The Equity Premium Puzzle, Ambiguity Aversion, and Institutional Quality: Implications for Islamic Finance

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Abstract

With cross-section data from 53 emerging and mature markets, we provide evidence that equity premium puzzle is a global phenomenon. In addition to risk aversion, equity premium may reflect ambiguity aversion. We explore the sources of equity premium using some pertinent fundamental independent variables, as well as the World Bank institutional quality indexes and other proxies for the degree of ambiguity in the sample countries. Some World Bank and other indexes are statistically significant, which indicates that a large part of equity premium may reflect investor aversion to ambiguities resulting from institutional weaknesses. Implications of the results for Islamic finance are discussed.

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I. Introduction

The equity premium puzzle (EPP) is the differential between return to equity and return to safe assets in excess of the premium that can be explained on the basis of a reasonable degree of risk aversion. [2] In addition to relative volatility and risk aversion,

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[2] Under some assumptions on the portfolio holder's utility function, the theory would predict that the risk averse decision maker would require a higher rate of return on the risky asset than on the safe asset in portfolio selection. For the seminal discussion of the

some macroeconomic fundamentals can explain the return differential, such as consumption smoothing, liquidity constraints, financial sector development, age composition of investors, and differences between the tax rates applying to equity earnings and safe asset returns. After accounting for the impact of such fundamentals on equity and safe asset returns, the observed differential between the two returns may still be large to the extent that it implies an extreme degree of risk aversion, which is empirically unsupported. [3]

Financial markets pose many unknown and unknowable risks that cannot be exhaustively parsed through analysis of data under the simplifying assumptions of efficient market theories. In general, financial markets exhibit Knightian uncertainty rather than precisely quantifiable risk.[4] Knightian uncertainty, or ambiguity, implies that the probabilities and payoffs associated with most investments are not known with precision. When ambiguous and risky economic prospects are compared, decision makers exhibit ambiguity aversion. Since the seminal contribution by Ellsberg (1961), ambiguity aversion has been documented in numerous experimental studies. There is a growing literature prominently, cumulative prospect theory that challenges the basic axioms of expected utility theory, which provides the theoretical context in which EPP is posited (Appendix II).

The paper makes three main contributions. First, it proposes ambiguity aversion as a possible explanation for EPP. [5] If markets perceive equity returns as more ambiguous than safe asset returns, then, in addition to a risk premium, markets pay an ambiguity premium on equity, making the observed equity premium larger. Second, while data from a few mature markets have been examined, we are not aware of studies that

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equity premium puzzle, see Mehra and Prescott (1985). Mehra (2003) provides a comprehensive review of the theories proposed to explain EPP. In this paper, we refer to Knightian uncertainty as uncertainty or ambiguity, as opposed to quantifiable risk.

3 There is evidence to the contrary in the case of the United States. McGrattan and Prescott (2003) argue that after accounting for taxes, regulations and transactions costs, equity premium is modest enough (less than 1 percent) to be explained by a moderate degree of risk aversion. Their results are confirmed by Imrohoroğlu (2003). We will briefly discuss some other models proposed to explain EPP in Appendix II.

4 IMF's September 2007 Global Financial Stability Report vividly illustrates how ambiguities may arise in one market (sub-prime mortgages) and spill over to other markets (structured credits).

5 Although uninsurable risks (e.g., permanent income shocks) have been examined in the literature on EPP, the impact of uncertainty has not received due attention. On the possible impact of uninsurable risks on EPP, see Constantinides and Duffie (1996), Rietz (1988), and Mehra's (2003) critique of their approach. Chen and Epstein (2002) underline the possible importance of ambiguity in explaining EPP and other puzzles.

have documented EPP across a large sample of countries.[6] The questions remain whether EPP is a global phenomenon and whether it prevails both in emerging and mature financial markets. Using a sample of 53 countries, comprising 29 emerging and 24 mature markets, the paper shows that EPP is a global phenomenon. Institutional quality may have a significant impact on the degree of uncertainty surrounding equity returns. The paper examines the possible impact of ambiguity aversion on equity premium by using the World Bank institutional quality indexes, as well as some other indexes, as proxies for the degree of uncertainty.[7] The correlation tests and regression results indicate statistically significant correlations between equity premium and some uncertainty proxies. To the extent institutional quality reflects on uncertainty, ambiguity aversion can explain a significant portion of the large equity premium across the sample countries.

The paper's third contribution is underlining the implications for Islamic finance of the empirical results that indicate a strong correlation between the institutional quality-uncertainty nexus and equity premium. The Islamic prohibition of interest-based debt contracts implies that Islamic finance has to operate on the basis of non-interest-based debt and risk-sharing contracts. Islam provides a specific legal-institutional framework—a network of rules and behavior—within which economic and financial systems are to operate (Archer and Abdel Karim, 2002; Iqbal and Mirakhor, 2007; Mirakhor, 2007; Askari and others, 2009). In the Islamic legal-institutional context, there are at least fourteen modes of financial transactions, with the theoretical possibility of extending them into a larger number of financial instruments through financial engineering.

Although Islamic finance has experienced rapid growth in and out of Muslim countries over the past three decades, it has a long way to go to become a serious alternative to conventional finance, despite the fact that there are compelling theoretical arguments for its advantages in terms of macroeconomic stability and growth (Khan and Mirakhor, 1987; Mirakhor and Zaidi, 1988; Mirakhor, 1990; Mirakhor and Krichene, 2009). The experience of the past three decades has shown that making significant progress in developing financial instruments in the Islamic

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6 See, however, Barro (2006) and our observations on the implications of CPT for the Rietz-Barro hypothesis concerning EPP in Appendix II.

7 Erbaş (2006) argues that the World Bank indexes may be robust operational proxies for the degree of uncertainty across countries and finds a strong positive correlation between insurability and institutional quality; the impact of uncertainty on insurability across countries is more significant than most other determinants of insurance coverage, including per capita income level.

modes remains a challenge in a clear majority of Muslim countries. Islamic finance operates within financial systems dominated by interest-based conventional finance. In that milieu, Islamic finance has faced the challenge of fully decoupling from interest-based finance. Consequently, a substantial portion of financial transactions in the Islamic mode have concentrated in short-term trade financing with significant reliance on collateral (Mirakhor, 1987). Even when innovative financial instruments such as *sukuk* have been introduced, the rate of return on such instruments have been directly or indirectly referenced to the interest rates in major financial centers. Moreover, Islamic financial instruments have required significant collaterals and/or government guarantees, thus overpricing the risks of underlying transactions (Mirakhor and Zaidi, 2007; Hassan and Lewis, 2007). Even Islamic institutions operating in the developed Western financial markets do not utilize the existing stock markets as a source of financing (Wilson, 2007). The slow pace of growth of genuine Islamic instruments of risk-sharing is reflected in the equally slow pace of growth of stock markets as efficient means of risk-sharing in Muslim countries. Those developments pose the question of why the purely Islamic models of risk-sharing have been so slow to emerge, despite their relative stability and growth potential.

The reluctance of Islamic finance, as it has developed thus far, to utilize equity participation through stock markets resembles the historically observed hesitation of conventional finance to rely on equity rather than debt financing, in spite of the significant differential between equity and debt returns. Thus, the history of equity participation points to the importance of institutional development in reducing uncertainty to support greater equity participation. Some researchers have focused on institutional factors (rules and norms, in the sense of Douglass North) and institutional quality to explain the slow pace of progress in stock market development in developing countries, which, as this paper argues, reflects on the equity premium puzzle (Gerretsen and others, 2004; Stulz, 1999, 2006; Guiso and others, 2005). The broad conclusion is that where institutional quality is high, there is greater reliance on equity finance. Those arguments and our empirical results suggest that Islamic and conventional finance share the EPP and that commonality can be explained by the institutional quality-uncertainty nexus.

The paper is organized as follows. In Section II, we present some vital observations on equity premium, stock return and safe asset return for the periods 1996–00, 2001–05, and 1996–05. Section III provides a simple example that sheds light on the impact of uncertainty on equity premium. Section IV presents an overview of the data used and correlation tests. Section V presents regression methodology and results. Section VI concludes.

II. Equity Premium Is a Global Phenomenon

A. Description of Data and Measurement

The overall period under consideration is 1996–05, which is a relatively short period. It is chosen on the basis of data availability in most emerging markets, where stock markets have become more active and have grown significantly only within the last decade. Also, the World Bank institutional quality indexes and most other indexes used are available only for this period. However, a ten-year period is long enough to facilitate robust inferences because it allows for market adjustments that distinguish longer-term market trends from temporary fluctuations in asset returns.

The real equity premia and stock and safe asset returns are presented in Table 1, with supplementary information shown in Table 2; also see Charts 1 and 2. The real stock market return is calculated as the yearly percentage change in the stock market index that is obtained by dividing the nominal stock market index by the CPI index. The real safe asset return is calculated as the nominal return minus CPI inflation.[8] The real equity premium is calculated as the difference between the real stock market and safe asset returns; it excludes dividend yield because reliable data on dividend yield in most emerging markets are not available; including dividend yield, equity premium may be significantly higher.

B. Main Observations

EPP is a global phenomenon. During 1996–05, average equity premium is substantial in both mature and emerging markets, ranging from 7.5 to 10.5 percent. These magnitudes are comparable to or in excess of the premia reported by Mehra and Prescott (1985) and Mehra (2003) for some mature markets (ranging from 3.3 to 8.0 percent in selected periods).

Equity premium is higher in emerging markets. During 1996–05, equity premium is 3 percent higher in emerging markets than in mature markets. However, during 1996–00, equity premium in emerging markets is (nearly) zero, while it is close to 14 percent in mature markets. This performance is reversed during 2002–05, as the premium in emerging markets jumps to 20.5 percent, while it declines by more than 12 percent to 1.5 percent in mature markets. The 19 percent difference between equity premium in emerging and mature markets during 2001–05 is remarkably large. This is the period during which emerging markets started attracting large capital

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[8] Appendix I, Tables 1 and 2 show the data sources of data for equity and safe asset returns and the selected safe asset returns in the sample countries.

inflows and experienced large stock markets gains and market development, following the recovery from the Southeast Asia crises which severely depressed stock returns in some of the sample countries. The increase in equity premium in emerging markets during 2001–05 is due to the fourfold jump in equity return, while safe asset return is half of that observed during 1996–00. Similarly, in mature markets, the decline in equity premium reflects mainly the decline in equity return by more than 13 percent, while the decline in safe asset return is only about 1 percent.

Equity premium is higher in Islamic countries. There are 11 Islamic countries in our sample, all classified as emerging markets.[9] The average equity premium during 1996-05 in those countries is 13.7 percent, significantly above the average of all sample countries and the sample of emerging markets.

[9] Those countries are: Bahrain, Egypt, Indonesia, Jordan, Kuwait, Malaysia, Morocco, Pakistan, Saudi Arabia, Tunisia, and Turkey.

