Can ambiguity aversion solve the equity premium puzzle? Survey evidence from international data

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Abstract

Ambiguity aversion has been suggested as a potential explanation for the equity premium puzzle in recent theoretical models. To test this hypothesis, we measure the amount of ambiguity aversion in a large-scale international survey. A comparison to the average equity premia in these countries demonstrates that ambiguity aversion does, indeed, have a significant influence on the amount of equity risk premium, even when controlling for macroeconomic parameters. Finally, we connect differences in ambiguity aversion to differences in uncertainty avoidance, one of Hofstede’s cultural dimensions.

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1. Introduction

1.1. What is the equity premium puzzle?

The equity premium, that is, the difference between the average return of stocks and bonds, has been noted to be surprisingly large – a phenomenon dubbed the “equity premium puzzle.” The equity premium puzzle was first identified by Mehra and Prescott (1985), who demonstrated that the difference in average returns between stocks and bonds can only be explained within a standard consumption-based expected utility framework if one assumes a much stronger risk aversion than commonly measured.
Since Mehra’s finding, many possible explanations for the puzzle have been suggested (see Mehra (2008) for an overview). Some explanations modified the preference structure in the original Mehra & Prescott setup. These alternative preference models include the generalized expected utility (GEU) theory where time and risk preferences are independent (Epstein and Zin, 1991), and the habit formation model, where the utility depends on both current and past consumption (Constantinides, 1990; Abel, 1990; Campbell, 1999). Behavioral models such as loss aversion from the prospect theory (Benartzi and Thaler, 1995; Barberis and Huang, 2008) and disappointment aversion (Gul, 1991; Routledge and Zin, forthcoming) have also been proposed. Hens and Wöhrmann (2006) even argue that the degree of risk aversion needed to explain the equity premium could be consistent with experiments if one applies mental accounting. Some models modify the probability distribution by taking into account rare, though disastrous events (Rietz, 1988; Mehra and Prescott, 1988; Barro, 2005), idiosyncratic income shocks (Constantinides and Duffie, 1996; Krebs, 2000) and survivorship bias (Brown et al., 1995). In addition to the above risk-based models, researchers have also explored factors other than aggregate risk to account for equity risk premium, such as borrowing constraints (Constantinides et al., 2002), liquidity limitations (Bansal and Coleman, 1996; Holmström, 1998) and tax reasons (McGrattan and Prescott, 2003; McGrattan and Prescott, 2005).

Our current study is related to recent literature that extends the risk-based model by linking the equity risk premium to ambiguity aversion. Therefore, we review this explanation in more detail in the following sections.

1.2. What is ambiguity aversion?

Ambiguity aversion is an aversion to lotteries where the probabilities involved are not precisely known. It is, therefore, a preference for known risks over unknown risks.

The difference between risk and uncertainty has first been pointed out by Knight (1921). Ambiguity aversion can be one of the possible explanations for the famous Ellsberg Paradox (Ellsberg, 1961) as following:

There is an urn with 300 balls. 100 of them are red, 200 are blue or green. You can pick red or blue and then take one ball (blindly, of course). If it is of the color you picked, you win a prize, otherwise not. Which color do you choose?

Most people choose red in this experiment. Let us look at the second experiment:

Same situation, you again pick a color (either red or blue) and then take a ball. This time, if the ball is not of the color you picked, you win a prize; otherwise, you do not. Which color do you choose?

Here, the situation is different. If you pick red, you win if either blue or green is chosen, and although you do not know the number of the green or the number of the blue balls, you know that there are 200 balls in total. Most people pick red.

Although both answers seem natural from the expected utility point of view, this implies that in the first experiment, subjects must have estimated that there are fewer blue balls than red balls and, hence, picked red. Given that, in the second experiment, they should have chosen blue as the estimated combined number of red and green balls would be larger than the combined number of blue and green balls. This demonstrates that ambiguity aversion cannot be explained within the framework of the expected utility theory.

The degree of ambiguity aversion can be measured experimentally if one varies the number of red balls in the above experiment. That is, people who prefer red in the first example, even given a relatively small number of red balls, are strongly ambiguity averse.

