year (from 9 months to 15 months). These numbers are close to the reasonable estimations of around 6.5% per year in the original research and are slightly lower if we use parameters from the neutral loss-aversion hypothesis. However, these estimations are quite high in those very short planning horizons.

Overall, the only conclusion we could extract from these results is a falling trend of the implied equity premia along the evaluation time spans. Loss aversion can play the main role in contributing to the equity premia when other cumulative prospect theory parameters are close to 1 and when loss aversion is larger than 2 (2.25 compared to the observed result of 1.65 recently). The implied evaluation periods are determined by the intersections between the implied equity premia graph and the line of observed equity premia. This suggests a large range from 14 months to 35 months in Panel A, or 6 months to 18 months in Panel B of Figure 3.2. Again, these would be caused by a lower value of the recent loss-aversion parameter (2.25 versus 1.65), or might be due to the fact that investors are nowadays less patient, that is, they trade more frequently with higher expectation of equity return in the short term.

The investigation with the set of all recent cumulative prospect theory values has less prediction power. Other parameters of cumulative prospect theory have effects on the implied equity premia by suggesting ideal investment horizons of either 3 months or 21–27 months. Intuitively, the weighting would play a role in causing these fluctuations. In short investment horizons, investors might overweight the probabilities of losses while underweight the potential probabilities of gains. In longer evaluation periods, the implied equity premia tend to increase. However, no clear implication can be derived from these results.

One interesting aspect here is the hypothetical implied equity premia suggested by

Figure 3.2: Implied equity premia versus observed equity premia in the US



myopic loss aversion, that is, the equity premia determined at the 12-month evaluation period. These values are 6.1% (Panel A), 1% (Panel B), and 3.6% (Panel C). The first estimation is closed to the original value of 6.5% per annum in Benartzi and Thaler (1995), which confirms that our research is not flawed and our data choice is long enough to suggest reasonable results. The recent parameterization of cumulative prospect theory values recommend shorter evaluation periods, but need more evidence before reaching a reasonable conclusion.

3.4 Tests of myopic loss aversion in other countries

Data availability from Datastream enables investigations on other countries. The Global Equity Indices are used to compute the stock return series, and the 10-year benchmark bond return series are chosen as proxies for risk-free assets. Datastream forms the benchmark bond index in every country by choosing a single bond that is the most representative bond available for the given maturity band at each point in time. Therefore, this guarantees the consistency of our comparison across 20 countries. Similarly, the two calibrations are reported with the two sets of parameters: neutral loss aversion and full cumulative prospect theory values. (Table 3.4). First, the calibration of prospective utilities against investment horizons is applied to determine the implied investment horizon. Second, we plot the implied equity premium series and the observed equity premium series against the investment horizons to determine the intersection points, and then compare them with the hypothetical implied equity premia at the 12-month horizons as recommended by Benartzi and Thaler (1995). Our conjectures are slightly different compared to the original research since the the implied equity premia at 12-month horizons are used as benchmarks for our comparision.

The first impression is that the MLA hypothesis suggests shorter investment horizons and large implied equity premia at very short investment periods. For instance, investors can expect a return of 13.08% a year in Sweden or 15.7% a year in Spain if they have an investment horizon of 1 month, and similarly, 14.8% a year in the US (with Benartzi

Table 3.4: Myopic loss aversion and international equity premia

Countries	Observed EPs	Ideal investment horizons			
		$(1,1,1,1,\theta)$	Hypo. EPs*	$(\alpha, \beta, \gamma, \delta, \lambda)$	Hypo. EPs
Australia	1.83%	2 months	0.24%	3-16 months	0.33%
Austria	0.03%	29-36 months	2.28%	25-26 months	2.00%
Belgium	3.55%	9-11 months	2.52%	11-23 months	3.45%
Canada	2.55%	4-5 months	5.55%	4-5 months	5.55%
Denmark	6.68%	4-6 months	3.09%	29-37 months	1.11%
Finland	6.82%	8 months	3.80%	10-23 months	5.19%
France	3.27%	13-18 months	3.38%	3-13 months	3.71%
Germany	-3.28%	19-27 months	-4.35%	NA**	-8.98%
Ireland	2.68%	10-27 months	2.07%	13-15 months	5.01%
Italy	-0.94%	NA	5.07%	NA	2.90%
Japan	-0.56%	NA	4.22%	NA	1.62%
Netherlands	2.36%	6 months	1.09%	24-32 months	-1.55%
New Zealand	1.38%	6-9 months	0.73%	NA	2.73%
Norway	4.13%	9 months	3.02%	4-27 months	6.10%
Portugal	-3.01%	NA	2.43%	NA	1.61%
Spain	2.25%	23-35 months	4.73%	14-24 months	2.99%
Sweden	5.46%	9 months	3.97%	18-34 months	1.09%
Switzerland	4.13%	6-8 months	2.89%	4-24 months	2.44%
UK	1.03%	9 months	0.90%	5-12 months	1.03%
US	4.33%	2-3 months	1.38%	15-26 months	5.1%

* *Hypothetical implied equity premia as myopic loss aversion predicted, by which 12 months is the ideal investment horizon.*

*** Not applicable*

and Thaler (1995)'s set of cumulative prospect theory values). Even though these are just hypothetical values, this would raise concern about the applicability of myopic loss aversion in practice in the very short evaluation periods. The assumption of 12-month time spans fails most of the time, since the hypothetical equity premia are markedly different to the observed equity premia (Column Hypo. EPs compared to Column Observed EPs in Table 3.4). Up to this point, our evidence is not sufficient to confirm an evaluation period of around 1 year, as Benartzi and Thaler (1995) suggest.

The myopic loss aversion hypothesis fails to explain the negative equity premia in Italy, Japan, and Portugal. One exception is Germany, where it can suggest an investment horizon when all implied returns are negative. We propose two conjectures that potentially account for this limitation. First, longer time series are needed to have a positive equity premium, which would be a severe constraint for any international research. Second, there might be a better set of cumulative prospect theory values that fits the current data. However, these are not recently available.

For robustness, we test the same process with some other functional forms of the weighting functions and value functions, as discussed in De Giorgi and Hens (2006) and Bui (2009). We attempt combinations among alternative weighting functions (Tversky–Kahneman; Karmarkar; and Prelec) and value functions (power; exponential; quadratic) of prospect theory according to the changing of evaluation periods, but find no improvement in our calibration results.

3.5 Discussion and conclusion

Our observations show that myopic loss aversion has limitations when applied to more recent data. First, the historical equity premium itself is a disadvantage due to being meaningful only with longitudinal data. Thus, the hypothesis of loss aversion together with time preference (myopia) works well in the US and some *survival* markets, but needs still longer historical data to prove its explanatory power. Other components of prospect theory play a role in predicting the equity premia in the US and also in other countries. However, we cast doubts on the current validity of the assumption of a 1-year planning horizon.

The constraints of historical equity premium limit further investigation of its potential determinants. Besides loss aversion, empirical studies of Rieger and Wang (2012) and Rieger et al. (2013b) document that hyperbolic time discounting, uncertainty avoidance, and ambiguity aversion may have effects on equity premium, again at the country-aggregated level.

The new measures of equity premia we proposed in Chapter 2 potentially provide a chance to overcome these limitations: the inclusion of a large set of firm-level controls promises more robust results. It might be argued that the equity premia estimated within a short period (10 years) are not a good proxy for the equity premia, but at least reflect a dimension of investors' expectations from equity investing. We discuss and provide some empirical observations along this line of research in the next chapter 4.

Chapter 4

Empirical investigation on equity premia and its determinants

4.1 Introduction

4.1.1 Erroneous investors

Shefrin (2008), in his book "A behavioral approach to asset pricing" (Academic Press, 2008), emphasizes that *"... Traditional asset pricing models such as Mehra and Prescott (1985) implicitly assume that investors hold correct beliefs, so asset prices are based on correct probabilities."* In attempts to explain the equity premium puzzle, these models assume that investors both hold the correct beliefs and know precisely about means, variances, and covariances of all the key terms. In addition, Shefrin (2008) suggests *"... the extent to which beliefs are biased can explain the equity premium puzzle."* This chapter follows that suggestion by attempting to connect behavioral biases and the distribution of equity premia worldwide. However, there is not yet a concrete theoretical background for this line of research. We base therefore our analysis on cumulative prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992) to provide a systematic psychological foundation.

Kahneman and Tversky (1979) rely on a series of binary choices to identify behavioral traits (Table 4.1), which are the main ingredients of prospect theory, and its successor

Table 4.1: Kahneman and Tversky's (1979) binary choices

1A ($2000, $0, 90%, 10%) 1B ($4000, $0, 45%, 55%)	2A ($2000, $0, 0.002, 0.998) 2B ($4000, $0, 0.001, 0.999)
3A ($4000, $0, 20%, 80%) 3B ($3000, $0, 35%, 75%)	4A ($4000, $0, 80%, 20%) 4B ($3000, 100%)
6A ($1 million, 100%) 6B ($5 million, $1 million, $0, 10%, 89%, 1%)	6A' ($5 million, $0, 10%, 1%) 6B' ($0, $5 million, 1%, 10%)
7A ($5 million, $0, 10%, 90%) 7B ($1 million, $0m 11%, 89%)	7A' ($5000, $0, 10%, 1%) 7B' ($0, $5000, 20%, 1%)
8A ($500, 100%) 8B ($1000, $0, 50%, 50%)	9A (-$500, 100%) 9B (-$1000, $0, 50%, 50%)
11C ($0, 100%) 11D ($10, -$10, 50%, 50%)	

cumulative prospect theory. We briefly summarize these as follows[1]:

- Common ratio effect: while facing choice issues between 1A and 1B and also between 2A and 2B, the majority of subjects chooses 1A over 1B and 2B over 2A. These preferences are inconsistent with expected utility, since the common ratios attached to these choices are $0.45/0.9 = 0.001/0.002 = 0.5$, which imply that rational choices have to be identical for both cases. Kahneman and Tversky (1979) suggest that people tend to overweight small probabilities in the second lottery, which leads to the observed deviation from rational behavior.

- Subcertainty and expected utility: subjects have to make choices between the lotteries: 3A or 3B, and 4A or 4B. They are then asked (question 5) "What would the probability of winning $4,000 in 4A have to be in order that you would be exactly indifferent between 4A (with the new odds) and 4B (a sure $3,000)?" The majority of subjects prefers 3A to 3B and 4B to 4A. Again, the likelihood ratio associated with the outcome $4,000 and the outcome $3,000 is 0.8 in both problems, but the certainty in 4B is given larger weight. Question 5 documents a

[1] More details can be found in Shefrin (2008). Behavioral bias is well documented in the literature, and we refer to Pompian (2011) as a starting point.

similar implication, in which subjects often demand a higher probability compared to those in 4A.

- Allais paradox and the independence axiom: independence means that if an agent is indifferent between two simple lotteries, then she is indifferent also between the same lotteries mixed with another arbitrary lottery. Violating this is known as the "common consequence" problem in the example of Allais (1953), where the choice of 6A is preferred over 6B, while 7A is preferred over 7B. If we exclude out the 89% of winning in both lotteries, the choice 6A' is identical to 6B', and so is the pair 7A' and 7B'. Nevertheless, people use thought processes in choosing among risky alternatives, which obviously violates the independence axiom.

- Isolation and framing effect: Kahneman and Tversky (1979) propose that people analyze choices in isolation, that is, they establish separate mental accounts for each choice, which are framed as gains or losses. Generally, people act as if they are risk averse in the domain of gains, but become risk-seeking when they perceive themselves to face the possibility of loss. Among the two almost identical lotteries: 8A and 8B after a win of $1,000 compared with 9A and 9B after a win of $2,000, the majority of subjects chooses 8A over 8B but prefers 9B to 9A.

- Isolation and the independence axiom: compare the abovementioned choice task 1A and 1B with the following two-stage task: if you win a lottery with a probability of 2/900, what would you choose as your prize, between 11A (a lottery ticket to play 1A) and 11B (a lottery ticket to play 1B). The majority of subjects who have chosen 1A continue to choose 11A, even when the compound probability to win is much lower. This also provides evidence for the framing effect.

- Loss aversion: this concept describes that losses loom larger than gains of the same magnitudes for most people. For instance, people prefer choice 11C to 11D. This is the key argument in prospect theory (Kahneman and Tversky, 1979), where people exhibit risk aversion in the domain of gains and risk-seeking in the domain of losses.

- Ambiguity aversion: ambiguity refers to the fact that most people are averse to situations that they are unfamiliar with, which is often illustrated as the aversion toward unknown probabilities in Ellsberg (1961)'s paradoxical choices. Ambiguity declines in situations in which people have more knowledge (Shefrin, 2008). This is the main topic in Chapter 5.