Table 1: Average Equity Premium, Stock Market and Safe Asset Return in the Sample Countries, 1996–00, 2001–05, 1996–05[1]

	1996-2000	2001-2005	1996-2005
	Real Values in Percent		
	All Sample Countries (53)		
Equity premium	**6.2**	**11.9**	**9.1**
σ_s (sample)	16.3	17.2	8.2
σ_p (period)	17.7	19.5	18.8
Stock market return	**10.7**	**14.3**	**12.5**
σ_s (sample)	15.9	16.9	8.4
σ_p (period)	12.5	18.7	18.3
Safe asset return	**4.3**	**2.4**	**3.4**
σ_s (sample)	3.7	2.5	2.8
σ_p (period)	0.4	0.9	1.2
	Emerging Markets (29)		
Equity premium	**0.0**	**20.5**	**10.5**
σ_s (sample)	16.6	18.6	10.0
σ_p (period)	22.5	19.2	23.2
Stock market return	**5.6**	**23.1**	**14.4**
σ_s (sample)	16.7	17.7	10.0
σ_p (period)	22.3	18.0	22.0
Safe asset return	**5.1**	**2.6**	**3.9**
σ_s (sample)	4.4	3.3	3.5
σ_p (period)	0.8	1.4	1.7
	Mature markets (24)		
Equity premium	**13.6**	**1.5**	**7.5**
σ_s (sample)	12.2	6.4	4.7
σ_p (period)	14.3	20.4	18.6
Stock market return	**16.9**	**3.7**	**10.3**
σ_s (sample)	12.4	6.6	5.0
σ_p (period)	14.5	20.1	18.7
Safe asset return	**3.3**	**2.2**	**2.7**
σ_s (sample)	2.3	0.9	1.4
σ_p (period)	0.3	0.3	0.6

Source: Authors' estimates; Appendix I.

[1] Period averages are calculated as the sample average of individual country averages for each period; σ is standard deviation. Because of missing data during 1996-97 for some emerging market countries, the period averages in this table may slightly differ from those that can be calculated from Table 2, and, equity premium may not exactly equal to the difference between stock market return and safe asset return in 1996-2000.

Table 2. Average Equity Premium, Stock Market and Safe Asset Return in the Sample Countries, 1996–05 [1] (in percent)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
					All sample countries					
Equity premium	**12.6**	**11.7**	**-10.7**	**33.9**	**-14.8**	**-10.1**	**-12.4**	**33.5**	**19.4**	**29.1**
Stock market return	16.5	16.2	-5.9	38.3	-11.1	-6.6	-9.1	35.5	21.2	30.5
Safe asset return	4.0	4.8	4.7	4.4	3.7	3.6	3.3	2.1	1.7	1.4
					Emerging markets					
Equity premium	**11.1**	**3.0**	**-29.0**	**35.4**	**-17.8**	**-3.5**	**0.3**	**44.5**	**24.5**	**36.6**
Stock market return	15.4	9.0	-22.8	40.5	-13.4	1.1	4.1	46.5	25.9	37.8
Safe asset return	4.4	6.1	6.2	5.1	4.4	4.6	3.9	2.0	1.3	1.2
					Islamic countries					
Equity premium	3.4	8.9	-23.5	41.1	-13.8	-11.7	0.3	46.3	28.2	52.9
Stock market return	11.5	14.4	-20.5	47.6	-10.3	-6.6	3.8	49.4	29.6	54.3
Safe asset return	4.6	5.0	2.9	6.5	3.5	5.1	3.5	3.0	1.5	1.3
					Mature markets					
Equity premium	**14.0**	**21.4**	**11.5**	**32.2**	**-11.1**	**-18.2**	**-27.8**	**20.1**	**13.3**	**20.0**
Stock market return	17.6	24.8	14.5	35.7	-8.2	-15.9	-25.1	22.4	15.5	21.7
Safe asset return	3.6	3.4	3.0	3.5	2.9	2.3	2.7	2.2	2.2	1.6
					Memorandum items: Sample sizes					
					Equity premium					
All sample countries	48	51	53	53	53	53	53	53	53	53
Emerging markets	24	27	29	29	29	29	29	29	29	29
Islamic countries	6	8	11	11	11	11	11	11	11	11
Mature markets	24	24	24	24	24	24	24	24	24	24
					Stock market returns					
All sample countries	49	53	53	53	53	53	53	53	53	53
Emerging markets	25	29	29	29	29	29	29	29	29	29
Islamic countries	7	11	11	11	11	11	11	11	11	11
Mature markets	24	24	24	24	24	24	24	24	24	24
					Safe asset returns					
All sample countries	51	51	53	53	53	53	53	53	53	53
Emerging markets	27	27	29	29	29	29	29	29	29	29
Islamic countries	9	9	11	11	11	11	11	11	11	11
Mature markets	24	24	24	24	24	24	24	24	24	24

Source: Authors' estimates; Appendix I, Tables 1,2.

[1] Period averages that can be calculated from this table may slightly differ from the period averages presented in Table 1 because of missing data for some countries during 1996-97. Percent change real stock market index is calculated on the basis of the nominal index divided by CPI. Real return safe asset is calculated as the nominal return minus CPI inflation.

Chart 1: Average Equity Premium, Stock Market and Safe Asset Return in the Sample Countries, 1996-05

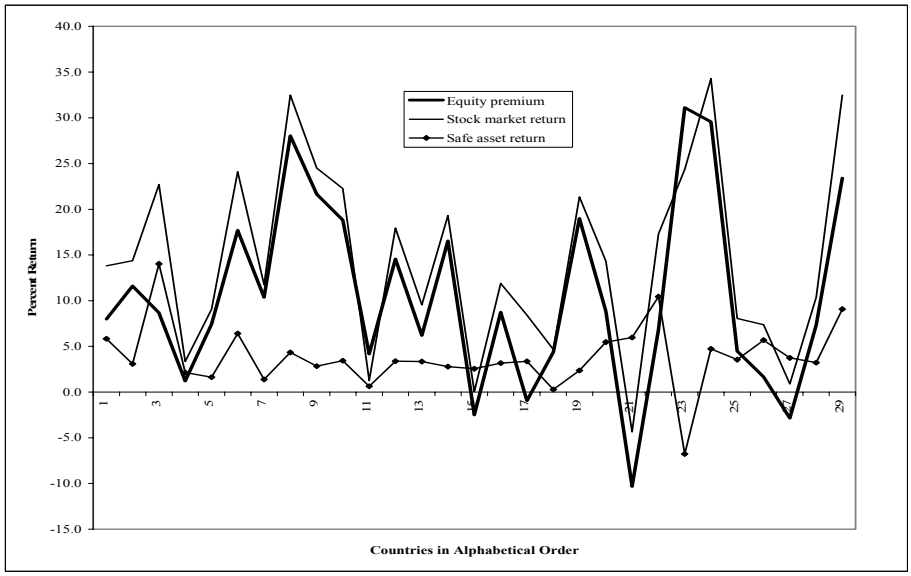
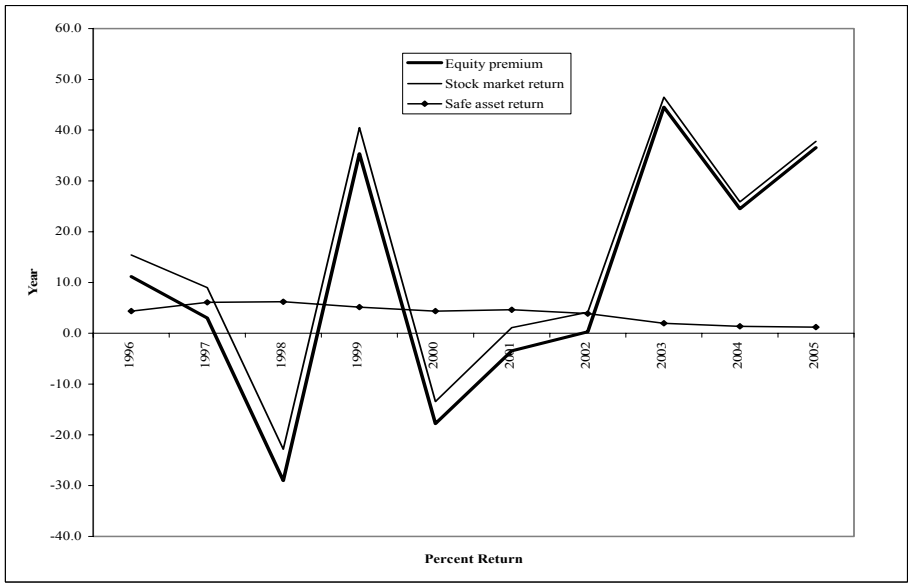


Chart 2: Average Equity Premium, Stock Market, and Safe Asset Return, Yearly Country Simple Averages, 1996-05



Sources: Authors' calculations; Table 2.

Volatility. Stock return across the sample shows greater variation (as measured by σs in Table 1) than safe asset return both in emerging and mature markets, which justifies risk premium on equity. The variation in both stock market and safe asset returns in emerging markets is significantly greater than the variation in mature markets.

Equity return and safe asset return correlations. Simple regression results in Table 3 indicate that equity return is positively correlated with safe asset return in the whole sample and in mature markets, while this correlation is not statistically significant in emerging markets.

The main determinant of equity premium is stock return in both emerging and mature markets (Table 3, Chart 1).

Equity premium over time. The robustness of inferences over time is limited by the small sample size. Nevertheless, the following observations are illuminating: (a) during 1996–05, the volatility of equity and safe asset returns (as measured by σp in Table 1) appears to be higher in emerging markets than in mature markets; (b) simple regression results indicate a significant negative correlation between stock return and safe asset return in emerging markets but those returns are not significantly correlated in the whole sample or in mature markets (Table 4); (c) the main determinant of equity premium over time is stock return in both emerging and mature markets (Chart 2); however, in emerging markets, simple regressions indicate a significant negative correlation between equity premium and safe asset return, which is consistent with the significant negative correlation between stock return and safe asset return (Table 4).

III. Ambiguity and Equity Premium

We now turn to the discussion of why ambiguity aversion is instrumental in explaining EPP. We do not intend to produce a formal portfolio model and our main focus is an empirical investigation of EPP across the sample countries. The discussion in this section will be limited to a simple example of the possible impact of uncertainty on equity premium.

A. An Example

We use cumulative prospect theory (CPT), originally developed by Kahneman and Tversky (1979, 1992).[10] According to CPT, the decision maker's probability assessment of a prospect is subjective. Suppose there is a safe prospect that requires an investment of $Y and pays a return in the amount of $C, so the rate of return on the safe prospect is C/Y. A risky investment in which $Y can be invested is expected to pay $R with probability p; let w(p) denote the subjective probability assessment of the investor. The utility from the return is defined by the function U(.),

Table 3: Equity Premium, Stock Market Return, and Safe Asset Return, Sample Correlations [1]

	Coefficient	P-value
Stock return regressed on safe asset return		
All sample countries	0.8	0.06
Emerging markets	0.6	0.30
Mature markets	1.3	0.07
Equity premium regressed on stock market return		
All sample countries	0.9	0.00
Emerging markets	0.9	0.00
Mature markets	0.9	0.00
Equity premium regressed on safe asset return		
All sample countries	-0.2	0.56
Emerging markets	-0.4	0.41
Mature markets	0.3	0.63

Source: Authors' estimates.