1.3. Theoretical models for ambiguity aversion and equity risk premium

Chen and Epstein (2002), Barillas et al. (2009), and Gollier (2011) suggest that ambiguity aversion could provide a potential solution to the equity risk premium puzzle, see also Aloysius (2005).

Their fundamental idea is that ambiguity aversion generates a premium on top of the usual risk premium, as the return distribution of stocks is not precisely known. To illustrate the intuition of this
hypothesis, consider a simple lottery with a probability $p$ to win 100 and otherwise 0. Let $U(x)$ be the utility function. The expected utility (EU) of this lottery is

$$ EU = pU(100). $$

If the probability $p$ is unknown for this lottery, then we encounter a lottery with ambiguity. We apply two simple models to represent the preference for such an ambiguous lottery. One of the first models for ambiguity aversion is the maxmin expected utility (MEU), also called multiple priors, proposed by Gilboa and Schmeidler (1989). Let $S$ be a set of states (in our example, $S = \{0, 100\}$), then the maxmin expected utility of the ambiguous lottery is

$$ MEU = \min_{s \in S} U_s = \min(U(100), 0) = 0 < pU(100) = EU. $$

Ghirardato et al. (2004) axiomatized a more general model, $\alpha$-maxmin($\alpha M$), which is a linear combination of maxmin expected utility and maxmax expected utility. The preference of our ambiguous lottery can be represented by

$$ \alpha M = \alpha \min_{s \in S} U_s + (1 - \alpha) \max_{s \in S} U_s = (1 - \alpha)pU(100) < pU(100) = EU \text{ for } \alpha > 0. $$

Note here that $\alpha$ can be interpreted as a measure of ambiguity aversion. We see that in both models, the lottery becomes less attractive than it is in the expected utility model; thus, the implicit risk premium increases under ambiguity. Therefore, stock prices would adjust downward in equilibrium, leading to higher expected returns and, therefore, an increased equity premium. Other models would yield qualitatively similar results.

Support for these models has been provided by a survey among practitioners described in Olsen and Troughton (2000) where the participants rated “uncertainty about the true distribution of possible future returns” as the second most important risk-related attribute of a stock. Moreover, participants estimated that stocks where only data, not the company name, were provided as riskier than the same stocks with the given company name.1 This, too, also suggests ambiguity aversion.

Although these observations make it seem plausible that ambiguity aversion is an important factor in determining the size of the equity premium, there is no sound empirical evidence supporting this conjecture. Thus, the aim of our article is to fill this gap.

2. Measuring ambiguity aversion and equity premium

2.1. Why a survey?

Although theoretical methods that estimate the impact of ambiguity aversion on the equity premium are certainly valuable, it is difficult to measure the effect directly. Recently, there have been attempts to do just that. In particular, Erbas and Mirakhor (2007) use indices composed by the World Bank (e.g., political stability or government effectiveness) as proxies for the “ambiguity” of the development of a country and consequently of its stock market. Using panel data for the equity risk premium, the authors found a relationship between these factors and the equity premium.

There are, however, certain questions about this approach. First, it would be preferable to use long-term averages for the equity premium rather than one year measurements that are bound to be influenced predominantly by short-term events. Second, and maybe more importantly, it is difficult to distinguish, by this methodology, ambiguity from risk as ambiguity is characterized by a lack of knowledge of probabilities for certain future events. This lack of knowledge is difficult, if not impossible, to measure. For instance, political stability could contribute to the risk associated with an investment in a country without making it impossible to estimate the probability for future returns. Moreover, the proxies mostly imply the amount of objective ambiguity in the market, whereas the subjective attitudes toward ambiguity aversion are not addressed.

1 In all cases, the stocks’ standard deviations of returns, betas, “safety ranks” as provided by an analyst company, and an Index of Analyst Disagreement were provided.
Therefore, in our study, we focus more directly on the investors’ ambiguity attitudes. Let us once more consider how ambiguity aversion may lead to an increased equity premium.