The above systematic deviations form rational assumptions are then used as components of prospect theory (Kahneman and Tversky, 1979), and its updated version, cumulative prospect theory (Tversky and Kahneman, 1992). All or some of these behavioral dimensions are then proved to have effects on equity premia. In the next section, we summarize some representative theories and empirical evidence supporting this hypothesis.

4.1.2 Which behavioral determinants account for the equity premium?

We have seen in Chapter 3 that Benartzi and Thaler (1995) propose the first behavioral theory to explain the equity premium puzzle—*myopic loss aversion*. To recap, a representative investor with prospect theory preferences and correct beliefs would consider a 50%–50% allocation between a low-risk bond and a high-risk stock if she were to evaluate her portfolio once a year. By doing so, the expected return premium (i.e., stocks over bonds) matched the observed return premium documented from historical data in the US. The intuition behind this is illustrated in the following decision problem. Imagine an investor whose time horizon consists of 2 years, and has the chance to invest in a risk-free asset ($0, 100%) and a risky stock ($300–$100, -$100, 50%, 50%), where $100 is the initial contribution. This investor might frame the decision of whether to invest (risky/risk-free asset) using a 1-year evaluation period or a full 2-year evaluation horizon. In the former time-horizon choice, the investor takes a myopic view, that is, considering the potential gains ($200, 50%) and the potential loss (-$100,50%), while in the latter time-horizon choice, the investor decomposes the investment in terms of probability as ($600–$200, 25%), ($300–$200,50%), and (-$200,25%). Hence, the investor making the latter time-horizon choice is more willing to take risks. The equity premium stems from the fact that too many investors are shortsighted and evaluate their portfolios more than once a year, thereby experiencing higher risk observed from the short-term movements of stocks.

Barberis and Huang (2001, 2006) extend this approach to an equilibrium framework and figure out the conditions under which their model captures the equity premium, interest rate, and level of volatility observed in practice.

Another important similar line of research is *disappointment aversion* (Gul, 1991, Bonomo et al., 1993, Fielding and Stracca, 2007, Routledge and Zin, 2010). Its key argument is that the decision maker with disappointment-averse preference puts more utility weight on outcomes that disappoint. In more detail, outcomes worse than a reference point (the certainty equivalence of the prospects) are the source of the disappointment. In the same way as loss aversion, the disappointment related to a reduction (outcomes below expectations) is then assumed to be stronger than when outcomes exceed expectations. Beyond risk aversion, disappointment aversion adds to the excess equity premium.

A lately promising approach is *Ambiguity Aversion* (Abel, 1989, 2002, Chen and Epstein, 2003, Klibanoff et al., 2005, Aloysius, 2005, Barillas et al., 2009, Gollier, 2011, Collard et al., 2011, Ju and Miao, 2012). The fact that the probability distributions associated with outcomes are *a priori* hardly known could play a role as an additional "risk" factor causing the equity premium. Ambiguity aversion as a potential determinant of equity premium is discussed in more detail in Chapter 5.

Along these lines, recent empirical findings report the relationship between equity premia and some particular dimensions of investor preferences, such as mental accounting (Hens and Wöhrmann, 2006), ambiguity aversion (Rieger and Wang, 2012), hyperbolic time discounting (Rieger et al., 2013b), and patience and risk aversion (Caliskan and Hens, 2014). As Shefrin (2008) points out "*... it is important to keep in mind that behavioral errors and behavioral preferences can both impact prices. Therefore, it is important to keep both behavioral variables in mind when structuring tests*" and "*...[h]owever, the evidence that investors commit systematic errors is substantial, and* *that evidence is consistent with errors being part of the explanation behind the equity premium puzzle.*" Without loss of generality, we can consider the tests of myopic loss aversion on the equity premium as the joint effect of loss aversion and time preference, and ambiguity hypothesis as the joint effect of risk aversion and ambiguity aversion. Consequently, we may conjecture also the joint effect of patience and attitude toward risks. Therefore, we build our empirical tests following these first behavioral attempts.

Our first firm-level data reported in Chapter 2 and the INTRA data (Rieger et al., 2014a,b) represent a great chance to empirically test these potential determinants and their joint effects, if any, in a global context. This, however, requires a careful research setting, since many possible factors might bias our results. We adopt the challenge and resolve potential bias by integrating a large set of controls, both at firm level and country-aggregated level, and investigate carefully the macro-economic factors in association with cultural characteristics. Our rigorous empirical tests and exploratory evidence suggest a broader view for further research, which might account for the equity premium puzzle.

In the following steps, we discuss behavioral factors and their measures from an international survey (section 4.2). Section 4.3 reports some evidence of the recent HEP and behavioral factors. Section 4.4 develops our hypotheses, and Section 4.5 presents our econometric models as well as the role of cultural values. Section 4.6 reports some first empirical evidence and Section 4.7 concludes.

4.2 How are behavioral parameters measured?

The collection of behavioral variables in INTRA (Rieger et al., 2014a,b) reports a substantial amount of between-country variation in variables measuring risk preferences and attitude toward time[2]. It is well known that risk attitudes cannot be measured only within the settings of rational models[3] but also require prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992). This means that risk attitudes depend

[2]We do not report parameters of the weighting function, since probability weightings are difficult to know in practice (Izhakian and Benninga, 2011).

[3]More details are discussed in, for example, Starmer (2000)

on whether the payoffs are in the gain or loss domain.

In INTRA, relative risk premia (RRP) for lotteries are computed via the standard formula:

$$RRP = \frac{(EV - CE)}{|EV|}, \tag{4.1}$$

where EV is the expected value of a lottery and CE denotes the certainty equivalence that has been provided by the participants. The RRP is positive whenever a person is risk averse and negative when a person is risk-seeking. In other words, a large RRP means *more* risk aversion (or *less* risk-seeking).

In more detail, the RRP *in gains* is computed by taking the average RRP over six lotteries in the gains, while the RRP *in losses* is computed by taking the average RRP over two lotteries in losses. The other key feature, loss aversion, is better parameterized by the methodology of Tversky and Kahneman (1992) where the *neutral* loss aversion θ can be computed as the ratio between a gain X and a loss L such that a 50–50 lottery of X and L is as attractive as an outcome of zero. In principle, RRP values can be converted back to cumulative prospect theory parameters. However, the precise scaling of this measurement is of less importance than its reliability as cross-country differences, which are of most interest in our research setting.

Time preferences of individual investors in INTRA are proxied by *patience*—the proportion of subjects in a country sample who prefer to wait when choosing between \$3,400 this month or \$3,800 next month. The higher the value is, the more patient is the subject. We report the key behavioral parameters used in Table 4.2.

Table 4.2: Investors' preferences in INTRA

Country	RRPgains	RRPlosses	Loss Aversion	Patience
Angola	0.64	-0.32	1.64	0.53
Argentina	0.74	-0.34	1.06	0.64
Australia	0.65	-0.44	1.24	0.51
Austria	0.65	-0.63	1.83	0.78

Table 4.2: Investors' preferences in INTRA

Country	RRPgains	RRPlosses	Loss Aversion	Patience
Azerbaijan	0.44	-0.27	1.14	0.48
Belgium	0.66	-0.35	1.96	0.87
Bosnia Herz.	0.77	-0.61	1.00	0.39
Canada	0.77	-0.33	2.00	0.79
Chile	0.67	-0.17	2.00	0.37
China	0.56	-0.35	1.83	0.62
Colombia	0.87	-0.67	2.00	0.62
Croatia	0.76	-0.69	2.33	0.58
Czech Rep.	0.65	-0.49	2.00	0.80
Denmark	0.64	-0.17	2.00	0.84
Estonia	0.91	-0.63	4.00	0.78
Finland	0.73	-0.32	2.00	0.85
France	0.54	-0.43	2.00	0.65
Georgia	0.56	-0.17	7.50	0.26
Germany	0.80	-0.54	2.00	0.89
Greece	0.66	-0.77	2.00	0.47
Hong Kong	0.93	-0.72	2.43	0.79
Hungary	0.83	-0.54	2.00	0.77
India	0.68	-0.54	2.30	0.59
Ireland	0.86	-0.53	2.00	0.69
Israel	0.83	-0.63	1.64	0.78
Italy	0.80	-0.35	1.06	0.44
Japan	0.76	-0.54	1.24	0.74
Lebanon	0.94	-0.88	1.83	0.71
Lithuania	0.88	-0.67	1.14	0.60
Luxembourg	0.77	-0.44	1.96	0.55

Table 4.2: Investors' preferences in INTRA

Country	RRPgains	RRPlosses	Loss Aversion	Patience
Malaysia	0.64	-0.81	1.00	0.62
Mexico	0.93	-0.72	2.00	0.58
Moldova	0.44	-0.32	2.00	0.54
Netherlands	0.44	-0.17	1.83	0.85
New Zealand	0.67	-0.64	2.00	0.45
Nigeria	0.69	-0.60	2.33	0.08
Norway	0.74	-0.46	2.00	0.85
Poland	0.78	-0.35	2.00	0.78
Portugal	0.61	-0.29	4.00	0.60
Romania	0.62	-0.24	2.00	0.57
Russia	0.88	-0.73	2.00	0.39
Slovenia	0.83	-0.53	7.50	0.71
South Korea	0.55	-0.39	2.00	0.72
Spain	0.72	-0.23	2.00	0.47
Sweeden	0.65	-0.21	2.43	0.84
Switzerland	0.78	-0.45	2.00	0.87
Taiwan	0.66	-0.54	2.30	0.69
Tanzania	0.04	-0.02	2.00	0.23
Thailand	0.60	-0.52	1.99	0.57
Turkey	0.63	-0.18	2.46	0.64
UK	0.72	-0.49	2.00	0.71
US	0.78	-0.43	1.74	0.68
Vietnam	0.67	-0.33	2.00	0.52

Table 4.3: Historical equity premia in the last decade (2001–2010)

Country	HEPs	Country	HEPs
Australia	-2.84%	Japan	3.50%
Austria	-6.36%	Netherlands	4.78%
Belgium	0.74%	New Zealand	-1.15%
Canada	-1.38%	Norway	-5.23%
Denmark	-2.16%	Portugal	1.21%
Finland	4.20%	Spain	-0.99%
France	3.31%	Sweden	-2.25%
Germany	2.13%	Switzerland	2.80%
Ireland	4.05%	United Kingdom	0.81%
Italy	5.92%	USA	2.33%

Table 4.4: Correlation table among 10-year historical equity premia and behavioral factors

Variables	HEPs	RRPgains	RRPlosses	Patience	Loss Aver.	Ambi. Aver.
HEPs	1.00					
RRPgains	0.12	1.00				
	(0.61)					
RRPlosses	0.13	-0.41	1.00			
	(0.59)	(0.02)				
Patience	-0.06	0.09	0.14	1.00		
	(0.80)	(0.60)	(0.42)			
Loss Aversion	0.22	-0.05	0.27	0.11	1.00	
	(0.35)	(0.76)	(0.12)	(0.55)		
Ambiguity Aversion	0.20	-0.17	0.02	-0.28	0.36	1.00
	(0.39)	(0.34)	(0.89)	(0.10)	(0.03)	

4.3 First intuitive correlation tests

We start by applying the simple correlation tests between the historical equity premium and our set of behavioral factors. To achieve this, we compute the historical equity premia from Datastream as in our previous work (Chapter 3) for the 10-year period (2001–2010), which is also the timeframe to estimate our firm-level equity premia (Chapter 2). While it is not clear whether these estimates represent the historical equity premia well owing to their short timeframes, they reflect to some extent at least a dimension of equity returns over risk-free assets. Since there is still a lack of theoretical background for our exploratory tests, some basic intuitions from the correlation tests may be implied for our further investigations (Table 4.3 and Table 4.4).

The abovementioned attempts do not show strong statistical power owing to the small sample size, but suggest some first intuitions about the possible relationships. Let us compare Germany and China. The INTRA survey suggests that Germans, in general, are risk averse (RRPgains: 0.84), less risk-seeking (RRPlosses: -0.54), and patient (Patience: 0.89), and thus, we expect a lower equity premium (3.26% per annum). By contrast, the Chinese, who are less risk averse (RRPgains: 0.56), less risk-seeking (RRPlosses: -0.35), and less patient (Patience: 0.62) require a larger equity premium (6.36% per annum). Given that, it seems possible that risk attitudes and time preferences could account for the equity premium. With our firm-level data, more controls can be used and more econometric power can be achieved in attempts to figure out more empirical evidence. We develop our hypotheses and methodology in the next section with the aim of answering this interesting research question.