[1] Simple regressions based on the 1996-2005 country averages, using $Y_i = c_0 + c_1 X_i$, where Y_i is the vector of independent variables and Xi is the vector of dependent variables (1996-2005 country averages); i = 1, 2, …, 53.

[10] In Appendix II, we provide a brief discussion of how CPT can be applied to obtain the results below. That appendix also provides numerical examples and simulations, and a discussion on the Rietz-Barro hypothesis on the possible impact of small probability disaster states on equity premium.

Table 4: Equity Premium, Stock Market Return, and Safe Asset Return Correlations over the Period 1996–05[1]

	Coefficient	P-value
Stock return regressed on safe asset return		
All sample countries	-5.8	0.29
Emerging markets	-8.0	0.05
Mature markets	6.9	0.52
Equity premium regressed on stock market return		
All sample countries	1.0	0.00
Emerging markets	1.0	0.00
Mature markets	1.0	0.00
Equity premium regressed on safe asset return		
All sample countries	-6.8	0.22
Emerging markets	-9.0	0.03
Mature markets	5.9	0.58

Source: Authors' estimates.

[1] Simple regressions based on the 1996-2005 country averages, using $Y_t = c_0 + c_1 X_t$, where Y_i is the vector of independent variables and Xi is the vector of dependent variables (1996-2005 country averages); t = 1996, 1997, …, 2005.

U' > 0, which obeys the risk aversion assumption, U" < 0, and, U(0) = 0.11 The expected utility from the payoff to the risky asset is w(p)U(R). For the risk averse investor to be indifferent between the safe and the risky asset, R must be greater than C. We can calculate R, the certainty equivalent of the risky prospect, from the inequality U(C) ≤ w(p)U(R) as

$$R = U^{-}\left(\frac{U(C)}{w(p)}\right); R \geq C, \qquad (1)$$

where U— is the inverse of the utility function U(.). The minimum rate of return on the risky investment that is acceptable to the risk averse investor is R and (R-C)/Y ≥ 0

[11] The CPT argument that *U(0) = 0* deviates from expected utility theory, which values total wealth after a loss or a gain (here, *Y*, because loss is zero, and *Y+A*).

is the risk premium.[12] Except for the subjective probability weighting, the foregoing results are the same as those that follow from expected utility theory (EUT).

Under CPT, it is possible to posit an ambiguous prospect as a compound lottery.[13] Suppose a prospect is expected to pay off, if two events occur in succession. This prospect pays $A if both Event I and Event II occur, otherwise the payoff is zero; the probability of Event I occurring is q, and the probability of Event II occurring is z.[14] To compare the ambiguous prospect, A, to the risky one, R, assume that p = qz. According to EUT, the investor's assessment of the ambiguous prospect would be exactly the same as his assessment of the risky prospect. This is because the compound lottery involving Events I and II can be reduced to a simple lottery under the reduction axiom of EUT. According to CPT, however, the expected utility from the ambiguous prospect is assessed as w(q)w(z)U(A). Under the CPT assumptions on the subjective probability weighting, w(.), it is possible to show that w(p) = w(qz) ≥ w(q)w(z) (Appendix II). Using the inequality w(p)U(R) ≤ w(q)w(z)U(A), and applying the same operations and arguments leading to (1), the value of A for which the investor would be indifferent between A and R is

$$A = U^{-}\left(\frac{w(p)}{w(q)w(z)}U(R)\right);\ A \geq R \geq C. \qquad (2)$$

Therefore,

$$\frac{A-C}{Y} = \frac{A-R}{Y} + \frac{R-C}{Y}, \qquad (3)$$

where (A-C)/Y is the total equity premium in percentage terms, and (A-R)/Y is the ambiguity premium in excess of the risk premium, (R-C)/Y.

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[12] $R \geq C$ because, $U\{U^{-}[U(C)/w(p)\} \geq U(C)$, that is, $U(C) \geq w(p)U(C)$, since $0 \leq w(p) \leq 1$. Since $w(p)R = w(p)U^{-}[U(R)/w(p)]$, we also have $U^{-}[U(X)/w(p)] \geq X/w(p)$, or, $U(X)/w(p) \geq U(X/w(p)]$. This means that the expected return on the risky prospect is greater than the return on the safe prospect. $U(X)/w(p) \geq U[X/w(p)]$ because, if $w(p) = 1$, the risky and safe investments are identical; as $w(p)$ declines from unity, the increase in $U(X)/w(p)$ is proportional to the decline in $w(p)$ but, due to diminishing marginal utility, the increase in $U(X/w(p)]$ is less than proportional to the decline in $w(p)$. Therefore, $U(X)/w(p)\} > U(X/w(p)]$ for all $X > 0$, $w(p) < 1$, and hence $w(p)C > X$.

[13] Erbaş (2004) provides more extensive arguments and the references to the related literature.

[14] For example, a firm turns a profit this year (*Event I*) and the firm managers decide to pay dividend (*Event II*).

From data, we observe (A-C)/Y. Since EUT does not differentiate between risk and uncertainty, in the EUT framework, the observed return differential (A-C)/Y is attributed to only to risk premium but, for risk premium, EUT predicts (R-C)/Y. In the literature based on EUT, the differential (A-C)/Y is deemed too large relative to (R-C)/Y to be explained by a justifiable degree of risk aversion, and hence the equity premium puzzle. However, if we take into account ambiguity aversion, the observed return differential may not be too large for empirically supportable degrees of ambiguity and risk aversion.

Simple simulations in Table 5, based on specifications for Equations (1)-(3), as well as on a specification for the CPT probability weighting function, indicate that ambiguity premium can significantly augment the magnitude of equity premium (see Appendix II). For relatively small changes in the behavioral parameter values (probability weighting parameter, α, and, risk aversion parameter, θ), it is possible to generate high equity premiums.

Of course, the impact of CPT subjective probability weighting and ambiguity on equity premium remains to be tested in a formal asset pricing model.15

B. Discussion

The example above posits that the greater the number of events that lead to the outcome, the smaller is the probability assessment of the payoff. Under uncertainty, investors tend to assign lower subjective probabilities to payoffs than they do under risk.16 Then the time dimension is introduced, uncertainty becomes easier to put in a more realistic context. In the case of the uncertain asset in our example, it is easy to surmise that the two events are happening over time (Event I at time t and Event II at time t+1).

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15 For an axiomatization, see Chen and Epstein (2002); those authors also note that the separation of risk and ambiguity premiums can be instrumental in explaining EPP.

16 The above example is related to Ellsberg's two-color problem, which posits a case of uncertainty as follows. Urn I contains exactly 50 black and 50 red balls; the decision maker bets on a color; if he draws that color from the urn, he wins $100; otherwise, he wins or loses nothing, that is, the payoff is zero. Urn II also contains exactly 100 balls but the proportion of black and red balls is not known; the decision maker bets on a color; if he draws that color, he wins $100; otherwise the payoff is zero. Most decision makers prefer to bet on Urn I (risky), instead of Urn II (uncertain). Segal (1987) formulates Ellsberg's problem as a case in which the EUT reduction axiom does not hold.

Table 5. Simulations for Equity Premium (in percent)

	EUT		CPT					
	Equity premium *(R-C)/Y*	Return on risky asset *R/Y*	Equity premium *(A-C)/Y*	Ambiguity premium *(A-R)/Y*	Risk premium *(R-C)/Y*	Return on Ambg. Asset *A/Y*	Return on risky asset *R/Y*	Return on Safe asset *C/Y*
Risk aversion parameter, **θ** = 0.50								
α								
0.550	2.1	4.1	15.4	8.8	6.5	17.4	8.5	2.0
0.575	2.1	4.1	12.6	6.8	5.8	14.6	7.8	2.0
0.600	2.1	4.1	10.6	5.3	5.2	12.6	7.2	2.0
0.625	2.1	4.1	8.9	4.2	4.7	10.9	6.7	2.0
0.650	2.1	4.1	7.7	3.4	4.3	9.7	6.3	2.0
0.675	2.1	4.1	6.7	2.7	4.0	8.7	6.0	2.0
0.700	2.1	4.1	5.8	2.2	3.7	7.8	5.7	2.0
Subjective probability weighting parameter, **α** = 0.65								
θ								
0.300	4.6	6.6	25.7	14.1	11.6	27.7	13.6	2.0
0.400	2.9	4.9	12.3	5.9	6.4	14.3	8.4	2.0
0.500	2.1	4.1	7.7	3.4	4.3	9.7	6.3	2.0
0.600	1.6	3.6	5.4	2.2	3.2	7.4	5.2	2.0
0.700	1.3	3.3	4.2	1.6	2.6	6.2	4.6	2.0
0.800	1.1	3.1	3.4	1.3	2.1	5.4	4.1	2.0
0.900	1.0	3.0	2.8	1.0	1.8	4.8	3.8	2.0
Probability values:								
	p = 0.70	q = 0.85	z = 0.82	p = qz				

Source: Authors' simulations.

Equity returns involve more layers of uncertainty and decision making than safe returns over space and time. Importantly, bond cash flows are known with certainty, while corporate cash flows and earnings are difficult to predict. Profitability of a corporation depends on more layers of information flows and decisions (events) than the return on bonds, such as the corporation's market share, innovative capacity, managerial prowess, as well as the prospects for such factors over time. Each layer of uncertainty and its interaction with the other layers need to be assessed by markets and this requires greater specialized knowledge. A corporation may have a comfortable niche in the market now but there may be concerns about its ability to make profitable innovations over time. Innovations, if and when they are made, may or may not catch on, they may prove more or less easy to imitate by competitors, and so on.[17] This is a familiar description of a riskier asset that an investor—particularly a

[17] Patent protection (a legal institution) has a bearing on how well innovations are protected and how easily they can be imitated. Movie and music piracy is an example of innovations that are easy to imitate.

professional investor—has in mind while making a portfolio decision but there is a fundamental difference. The additional layers of uncertainty, especially over time, underline the impossibility for even a specialized investor of predicting all possible events—some unknown, some unknowable—and their impact on equity return with precision. Summers (1993) underlines that market prices do not necessarily reflect only rational assessments of the fundamentals. Schiller (1993) concurs that stock prices are highly ambiguous; in addition to fundamentals, stock price movements may reflect unquantifiable factors such as suggestibility and group pressure, diffusion of opinions, social movements, and even fashions and fads.[18] Corporate fortunes exhibit the type of uncertainty examined by Frank Knight in his *Risk, Uncertainty and Profit* (1921, 2002). Broadly, Knight's main argument is that return to investment is return to uncertainty rather than quantifiable (therefore, diversifiable) risk; so is return to equity, reflecting varying degrees of uncertainty. Safe assets, mainly government bonds, however, have fewer layers of uncertainty and are generally subject to fewer number of possible events that lead to their final payoff.