First, returns of stocks are perceived as ambiguous, i.e., the probability of a certain return cannot be estimated exactly. Second, ambiguity aversion of the investors leads to an increase in the required equity premium for stocks. While the first point is difficult to elicit, the second can be measured experimentally by the Ellsberg paradox: the more ambiguity averse investors are, the more they should react to the existing ambiguity on the market and demand a higher equity premium. Note that in this article, we have measured the ambiguity attitude but not the degree of (actual or perceived) ambiguity that exists in certain financial markets or economies.²

We cannot modify the degree of ambiguity aversion of the investors in a financial market to study effects on the equity premium. Therefore, we must use cross-country data to compare differences in equity premium with differences in the average degree of ambiguity aversion. Here, we utilize the home bias, that is, investors prefer to invest in their own country. Therefore, financial markets are mostly driven by preferences of the investors in the respective country. This natural separation will turn out to be sufficient for our study.³ Finally, we must make certain that samples across countries are comparable, and we must control for macroeconomic differences.

2.2. Methodology

To measure the ambiguity aversion, we use an Ellsberg paradox type question similar to the questions used in Becker and Brownson (1964) and many subsequent studies⁴:

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.

<table>
<thead>
<tr>
<th>30 Balls</th>
<th>70 Balls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

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

The question was included as part of a survey that we conducted in 45 countries worldwide, the “International Test of Risk Attitudes” (INTRA). The survey methodology is described in more detail in Rieger et al. (2011); however, we describe the most important features herein.

The subjects for the INTRA study were mostly undergraduate students of economics or business. The total number of subjects was N = 5912. The questionnaire was distributed in university classes, typically by the local professor. No remuneration was offered for participation.

This approach had several advantages in addition to its feasibility. First, the subject groups were comparable on a cross-country level. Second, given their background, the students were capable of...
understanding numerical questions in a survey such that few erroneous answers were given. Third, students of economics and business will probably, later in life, play an active role in financial markets, thus eliciting their preferences may be the closest one can realistically get to an investor sample. Finally, because the questionnaires were distributed in the classroom, response rates were very high (above 90%), there was virtually no self-selection and students put more effort into answering the questions than do typical survey respondents.

The data were aggregated on a country level where the percentage of subjects choosing the unambiguous lottery was taken as a proxy for the average ambiguity aversion in a country. This rough approximation worked astonishingly well, as we will see later. Fig. 1 displays the country ranks in our study with respect to ambiguity aversion.5

To obtain equity premium data, we collected all published estimates that compared stock returns to bond returns that we could find in the literature (Alpalhao and Alves, 2005; Barro, 2005; Campbell, 2003; Dimson et al., 2006; Goetzmann and Ibbotson, 2006; Kyriacou et al., 200; Lally and Marsden, 2004; Mehra, 2003, 2007, 2008; Mehra and Prescott, 1985, 2003; Canova and Nicolo, 2003; San Martin, 2003; Schackman, 2006; Salomons and Grootveld, 2003). Studies that were updated later using the same methodology and mostly the same data set were omitted to avoid their being overrepresented. In most countries, we had more than one estimate for the equity premium, in which case, we used the mean of all the estimates. Table 1 summarizes our equity premium data.

2.3. Empirical results

Having collected the data on ambiguity aversion and the equity premium, we can now verify whether there is any correlation between the two, as the theoretical studies would suggest. Fig. 2 shows that this is indeed the case: the higher the ambiguity aversion in a country, the higher the equity premium.

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5 We only report countries that are used for the later analysis, i.e., where there are also historical data on the equity risk premium available. This was not the case in several developing countries and countries with very young stock exchanges (e.g., several Eastern European countries).
Controlling for a number of macroeconomic factors that may potentially affect equity premia does not change this result. In fact, we find that, except for the GDP growth rate, macroeconomic variables, namely, the GDP per capita, macroeconomic stability and economic freedom do not influence the equity premium significantly. Ambiguity aversion attitude as measured in our survey has substantial predictive power, which is robust across all of our models. We summarize the regression results in Table 1.

### Table 1
Average measurements of the equity risk premium (compared to long-term bonds) composed from various studies. N denotes the number of independent studies measuring the equity premium in the specific country.