4.4 Empirical research settings

4.4.1 Hypothesis development

It is natural to follow the theory of myopic loss aversion (Benartzi and Thaler, 1995; Barberis and Huang, 2006) to integrate *loss aversion* together with time preference to account for the size of the equity premium. According to myopic loss aversion, the dispersion of equity premia should relate positively to loss aversion and time discounting (as a proxy for the time horizon) in our models. The higher the degree of loss aversion is, the larger is the required equity premium that investors demand. Similarly, the less patient the investors are, the more equity premia they expect on stock investments. Therefore, we propose the following hypothesis.

Hypothesis 1: *Equity premia increase as aggregate loss aversion increases and time discounting increases (i.e., as willingness to wait decreases).*

Of course, besides loss aversion, general risk aversion also influences the equity premium. In terms of cumulative prospect theory, we arrive at the following hypothesis.

Hypothesis 2: *Equity premia increase as aggregate risk aversion increases and patience decreases (less willingness to wait).*

In addition, given the available international data, we would like to study the effects of culture on the equity premium, given that its effects on risk perception and time preferences have been confirmed in previous studies (Rieger et al., 2013a, 2014a). To our knowledge, there are still no theoretical models to link these two phenomena in a convincing manner. However, there is increasing empirical evidence supporting the link. Chui et al. (2010), for example, report a positive relationship between overconfidence and self-attribution bias, proxied by the Individualism Index of Hofstede (2001), and momentum returns in 41 countries. Similarly, Chui et al. (2012) explain the value premium by applying Hofstede (2001)'s UAI and the Individualism Index as benchmarks for the attitude toward risks. The finding most directly related to ours is the empirical evidence on relationships between uncertainty avoidance and the HEP (Rieger and Wang, 2012) and between patience and risk aversion on the value premium (Caliskan and Hens, 2014). We aim to contribute to this line of research by studying the impact of cultural factors on the equity premium.

Hypothesis 3: *Cultural characteristics have effects on the equity premium across countries*

4.5 Our econometric models

We aim to test these hypotheses by using regressions. Since the number of companies per country in our database varies a lot, we imply robust weighted regressions to reduce the impacts of extreme cases that might otherwise bias our models:

$$w_i ERP_{i,j} = \alpha_i + w_i M_i \beta_{1i} + w_i C_i \beta_{2i} + \epsilon_i, \tag{4.2}$$

where $ERP_{i,j}$ is the equity risk premium of firm j in country i, M_i is a vector of the variables of interest (behavioral parameters solely or in combinations), C_i is a vector of controls, w_i is the ratio of the number of companies in a country over the total number of companies in the sample, and ϵ_i is the error term.

Linking the equity premium and investors' preferences in our international research requires an assumption about the representativeness of our data. In other words, the composition of investors is not homogeneous across countries. Since our behavioral factors are aggregated from individual preferences, we assume that this represents the whole market. Although institutional investors might outperform individual ones[4], the majority of investors are individuals, especially in emerging markets (De Bondt, 1998). Despite this, in a world of institutional investors, such as pension, mutual, and hedge funds, managers investing others' money often exhibit interests aligned with those of their clients (Haigh and List, 2005). In fact, our estimation of investors' preferences in INTRA seems to be a reasonable proxy to model a representative investor in every country in the sample.

In addition, we assume that price discovery that causes the equity premium would be led by the home market. This is empirically supported by the "home bias"[5] literature (French and Poterba, 1991; Uppal, 1992; Bekaert and Harvey, 1995; Chan et al., 2005; Bekaert and Wang, 2009). Although significant gains for international diversification have been reported, for example, home inflation hedges (Krugman, 1981; Adler and Dumas, 1983; Stulz, 1981a, 1983), there would be obvious constraints to doing so. More investors prefer local stocks owing to institutional barriers to foreign investments (Halliday, 1989), transaction costs (Black, 1974; Stulz, 1981b, 1983), and tax reasons (Cooper and Kaplanis, 1986, 1991; French and Poterba, 1993), while psychological reasons surely exist as well (Dlugosch et al., 2014).

[4] Individuals in general are prone to *heuristic simplification* (salient and availability effect, framing, money illusion, and mental accounting), *self-deception* (overconfidence, biased self-attribution, confirmatory bias, hindsight bias, rationalization, and cognitive dissonance), and last but not least, *feeling or emotion-based judgments* (mood effects, attribution errors, problems of self-control, and hyperbolic discounting) (Daniel et al., 2002).

[5] French and Poterba (1991) document that investors from the US, Japan, and the UK invest 93%, 98%, and 82%, respectively, of their total stock investment in domestic stocks. Investors may find their national stock market to be more familiar than foreign stock markets. These familiar situations are preferred, as investors consider themselves to be in a better position than others.

4.5.1 Control variables

We collect a number of firm-specific variables and country-specific characteristics that are likely to affect the equity premium. At firm level, beta of stock (computed using the last 1-year returns referring to the respective market indexes), stock volatility (over the last 360 trading days[6]), and the log of firm' leverage ratio are used as controls for firm-specific risks. For the information risk, the amount of earnings estimates for a stock (analysts) and the last year's cumulative stock return are selected. Those variables are extracted from OSIRIS using data over the last year.

On country aggregation, the effects of market-wide determinants and country characteristics seem to be more complex. Intuitively, the risks in equity as a class come from general concerns about the strengths and weaknesses of the economy as a whole. Institutional environment, government policies, and differences in culture are documented to have impacts on the equity premium even though the mechanism is not clearly predictable. We categorize these controls into six groups: (i) economic and financial development, (ii) economic growth (iii) law origin (iv) measure of enforcement (v) corporate governance environment and (vi) investor protection and corporate governance (details in Appendix). Cultural characteristics play the roles of additional controls and are proxied by the cultural dimensions in Hofstede (1984)[7].

The most potentially critical issue of these country-level variables is the multicollinearity problem. This has been carefully checked in every model by using the Collin test (Belsley et al., 2005).

[6]"The 360-day volatility as of a specific date is the unbiased standard deviation of the 359 most recent logarithmic daily returns, multiplied by an 'annualisation' factor (which is 260, since there are 260 working days in a calendar year)" [OSIRIS dataguide]

[7]Recently, the culture model of Schwartz (1992) has become more popular because it can overcome some weaknesses in *Hofstede's* model (Imm Ng et al., 2007). However, Schwartz's seven universal value types (conservatism, autonomy, hierarchy, mastery, egalitarianism, and harmony) are too broad to imply direct effects on the equity premium in our investigations. *Hofstede's* dimensions have been more frequently used in the economic literature (see Kirkman et al., 2006) and were included in the INTRA study itself, and thus, we have measurements for these dimensions for the same subject pool for which we also measured the time and risk preferences.

4.6 Results and discussion

Before we discuss the results, some general comments are needed. First, the R-square of all regressions cannot be expected to be large in this kind of analysis, since we do not aim to forecast any equity premium with our models, as too many other unobserved factors influence stock market returns. Within the context of behavioral research, our preference variables are obviously not the major contributors to accounting for the equity premium. Moreover, almost all of the coefficients of independent determinants and controls are stably significant across our models, hence, resulting in consistent prediction powers.

One additional issue is the limited explanatory power of our behavioral variables. Precise values of risk aversion, risk-seeking, and time preference of investors would be nice to know, but the elicitation method in the INTRA survey in any event does not allow obtaining precise quantitative data on the amount of these factors. Thus, the extent to which equity premia can be explained by these parameters is difficult to observe. However, these relative differences are consistent with the INTRA study data, and therefore, are relevant for our empirical research.

4.6.1 Loss aversion, time preference, and equity premia

Our first attempt (Hypothesis 1) is to figure out the effects that loss aversion have—alone and in combination with time preference (*patience* in INTRA)—on the equity premia (Table 4.5). *Patience* has a negative effect as theoretically predicted, but *loss aversion* shows the reverse effect in these models. Both loss aversion and time preference (*Patience*) contribute to explain the equity premia, and this is also the case in tests without the inclusion of country-level factors and in robustness checks with other sets of country-level controls. Indeed, our results suggest an effect of myopia, but there are no clear results on loss aversion.

The concept of loss aversion has been used widely to explain the endowment effect[8].

[8]The endowment effect (Thaler, 1980), also known as "status quo bias" (Samuelson and Zeckhauser, 1988), is the phenomenon in which most people would demand a considerably higher price for a product that they own compared to one they would be prepared to pay for. In an early experiment, a seller would ask for $7.12 in exchange for a coffee mug, while a buyer was willing to pay no more than $2.87 (Kahneman et al., 1990). This is due to loss aversion, since sellers evaluate the mug as a loss, whereas

Table 4.5: Myopic loss aversion–empirical tests

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Neutral loss aversion	-0.63***		-0.72***	-0.31***
	(0.197)		(0.230)	(0.105)
Patience		-0.81***	-1.06***	-0.20**
		(0.299)	(0.380)	(0.087)
Beta of stock	0.10	0.16**	0.12*	0.01
	(0.060)	(0.077)	(0.066)	(0.031)
Stock volatility	0.00	0.03	-0.00	0.03
	(0.021)	(0.023)	(0.021)	(0.020)
Leverage ratio	-0.04***	-0.04***	-0.04***	-0.03***
	(0.016)	(0.016)	(0.017)	(0.011)
Analysis	-0.01	-0.01*	-0.01*	-0.00
	(0.004)	(0.004)	(0.004)	(0.003)
Past stock return	-0.01	-0.01	-0.01	-0.00
	(0.012)	(0.012)	(0.012)	(0.011)
Anti-director Index	-0.22***	-0.20***	-0.21***	
	(0.077)	(0.070)	(0.073)	
Anti-self-dealing Index	1.16***	0.82***	1.00***	
	(0.381)	(0.269)	(0.329)	
Creditor right Index	-0.17***	-0.11***	-0.17***	
	(0.052)	(0.034)	(0.053)	
Judicial efficiency Index	0.20***	0.29***	0.34***	
	(0.067)	(0.097)	(0.113)	
Stock market capitalization	-0.00	0.00**	0.00**	
	(0.000)	(0.000)	(0.000)	
Constant	0.23*	-0.16	0.43***	0.50***
	(0.120)	(0.117)	(0.152)	(0.149)
Observations	11,176	11,176	11,176	15,424
R-squared	0.81%	0.69%	0.97%	0.11%

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

As losses loom larger than gains, a larger degree of loss aversion would intuitively imply a higher return expectation and thus, a larger equity premium. However, some scholars do not agree with this. For instance, Novemsky and Kahneman (2005) propose that monetary values of trading within an intended budget do not exhibit loss aversion. If a consumer buys shoes and brings them home, the shoe merchant experiences no loss aversion, since giving up the shoes means receiving a profit. In the financial world, a typical investor has always a predetermined budget for investments, and might not experience any loss aversion toward the portfolio's monetary costs. Because the majority of investors on stock markets trades for returns, that is, monetary outcomes, loss aversion might not be the driving force[9].

In addition, there is a different potential explanation as to why loss aversion might not affect equity premia in a global context. It is well known that relatively few people enter equity markets (Hill, 2006; De Meyer, 2010), and it is possible that the majority of loss-averse investors simply stays away from stocks. Moreover, less loss-averse investors who make investments are expected to exhibit less risk aversion, as this might be correlated with loss aversion. Therefore, in countries with comparably high average loss aversion in the total population might end up having investors with *low* risk aversion, leading to a *low* equity premium. However, it is difficult to define a certain level of loss aversion, in which investors decide not to enter the markets, making it difficult to prove this conjecture.

Another issue of loss aversion that is often bypassed in the literature is the fact that intention, budgeting, and size of transactions contribute to predicting investors' behavior (Novemsky and Kahneman, 2005). The potential sure loss, that is, the initial money or a part thereof, has to be judged as the first boundary of entering stock markets, that is, *a priori* considered as a part of the "investment game." In continuous time, certain losses have to be rebalanced, and the investment game continues as long as the investor wants and her budget allows. This results in lower loss aversion acting similarly to more risk-seeking.

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buyers evaluate the mug as a gain.