It is possible to extend this insight to the behavior of equity premium across countries that exhibit varying degrees of uncertainty in the Knightian sense. In addition to generally quantifiable risks associated with observable economic fundamentals, such uncertainty reflects institutional quality. The fundamentals that can be quantified with a reasonable degree of precision include growth, capital market development, debt level, inflation, and so on. The factors that are more difficult to quantify include policymakers' track record and the credibility of their commitment to robust macroeconomic management and policies, as well as effectiveness of government policies. Institutional factors play an important role in maintaining policy commitments and effective implementation, and a stronger institutional environment makes commitments more credible. Institutional strength also plays an important role in determining the quality of litigation and settlement of business disputes, quality of taxation and expenditure, regulation, investor protection, enforcement of property rights and protections against expropriation by the state, and the integrity of available economic data. Control of corruption and regulatory quality reflect on corporate costs, as well as on the quality of corporate governance. Similarly, the extent of political stability and rule of law have an impact on many unquantifiable and subjectively evaluated business risks. Those factors, evaluated on a subjective basis by respondents from different countries, are embedded in the World Bank institutional quality (and other) indexes, which have significant and intuitively appealing effects on investor decisions and profitability.[19]

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[18] For a recent discussion of investment into the unknown and unknowable, see Zeckhauser (2006).

[19] For the details of the World Bank institutional quality indexes, see Kaufman and others (2004).

Greater uncertainty emanating from institutional weaknesses may have a significant impact on economic outcomes, including asset returns.[20]

In this vein, Stulz (2005) argues that the "twin agency problem" is important in explaining why country-specific attributes can outweigh the fundamentals in the determination of financial flows and rates of return.[21] The twin agency problem refers to corporate insider discretion and state ruler (government) discretion in expropriating rents from investors, which can deter investment and wide stock market participation, and result in higher equity returns. A preponderance of insider discretion implies weaker rules that govern state and corporate behavior. Due to restrictions on freedoms to disseminate accurate information and lack of transparency and accountability, rules may not be widely known or understood by decision makers; if they are, their enforcement may also be subject to discretionary inconsistencies through corruption. In such an environment, the uncertainty emanating from discretionary insider decisions is hardly quantifiable and possible outcomes are hardly predictable with precision. Thus, the twin agency problem emanating from institutional weaknesses is directly connected to ambiguity. As underlined in the literature, institutions have two fundamental effects. First, they provide the right (or wrong) incentives to invest (e.g., protection against expropriation by the twin agents) (North, 1991, 1994). Secondly, they reduce (or increase) ambiguity over space and time by excluding some outcomes or events (e.g., discretionary rent-seeking by the twin agents through corruption) (Erbaş, 2004). The second effect indicates a negative correlation between the degree of ambiguity and institutional strength. La Porta and others (1998) examine a fundamental institutional factor, legal rules, and their historical origins and enforcement for the protection of equity holders. They provide evidence for a negative correlation between the concentration of equity ownership and investor protection, based on a sample of mature and emerging markets (closely approximating our sample). If investor protection is low, small investors may be less willing to hold shares. This implies that, if the relative size of small investors is large

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[20] Significant correlations have been documented between institutional quality and economic performance. For example, Rodrik and others (2002) provide evidence that institutions' influence on growth and development has been more significant than geography and trade. Gelos and Wei (2002) find that transparency (as measured by certain indexes) has a significant impact on international portfolio investment, with less transparent countries attracting less investment. Erbaş (2005) presents further evidence in support of those results and provides an interpretation in the context of Knightian uncertainty. Glennerster and Shin (2003) present evidence that adoption of some transparency reforms has resulted in a decline in sovereign spreads in some countries.

[21] For example, limited capital flows to developing countries despite higher returns on investment and lower trade barriers (Lucas paradox); home equity bias.

in an economy, lack of wide participation in the stock market may push equity returns up and safe asset returns down, and thus result in a high equity premium.

Guiso and others (2005) present evidence that equity market participation is negatively correlated with attitudes of trust across countries. They define trust as the subjective probability of being cheated by equity issuers (corporate boards and managers), as well as by the institutions that facilitate and regulate stock market participation (brokerage houses, hedge funds, regulatory and supervisory bodies). This probability is partly determined by the characteristics of the financial system, including the quality of investor protection and its enforcement. Survey data from some industrial countries indicate that low trust significantly accounts for low equity market participation, as well as for the low share of wealth invested in equity. If low trust results in lower equity holdings, on the firms' side, more firms will be reluctant to broaden their shareholder base and, combined with low demand for equity, this result in lower stock market development. The implication for equity premium is that low trust can result in high equity premium because low trust tends to lower investment in equity, thereby increasing equity return, and, low trust tends to increase investment in safe assets, thereby decreasing safe asset return.

There is experimental evidence that decision maker preferences depend not only on the degree of uncertainty but also on the source of uncertainty; this is known as *source dependence* in the literature (Fox and Tversky, 1995; Tversky and Wakker, 1995). Decision makers tend to prefer bets on events they are particularly knowledgeable about to making bets on events on which they are not, even when the events they are knowledgeable about are ambiguous.[22] However, an ambiguous prospect becomes less attractive when decision makers become aware that more knowledgeable decision makers are also evaluating the same prospect. Thus, investor trust in the actions of more knowledgeable decision makers (corporate insiders; rating agencies), and their trust in the institutional checks and balances (government insiders) on such actions can play an important role in the determination of the extent of stock market participation and equity premium.

The same factors are also at play in the determination of (the relatively) safe asset returns; by the same logic, unquantifiable uncertainties should have an impact on safe

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[22] For example, an investor who is knowledgeable about a particular stock may prefer to invest in that stock and not in a risky (or less ambiguous) bond. Similarly, an investor who is more knowledgeable about emerging markets may invest in emerging market securities and not in mature market securities.

asset returns in the same direction.[23] For example, sovereign bonds exhibit inflation and exchange rate uncertainty. As observed in many countries, it is possible to reduce inflation and exchange rate uncertainty by issuing inflation-indexed and foreign currency-indexed bonds. To a great extent, having to issue inflation-indexed bonds or to borrow in foreign currency reflects weakly credible policies to maintain inflation and exchange rate stability. If a bond is indexed to the U.S. dollar, uncertainty about the exchange rate between the U.S. dollar and the domestic currency is eliminated, although uncertainty about the exchange rate between the U.S. dollar and, for example, the yen remains. However, opting for U.S. dollar-denominated bonds is a manifestation of the market judgment that the uncertainty of the US$/¥ exchange rate is smaller. This reflects fundamentals but, at the same time, it reflects a more credible institutional stance (or a less uncertain source), for example, the market belief that the institutions (budgetary discipline; central bank independence; regulatory quality) in the United States or Japan will not permit a sudden reversal of monetary policy to spur high unanticipated inflation. As a result, foreign currency-denominated bonds tend to have lower interest rates and longer term structures. Alternatively, those desirable foreign borrowing terms might be achieved by establishing a track record of credible inflation targeting, which serves to reduce uncertainty surrounding inflation and exchange rates. A reasonably narrow band for targeted inflation excludes possible inflation rates (events) outside that band.[24] If this policy proves successful by establishing a credible track record, the benefits of a more credible monetary policy may be reaped because uncertainty about inflation rate is reduced. For such a policy rule to prove successful and durable, it needs to be supported by strong institutional checks and balances, such as political consensus about basic macroeconomic policies, central bank independence, accurate data dissemination, and so on. This is institutional strength.

Experimental studies indicate that ambiguity aversion is sensitive to *comparative ignorance* (Fox and Tversky, 1995). This means that ambiguity aversion is driven by the comparison of prospects. In the case of equity premium, ambiguity aversion emanates from the comparison of stock and safe asset returns. The same comparison is relevant between emerging markets and mature markets for both stocks and bonds. It is possible, therefore, that ambiguity aversion, emanating from market comparisons

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[23] Data show that safe asset returns in emerging markets are considerably higher than in mature markets (Table 1). This fact may be a reflection of greater uncertainty also about safe assets in emerging markets.

[24] For example, in Ellsberg's two-color problem, drawing from an urn that contains a minimum of 40 and a maximum of 60 black or red balls with an unknown proportion may be preferred to drawing from an urn that contains 0 to 100 black or red balls with an unknown proportion.

of stocks to bonds and comparisons of emerging markets to mature markets, plays a significant role in the determination of equity premium. In the comparison of prospects in emerging and mature markets, perceptions of relative institutional strength can be particularly important.[25]

As noted, when the time dimension is considered, ambiguity is placed in a more realistic context. Since investment in financial instruments is a forward-looking phenomenon, greater ambiguity over time reflects on equity premium, as well as on the differences between equity premia in emerging and mature markets (Table 1). Over time, institutions play an important role in reducing uncertainty by establishing rules for dealing with events that can be anticipated with varying degrees of precision and events that cannot be foreseen (North, 1994). Knight (2002) stresses that basic market institutions evolve to deal with uncertainty.[26] Strong institutions make future policy responses to unforeseen events more easily predictable or less ambiguous, which may also reflect on the degree of volatility. Hale and others (2006) present evidence that institutional quality (better shareholder and creditor rights) lowers the probability of financial crises; higher probability of crises increases stock market volatility; and, deeper markets are less volatile than thinner markets. Those authors conclude that institutional weaknesses increase the variance of stock returns, which may contribute to the spread between stock and safe asset returns; thus, institutional factors may have significant explanatory power in deconstructing EPP.

Finally, it should be highlighted that our example is based on the comparison of only pure-gain prospects. Modeling ambiguity with mixed prospects involving both gains and losses under CPT may have greater power in explaining asset return behavior over time.[27]

IV. Examination of Data and Cross-Correlations

The comparison of emerging and mature markets has revealed some important differences between the two samples. To a significant degree, those differences may

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[25] The impact of ambiguity aversion and institutional strength on home equity bias is a promising area of research. Faria and Mauro (2004) find that the share of equity and equity-like liabilities in countries' total external liabilities is positively correlated with institutional quality.

[26] Knight examines "structures and methods for reducing uncertainty", including increasing scientific knowledge and data accumulation, consolidation and specialization through large-scale organization of economic activity. Uncertainty is consolidated and diversified through integrated business organizations and specialized markets, for example, equity and bond markets.

[27] See Appendix II for further discussion of the related literature.

reflect differences in institutional quality. A comparison of data in mature and emerging markets is provided in Table 6, which summarizes the independent variables chosen to explain equity premium across the three samples during the three periods we examine. The fundamental independent variables are chosen on the basis of the factors examined in the literature; the institutional quality indexes are proposed as proxies for the degree of uncertainty.

We first explore the extent of cross-correlation between the variables by calculating the Pearson Product Moment Correlation Matrix.[28] The results are presented in Table 7. As confirmed by the results in Table 3 above, equity premium is mainly determined by stock return. The correlation between stock return and safe asset return is not significant at the 5 percent level. However, during 1996–05, the results indicate a positive correlation between stock and safe asset returns at about 7 percent level of significance in the whole sample and mature markets (the *t* values shown in parentheses in Table 7), which is corroborated by the results in Table 3.

Equity premium and stock return are positively correlated with **real growth**, indicating plausibly that higher return to equity investment is associated with higher growth. A negative correlation is indicated between real growth and safe asset return in emerging markets during 2001–05. On average, real growth in emerging markets during 2001–05 is one percent higher than growth during 1996–00 and, while stock return increases sharply during 2001–05, safe asset return declines significantly. Relatively more attractive equity investment might have driven safe asset return down in emerging markets during 2001–05.