<table>
<thead>
<tr>
<th>Country</th>
<th>Equity premium Mean</th>
<th>N</th>
<th>Country</th>
<th>Equity premium Mean</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>19.04</td>
<td>2</td>
<td>Japan</td>
<td>8.58</td>
<td>6</td>
</tr>
<tr>
<td>Australia</td>
<td>5.75</td>
<td>9</td>
<td>Korea</td>
<td>10.02</td>
<td>2</td>
</tr>
<tr>
<td>Austria</td>
<td>5.69</td>
<td>3</td>
<td>Malaysia</td>
<td>10.23</td>
<td>2</td>
</tr>
<tr>
<td>Belgium</td>
<td>7.59</td>
<td>4</td>
<td>Mexico</td>
<td>17.84</td>
<td>2</td>
</tr>
<tr>
<td>Brazil</td>
<td>2.53</td>
<td>2</td>
<td>Netherlands</td>
<td>6.09</td>
<td>8</td>
</tr>
<tr>
<td>Canada</td>
<td>5.32</td>
<td>8</td>
<td>New Zealand</td>
<td>5.51</td>
<td>3</td>
</tr>
<tr>
<td>Chile</td>
<td>26.17</td>
<td>2</td>
<td>Norway</td>
<td>8.04</td>
<td>3</td>
</tr>
<tr>
<td>China</td>
<td>8.04</td>
<td>1</td>
<td>Pakistan</td>
<td>2.94</td>
<td>2</td>
</tr>
<tr>
<td>Colombia</td>
<td>10.62</td>
<td>2</td>
<td>Peru</td>
<td>14.67</td>
<td>2</td>
</tr>
<tr>
<td>Denmark</td>
<td>6.84</td>
<td>4</td>
<td>Philippines</td>
<td>10.24</td>
<td>2</td>
</tr>
<tr>
<td>Finland</td>
<td>18.73</td>
<td>2</td>
<td>Portugal</td>
<td>14.20</td>
<td>3</td>
</tr>
<tr>
<td>France</td>
<td>7.11</td>
<td>10</td>
<td>Singapore</td>
<td>14.65</td>
<td>2</td>
</tr>
<tr>
<td>Germany</td>
<td>5.49</td>
<td>10</td>
<td>South Africa</td>
<td>7.19</td>
<td>3</td>
</tr>
<tr>
<td>Greece</td>
<td>15.90</td>
<td>2</td>
<td>Spain</td>
<td>4.84</td>
<td>5</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>20.95</td>
<td>2</td>
<td>Sweden</td>
<td>9.63</td>
<td>5</td>
</tr>
<tr>
<td>India</td>
<td>10.38</td>
<td>4</td>
<td>Switzerland</td>
<td>6.84</td>
<td>4</td>
</tr>
<tr>
<td>Indonesia</td>
<td>3.46</td>
<td>2</td>
<td>Taiwan</td>
<td>14.22</td>
<td>2</td>
</tr>
<tr>
<td>Ireland</td>
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<td>9</td>
<td>Thailand</td>
<td>11.78</td>
<td>2</td>
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<tr>
<td>Israel</td>
<td>8.80</td>
<td>2</td>
<td>UK</td>
<td>5.12</td>
<td>10</td>
</tr>
<tr>
<td>Italy</td>
<td>7.86</td>
<td>8</td>
<td>USA</td>
<td>6.11</td>
<td>14</td>
</tr>
</tbody>
</table>

Fig. 2. Correlation between ambiguity aversion and equity risk premium: the Pearson correlation is 0.501*** (p = 0.008, N = 27).
Table 2. Besides the controls reported in this table, we also used market efficiency, origin of law, easiness to obtain a loan and the Gini index as control variables, but ambiguity aversion remained a significant factor in these cases.

We may now question whether the effect that we have measured is just an artifact. In other words, could it be that ambiguity aversion correlates strongly with risk aversion, and thus, the above results simply demonstrate what everybody already knows, namely, that risk aversion influences the amount of the equity premium (which is why it is also called equity risk premium)? We have measured risk aversion (and loss aversion) in the INTRA survey as well (Rieger et al., 2011), but we find no significant correlation with the measure for ambiguity aversion. This confirms the results of previous laboratory studies (Cohen et al., 1985; Curley et al., 1986; Hogarth and Einhorn, 1990) for individual subjects.