[9]This is supported by the empirical evidence in Chapter 3

Table 4.6: Correlation tests between loss aversion and risk attitudes–Individual level

Variables*	RRPgains	RRPlosses	θ
RRPgains	1		
RRPlosses	-.327**	1	
	(0.000)		
θ	.257**	-.120**	1
	(0.000)	(0.000)	

**. N=4777*

***. Correlation is significant at the 0.01 level (2-tailed).*

Table 4.7: Correlation tests with *less* loss-averse subjects at the country level

Variables*	RRPgains ($\theta < 2$)	RRPlosses ($\theta < 2$)	θ
RRPgains ($\theta < 2$)	1		
RRPlosses ($\theta < 2$)	-.641**	1	
	(0.000)		
θ	0.162	-0.121	1
	(0.246)	(0.389)	

**. N=53*

***. Correlation is significant at the 0.01 level (2-tailed).*

To obtain at least some empirical evidence regarding these possible effects, we correlate the neutral loss aversion and the parameters of risk attitudes in the INTRA data at individual level (Table 4.6), and assume a level of 2 as the cut-off point of loss aversion[10] in which investors participate in the market (Table 4.7). We note that RRPlosses is measured in negative values, and thus, a negative correlation means a positive relationship. The correlation results show that the correlation of loss aversion and RRPs become insignificant at the country level, when taking into account only the subjects with loss aversion below the cut-off value. While this offers some support for a potential "crowding-out" effect for loss-averse investors, more empirical evidence is certainly needed in future studies.

[10]This is the median value in this survey

4.6.2 Attitudes toward risks, time preference, and equity premia

As pointed out in Chapter 3 and the abovementioned empirical result, loss aversion fails to explain the high values of the implied equity premia in very short evaluation horizons (e.g., 14% in the time span of 1 month in the US), and suggests controversial predictions between country-level and firm-level investigations. This might be due to the fact that the individual investors, in reality, make choices among alternative risk profiles, not simply between risky and riskless profiles. In this case, the loss probabilities considered as a part of the trade yield less predictive power compared to risk attitudes.

There is not yet a concrete model—to the best of our knowledge—that connects behavioral factors to explain the equity premium, although there are some empirical attempts (Hens and Wöhrmann, 2006; Rieger et al., 2013b; Caliskan and Hens, 2014). We follow the approach of Caliskan and Hens (2014), using the same INTRA data. In their research, Caliskan and Hens (2014) report the relationship between risk aversion, patience, and the value premia estimated from worldwide data. We expand their hypothesis by adding one more parameter for risk attitudes, that is, risk-seeking, in our models. From a psychological point of view, the behavior of investors might be driven by risk aversion and/or risk-seeking. An example of the suboptimal choice could refer to the cases of isolation and the independence axiom discussed in Subsection 4.1.1, in which suboptimal decisions are made when investors face compound probabilities. Without loss of generality, investors may exhibit risk aversion, risk-seeking, and/or (im)patience while judging alternative risk profiles. Therefore, we conjecture that all these preferences would have impacts on the equity premia.

In our tests, behavioral factors are investigated one by one and in combination together with other controls. *Risk aversion* and *risk-seeking* have positive effects on the equity premia alone and in combination with *patience*. In countries whose investors are prone to *more* risk-averse, *less* risk-seeking, and *impatient* behavior, larger values of equity premia are observed (Table 4.8).

To test whether our results are driven by macroeconomics factors, we run the regres-

Table 4.8: Regression results for risk preferences, patience, and equity premia

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
RRPgains	0.47**			0.87**	0.67***
	(0.226)			(0.379)	(0.259)
RRPlosses		0.15***		0.44***	0.34***
		(0.049)		(0.172)	(0.112)
Patience			-1.22***	-1.19***	-0.29***
			(0.431)	(0.422)	(0.106)
Beta of stock	0.18**	0.18**	0.21**	0.27**	0.08
	(0.086)	(0.081)	(0.093)	(0.114)	(0.049)
Stock volatility	0.04*	0.05*	0.05**	0.04	0.03
	(0.024)	(0.025)	(0.025)	(0.023)	(0.019)
Leverage ratio	-0.04**	-0.04***	-0.04**	-0.05**	-0.03***
	(0.016)	(0.017)	(0.017)	(0.018)	(0.010)
Analysts	-0.01	-0.01*	-0.01*	-0.01*	-0.00
	(0.004)	(0.004)	(0.004)	(0.005)	(0.003)
Past stock return	-0.01	-0.01	-0.01	-0.01	0.00
	(0.013)	(0.012)	(0.012)	(0.013)	(0.012)
Anti-director index	-0.33***	-0.30***	-0.31***	-0.39***	
	(0.115)	(0.100)	(0.105)	(0.137)	
Rule of law index	0.25***	0.23***	0.33***	0.36***	
	(0.081)	(0.072)	(0.105)	(0.118)	
Anti-self-dealing index	1.37***	1.38***	1.29***	1.46***	
	(0.449)	(0.448)	(0.420)	(0.481)	
Creditor right index	-0.11***	-0.11***	-0.12***	-0.09***	
	(0.035)	(0.037)	(0.037)	(0.028)	
Judicial efficiency index	-0.04	-0.00	0.10**	-0.04	
	(0.026)	(0.016)	(0.039)	(0.038)	
Stock market capitalization	-0.00***	-0.00	0.00*	0.00	
	(0.000)	(0.000)	(0.000)	(0.000)	
Constant	0.37***	0.49***	0.78***	1.12***	0.03
	(0.141)	(0.170)	(0.251)	(0.377)	(0.061)
Observations	11,176	11,176	11,176	11,176	15,424
R-squared	0.75%	0.72%	0.90%	0.99%	0.14%

Robust standard errors in parentheses

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

sions again with the exclusion of all country-level controls, and with the integration of macroeconomic variables one by one. In addition, robustness checks with a different set of country-level controls are applied. Still, the same results are documented (Table 4.9 and Table 4.10). The impacts of macroeconomic factors are consistent and meaningful, as suggested in previous research (Rieger and Wang, 2012; Rieger et al., 2013b; Caliskan and Hens, 2014).

4.6.3 Culture and equity premia

We apply direct tests to investigate the impacts of cultural factors proxied by Hofstede (2001)'s indexes. Since the concepts of cultural dimensions are more general and broader compared to our risk preferences and time factors, we use these indexes as additional country-level controls and apply collinearity checks to exclude any potential interaction effects. First, adding cultural variables does not erase the effects of risk and time preferences we report previously. Second, we document positive links between individualism and the masculinity index on the dispersion of equity premia. The long-term orientation index yields similar predictions as the *(im)patience* parameter, and might reflect the same aspect. However, we find a negative effect of the UAI. Because the concept of the UAI is different to ambiguity aversion, we cannot state there are any implications about whether investors are averse toward uncertainty or embrace it (high risks–high returns) (Table 4.11).

4.6.4 Impacts of controls

The large dataset enables us to test directly the effects of many firm-level determinants of the equity premium, which was not possible previously. Traditional risk factors, such as *beta of stock,* and *stock volatility*, contribute positively in most of our models. A high *leverage ratio* is documented to have a negative effect on the equity premium. Additionly, at country level, institutional environment, corporate governance environment, and investor protection have significant effects on equity premia. In robustness checks with another set of country-level factors, the overall market efficiency, govern-

Table 4.9: Risk preferences, patience, and macroeconomic factors

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
RRPgains	0.22**	0.66***	0.65**	0.35**
	(0.112)	(0.255)	(0.261)	(0.152)
RRPlosses	0.17***	0.29***	0.35***	0.33***
	(0.057)	(0.093)	(0.110)	(0.109)
Patience	-1.06***	-0.36***	-0.29***	-0.43***
	(0.382)	(0.139)	(0.105)	(0.157)
GDP per capita	0.00***			
	(0.000)			
GDP growth rate		-0.02**		
		(0.008)		
Stock market capitalization			0.00**	
			(0.000)	
Economic freedom				0.01***
				(0.004)
Beta of stock	0.19**	0.12*	0.09*	0.11*
	(0.086)	(0.067)	(0.052)	(0.060)
Stock volatility	0.04*	0.03*	0.03	0.03
	(0.020)	(0.020)	(0.019)	(0.018)
Leverage ratio	-0.03***	-0.03***	-0.03***	-0.03***
	(0.010)	(0.010)	(0.010)	(0.009)
Analysts	-0.01*	-0.01	-0.00	-0.00
	(0.004)	(0.004)	(0.003)	(0.003)
Past stock return	-0.00	0.00	0.00	-0.00
	(0.011)	(0.011)	(0.012)	(0.011)
Constant	0.36***	0.13**	0.04	-0.39**
	(0.099)	(0.051)	(0.065)	(0.197)
Observations	15,424	15,424	14,540	15,424
R-squared	0.38%	0.18%	0.14%	0.23%

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 4.10: Robustness checks for risk preferences, patience, and macroeconomic factors

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
RRPgains	0.71*	2.26**	1.70**	0.80*
	(0.376)	(0.958)	(0.661)	(0.431)
RRPlosses	1.20***	2.07***	1.06***	0.87***
	(0.435)	(0.770)	(0.387)	(0.318)
Patience	-1.10***	-0.52*	-1.85***	-1.09***
	(0.423)	(0.281)	(0.640)	(0.410)
GDP per capita	0.12***			
	(0.045)			
Stock market capitalization		-0.35***		
		(0.133)		
GDP growth rate			-0.08	
			(0.048)	
Economic freedom index				0.01*
				(0.003)
Beta of stock	0.14*	0.26**	0.10	0.13*
	(0.078)	(0.119)	(0.071)	(0.075)
Stock volatility	0.04	0.03	0.05	0.05
	(0.028)	(0.028)	(0.033)	(0.029)
Leverage ratio	-0.06**	-0.07**	-0.06**	-0.06**
	(0.026)	(0.030)	(0.029)	(0.025)
Analysts	-0.01	-0.01*	-0.00	-0.01
	(0.005)	(0.006)	(0.004)	(0.005)
Past stock return	-0.00	-0.02	0.01	0.00
	(0.016)	(0.015)	(0.018)	(0.017)
Corruption index	-0.20**	-0.11	-0.04	-0.02
	(0.097)	(0.074)	(0.074)	(0.049)
GINI index	0.03***	0.06***	0.02***	0.02***
	(0.009)	(0.024)	(0.007)	(0.007)
Market efficiency index	0.83***	1.18***	0.61***	0.53***
	(0.308)	(0.436)	(0.225)	(0.204)
Constant	-5.05***	-6.66***	-2.72**	-2.95**
	(1.949)	(2.567)	(1.145)	(1.165)
Observations	12,324	11,440	12,242	12,324
R-squared	0.94%	1.27%	0.94%	0.76%

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 4.11: Culture dimensions and equity premia

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
RRPgains	0.66**	0.64**	0.82**	1.01**
	(0.323)	(0.308)	(0.368)	(0.415)
RRPlosses	0.11	0.55**	0.30**	0.29**
	(0.092)	(0.227)	(0.135)	(0.132)
Patience	-1.01***	-1.00***	-1.12***	-0.78**
	(0.370)	(0.367)	(0.405)	(0.313)
Individualism vs. collectivism	0.01***			
	(0.002)			
Masculinity		0.00**		
		(0.001)		
Uncertainty avoidance			-0.00***	
			(0.001)	
Long-term orientation				-0.01***
				(0.002)
Beta of stock	0.27**	0.27**	0.26**	0.28**
	(0.114)	(0.114)	(0.113)	(0.117)
Stock volatility	0.04	0.04*	0.04*	0.02
	(0.023)	(0.024)	(0.022)	(0.020)
Leverage ratio	-0.04**	-0.04**	-0.04**	-0.04**
	(0.017)	(0.018)	(0.016)	(0.016)
Analysts	-0.01*	-0.01*	-0.01	-0.01*
	(0.005)	(0.004)	(0.004)	(0.005)
Past stock return	-0.01	-0.01	-0.02	-0.02
	(0.013)	(0.014)	(0.013)	(0.013)
Anti-director index	-0.32***	-0.40***	-0.41***	-0.39***
	(0.114)	(0.139)	(0.142)	(0.136)
Rule of law	0.21***	0.38***	0.34***	0.33***
	(0.069)	(0.124)	(0.113)	(0.108)
Anti-self-dealing index	1.33***	1.64***	1.48***	1.19***
	(0.435)	(0.539)	(0.488)	(0.403)
Creditor right index	-0.09***	-0.11***	-0.12***	-0.09***
	(0.028)	(0.032)	(0.038)	(0.026)
Judicial efficiency index	0.01	-0.05	-0.01	-0.06
	(0.034)	(0.044)	(0.035)	(0.040)
Stock market capitalization	0.00	-0.00	-0.00**	0.00*
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.39**	1.05***	1.19***	1.20***
	(0.193)	(0.381)	(0.402)	(0.397)
Observations	11,165	11,165	11,165	11,176
R-squared	1.08%	1.02%	1.06%	1.11%

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

ment capacity, and judicial development yield economic impacts beyond our behavioral variables.