Equity market capitalization is used as a proxy for financial market development and depth, along with bond market capitalization. The mature market averages for both variables are two or more times higher than the emerging market averages. A negative correlation between stock return and the level of equity market capitalization seems plausible because a more developed equity market enables less costly portfolio adjustments and better arbitrage and risk diversification, which can result in a decline in stock returns.[28] However, the tests do not indicate a statistically significant correlation between equity premium or stock return and equity market capitalization. This result may reflect the impact of the large decline in equity premium along with stock returns in mature markets during 2001–05, even though equity market capitalization remained high (Tables 1 and 6).

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[28] The null hypothesis is there is no correlation. Let r represent the sample correlation coefficient; the relevant t test is $t = r / \sqrt{(1-r^2)(n-2)}$, where n is the number of observations,

Table 6: Summary of Variables in the Sample Countries

	1996-00	2001-05	1996-05	1996-00	2001-05	1996-05	1996-00	2001-05	1996-05
	All sample countries			Emerging markets			Mature markets		
Dependent variables (in percent)									
Real equity premium	6.2	11.9	9.1	0.0	20.5	10.5	13.6	1.5	7.5
Real stock market return	10.7	14.3	12.5	5.6	23.1	14.4	16.9	3.7	10.3
Real safe asset return	4.3	2.4	3.4	5.1	2.6	3.9	3.3	2.2	2.7
Independent variables									
Fundamentals									
Real growth rate [1]	3.6	3.5	3.6	3.6	4.6	4.1	3.6	2.3	2.9
Equity market capitalization [2]	70	74	73	42	53	50	102	98	100
Bond market capitalization [2]	68	82	75	37	49	43	105	123	114
Credit to private sector [2]	69	77	73	48	47	47	94	113	104
Lagged consumption [3]	-0.3	-0.1	-0.2	-0.2	-0.2	-0.2	-0.3	0.0	-0.1
Unanticipated inflation [4]	-2.0	-0.2	-1.1	-3.5	-0.3	-1.9	-0.2	-0.1	-0.1
Tax ratio (CIT/PIT) [5]			0.86			0.94			0.75
Age composition [6]	35	37	36	27	29	28	44	47	46
Institutional Quality Indexes									
Overall World Bank index [7]	68	67	68	51	50	51	89	88	89
Voice and accountability	63	65	64	43	46	45	86	88	87
Political stability	58	55	56	38	38	38	82	76	78
Government effectiveness	75	74	74	60	59	59	92	92	92
Regulatory quality	72	72	72	58	56	57	89	91	90
Rule of law	72	69	70	55	51	52	92	91	91
Control of corruption	72	70	71	55	52	53	92	92	92
Memorandum items:									
Per capita GDP growth rate [1]	2.4	2.5	2.5	2.0	3.3	2.7	2.9	1.5	2.2

Sources: IFS; World Bank; Heritage Foundation; World Federation of Exchanges; Bureau of International Statistics (BIS); U.S. Census Bureau, International Database; Appendix I, Tables 1, 2.

[1] Rate of growth of GDP in constant 2000 U.S. dollars.

[2] In percent of GDP.

[3] $(C_t/Y_t - C_{t-1}/Y_{t-1})$, where C is private consumption and Y is GDP.

[4] π_t-π_{t-1}, where π_t is CPI inflation, $\pi_t = (CPI_t - CPI_{t-1})/CPI_{t-1}$.

[5] Statutory corporate income tax rate divided by statutory personal income tax rate (2005 data only).

[6] Percent of population above forty.

[7] 1996-2000 (1996, 1998, 2000); 2002-2005; 1996-2005 averages only; higher value indicates higher (better) ranking. Overall index is the simple average of individual indexes.

Table 7: Summary of Statistically Significant Cross-Correlations between Independent and Dependent Variables (*t statistics*)

	EQP	STR	SAFE	EQP	STR	SAFE	EQP	STR	SAFE
	1996-2000			2001-2005			1996-2005		
Dependent Variables									
Stock return (STR)									
All	25.4			48.9			18.6		
Emerging	15.5			29.5			12.9		
Mature	24.5			40.4			16.2		
Safe asset return (SAFE)									
All								(1.9)	
Mature								(1.9)	
Independent variables									
Real growth rate									
All	2.1	2.2		2.7	2.4				
Emerging	2.3	2.4				-2.7			
Equity market capitalization									
Bond market capitalization									
All	2.4	2.2		-3.8	-3.9				
Emerging						2.5			
Mature						-2.4			
Credit to private sector									
All				-4.4	-4.8		-3.4	-4.1	
Emerging							-2.4	-2.7	
Mature	-2.6	-2.8					-2.8	-3.2	
Lagged consumption									
Mature						2.2			
Unanticipated inflation									
All						-3.1	-3.4	-2.8	
Emerging	-2.1					-2.4	-2.5		
Tax ratio (CIT/PIT)									
All				4.0	3.5	-3.1	2.3		-2.1
Emerging				2.8	2.2	-3.3	2.0		
Age composition									
All	3.4	2.7		-4.2	-4.6				
Mature				-2.1	-2.1				
World Bank Indexes									
Voice and accountability									
All				-4.3	-4.3		-2.0		
Political stability									
All	2.3			-4.3	-4.5			-2.0	
Government effectiveness									
All				-4.9	-5.0		-2.3	-2.3	
Regulatory quality									
All				-4.1	-4.2		-2.1	-2.1	
Rule of law									
All	2.2	2.1		-3.9	-4.0				
Control of corruption									
All	2.7	2.6		-3.7	-3.7				

Source: Authors' estimates.

It is also plausible that higher **bond market capitalization** tends to lower bond return, induce a substitution of stocks for bonds, and result in lower stock return. The reverse argument is that lower bond market capitalization may drive up bond return along with stock return. For the whole sample, the correlation between bond market capitalization and stock return is negative during 2001–05; however, the correlation is positive during 1996–00. During 1996–00, bond market capitalization and stock return are high in mature markets but they are much lower in emerging markets; high bond market capitalization and high stock return in mature markets appear to dominate, resulting in a positive correlation between those two variables in the whole sample. But during 2001–05, bond market capitalization increased by a large margin in mature markets relative to 1996–00, while stock return declined sharply, which may explain the negative correlation between those two variables for the whole sample. Also during 2001–05, there is a positive correlation between bond-market capitalization and safe asset return in emerging markets, but a negative one in mature markets. In emerging markets, safe asset return declined, while stock return rose sharply during 2001–05; along with the significant increase in bond market capitalization, the increase in stock return may have had a positive impact on safe asset return so that the decline in safe asset return was less, and hence the positive correlation between bond market capitalization and safe asset return. Similarly, in mature markets, the significant increase in bond market capitalization, along with the sharp decline in stock return, may have resulted in a decline in safe asset returns, and hence the negative correlation.

Like equity and bond market capitalization, **credit to private sector** in mature markets is about two times larger than it is in mature markets. This variable is used as a proxy both for liquidity availability to investors and financial market development. Overall, credit to private sector shows a negative correlation with equity premium and stock return. This is a plausible result because greater availability of liquidity can stimulate greater investment in stocks and result in a decline in stock return. In addition, along the lines of the arguments by La Porta and others (1998), credit to private sector can also be interpreted as an indicator of the degree of confidence and transparency in the financial system, reflecting better lender protection, greater availability of reliable credit information, and better enforcement of laws. If so, then the negative correlation between credit and equity premium and stock return also indicates less uncertainty in the financial system, which reduces the ambiguity premium and results in lower equity premium. It is worth highlighting that both credit to private sector and institutional quality ratings in mature markets are much higher than they are in emerging markets (Table 6).

If financial instruments that can be used for consumption smoothing are accessible by

a greater segment of the population, then consumption volatility is likely to be lower. Therefore, greater investment in such instruments to reduce consumption volatility can be expected to drive down their returns. At the same time, however, if the return on such instruments tends to move in the same direction as income and consumption, then the return needs to be higher to cover for volatility risk. **Lagged consumption**, which is used as a proxy for the degree of consumption volatility, shows a positive correlation with safe asset return only in mature markets during 2001–05; this means the greater the consumption volatility, the higher is the safe asset return. In mature markets, consumption volatility is (nearly) zero during 2001–05; stock return declines sharply and safe asset return declines by more than one percent. Consequently, the positive correlation between safe asset return and lagged consumption during 2001–05 may reflect the positive correlation between stock and safe asset returns in the mature markets sample (Table 3); that is higher consumption volatility is associated with higher return on safe assets to cover the risk of a decline in safe asset returns.

Unanticipated inflation shows a remarkable decline in emerging markets, reflecting the overall decline in inflation; in mature markets, it is negligible.[29] Reflecting the decline in inflation in the sample, the estimated unanticipated inflation ($\pi t - \pi t\text{-}1$) is negative (Table 6). Unanticipated inflation is negatively correlated with equity premium and stock return, as well as safe asset return. This result appears plausible because it indicates that asset returns are vulnerable to the uncertainties surrounding inflation. To the extent inflation is anticipated, investors hedge against it by requiring commensurate nominal returns; but to the extent investors are wrong in their inflation expectations, actual returns are high when unanticipated inflation is low, and returns are low when unanticipated inflation is high. However, it should also be noted that this result may also reflect the biases in the way we calculated real stock and safe asset returns (Section II. A).

Tax ratio (CIT/PIT) in emerging markets is significantly higher than it is in mature markets. It shows a positive correlation with stock return but a negative correlation with safe asset return. This result can be expected because a higher corporate tax burden (CIT) tends to increase gross stock return in order to make the net stock return attractive relative to bond return that is subject to a lower tax burden (PIT).

Data indicate that populations are significantly older in mature markets than in

[29] The period average inflation rate in emerging markets declined from 1996–00 to 2001–05 by nearly 5 percent. The same decline in mature markets was 0.1 percent. For the whole sample, inflation shows more or less a steady decline during 1996–05 by about 5.1 percent.

emerging markets. On average, the share of population over forty years of age in mature markets exceeds the same share in emerging markets by 17–18 percent. This comparison underscores that, in mature markets, older wealth holders are the more pivotal investors in equity markets. An older population—with higher and more stable income and smaller liquidity constraints that are compatible with more established jobs—is likely to have a higher share of equity income. Thus, for an older population, equity income volatility has a larger impact on total income volatility; therefore, a higher stock return is necessary to cover for higher volatility. It can be expected that, if the share of older cohorts is large in total population, then stock return and equity premium are likely to be high. Hence, a positive correlation may be posited between age composition and stock return. **Age composition** shows a positive correlation with equity premium and stock return during 1996–00, however, the correlation turns negative during 2001–05, reflecting mainly the impact of mature markets. This sign reversal between periods may be explained by factors other than age; in mature markets, stock return declined sharply during 2001–05, even though the share of the population above forty rose.