2.4. Cultural dimension: uncertainty avoidance

In recent years, many studies have found that financial markets and the behavior of the agents in these markets differ from country to country, not only for institutional or macroeconomic reasons, but also for deeper reasons that are usually summarized as “cultural”. Sociologists have developed standardized and quantifiable measures that capture several parameters of culture. One of the most widely applied concepts is the “cultural dimensions”-concept by Hofstede (2001). Concepts such as this made applications to economy and finance possible, see, e.g., the recent work on the momentum effect by Chui et al. (2010).

It is interesting to observe whether differences in equity risk premia are related not only to ambiguity aversion (i.e., different preferences), but also to differences in culture. Indeed, we will show that this is the case.

Among the four classical cultural dimensions of Hofstede (individuality, power distance, masculinity and uncertainty avoidance), uncertainty avoidance certainly comes closest to ambiguity aversion. The uncertainty avoidance index (UAI) measures the degree to which people prefer to avoid “unclear” situations, e.g., at work. The country in our survey that scores highest on this scale is Greece (UAI = 112), where traditional culture is rather fixed and people try to avoid situations without predefined ways to handle them (Hofstede, 2001). On the other extreme, Denmark scores lowest on this scale.

In this context, it is interesting to mention that a relationship between ambiguity aversion and a psychometric scale measuring “intolerance to ambiguity” has already been found by Sherman (1974).

---

Table 2

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambiguity aversion</td>
<td>0.353</td>
<td>0.492</td>
<td>0.414</td>
<td>0.441</td>
</tr>
<tr>
<td></td>
<td>0.077</td>
<td>0.010</td>
<td>0.040</td>
<td>0.009</td>
</tr>
<tr>
<td>log (GDP/capita)</td>
<td>−0.309</td>
<td>0.010</td>
<td>0.040</td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>0.119</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macroeconomic stability</td>
<td>0.083</td>
<td>−0.304</td>
<td>0.124</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.642</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic freedom</td>
<td></td>
<td>−0.304</td>
<td>0.124</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.642</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP growth rate</td>
<td></td>
<td></td>
<td></td>
<td>0.422</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.012</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.325</td>
<td>0.258</td>
<td>0.309</td>
<td>0.426</td>
</tr>
<tr>
<td>$N$</td>
<td>26</td>
<td>26</td>
<td>22</td>
<td>26</td>
</tr>
</tbody>
</table>

* Significant on the 10% level.
** Significant on the 5% level.
*** Significant on the 1% level.
in our sample (UAI = 23). Danish people seem not to fear unclear situations. Fig. 3 shows a world map of the uncertainty avoidance index as measured by Hofstede. We can clearly observe systematic differences between cultural regions but also differences at the level of the individual countries.

When testing the relationship between uncertainty avoidance and equity premium, we find a clear relationship. This effect, however, disappears when adding ambiguity aversion to the regression (see Table 3). The results are stable when using either the original data from Hofstede (2001) or new measurements taken from the INTRA study (where the same questions as in Hofstede’s survey were included).

Taking everything into account, we see some kind of mediator effect. That is, uncertainty avoidance as a cultural dimension appears to affect the size of the equity premium through ambiguity aversion attitude. However, we need to be cautious when drawing a conclusion on causal effects based purely on statistical models. Our result may serve as input to formulate further testable hypotheses on the interaction between culture, attitudes, and the economic situation. Other cultural dimensions show no significant impact on the equity premium, as expected.

3. Summary and conclusions

Ambiguity aversion has been suggested as a potential factor for explaining high equity premia. Thus far, however, only theoretical models or indirect inference from estimations of ambiguity on a
market have been used to underpin this idea. In our study, we have brought together empirical data on equity premia and on ambiguity aversion on a cross-country level. We find strong evidence in favor of the hypothesis that ambiguity aversion increases the equity premium. The result is stable when taking into account various macroeconomic controls.

Finally, we have noted a connection between uncertainty avoidance, one of Hofstede’s cultural dimensions, and the equity premium that appears to work via ambiguity aversion as a mediator. This would imply that cultural differences influence market outcomes, such as the equity premium, by forming specific patterns of preferences.

Acknowledgments

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