4.7 Conclusions

Our empirical results suggest taking a second look at the role of loss aversion in individual investors' choice problems. When facing the probability of loss, investors would simply accept the sure losses, and then face the same risky situations that drive them to exhibit risk-seeking behavior. This is the case when stocks are considered as means of exchanges, where loss aversion is not as relevant (Chapman, 1998; Van Dijk and Van Knippenberg, 1998). However, further empirical work is needed to lend additional support to this hypothesis.

The other interesting issue, which is addressed in Langer and Weber (2005), would be to investigate whether investors judge outcomes in consequences or in prospects. In the former case, if investors were to put more weight on loss probabilities of outcomes, they would normally exhibit loss aversion. In the latter case, if a high loss probability were associated with a high gain probability, the fact that investors tend to accept a large degree of loss probability would be due to their high expectation of larger future gains (high risks–high returns). This means that investors prefer the lottery choices in the loss domain because of investors' risk-seeking attitude, not loss aversion.

The next contribution we discuss is the possibility of integrating risk attitudes and time preference in theories accounting for the equity premium puzzle. Beyond traditional risk aversion, risk-seeking and patience (a proxy for investors' time preference) contribute to explaining the equity premia. This opens the possibility to relax assumptions about investors' preferences toward integrating more factors that might play a role in modeling investors' behavior.

Last but not least, culture and macroeconomic factors also determine the size of the equity premia. However, the mechanism of how these values interact and contribute to the equity premia still leaves many open questions.

Chapter 5

Ambiguity aversion as an explanation of the equity premium puzzle

5.1 Introduction and related literature[1]

While the empirical evidence for the myopic loss aversion hypothesis seems to be rather mixed (compare Chapter 3 and Chapter 4), the new "fundamental" data on equity premia in Chapter 2 also enable us to test the ambiguity aversion approach (Chen and Epstein, 2003, Barillas et al., 2009, Gollier, 2011), with the aim of explaining the equity premium puzzle. This line of research is based on the fact that in reality, investors face not only a risky choice but also an ambiguous situation. An ambiguity-averse individual prefers an alternative in which the probability distribution of the outcomes is known (risky situation) over one in which the probabilities are unknown (ambiguous situation). The ambiguity itself in association with investors' attitudes towards ambiguity lead to additional *risk* factors, accounting for the excess ambiguity premium beyond the risk premium in asset pricing models.

Ambiguity is introduced in the seminal work by Knight Frank (1921), in which *Knightian uncertainty* is defined as the situation in which some events do not have an

[1]Parts of this chapter have been used for conference presentations of a joint working paper with Marc Oliver Rieger. That paper was awarded the "Best Doctoral Student Paper in Behavioral Finance and Economics" at the Annual Meeting of the Academy of Behavioral Finance & Economics, Chicago, 2013.

obvious probability assignment. The experimental relevance of this distinction between risk and uncertainty is first introduced through the Ellsberg paradox (Ellsberg, 1961), whereby people would rather choose to bet on the outcome of an urn with 50 red balls and 50 blue balls than to bet on the one with 100 balls but for which the distribution of blue or red balls is unknown. The behavior of preferring risky choices over ambiguous choices is, therefore, *ambiguity aversion*.

In later literature, attitudes toward ambiguity and the degree of ambiguity are mixed in some axiomatizations (Gilboa and Schmeidler, 1989, Epstein and Miao, 2003), but they are two different concepts in other works (Ghirardato et al., 2004; Klibanoff et al., 2005). While attitudes toward ambiguity (ambiguity aversion) can be measured with data from experiments in the setting of the abovementioned Ellsberg paradox, other works argue that the degree of ambiguity can be observed directly from market data (Izhakian, 2012b and references therein). However, behaviorists maintain a skeptical view on the direct measurement of ambiguity: the distinction between risk and ambiguity exists in the mind of the decision maker, rather than in data. Thus, only attitudes toward ambiguity can be observed, rather than the ambiguity that influences the decisions of agents (Chen and Epstein, 2003; Barillas et al., 2009; Gollier, 2011).

Intuition suggests that the effect of ambiguity aversion adds to those of risk aversion: the effect reduces the demand for ambiguous assets and acts as an extra risk aversion. Then, the equity premium is the sum of two positive terms, one for risk aversion, and the other for ambiguity aversion (Chen and Epstein, 2003). However, definitions of ambiguity aversion differ among scholars, such as the aversion toward model misspecifications in robust control asset pricing (Hansen et al., 1999), or the aversion towards unknown probability distribution of contingent events (Mukerji and Tallon, 2001; Mukerji et al., 2005). In line with this, the most widely known theory, the *smooth ambiguity model* (Klibanoff et al., 2005, 2009) succeeds in separating *ambiguity* and *ambiguity attitudes* to form the preference foundations for introducing *ambiguity* as an additional *(risk)* factor. Investors require a premium for their compensation for risks, but also an ambiguity premium for additional ambiguity. In theoretical models, this is proven to hold under some specific conditions (Gollier, 2011). Ambiguity aversion implies an increased *implicit* risk, not necessarily an increase in risk aversion. The increasing implicit risk reduces the risk-free return, thereby leading to a larger equity premium. For the reader's convenience, we summarize the arguments of applying ambiguity aversion to explain the equity premium in Gollier (2011) briefly.

1. The portfolio choice: a representative investor considers an asset allocation between two assets, a safe asset with a normalized zero return, and a risky asset with (excess) return x. She has initial wealth w_0 and plans to invest Δ in the risky asset. This yields a utility conditional to x of $Eu(w_0 + \Delta x)$.

2. Ambiguous environment: there are n possible return distributions described by a parameter $\theta \in \{0, 1, ..., n\}$, each with probability $(q_1, ..., q_n)$. The expected utility conditional on θ can be written as $U(\Delta, \theta) = Eu(w_0 + \Delta\tilde{x_\theta})$, where x_θ is the distribution of x conditional on θ.

3. Ambiguity aversion: following Klibanoff et al. (2005), the agent is averse to any mean-preserving spread of U. The preference functional V is such that

$$\phi(V(\Delta)) = \sum_{\theta=1}^{n} q_\theta \phi(U(\Delta, \theta)) = \sum_{\theta=1}^{n} q_\theta \phi(Eu(w_0 + \Delta\tilde{x}_\theta)), \tag{5.1}$$

   where the degree of concavity of the function ϕ, that is, $-\frac{\phi''}{\phi'}$, is a measure of ambiguity aversion (Pratt, 1964). The maxmin model of Gilboa and Schmeidler (1989) is a special case with $\phi(U) = -exp(-kU)$, where k tends to infinity.

4. Optimal condition of asset allocation under ambiguous environment: if the investors' preferences exhibit constant absolute risk aversion $u(z) = -A^{-1}exp(Az)$ and constant relative ambiguity aversion $\phi(U) = -\frac{(-U)^{1+\gamma}}{1+\gamma}$, the first-order condition implies that the optimal demand for the uncertain asset is

$$\Delta^* = \frac{\mu}{A(\sigma^2 + (1+\gamma)\sigma_0^2}, \tag{5.2}$$

assuming that priors are normally distributed with variance σ^2, and the ambiguity over the equity premium θ is itself normally distributed: $\tilde{\theta} \sim N(\mu, \sigma_0)$. Condition (5.2) suggests that an increase in ambiguity aversion γ reduces the demand for the risky asset. This exponential–power specification for (u, θ) performs better compared to the exponential–exponential specification of Taboga (2005), the power–power specification of Ju and Miao (2012), and the power–exponential specification of Collard et al. (2011).

5. Mathematical proofs in Gollier (2011) state that under specific conditions, ambiguity aversion may yield an increase in demand for the risky and ambiguous asset, and a reduction in demand for the safe asset. Even though it is intuitive to imply a positive relationship between ambiguity aversion and the equity premium in the economy, this implication is proven to hold only under some sufficient conditions, which are, however, satisfied in most cases.

In addition, empirical attempts in this line of research yield promising results. Similar to ambiguity aversion, Abel (1989, 2002) introduces uniform pessimism and doubt as additional *risk* factors, which cause the required average equity premium to be higher than under the rational assumption. Uniform pessimism is defined as the leftward translation of the objective distribution of the logarithm of the growth rate of aggregate consumption, which increases the average equity premium. While doubt is characterized as the subjective distribution whenever it is a mean-preserving spread of the objective distribution. Calibrating a simple asset pricing model under pessimism and doubt on Mehra and Prescott (1985)'s same data, Abel (1989, 2002) proposes a range of reasonable values of risk aversion and time preference discount factor. However, pessimism and doubt are rarely measured in psychology research, which prevents further empirical investigations following this idea.

Other evidence supporting the smooth ambiguity model (Klibanoff et al., 2005, 2009) is found in tests with the HEP (Collard et al., 2011), with the equity premium in production economy (Jahan-Parvar and Liu, 2011), or with the mean equity premium (Ju and Miao, 2012). In Collard et al., 2011, ambiguity is constructed as the conditional uncertainty about the mean of the probability distribution on dividend and consumption growth observed from historical paths. Standard expected utility is relaxed by allowing for ambiguity sensitivity. Ambiguity aversion is then calibrated based on an amended Lucas-tree model to match the first moment of the risk-free rate in US data from 1978 to 2011. Their model invokes a plausible level of ambiguity premium beyond risk premium, in which the constant relative risk aversion is restricted to a range between one and three, and also matches the levels, volatility, and dynamics of asset returns and prices. Jahan-Parvar and Liu, 2011 applies the "smooth ambiguity preferences" (Klibanoff et al., 2009; Ju and Miao, 2012) in another calibration on US data from 1929 to 1998. Their production-based model suggests that ambiguity aversion produces an annualized mean equity premium of 4.37% in the full information case and 3.77% in the incomplete information case. These results are generated with a low coefficient of relative risk aversion ($\alpha = 2$), maintain low and smooth risk-free rates, and assume an intertemporal elasticity of substitution greater than one. Finally, Ju and Miao (2012) introduce a modified smooth ambiguity framework to assess the effect of ambiguity on dynamics of asset prices. The authors propose a calibration using a certain set of parameters (risk aversion $\alpha = 2$, subjective discount factor $\beta = 0.975$, ambiguity aversion $\eta = 8.864$, and elasticity of intertemporal substitution of 1.5), which matches the mean equity premium of 5.75%, the mean risk-free rate of 2.66%, and the volatility of the equity premium of 19.02% observed from century-long annual US data.

Recently, model-free attempts have been proposed. Since alternative theoretical models have to compete for preciseness, a regression approach is applied to examine whether equity premium may reflect ambiguity aversion beyond risk aversion. Theoretical models suggest that ambiguity aversion has a positive impact on equity premium, but the regression methodology is insufficient to estimate the proportion of equity premium that can be explained by it. The two representative studies following this approach are Erbas and Mirakhor (2007) and Rieger and Wang (2012), which document a positive relationship between ambiguity/ambiguity aversion and the HEP. In Erbas and Mirakhor (2007), the HEP is correlated and regressed on alternative proxies for market uncertainty on cross-sectional data from 53 emerging and mature markets. The equity premia are documented to have larger magnitudes in countries where investors exhibit more aversion to ambiguity resulting from institutional weakness. During 1996–2005, average equity premium is substantial across countries, and is higher in emerging markets, particularly in Islamic countries.

Rieger and Wang (2012) documents a direct positive relationship between equity premia and ambiguity aversion, a behavioral parameter estimated from a large-scale international survey. HEP data for 40 countries are collected from recent publications and then regressed on ambiguity aversion controlled for macroeconomic factors. Intuitively, this would be the case if ambiguity aversion of the investors were to lead to an increase in the required equity premia for stocks, since the majority of investors prefers local equities owing to home bias. The authors' results suggest a proportional relationship between the dispersion of equity premia worldwide and levels of ambiguity aversion, like uncertainty avoidance—one of Hofstede (1984)'s cultural dimensions. Methodological concerns remain, since their analysis at the country level includes a small number of data points that make it difficult to control efficiently for other variables.

A similar approach can be applied given the "fundamental" equity premia we estimate from Chapter 2. We follow this approach in this chapter and demonstrate the stable effect of ambiguity aversion on equity premia. Traditional risk factors, behavioral determinants, and cultural characteristics also play significant roles in accounting for this puzzle, with or without controlling for a large set of variables.

The rest of this chapter is organized as follows: Section 5.2 describes our data and methodology, Section 5.3 provides the regression results and some further discussion, and Section 5.4 concludes.