The World Bank **institutional quality indexes** rank mature markets significantly higher than emerging markets. The rankings for either sample do not show a significant variation between the two sub periods under consideration. The institutional quality indexes are used as proxies for the degree of uncertainty across the sample countries. Our main prior argument concerning the correlations between equity premium, stock and bond returns and the institutional quality indexes is that the higher the institutional quality, the lower is ambiguity. This logic implies that higher institutional quality should reduce ambiguity premium and result in lower stock and safe asset returns. Although the impact on equity premium is *ex ante* indeterminate, since stock return is the main determinant of equity premium, a negative correlation between equity premium and institutional quality indexes can be posited. However, along with reducing uncertainty, institutional quality also has incentive effects (e.g., strong property rights; investor protection). Thus, higher institutional quality may stimulate larger and longer-term investments with significantly higher returns. So, while less ambiguity may serve to lower the asset returns, greater incentives to invest may serve to increase equity returns. Consequently, a positive correlation between stock return and institutional quality is also quite plausible. For the whole sample, the tests show a significantly negative correlation between the World Bank indexes and equity premium during the periods 2001–05 and 1996–05. This result provides strong support to our hypothesis that higher institutional quality reduces ambiguity and results in lower stock return, and hence in lower equity premium. On the other hand, the correlations are positive during 1996–00; this indicates that higher institutional quality is associated with in

higher equity premium in that period, which may be due to the incentive effect of institutional quality. Real growth is at the same level in both samples during 1996–00, and equity premium is near zero in emerging markets but it is high in mature markets; high equity premium in mature markets, which rank higher in institutional quality, dominates the near zero equity premium in emerging markets, which rank lower in institutional quality. Consequently, during this period, high equity premium and stock return are associated with high institutional quality, hence the positive correlation. But during 2001–05, equity premium and stock return are high in emerging markets and low in mature markets, and high equity premium and stock return are associated with low institutional quality, and, hence the negative correlation between equity premium and all of the World Bank indexes. It may be argued that, when stock market activity picked up in emerging markets during 2001–05, markets added a significant ambiguity premium to stock returns. For the whole period 1996– 05, the *negative* correlation persists between equity premium and stock return and most institutional quality indexes, which support our hypothesis.

V. Regression Methodology and Results

A. Regression Methodology

We propose the following general model: $Y = f(X_1, X_2, X_3, \ldots)$, where the dependent variable Y is the vector of values in, respectively, the equity premium, stock returns, or, the safe asset returns sample; $Y = \{y_1, y_2, \ldots, y_j\}$, with j denoting a country. As we have argued above, some independent variables may have an impact on equity and safe asset returns in the same direction and, therefore, their impact on equity premium may be ambiguous. Thus, there is merit in regressing equity and safe asset returns on the independent variables separately because this allows us to identify whether equity premium is affected primarily through the equity channel or the safe asset channel. The independent variables $X_1, X_2, X_3, \ldots$ are the vectors of the variables shown in Table 5. All variables, including the dependent variables, are normalized as $v_{ij} = (x_{ij} - \mu_i)/\sigma_i$, where x_{ij} is the observation for variable i in country j; μ_i is the sample mean; and, σ_i is the sample standard deviation for variable i, so that $X_i = \{v_{i1}, v_{i2}, \ldots, v_{in}\}$. We run the following regression:

$$Y_i = c_0 + \sum_{i=1}^{k} c_i X_i + u_i, \qquad (4)$$

where u_i is a random error term that is assumed to obey the properties of multiple regression.

B. Regression Results

The regression results excluding the World Bank indexes are presented in Table 8. The results including the World Bank indexes are presented in Table 9. We focus on the results on equity premium.

Results Excluding the World Bank Indexes

First, we examine regression results excluding the World Bank indexes in order to make a judgment on the robustness of the fundamentals in explaining equity premium. Regression results show that most independent variables have high explanatory power at the 5 percent or higher level of significance. Independent variables have an impact on equity premium mainly through stock return. As indicated by the correlation test, regression results show that equity premium is positively correlated with real growth. Although not supported by the correlation tests, regression results indicate a negative correlation between equity premium and equity market capitalization in 2001–05, which is plausible in view of the arguments in the previous section. Contrary to the indication of the correlation tests, regression results show no significant correlation between equity premium and bond market capitalization. As expected, regressions results indicate a negative correlation between equity premium and credit to private sector. In contrast to the correlation test result for mature markets, equity premium shows a negative correlation with lagged consumption during 2001–05. However, as argued earlier, consumption smoothing through access to stock market by a significant segment of the population could result in a decline in stock return. This result may also reflect the fact that, while consumption volatility is lower during 2001–05 relative to 1996–00, equity premium and stock return are higher (Table 6). Regression results also show that equity premium is negatively correlated with unanticipated inflation and it is positively correlated with tax ratio, as indicated by the correlation tests. Finally, equity premium is positively correlated with age composition, as suggested by the correlation tests.

Table 8: Summary of Statistically Significant Regression Results Excluding Uncertainty Proxies [1]

	1996-2000			2001-05			1996-05		
	EQP	**STR**	**SAFE**	**EQP**	**STR**	**SAFE**	**EQP**	**STR**	**SAFE**
Real growth rate									
All	**0.3**	**0.3**							-0.3
Equity market capitalization									
Mature	0.4			**-0.7**	**-0.7**				
Bond market capitalization									
Credit to private sector									
All	-0.3	**-0.4**	**-0.4**				**-0.4**	**-0.5**	**-0.4**
Emerging							-0.5	**-0.6**	
Mature	**-0.6**	**-0.7**						**-0.5**	-0.5
Lagged consumption									
All				**-0.2**	**-0.3**	**-0.2**			
Emerging						-0.2			
Unanticipated inflation									
All						**-0.4**			
Emerging	**-0.7**	**-0.7**				**-0.4**			
Tax ratio (CIT/PIT)									
All				**0.3**	**0.3**	**-0.4**			**-0.5**
Emerging		-0.5		0.4		**0.4**	**-0.4**		**-0.6**
Age composition									
All	**0.5**				-0.3	**-0.6**			**-0.4**
Emerging						**-0.4**			
Mature	**0.8**	**0.7**					0.6		
Memorandum items:									
Sample sizes									
All		51			53			53	
Emerging		27			29			29	
Mature		24			24			24	

Sources: Authors' estimates.

1 Coefficient values. Statistically significant results at least at the 10 percent level are presented. The results that are statistically significant at the five percent level or better are highlighted.

Table 9: Summary of Statistically Significant Regression Results Including Uncertainty Proxies [1]

	EQP	STR	SAFE	EQP	STR	SAFE	EQP	STR	SAFE
	1996-2000			2001-2005			1996-2005		
Real growth rate									
All	0.3								
Emerging	**0.4**	**0.4**							
Equity market capitalization									
Mature	0.8	0.8		**-1.0**	**-1.0**				
Bond market capitalization									
Emerging							0.4	**0.6**	
Mature	-0.5								
Credit to private sector									
All	**-0.4**	**-0.5**					**-0.6**	**-0.7**	-0.4
Emerging							-0.5	-0.5	
Mature		-0.6	-0.7						
Lagged consumption									
All				-0.2	**-0.2**	**-0.2**			
Emerging								**0.4**	
Unanticipated inflation									
All						**-0.4**			
Emerging						**-0.4**			
Mature									-1.3
Tax ratio (CIT/PIT)									
All				**0.3**	**0.3**	**-0.4**			**-0.4**
Emerging				0.5	0.5	**-0.4**			
Age composition									
All	**0.8**	**0.7**				**-0.5**	**0.6**		
Emerging							**1.0**	**0.9**	
Mature	**0.9**	**0.9**							
World Bank indexes									
Voice and accountability									
All	**-0.6**	**-0.6**					-0.5		
Emerging	**-0.7**	-0.5					**-0.8**	**-0.7**	
Political stability									
Emerging				-1.0	-1.1		-0.8	**-1.1**	
Government effectiveness									
All				**-1.4**	**-1.3**		-1.1		
Emerging				-1.4	**-1.4**			-1.0	
Regulatory quality									
Rule of law									
All							**1.5**	1.2	
Emerging				1.3	1.3		0.9		
Control of corruption									
Emerging								**1.3**	

Source: Authors' estimates.

[1] Coefficient values. Statistically significant results at least at the 10 percent level are presented. The results that are statistically significant at the five percent level or better are highlighted. The regression sample sizes are the same as those shown in Table 8.

Results Including the World Bank Indexes

We now turn to the regression results including the World Bank indexes to see if the fundamentals continue to have significant explanatory power and to compare the significance of the World Bank indexes to the fundamentals; the results are presented in Table 9. The fundamentals continue to have significant explanatory power and most World Bank indexes are equally significant. At the 5 percent (or higher) level of significance, equity premium is correlated with real growth, equity market capitalization, credit to private sector, tax ratio, and age composition; the signs of those correlations are the same as those in Table 8. Relatively less significant correlations (at 6 to 10 percent level) are indicated between equity premium and bond market capitalization, as well as lagged consumption.

Compared to the fundamentals, most World Bank indexes have equally significant explanatory power for equity premium. Equity premium is negatively correlated with voice and accountability, government effectiveness, and political stability. The negative correlations support our hypothesis that greater institutional strength results in less uncertainty, reduces the ambiguity premium, and hence the equity premium. A significant positive correlation is indicated between equity premium and rule of law, which may be attributable to incentive effects. It is interesting to note that the significance of the World Bank indexes mainly emanates from emerging markets. In those markets, equity premium shows a greater variation within the sample (Table 1). Furthermore, the World Bank indexes also show a greater variation in the emerging markets sample.30 Institutional quality matters in the determination of equity premium in emerging markets.

The more general point is that, through the uncertainty and incentive effects, equity premium is significantly correlated with institutional quality, at least, as significantly as it is correlated with the fundamentals. To the extent institutional quality reflects on ambiguity, a strong case can be made for a significant correlation between equity premium and ambiguity.[31]

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[30] During all the periods under consideration, the average standard deviation in all six categories of the World Bank indexes in emerging markets is about 19 but in the mature markets sample the average standard deviation is about 9.

[31] Correlation tests (not shown) also indicate a strong correlation between the institutional quality indexes and real growth for the whole sample, especially during the period 2001-05. In order to check robustness, we ran the same regressions in Table 8 excluding real growth. Comparison of the results in that table to those in Table 9 above confirms the results.

Regressions with other Uncertainty Proxies

We use a number of other proxies for uncertainty, which are explained in Appendix III, Table 1. Data availability restricts regressions to the period 1995–06. We only present the results for which a significant correlation is indicated between equity premium, stock return, and safe asset return, and the uncertainty proxy used.32 The significant regression results are presented in Table 10.

Table 10: Summary of Statistically Significant Results for other Uncertainty Proxies, 1996–05[1]

	EQP	STR	SAFE
Heritage indexes			
Government intervention			
All	**0.4**	**0.4**	
Emerging	**0.5**	**0.5**	
Overall index			
Mature			**-1.0**
World Bank Enterprise Surveys			
Infrastructure			
All	**0.7**	**0.7**	
Tax burden			
All	1.0	1.0	
World Values Survey Confidence Index			
Average of categories 1-7			
All	**0.4**	**0.4**	
Average of categories 2-7			
All		0.3	

Source: Authors' estimates.