5.2 Data & methodology

5.2.1 The "fundamental" equity premia

It is particularly helpful to obtain an estimate of the equity premium at not only the country level, but also the firm level, since this allows the inclusion of various firm-level controls that are necessarily missing in a countrywide comparison. The data on "fundamental" equity premia available in 54 countries, which are described in Chapter 2, serve exactly this purpose. Data matching with the INTRA survey (Rieger et al., 2014a,b) results in a total of *25,748* companies in *35* countries worldwide ready for use in our investigation.

5.2.2 Data on ambiguity aversion and risk preferences

In order to find empirical evidence for the ambiguity aversion hypothesis, we need data on ambiguity aversion and risk preferences in different countries. The INTRA survey (Rieger et al., 2014a,b) shows that there is a substantial amount of between-country variation in variables measuring risk preferences and ambiguity aversion. If this relates to the dispersion of the equity premia worldwide beyond other risk factors, ambiguity aversion might play an additional role in accounting for the equity premium.

The first experimental design to capture the ambiguity-averse attitude is the well-known Ellsberg paradox (Ellsberg, 1961). By recording choices of decision makers between alternative lotteries with precise and imprecise probabilities, Ellsberg (1961) determines a preference for known risks over unknown risks. The degree of ambiguity aversion can be measured experimentally with minor modifications in the settings of the original lottery selection game. In the INTRA survey, ambiguity aversion is measured using an Ellsberg paradox-type question, as follows.

Please imagine the following offers and mark your choice.

In an urn, there are 100 balls with three colors (red, yellow, and blue), 30 balls are red, whereas the remaining 70 consist of yellow and blue balls.

Imagine a ball is drawn randomly from the urn. You are offered the following two

30 balls	*70 balls*	
Red	*Yellow*	*Blue*

lotteries. Which lottery would you prefer?

A. If the color of this ball is red, you win \$100; otherwise you win nothing

B. If the color of this ball is yellow, you win \$100; otherwise you win nothing.

(A preference for option A points to a significant amount of ambiguity aversion).

These data are then aggregated at a country level to determine a proxy for the average ambiguity aversion of individual investors in a country. A *lower* value means *more* ambiguity aversion.

Similarly, we use the relative risk premium parameters from INTRA as proxies for risk preferences. The *RRP* is positive whenever a person is risk averse, and negative when a person is risk-seeking. A large *RRP* means *more* risk aversion (or *less* risk-seeking) (Table 5.1).

Connecting investors' preferences to the equity premium requires us to overcome the critique of the representativeness of our countrywide aggregation. Thanks to home bias (Coval and Moskowitz, 1999), investors tend to hold local stocks in the majority. For instance, French and Poterba (1991) empirically report the domestic ownership share in 1990 of the world's five largest stock markets to be 92.2% (US), 95.7% (Japan), 92% (UK), 79% (Germany), and 89.4% (France). This tendency to prefer local stocks is due to institutional barriers to foreign investments (Halliday, 1989), transaction costs (Black, 1974; Stulz, 1981b, 1983), and tax reasons (Cooper and Kaplanis, 1986, 1991; French and Poterba, 1993).

While we do not assume that ambiguity aversion of average investors corresponds exactly to that measured in the INTRA study, the relative differences between countries should be reflected by the relative differences between investors of companies from the respective countries[2]. For instance, it might be the case that participants of the

[2]Cross-listing and foreign ownership could be issues if the aim is to precisely estimate the equity premia acquired by local investors. However, firm-level data on ownership structures are difficult to find. Moreover, the relative differences of equity premia across countries, not their absolute values, are the main subjects of our investigation in accordance with the variation in investors' preferences. This could be improved in further research, provided that more data are available.

Table 5.1: Equity premia, ambiguity aversion, and risk preferences

Country	Number of Companies	ERPs	RRP Gains	RRP Losses	Ambiguity Aversion
Argentina	81	4.66%	0.74	-0.34	0.59
Austria	58	5.57%	0.65	-0.63	0.39
Australia	1,344	3.61%	0.65	-0.44	0.48
Belgium	96	5.88%	0.66	-0.35	0.72
Canada	2,596	1.50%	0.77	-0.33	0.63
Switzerland	119	6.04%	0.78	-0.45	0.57
Chile	69	4.73%	0.67	-0.17	0.68
China	2,236	6.36%	0.56	-0.35	0.67
Germany	489	3.26%	0.84	-0.54	0.47
Denmark	58	0.94%	0.64	-0.17	0.59
Spain	98	4.75%	0.72	-0.23	0.60
Finland	101	5.83%	0.73	-0.32	0.46
France	564	6.63%	0.54	-0.43	0.54
UK	1,075	6.30%	0.72	-0.49	0.61
Greece	200	1.66%	0.66	-0.77	0.59
Hong Kong	123	7.34%	0.93	-0.72	0.64
Ireland	50	6.98%	0.86	-0.53	0.48
Israel	364	5.68%	0.83	-0.63	0.58
India	2,756	5.01%	0.68	-0.54	0.82
Italy	197	3.29%	0.80	-0.35	0.53
Japan	2,435	3.02%	0.76	-0.54	0.62
South Korea	1,288	7.48%	0.55	-0.39	0.58
Mexico	83	5.43%	0.93	-0.72	0.62
Malaysia	672	5.48%	0.64	-0.81	0.59
Nigeria	84	11.25%	0.69	-0.60	0.65
Netherlands	98	7.75%	0.44	-0.17	0.57
Norway	98	5.65%	0.74	-0.46	0.46
New Zealand	81	7.95%	0.67	-0.64	0.53
Portugal	38	1.46%	0.61	-0.29	0.60
Sweden	265	7.29%	0.65	-0.21	0.50
Thailand	409	7.78%	0.60	-0.52	0.80
Turkey	228	5.16%	0.63	-0.18	0.62
Taiwan	1413	6.86%	0.66	-0.54	0.67
US	5,727	9.93%	0.78	-0.43	0.42
Vietnam	155	15.06%	0.67	-0.33	0.70

INTRA study in Vietnam and Germany have higher ambiguity aversion than average investors in their respective countries, but given that the participants in Vietnam have a higher ambiguity aversion than those in Germany, the result nevertheless suggests that investors in Vietnam are likely to have a higher ambiguity aversion than investors in Germany. That this relative difference is consistent with the INTRA study data is relevant for our empirical result. A precise value of ambiguity aversion of investors would be nice to know, but the elicitation method in the INTRA survey in any event does not allow us to obtain precise quantitative data on the amount of ambiguity aversion. This is definitely a task for future research.

Since preference variables from INTRA are results of the aggregation among individual investors, a possible criticism is that institutional investors might outperform individual investors. However, the majority of investors, especially in emerging markets, are individuals (De Bondt, 1998). Even when that is not the case, in a world of institutional investors such as pension, mutual, and hedge funds, managers investing others' money often exhibit interests aligned with those of their clients (Haigh and List, 2005). In fact, our estimation of investors' preferences in INTRA proves a good proxy to model a representative investor in every country in the sample.

5.2.3 Regression models and controls

Again, we apply the robust weighted regression similarly to formula (4.2):

$$w_i EP_{i,j} = \alpha_i + w_i A_i \beta_{1i} + w_i C_i \beta_{2i} + \epsilon_i, \tag{5.3}$$

where $EP_{i,j}$ is the equity premium of firm j in country i and A_i is the vector of ambiguity aversion and/or other risk factors. C_i is the vector of controls, w_i is the weight, which equals the ratio of the number of companies in a country over the total number of companies in the sample, and ϵ_i is the error term. This weighted least squares regression method is robust in that it reduces the effects of extreme cases on the estimated models. As robustness checks, we imply regressions using down-weighting outlier methodology, as introduced in Street et al. (1988). This helps to create a smoother dataset by assigning case-by-case weights associated with every extreme case. However, for international data, an outlier in one country could be the normal case in the sample of another region. This approach increases the explanatory power (high *R-square*) but reduces the effects of global-wide dispersion in our investigated variables.

Controls have been collected with care. For firm-specific risks, we use beta of stock (computed using the last 1-year returns in reference to the market indexes), a stock's volatility (over the last 360 trading days[3]), a log of the firm's leverage ratio, the number of analysts following a stock, and the past 1-year's cumulative stock return. Those variables are available from the OSIRIS database.

Similarly to Chapter 4, the effects of market-wide determinants and country-level factors are controlled by proxies representing information quality, transparency, institutional environment, and government policies. To overcome collinearity, we report only results in regressions with selected macroeconomics factors as controls. In particular, all our regressions are tested using the Collin tests (Belsley et al., 2005).

We use log of gross domestic product (GDP) per capita, log of the ratio of stock market capitalization to GDP, log of GDP growth rate, and the economic freedom index as macroeconomic controls. For robustness checks, the investor protection index, market efficiency index ,and GINI index are investigated, as well as the $LLSV^4$-type variables (details in the Appendix), which control for the relationship between law, institutional system, and finance, and all may have some impact on the equity premium.

Since our data are unique, we integrate additional behavioral variables from other international surveys. One of these is the proportion of participants who describe themselves as risk-seeking or risk averse in the World Value Survey[5], and the UAI from Hofstede (1984, 2001), which is more closely related to ambiguity aversion. Last but not least, the cultural indexes of Hofstede are investigated to shed light on the rela-

[3]"The 360-day volatility as of a specific date is the unbiased standard deviation of the 359 most recent logarithmic daily returns, multiplied by an 'annualisation' factor (which is 260, since there are 260 working days in a calendar year) [OSIRIS definition].

[4]Rafael La Porta, Florencio Lopez-de-Silanes, Andrei Shleifer, and Robert Vishny (La Porta et al., 1998, 2000; Djankov et al., 2008)

[5]http://www.worldvaluessurvey.org/

tionship between the equity premium and cultural determinants, similarly to Chapter 4.

5.3 Results and discussion

We begin our investigation by using equity premium as the dependent variable and other potential determinants as independent components of the weighted least square regressions. Starting with only firm-level controls, we investigate our ambiguity-aversion measure together with other macroeconomics factors in turn (Table 5.2). Our evidence supports the additional role of ambiguity aversion beyond other risk preferences to account for the equity premia (Table 5.3). The coefficients of ambiguity aversion are significantly negative in all of our models, that is, the equity premia are higher in countries where investors are ambiguity averse, in line with the prediction by Gollier (2011).

In the next step, we attempt to test cultural factors, in particular, Hofstede (2001)'s Individualism–Collectivism index (IDV) and UAI. All the four behavioral dimensions might have effects, but we focus more on the abovementioned two factors because they have been shown previously to affect financial markets (Stulz and Williamson, 2003; Kwok and Tadesse, 2006; Beugelsdijk and Frijns, 2010). The feasible approaches have been applied on momentum returns (Chui et al., 2012), value premium (Chui et al., 2012; Caliskan and Hens, 2014), foreign equity holdings of institutional investors (Anderson et al., 2011), and similarly, in the field of cultural behavioral finance (Lucey and Dowling, 2013).

According to Hofstede (2001), the individualism dimension reflects the degree to which individuals address themselves as unique and independent, or alternatively, as integrated into groups. However, because the individualism index is the result of an aggregation of cultural values, it is difficult to imply a direct link from cultural norms to investors' risk attitudes. On the one hand, individualism is positively related to overconfidence and self-attribution bias (Chui et al., 2010): where investors in more

Table 5.2: Regression results for the equity premium and ambiguity aversion

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
Ambiguity aversion	-1.88***	-2.53***	-1.88***	-2.08***	-0.77***
	(0.762)	(0.877)	(0.695)	(0.763)	(0.286)
GDP per capita	0.00**				
	(0.000)				
GDP growth rate		-0.05**			
		(0.022)			
Stock market capitalization			0.00***		
			(0.000)		
Economic freedom				0.03***	
				(0.009)	
Beta of stock	0.19**	0.08**	0.14**	0.17**	0.06
	(0.087)	(0.052)	(0.069)	(0.078)	(0.043)
Stock volatility	0.00	-0.00	0.02	0.02	0.03*
	(0.019)	(0.04)	(0.019)	(0.018)	(0.020)
Leverage ratio	-0.03**	-0.03**	-0.03**	-0.03***	-0.03***
	(0.012)	(0.014)	(0.013)	(0.012)	(0.009)
Analysts	-0.01	-0.00	-0.01	-0.01	-0.01
	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)
Past stock return	-0.02	-0.001	-0.02	-0.02	-0.00
	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)
Anti-director index	-0.24***	-0.24***	-0.27***	-0.33***	
	(0.078)	(0.081)	(0.090)	(0.109)	
Rule of Law	-0.36**	-0.07	-0.05	-0.16**	
	(0.163)	(0.038)	(0.036)	(0.070)	
Anti-self-dealing index	1.53***	1.46***	1.42***	1.40***	
	(0.513)	(0.490)	(0.473)	(0.467)	
Creditor right index	-0.13***	-0.15***	-0.14***	-0.15***	
	(0.044)	(0.050)	(0.045)	(0.050)	
Judicial efficiency index	0.09**	0.20***	0.17***	-0.01	
	(0.039)	(0.074)	(0.066)	(0.023)	
Constant	0.84***	0.94**	0.97***	0.41**	0.58***
	(0.294)	(0.332)	(0.341)	(0.175)	(0.186)
Observations	11,176	11,176	11,176	11,176	15,424
R-squared	1.19%	1.00%	0.98%	1.12%	0.18%

Robust standard errors in parentheses

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

Table 5.3: Regression results for the equity premium, ambiguity aversion, and risk preferences

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
Ambiguity aversion	-2.98***	-3.42***	-3.08***	-3.30***	-0.71***
	(1.104)	(1.206)	(1.130)	(1.201)	(0.261)
RRP gains	0.36*	0.57*	0.55**	0.28	0.44**
	(0.207)	(0.298)	(0.273)	(0.195)	(0.184)
RRP losses	1.11***	1.35***	1.20***	1.34***	0.23***
	(0.407)	(0.486)	(0.441)	(0.490)	(0.079)
GDP per capita	0.30**				
	(0.149)				
GDP growth rate		-0.11***			
		(0.037)			
Stock market capitalization			0.00**		
			(0.000)		
Economic freedom				0.03***	
				(0.012)	
Beta of stock	0.18**	0.10	0.20**	0.26**	0.10*
	(0.084)	(0.063)	(0.091)	(0.112)	(0.055)
Stock volatility	-0.02	-0.06*	-0.02	-0.03	0.03
	(0.023)	(0.031)	(0.022)	(0.024)	(0.018)
Leverage ratio	-0.04***	-0.04**	-0.04***	-0.04***	-0.03***
	(0.015)	(0.015)	(0.014)	(0.013)	(0.009)
Analysts	-0.01*	-0.00	-0.01*	-0.01**	-0.01*
	(0.005)	(0.003)	(0.005)	(0.007)	(0.004)
Past stock return	-0.01	-0.00	-0.01	-0.02	0.00
	(0.013)	(0.014)	(0.012)	(0.012)	(0.012)
Anti-director index	-0.29***	-0.28***	-0.32***	-0.41***	
	(0.097)	(0.102)	(0.113)	(0.146)	
Rule of law index	-0.39**	-0.27***	-0.21**	-0.13**	
	(0.187)	(0.103)	(0.093)	(0.061)	
Anti-self-dealing index	1.91***	2.00***	1.87***	1.89***	
	(0.641)	(0.674)	(0.626)	(0.634)	
Creditor right index	-0.10***	-0.13***	-0.09***	-0.13***	
	(0.032)	(0.042)	(0.029)	(0.042)	
Judicial efficiency index	0.08*	0.14***	0.09**	-0.29**	
	(0.047)	(0.055)	(0.042)	(0.119)	
Constant	-0.49	2.53***	2.30***	2.48***	0.35***
	(0.692)	(0.876)	(0.812)	(0.874)	(0.089)
Observations	11,176	11,176	11,176	11,176	15,424
R-squared	1.28%	1.36%	1.26%	1.50%	0.22%

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

individualistic countries tend to see themselves as better than others, this leads to overweighting their own trading skills and private information, and consequently, more risk-seeking. This eventually causes excess noise-trading and therefore, higher equity premia. On the other hand, the "cushion hypothesis" (Hsee and Weber, 1999) proposes the opposite: the strong social network in a collectivistic (i.e. low individualism) society provides a "cushion" against potential financial catastrophe, and therefore, induces less risk-averse behavior. Our empirical results slightly support the first of these ideas by finding positive significant coefficients of the IDV in all our models (Table 5.4).

The second cultural dimension that we investigate is the UAI, which is to some extent related to our ambiguity aversion. This dimension expresses the degree to which the members of a society feel comfortable with uncertainty or ambiguity. In the original definition by Hofstede (2001), uncertainty avoidance measures how a society deals with the fact that *"the future can never be known: should we try to control the future or just let it happen?"* Uncertainty avoidance is a much more general concept than ambiguity aversion itself. In our tests, the effects of uncertainty avoidance on the equity premium are weak and negative, suggesting a need for further investigation before any implication can be drawn (Table 5.5).

Two possible concerns are the possibility of collinearity between cultural variables with ambiguity aversion, and the strong effect of ambiguity aversion in joint models with other macroeconomic and cultural characteristics. We check these issues by removing ambiguity aversion from the abovementioned models after the collinearity tests. However, the results remain similar and therefore, are not reported.

5.3.1 Robustness checks

To test for robustness, we employ a new group of control variables that may have effects on the return distributions, which are well documented in the literature. We add the Investor Protection Index and Market Efficiency Index from the Global Competitiveness Report 2010 by the World Economic Forum, and the GINI index as controls for the development of a country's stock market. Other firm-level factors remain unchanged.

Table 5.4: The equity premia, ambiguity aversion, and the Individualism Index

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
Ambiguity aversion	-2.31***	-2.34***	-2.19***	-2.30***	-0.35**
	(0.874)	(0.845)	(0.824)	(0.860)	(0.158)
Individualism Index	0.01***	0.01***	0.01***	0.02***	0.00***
	(0.003)	(0.004)	(0.004)	(0.005)	(0.002)
GDP per capita	0.00**				
	(0.000)				
GDP growth rate		-0.12***			
		(0.041)			
Stock market capitalization			0.00**		
			(0.000)		
Economic freedom				0.04***	
				(0.015)	
Beta of stock	0.22**	0.08	0.17**	0.26**	0.14**
	(0.095)	(0.052)	(0.079)	(0.111)	(0.065)
Stock volatility	-0.01	-0.04	-0.00	-0.03	0.04*
	(0.020)	(0.026)	(0.019)	(0.023)	(0.021)
Leverage ratio	-0.03**	-0.03**	-0.03***	-0.03***	-0.03***
	(0.013)	(0.014)	(0.014)	(0.013)	(0.011)
Analysts	-0.01*	-0.00	-0.01*	-0.01**	-0.01**
	(0.005)	(0.002)	(0.005)	(0.006)	(0.005)
Past stock return	-0.02*	-0.01	-0.02**	-0.03**	-0.00
	(0.012)	(0.012)	(0.012)	(0.013)	(0.011)
Anti-director index	-0.16***	-0.14***	-0.18***	-0.27***	
	(0.053)	(0.052)	(0.062)	(0.094)	
Rule of law	-0.61**	-0.35***	-0.32**	-0.32**	
	(0.255)	(0.132)	(0.136)	(0.131)	
Anti-self-dealing index	1.50***	1.53***	1.37***	1.20***	
	(0.497)	(0.510)	(0.445)	(0.386)	
Creditor right index	-0.12***	-0.17***	-0.11***	-0.13***	
	(0.039)	(0.055)	(0.036)	(0.045)	
Judicial efficiency index	0.09**	0.28***	0.20**	-0.31**	
	(0.041)	(0.101)	(0.076)	(0.126)	
Constant	0.41**	0.33**	0.43**	0.23	0.04
	(0.181)	(0.159)	(0.183)	(0.145)	(0.045)
Observations	11,165	11,165	11,165	11,165	15,413
R-squared	1.47%	1.39%	1.26%	1.63%	0.33%

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 5.5: The equity premia, ambiguity aversion, and the Uncertainty Avoidance Index

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
Ambiguity aversion	-1.69***	-1.82***	-1.62**	-1.68***	-0.75***
	(0.650)	(0.679)	(0.639)	(0.645)	(0.281)
Uncertainty Avoidance Index	-0.00***	-0.00***	-0.00***	-0.00	-0.00***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
GDP per capita	0.52**				
	(0.229)				
GDP growth rate		-0.08***			
		(0.030)			
Stock market capitalization			0.00		
			(0.000)		
Economic freedom				0.02**	
				(0.009)	
Beta of stock	0.21**	0.11*	0.17**	0.22**	0.06
	(0.092)	(0.059)	(0.077)	(0.096)	(0.043)
Stock volatility	-0.00	-0.01	0.02	0.01	0.04*
	(0.019)	(0.021)	(0.018)	(0.018)	(0.020)
Leverage ratio	-0.03**	-0.03**	-0.03**	-0.03***	-0.03***
	(0.012)	(0.013)	(0.013)	(0.012)	(0.009)
Analysts	-0.01	-0.00	-0.01	-0.01*	-0.01
	(0.004)	(0.002)	(0.004)	(0.005)	(0.004)
Past stock return	-0.02	-0.01	-0.02*	-0.02*	-0.00
	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)
Anti-director index	-0.27***	-0.26***	-0.29***	-0.35***	
	(0.090)	(0.088)	(0.096)	(0.122)	
Rule of law	-0.36**	-0.04	0.02	0.07***	
	(0.176)	(0.029)	(0.023)	(0.023)	
Anti-self-dealing index	1.60***	1.66***	1.62***	1.55***	
	(0.533)	(0.557)	(0.534)	(0.513)	
Creditor right index	-0.17***	-0.19***	-0.16***	-0.17***	
	(0.055)	(0.062)	(0.049)	(0.056)	
Judicial efficiency index	0.19**	0.26***	0.18**	-0.06	
	(0.073)	(0.094)	(0.072)	(0.049)	
Constant	-4.05**	0.72***	0.75***	0.67***	0.62***
	(1.864)	(0.250)	(0.254)	(0.233)	(0.196)
Observations	11,165	11,165	11,165	11,165	15,413
R-squared	1.19%	1.13%	1.05%	1.19%	0.19%

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Further tests are implemented by collecting $LSSV$-type variables, such as the rule of law (La Porta et al., 1998), investor protection index (La Porta et al., 2000), and self-dealing regulations (Djankov et al., 2008). In addition, ambiguity aversion remains a significant contributor in tests with or without controlling for risk-preference parameters (Table 5.6 and Table 5.7).

The second robustness test we employ is the robust regression for down-weighting outliers (Street et al., 1988). An algorithm is applied in the first step to form the case-by-case weight for every extreme case, with the aim of minimizing the sum of a less rapidly increasing function of the residuals. The next step is to run a weighted least squares regression with these case-by-case weights, which yields robust results, since all the outliers are down-weighted to create smoother data. This approach helps to minimize the sum of residuals to the lowest extent, that is, a significantly high *R-square*. However, this case-by-case weighting approach bypasses the country effect of those extreme values, which is captured successfully by the case-by-country weighting methodology.

In all regressions, the effect of ambiguity aversion remains significant (with a high *R-square)* (Table 5.8 and Table 5.9). As previously mentioned, the down-weighting methodology smooths out all the country effects, and therefore, it is not appropriate to interpret the regression coefficients in the usual way. However, the strong explanatory power of ambiguity aversion on the equity premia is robust, as can be observed by its statistical significance, which is at the 1% level in all models.