[1] Coefficient values. See Appendix III, Table 1 for the description of the variables reported in this table. Results that are significant at 5 percent or better are highlighted.

The Heritage Foundation index rankings are valued such that a lower (worse) ranking is assigned a high index value and higher (better) ranking is assigned a low index value; the same is true for the World Bank Enterprise Surveys. Equity premium is positively correlated with government intervention (Heritage) and infrastructure (World Bank) indexes, which is plausible. This result indicates greater degree of government intervention results in higher equity premium; similarly, less satisfactory infrastructure results in higher equity premium. Both factors imply higher uncertainty in the business environment.

[32] We find no significant correlation in the case of Transparency International, International Country Risk Guide, Global competitiveness, and World Bank Doing Business indexes.

On the other hand, equity premium is positively correlated with the index that measures the degree of confidence in various social and political categories. The index is constructed (by the authors) such that a higher value indicates higher confidence ranking. Therefore, the positive correlation between equity premium and the confidence index may be attributable to the incentive effects of greater confidence, that is, higher social confidence may stimulate investment in riskier areas with higher returns, which results in higher stock return.[33]

VI. Conclusions

Equity premium puzzle is a global phenomenon that is present in both emerging and mature markets. The impact of the fundamentals on equity premium is mainly through stock return because stock return is the dominant determinant of equity premium.

Institutional quality indexes play as significant a role as the fundamentals in the determination of equity premium. Equity premium and stock return have a significantly negative correlation with the World Bank indexes for voice and accountability, political stability and government effectiveness. Similarly, greater government intervention (Heritage) and less satisfactory infrastructure (World Bank) indicate higher equity premium. We interpret these results as an indication of institutional quality reflecting on unquantifiable uncertainty or ambiguity. We argue that lower ambiguity results in a decline in equity premium. The same effect may be posited for safe asset returns; however, safe assets display less ambiguity than equity across the countries in the institutional quality spectrum. This observation is supported by the result that there is no statistically significant correlation between safe asset returns and the World Bank institutional quality indexes.

In the case of two World Bank institutional quality indexes, rule of law and control of corruption, as well as in the case of the confidence indexes (World Values Survey), we find significantly positive correlations with stock return and equity premium. A plausible case can be made for a positive correlation. It is intuitively appealing that better rule of law and better control of corruption induce greater social trust, which makes the investment environment more stable and predictable, and levels the playing field. This creates incentive effects and serves to induce greater innovation and longer-term, higher-yield investments, which might not have been undertaken in a less politically, stable and more corrupt environment. Consequently, higher rankings

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[33] This result is *not* in line with the interpretation of the arguments and findings of Guiso and others (Section III.B) because higher trust can be expected to reduce ambiguity premium, and hence equity premium. However, this result can also be interpreted as an example of source dependency. More trustworthy sources (in this case, various social institutions) may induce decision makers to invest in ambiguous but high-return prospects.

in those areas are associated with higher stock return, and hence with higher equity premium.

Interestingly, the results also indicate that institutional quality indexes are significant in emerging markets but not in mature markets. On average, mature markets are ranked significantly higher by the World Bank institutional quality indexes; furthermore, the emerging markets sample shows a significantly greater variation (as measured by the sample standard deviation) than the mature markets sample.[34] These observations help explain why institutional quality indexes are significant in the emerging market regressions. They also lend support to Stulz's (2005) point that "the reason why countries matter is that finance is critically affected by twin agency problems" (p. 1633). Evidently, institutional quality shows a greater variation in emerging markets, reflecting significantly on perceptions of risk and ambiguity, so that stock returns are significantly affected by the institutional quality ranking of the countries.

The foregoing findings have significant implications for Islamic finance. As shown in Table 11 below, the Islamic countries exhibit higher equity premium and generally rank lower in the World Bank institutional quality ratings relative to the other emerging market countries.

Table 11: Islamic Countries, Emerging Markets, and Mature Markets:
World Bank Institutional Quality Rankings and Equity Premium (1996-2005 averages)

	World Bank Institutional Quality Indexes (1996-2005 Averages) [1]							1996-05
	Voice and account.	Political stability	Government effectiveness	Regulatory quality	Rule of Law	Control of corruption	Overall index	Average Eqty. Pr. [2]
Islamic countries	28	33	57	51	54	55	46	13.7
Emerging markets								
Including Islamic countries	45	38	59	57	52	53	51	10.5
Excluding Islamic countries	57	41	60	58	48	51	53	8.5
Mature markets	87	78	92	90	91	92	89	8.1

Sources: World Bank; Tables 1, 6; authors' calculations.

[1] A higher number indicates a higher ranking.

[2] In percent.

[34] During the period 1996–05, the standard deviation of voice and accountability in emerging markets is 22.1 compared to the standard deviation of 13.6 in mature markets. Similarly, the emerging market and mature
market standard deviations for political stability are, respectively, 20.0 and 17.4; the same for control of corruption are, respectively, 19.7 and 6.7; and, for rule of law, they are, respectively, 18.6 and 7.4.

First, the findings suggest that Islamic finance and conventional finance share the equity premium puzzle in the institutional quality-uncertainty context. Second, the findings indicate that the slow pace of development of Islamic modes and instruments of finance may be due to non-existence of Islamic behavioral rules and institutions or their poor quality. Third, the findings may provide guidance for future progress of Islamic finance. In order to promote genuine Islamic finance, the institutional framework prescribed by Islam must prevail to enhance market trust and reduce ambiguity on the part of equity market participants. Future progress will depend on how far and how fast the Muslim countries which endorse Islamic finance are willing to go toward implementing the elements of the financial institutional framework prescribed by Islam.

As Benartzi and Thaler (1995) underline, "the equity premium is a *puzzle* within the standard expected utility maximizing paradigm" (p. 90). Within that paradigm, the theories that have attempted to explain this puzzle have proposed some quantifiable fundamentals. The theories that relax the assumptions of the expected utility paradigm (e.g., incorporating nonexpected utility preferences; rank dependent utility; subadditive probability weighting) seem to fare better in explaining EPP. However, the literature has not focused on an important aspect of behavior under uncertainty, namely, ambiguity aversion. Ambiguity aversion may be instrumental in explaining the observed equity premium, which seems too large under expected utility theory. Without a formal portfolio model, we propose that uncertainty can be modeled using cumulative prospect theory, according to which equity premium can be decomposed into two conceptual parts, risk premium and ambiguity premium. Thus, when ambiguity aversion is taken into account, a significant part of the premium can be attributed to unquantifiable uncertainty or ambiguity. The empirical results support our main hypothesis that unquantifiable uncertainty plays an important role in the determination of equity returns. Safe assets, on the other hand, appear to exhibit less ambiguity, and this is the fundamental reason why markets see them as relatively safer than equity. To the extent that institutional quality is a good proxy for the degree of ambiguity in an economy, a strong case can be made that ambiguity aversion significantly augments equity premium and explains a large part of the equity premium puzzle.

For future research, a time-series analysis of the impact of ambiguity on assets returns across countries would be illuminating. Importantly, the relative significance of risk and ambiguity aversion in the determination of asset returns could provide important clues on the dynamics of financial markets, and perhaps even on the processes of decision making in ambiguity that underlie the onset of financial crises.[35]

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[35] We are grateful to our colleagues from IMF's Monetary and Capital Markets and Research Departments who commented on this paper for proposing a time-series application across countries, which may be pursued in future research.

Appendix I: Data Sources for Stock Market and Safe Asset Returns

Table 1: Data Sources for Stock Market Indexes

	Country	Source		Country	Source
1	Argentina	S&PIFC	27	Korea	KOSPI Index
2	Australia	AS51 Index	28	Kuwait	KGGIGEN Index
3	Austria	WBI Index	29	Malaysia	KLCI Index
4	Bahrain	S&PIFC	30	Mexico	MEXBOL Index
5	Belgium	BEL20 Index	31	Morocco	S&PIFC
6	Brazil	IBOV Index	32	Netherlands	AEX Index
7	Canada	SPTSX Index	33	New Zealand	NZSE Index
8	Chile	IPSA Index	34	Nigeria	S&PIFC
9	China	SHCOMP Index	35	Norway	Oslo SE Total Index
10	Colombia	IGBC Index	36	Pakistan	S&PIFC
11	Czech Republic	PX Index	37	Peru	S&PIFC
12	Denmark	KFX Index	38	Philippines	S&PIFC
13	Egypt	S&PIFC	39	Poland	WIG20 Index
14	Finland	HEX Index	40	Portugal	BVLX Index
15	France	CAC Index	41	Russia	RTSI$ Index
16	Germany	DAX Index	42	Saudi Arabia	S&PIFC
17	Greece	ASE Index	43	Singapore	STI Index
18	Hong Kong	HSI Index	44	Slovakia	SKSM Index
19	Hungary	BUX Index	45	South Africa	JALSH Index
20	India	SENSEX Index	46	Spain	IBEX Index
21	Indonesia	JCI Index	47	Sweden	SBX Index
22	Ireland	ISEQ Index	48	Switzerland	Swiss Exchange
23	Israel	WFOE	49	Thailand	SET Index
24	Italy	SPMIB Index	50	Tunisia	S&PIFC
25	Japan	NKY Index	51	Turkey	XU100 Index
26	Jordan	S&PIFC	52	UK	UKX Index
			53	US	SPX Index

Memorandum item:

Equity market capitalization data sources are *Datastream; S&PIFC Emerging Markets Database*; and *World Federation of Exchanges*.