5.4 Conclusions and further discussion

The main contributions of this chapter are to provide rigorous empirical evidence supporting the approach of ambiguity aversion in explaining the equity premium puzzle. Intuitively, the interaction effect of ambiguity and ambiguity aversion causing an ambiguity premium beyond the risk premium must be the central object. Recent research has attempted to apply the mean-variance approach to integrate ambiguity sensitivity

Table 5.6: Regressions with different controls for the equity premia and ambiguity aversion

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Ambiguity aversion	-0.95**	-2.20***	-1.36***	-1.88***
	(0.404)	(0.852)	(0.518)	(0.695)
GDP per capita	0.21***			
	(0.073)			
GDP growth rate		-0.78**		
		(0.307)		
Stock market capitalization			0.03***	
			(0.011)	
Economic freedom				0.04***
				(0.015)
Beta of stock	0.06	0.07	0.04	0.16*
	(0.052)	(0.056)	(0.048)	(0.080)
Stock volatility	0.04	0.05	0.04*	0.03
	(0.026)	(0.031)	(0.027)	(0.023)
Leverage ratio	-0.05**	-0.06**	-0.05**	-0.05**
	(0.023)	(0.028)	(0.023)	(0.022)
Analysts	-0.01	-0.01	-0.01	-0.01*
	(0.005)	(0.005)	(0.004)	(0.006)
Past stock return	-0.00	0.00	-0.00	-0.01
	(0.014)	(0.016)	(0.014)	(0.014)
Investor protection index	0.05***	0.04***	0.05***	0.06***
	(0.018)	(0.014)	(0.017)	(0.022)
Market efficiency index	0.06	-0.02	0.18***	-0.31**
	(0.041)	(0.029)	(0.063)	(0.124)
GINI index	0.02***	0.05***	0.02***	0.02***
	(0.007)	(0.018)	(0.006)	(0.008)
Constant	-1.33***	0.62*	-0.90***	-1.34***
	(0.461)	(0.323)	(0.325)	(0.467)
Observations	12,324	12,324	12,324	12,324
R-squared	0.63%	1.07%	0.61%	0.87%

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 5.7: Regressions with different controls for the equity premia, ambiguity aversion, and risk preferences

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
Ambiguity aversion	-2.85***	-2.17***	-1.21***	-2.17***	-2.01***
	(1.083)	(0.769)	(0.396)	(0.771)	(0.735)
RRP gains	1.69**	1.63**	0.88**	0.44	0.77**
	(0.771)	(0.634)	(0.447)	(0.394)	(0.393)
RRP losses	1.67***	1.49***	1.86***	1.16***	1.36***
	(0.601)	(0.510)	(0.691)	(0.448)	(0.473)
GDP per capita	-0.43**				
	(0.181)				
GDP growth rate		-0.08**			
		(0.035)			
Stock market capitalization			-0.00**		
			(0.002)		
Economic freedom				0.02*	
				(0.009)	
Beta of stock	0.15*	0.13	0.28**	0.17**	0.15*
	(0.083)	(0.083)	(0.136)	(0.088)	(0.084)
Stock volatility	0.01	0.01	-0.01	0.01	0.01
	(0.022)	(0.028)	(0.028)	(0.022)	(0.023)
Leverage ratio	-0.05**	-0.06**	-0.06**	-0.05**	-0.05**
	(0.022)	(0.028)	(0.028)	(0.023)	(0.023)
Analysts	-0.01	-0.01	-0.01*	-0.01*	-0.01
	(0.006)	(0.006)	(0.008)	(0.006)	(0.006)
Past stock return	0.00	0.02	-0.01	-0.00	0.00
	(0.016)	(0.021)	(0.015)	(0.018)	(0.017)
Investor protection index	0.06***	0.10***	-0.00	0.07***	0.06***
	(0.019)	(0.031)	(0.010)	(0.023)	(0.022)
Market efficiency index	0.62***	0.21***	0.86**	0.09	0.30***
	(0.233)	(0.070)	(0.340)	(0.126)	(0.098)
GINI index	0.03***	0.04***	0.07**	0.04***	0.04***
	(0.012)	(0.016)	(0.029)	(0.014)	(0.014)
Constant	0.94*	-1.99***	-5.45**	-1.76**	-1.85***
	(0.518)	(0.737)	(2.238)	(0.687)	(0.700)
Observations	12,324	12,242	11,440	12,324	12,324
R-squared	1.18%	1.34%	1.38%	1.13%	1.10%

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 5.8: Down-weighting outliers for the equity premium and ambiguity aversion

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Ambiguity aversion	-0.10***	-0.06***	-0.09***	-0.04***
	(0.011)	(0.010)	(0.011)	(0.011)
GDP per capital	-0.00***			
	(0.000)			
GDP growth rate		0.01***		
		(0.000)		
Stock market capitalization			0.00***	
			(0.000)	
Economic freedom				0.00***
				(0.000)
Beta of stock	0.01***	0.01***	0.01***	0.01***
	(0.001)	(0.001)	(0.001)	(0.001)
Stock volatility	-0.17***	-0.17***	-0.17***	-0.17***
	(0.001)	(0.001)	(0.001)	(0.001)
Leverage ratio	-0.02***	-0.02***	-0.02***	-0.02***
	(0.001)	(0.001)	(0.001)	(0.001)
Analysts	0.00***	0.00***	0.00***	0.00***
	(0.000)	(0.000)	(0.000)	(0.000)
Past stock return	0.00***	0.00***	0.00***	0.00***
	(0.000)	(0.000)	(0.000)	(0.000)
Anti-director index	-0.03***	-0.03***	-0.02***	-0.03***
	(0.001)	(0.001)	(0.001)	(0.001)
Rule of law	0.02***	0.02***	-0.01***	0.01***
	(0.003)	(0.002)	(0.002)	(0.002)
Anti-self-dealing index	0.01***	0.02***	-0.01***	-0.01***
	(0.004)	(0.004)	(0.004)	(0.004)
Creditor right index	-0.00	0.00	-0.00	-0.00
	(0.001)	(0.001)	(0.001)	(0.001)
Judicial efficiency index	-0.02***	-0.03***	-0.02***	-0.06***
	(0.002)	(0.002)	(0.002)	(0.003)
Constant	0.41***	0.34***	0.38***	0.38***
	(0.008)	(0.009)	(0.008)	(0.009)
Observations	11,176	11,176	11,176	11,176
R-squared	68.75%	68.70%	67.94%	67.78%

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

Table 5.9: Down-weighting outliers for the equity premia, ambiguity aversion, and risk preferences

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Ambiguity aversion	-0.14***	-0.14***	-0.17***	-0.15***
	(0.013)	(0.013)	(0.013)	(0.013)
RRPgains	0.02**	-0.05***	-0.02**	-0.01
	(0.011)	(0.010)	(0.010)	(0.011)
RRPlosses	0.07***	0.05***	0.08***	0.07***
	(0.008)	(0.008)	(0.008)	(0.008)
GDP per capita	-0.00***			
	(0.000)			
GDP growth rate		0.01***		
		(0.000)		
Stock market capitalization			0.00***	
			(0.000)	
Economic freedom				0.00
				(0.000)
Beta of stock	0.01***	0.01***	0.01***	0.01***
	(0.001)	(0.001)	(0.001)	(0.001)
Stock volatility	-0.17***	-0.17***	-0.17***	-0.17***
	(0.001)	(0.001)	(0.001)	(0.001)
Leverage ratio	-0.02***	-0.02***	-0.02***	-0.02***
	(0.001)	(0.001)	(0.001)	(0.001)
Analysts	0.00***	0.00***	0.00***	0.00***
	(0.000)	(0.000)	(0.000)	(0.000)
Past stock return	0.00***	0.00***	0.00***	0.00***
	(0.000)	(0.000)	(0.000)	(0.000)
Anti-director index	-0.02***	-0.02***	-0.01***	-0.02***
	(0.002)	(0.002)	(0.002)	(0.002)
Rule of law	0.00	0.00	-0.03***	-0.02***
	(0.004)	(0.003)	(0.003)	(0.003)
Anti-self-dealing index	0.01**	0.01***	-0.01***	0.00
	(0.004)	(0.004)	(0.005)	(0.005)
Creditor right index	0.00	0.00	0.00**	0.00**
	(0.001)	(0.001)	(0.001)	(0.001)
Judicial efficiency index	-0.03***	-0.02***	-0.02***	-0.03***
	(0.003)	(0.003)	(0.003)	(0.003)
Constant	0.47***	0.39***	0.46***	0.46***
	(0.011)	(0.011)	(0.011)	(0.013)
Observations	11,176	11,176	11,176	11,176
R-squared	69.02%	69.05%	68.14%	68.40%

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

and ambiguity in a more general model of asset pricing (Izhakian and Benninga, 2011; Izhakian, 2012a). Since ambiguity can be defined as the unknown distribution of the probabilities of future outcomes, the variance of this probability distribution can be computed as an estimation of ambiguity directly observed from market data. The relationship of return risk can be extended to return–risk–ambiguity, in which the measures would be mean–variance–variance of variance (Izhakian, 2012b). Given the current data and results, we can conclude only that ambiguity aversion has a positive impact on equity premium. Theoretical models suggest that ambiguity aversion can explain the equity premium puzzle, but our current data are insufficient to estimate the *proportion* of equity premium that can be explained by it.

A further interesting aspect of our research is the significant impact of cultural differences on the size of the equity premium. The cross-country differences in investors' preferences can be translated into a systematic distribution of the equity premia worldwide. Our research, based on a large international database, is the first to understand the equity premium at a level beyond country aggregation. Since it is difficult to connect preferences and behavior at individual level, our results suggest some initial causal effects, which could be investigated in more detail in future research in the field of cultural finance.

The theoretical arguments in Gollier (2011) suggest that investors might not exhibit ambiguity aversion under some circumstances. Ellsberg himself questions whether ambiguity-seeking would be equally relevant empirically to ambiguity aversion (Ellsberg, 1961). In a recent working paper, Kocher et al. (2014) documents that a four-fold pattern of ambiguity emerges from their survey: ambiguity aversion is found for modest likelihood gain and low likelihood-loss prospects. Ambiguity seeking is found for low likelihood-gain prospects and modest likelihood-loss prospects. In all domains, the majority of subjects exhibit ambiguity neutrality. How this result might influence the model by Gollier (2011) is another interesting question.

Chapter 6

Conclusion

This dissertation has tested some alternative behavioral approaches to explain the famous equity premium puzzle (Mehra and Prescott, 1985). The contributions are twofold: a fundamental estimation of equity premia worldwide and the empirical tests of equity premia on alternative behavioral hypotheses. Myopic loss aversion (Benartzi and Thaler, 1995) performs well with HEP, but a reverse effect is documented in the firm-level tests. The hypothesis of ambiguity aversion (Chen and Epstein, 2003; Epstein and Schneider, 2008; Gollier, 2011) is thoroughly supported by our empirical analysis. Our first firm-level estimates of equity premia worldwide help to include many potential determinants of the equity premium in the empirical analysis, which previous attempts often bypassed.

Risk preference, loss preference, ambiguity preference, and time preference all have to be considered in both theoretical and empirical models for the equity premium. Recent behavioral theories suggest that some set of combinations among those preferences might account for the equity premium, for example, loss aversion and myopia (myopic loss aversion), risk aversion and ambiguity aversion, or risk aversion, loss aversion, and patience, as our empirical results document.

Using regression analysis, we investigated the potential effects of behavioral factors and cultural determinants on the equity premium. Our data cannot predict a precise proportion of the size of the effects on equity premia, but strongly suggest a causal impact of some characteristics. We hope that these empirical results open the road for future research, in which rational assumptions can be relaxed to integrate additional behavioral attitudes, such as attitudes toward losses, risks, and ambiguity.

Appendix

List of Control Variables

Variables	Descriptions	Sources
(1) Firm level controls		
Beta of stock	The last 1 year beta of stock	OSIRIS
Stock volatility	The stock's volatility (the last 360 trading days)	OSIRIS
Leverage ratio	Log of (long-term debt/ market capitalization)	OSIRIS
Analysts	The number of analysts following a stock	OSIRIS
Past stock return	Log of the last 1-year cumulative return	OSIRIS
(2) Country aggregate controls		
GDP per capita	Log of GDP per capita	World Development Indicators[a]
Stock market capitalization	Ratio of the stock market capitalization to GDP	World Development Indicators
GDP growth rate	Log of annual GDP growth rate	World Development Indicators
Economic freedom	A series of 10 economic measurements (World Heritage)	Economic Freedom Index [b]
GINI index	The index measures the equality of income distribution	World Bank[c]
Market efficiency index	Index of market efficiency by World Economic Forum	The Global Competiveness Report[d]
Investor protection index	Index of minority investor protection by World Economic Forum	The Global Competiveness Report[e]
(3) LLSV-type variables		
Rule of law (0-10)	Rule of law (0 to 10)	La Porta et al. (1998)
Eff. of the jud. system	Efficiency of the judicial system (0-10)	La Porta et al. (1998)
Corruption	Corruption index (0-10)	La Porta et al. (1998)
Accounting standard	Accounting standard index	La Porta et al. (1998)
Anti-director index (0-6)	Measure of shareholder protection	La Porta et al. (2000)
Creditor right (0-4)	Creditor rights protection	La Porta et al. (2000)
Anti-self-dealing index	Legal protection of minority shareholders	Djankov et al. (2008)

[a] http://data.worldbank.org/data-catalog/world-development-indicators
[b] http://www.heritage.org/index/about
[c] http://data.worldbank.org/indicator/SI.POV.GINI
[d] http://reports.weforum.org/global-competitiveness-2011-2012/
[e] http://reports.weforum.org/global-competitiveness-2011-2012/

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DECLARATION

This thesis is a presentation of my original research work. Wherever contributions of others are involved, every effort is made to indicate this clearly, with due reference to the literature, and acknowledgment of collaborative research and discussions. The work was conducted under the guidance of Prof. Dr. Marc Oliver Rieger at the University of Trier, Germany.

Trier, April 12, 2016, Minh Hai Ngo