Table 2: Selected Safe Asset Returns and Data Sources

Country	Safe asset returns	Data sources
1 Argentina	Deposit rate	IFS
2 Australia	15-year treasury bond rate	IFS
3 Austria	10-year government bond yield	Central Bank of Denmark
4 Bahrain	Treasury bill rate	Central Bank of Bahrain
5 Belgium	10-year government bond yield	Central Bank of Denmark
6 Brazil	Domestic currency treasury bill rate	IFS
7 Canada	3-5 year government bond yield	IFS
8 Chile	Interest rate on 10-year indexed promissory notes	Central Bank of Chile
9 China	12-month institutional investor deposits	IFS
10 Colombia	360-day certificate of deposit rate	Bank of Colombia
11 Czech Republic	Treasury bill rate	IFS
12 Denmark	10-year government bond yield	Central Bank of Denmark
13 Egypt	3-month deposit rate	IFS
14 Finland	10-year government bond yield	Central Bank of Denmark
15 France	10-year government bond yield	Central Bank of Denmark
16 Germany	10-year government bond yield	Central Bank of Denmark
17 Greece	12-month treasury bill yield up to 1998; government bond yield for 1998-2005	IFS
18 Hong Kong	Treasury bill rate	IFS
19 Hungary	Treasury bill rate	IFS
20 India	Government bond yield	IFS
21 Indonesia	JIBOR 12-month rupiah rate	Bloomberg
22 Ireland	10-year government bond yield	Central Bank of Denmark
23 Israel	Treasury bill rate	IFS
24 Italy	10-year government bond yield	Central Bank of Denmark
25 Japan	11-year government bond yield	Central Bank of Denmark

(continued)

Table 2: Selected Safe Asset Returns and Data Sources (concluded)

Country	Safe asset returns	Data sources
26 Jordan	Deposit rate	IFS
27 Korea	Time deposit at deposit money banks, one year or more	IFS
28 Kuwait	Saving deposits rate	IFS
29 Malaysia	5-year government bond rate	IFS
30 Mexico	Treasury bill rate	IFS
31 Morocco	3-month time deposits rate	IFS
32 Netherlands	10-year government bond yield	Central Bank of Denmark
33 New Zealand	Government bond yield	IFS
34 Nigeria	Treasury bill rate	IFS
35 Norway	10-year government bond yield	Central Bank of Denmark
36 Pakistan	Call rate for 1998-99; treasury bill rate otherwise	IFS
37 Peru	Deposit rate	IFS
38 Philippines	Government bond yield	IFS
39 Poland	Money market rate, 1996-2000; treasury bill rate 2001-2006	IFS
40 Portugal	10-year government bond yield	Central Bank of Denmark
41 Russia	Weighted average GKOs yield	Central Bank of Russia
42 Saudi Arabia	52-week Saudi Riyal treasury bill rate	IFS
43 Singapore	Treasury bill rate	IFS
44 Slovakia	Government bond yield	Central Bank of Slovakia
45 South Africa	Treasury bill rate	IFS
46 Spain	10-year government bond yield	Central Bank of Denmark
47 Sweden	10-year government bond yield	Central Bank of Denmark
48 Switzerland	5-7 year government bond index yield	Swiss Bond Index
49 Thailand	Government bond yield	IFS
50 Tunisia	Money market rate	IFS
51 Turkey	12-month deposit rate	Central Bank of Turkey
52 UK	10-year government bond yield	Central Bank of Denmark
53 US	10-year government bond yield	Central Bank of Denmark

Memorandum item:

Bond market capitalization data sources are BIS Quarterly Review (December 2006) , *International Bonds and Notes* (all issuers, by residence of issuer, in US$ billion), amounts outstanding (Table 14 B), plus, *Domestic Debt Securities* (by sector and residence of issuer, in US$ billion), amounts outstanding (Table 16A).

Appendix II: A CPT Model of Risky and Ambiguous Prospects and Illustrative Simulations

Based on cumulative prospect theory (CPT), the ambiguous prospect can be evaluated as follows. Let us express the ambiguous prospect as $\{1\text{-}q,\ 0;\ q,\ VII;\ 1\text{-}z,\ 0;\ z,\ A\}$, where q is the probability of *Event I*, z is the probability of *Event II*, $p = qz$, VII is the value of *Event II*, and A is the payoff, if *Events I* and *II* occur in succession. According to CPT, *Event II* will be valued after ranking the possible payoffs from the lowest to the highest, which, in this case, is $0 < A$. Thus, *Event II* is valued as

$$VII = [w(1\text{-}z+z) - w(z)]U(0) + w(z)U(A) = [1\text{-}w(z)]U(0) + w(z)U(A)$$

$$= w(z)U(A).$$

Under CPT, $U(0) = 0$ because CPT is based on the valuation of deviations from the initial wealth position, Y, which is indexed at zero. Consequently, *Event I* can be evaluated on the basis of the ranking $0 < U^{-}[w(z)U(A)]$ as

$$VI = [w(1\text{-}q+q) - w(q)]U(0)+w(q)U^{-}\{U^{-}[w(z)U(A)]\} = [1-w(q)]U(0) + w(q)w(z)U(A)$$

$$= w(q)w(z)U(A),$$

where $U^{-}(.)$ is the inverse of the utility function. On the other hand, the risky prospect with the payoff $R > 0$, which involves only one event, is valued as

$$V(R) = [w(1\text{-}p+p) - w(p)]U(0) + w(p)U(R) = [1-w(p)]U(0) + w(p)U(R)$$

$$= w(p)U(R).$$

According to CPT, the *lower subadditivity condition* requires that

$$w(q+z) \leq w(q) + w(z) \text{ for } q+z \leq 1\text{-}\varepsilon,$$

where ε is a small number. The foregoing condition means that the smaller probability, q $(q < q+z)$, has a greater impact on probability weighting due to the diminishing sensitivity of the probability weighting function $w(.)$. This is because q turns impossibility to possibility but the increase in probability by z makes an event more possible, therefore, it has a smaller impact on probability weighting. If the event leading to a payoff can be split into two events, then their probability weighting exceeds that of a single event. This effect is called the *event-splitting effect*; see Starmer and Sugden (1993) and Humphrey (1995).

For a proof that $w(q)w(z) \leq w(p)$ subject to the lower subadditivity condition and $0 < p, q, z < 1$, see Erbaş (2004). The intuition is as follows. First notice that $p = qz < q \leq z$, that is, $w(p) < w(q) \leq w(z)$ because $w(.)$ is an increasing function of probability for

all $0 \leq p \leq 1$, and it therefore follows that $q = p + v1$ and $z = p + v2, v1, v2 > 0$. The smaller probability, p, has a larger impact on subjective probability weighting because p turns impossibility to possibility but the greater probabilities, q and z, make events more possible, therefore, they are weighted less than p. The product of weighted q and z, that is, $w(q)w(z) = (p+v1)w(p+v2)$, is therefore smaller than $w(p) = w[(p+v1)(p+v2)]$. It therefore follows that, for $w(p)U(R) = w(q)w(z)U(A)$, it is necessary that $A \geq R$, as stated in Equation (2) in Section III.

A Numerical Example

On the basis of the below probability weighting function, the following numerical example illustrates the possible impact of ambiguity on equity premium. A specification for the probability weighting function is

$$w(p) = \frac{p^{\alpha}}{[p^{\alpha} + (1-p)^{\alpha}]^{1/\alpha}}, \quad 0 < \alpha < 1,$$

where α is the ambiguity aversion parameter, which has been estimated in the range of 0.56-0.69 (Tversky and Kahneman, 1992). Assume α = 0.65. Let the risk-averse investor's utility function be $U(X) = X^{\theta}$, $0 < \theta < 1$, so that (1-θ) is the constant relative risk aversion parameter, $(1-\theta) = -XU''(X)/U'(X)$; the lower the value of θ, the higher the relative risk aversion; assume θ = 0.5. Suppose the safe asset pays C = \$20, which yields the utility level of $U(20)$ = 4.47 (only two decimals are shown). Suppose the risky asset pays R with probability $p = 0.70$; applying the above probability weighting function with α = 0.65, we have $w(0.7) = 0.56$. The certainty equivalent of the risky asset for which the investor is indifferent between the risky and the safe asset can be calculated from Equation (1) as R = \$63.23, $U(R) = U(C) = 4.47$. Thus, $R - C$ = \$43.23 is the risk premium. For the ambiguous asset, assume $q = 0.85$, $z = 0.82$ so that $qz = p = 0.70$. Applying the above probability weighting function, we have $w(q)w(z) = (0.69)(0.66) = 0.45 < w(p) = 0.56$. Thus, from Equation (2), we can calculate the value for which the investor would be indifferent between the ambiguous and the safe asset, as A = \$76.74, $U(A) = U(R) = U(C) = 4.47$. As a result, $(A-C) = (A-R) + (R-C)$ is \$76.74 = \$33.52 + \$43.22. If the initial investment were Y = \$1,000, then these values in percentages would correspond to Equation (3) in Section III, that is, to $(A-C)/Y = (A-R)/Y + (R-C)/Y$, with the values 7.7% = 3.4% + 4.3%. So, the equity premium on the ambiguous asset is 7.7 percent, which is the sum of the ambiguity premium of 3.4 percent and risk premium of 4.3 percent. Greater ambiguity aversion and risk aversion (lower values for α and θ) would result in larger ambiguity and risk premium, and hence in a larger equity premium.

Under CPT, the equity premium values are higher than the values that can be obtained under EUT. This is because; there are two effects at work here. First, CPT probability weighting indicates that sufficiently high probabilities (those above 30–40 percent) are weighted at lower values ($p = 0.70 < w(p) = 0.56$), which increases risk premium.[36] Second, ambiguity further reduces the probability of a payoff, that is,

$$w(q)w(z) = w(0.85)w(0.82) = 0.45 < w(p) = w(0.70) = 0.56.$$

For a given low probability of no payoff, the probability of no payoff is subjectively weighted higher under CPT; here, we have

$$1\text{-}p = 0.30 < 1\text{-}w(p) = 0.44 < [1\text{-}w(q)] + w(q)[1\text{-}w(z)] = 0.54.$$

It is possible to conjecture "more ambiguous" cases by increasing the number of stages (sublotteries) in the compound prospect that yields the same expected rate of return under EUT and obtain higher equity premia. A more ambiguous asset (*MA*) would require an even higher rate of return for $w(m)w(n)w(v)\ MA = w(q)w(z)A = w(p)R = C$ because $w(m)w(n)w(v) < w(q)w(z) < w(p)$ for all $0 < p < 1$, while $m{\cdot}n{\cdot}v = q{\cdot}z = p$; thus we would have $MA > A > R > C$. For example, suppose a corporation wins a contract with probability *m*; the corporation turns a profit with probability *n*; and, it pays dividend with probability *v*. As a country example, suppose in *Country 1*, a political party may win elections with probability *m*; the new government may lower corporate tax rates with probability *n*; and, it may give tax concessions on dividend earnings with probability *v*. Now compare this country to *Country 2*; there are no elections coming up; the government may lower corporate tax rates with probability *q*; and, it may give tax concessions on dividend earnings with probability *z;* and, $m{\cdot}n{\cdot}v = q{\cdot}z$. Suppose the safe asset return is exactly the same in both countries. Our simple argument is that equity premium in *Country 1* will be higher than in *Country 2*.

Probability Values Chosen for Simulation Purposes

The choice of the probability values used in the foregoing example is based on the following observations. In the United States and the United Kingdom, based on 110 observations over the period 1896–2006, the probability of winning by investing in the stock market as opposed to the safe asset (a positive equity premium) ranges from

[36] With $\alpha = 0.65$, the value for p for which $p \approx w(p)$ is about 0.36. However, for values of *p* below this critical value, it is possible that $p < w(p)$, for example, if $p = 0.20$, then $w(0.20) = 0.26$. This implies that for sufficiently low probabilities, risk premium can be smaller under CPT than it is under EUT because $w(p) > p$. Here, the main focus of comparison is between the risky and the ambiguous asset under CPT. Such low probabilities of winning do not appear to characterize the probabilities of winning by investing in the stock market on average (see below). But, interestingly, they may characterize the probabilities of winning by investing in venture capital that may pay extraordinarily high returns.

about 45 (UK) to 55 (US) percent; during 1996–2005, the same probabilities are 70 percent (UK) and 50 percent (US).[37] In our limited sample with only ten observations during 1996–2005, those probabilities are 60 percent for the sample as a whole and 70 percent in both the emerging and mature market samples (see text Table 2). Thus, for simulation purposes in the context of our simple example, the 50–70 percent range for the probability of winning ($p = qz$) seems plausible. Simulation results for this range of probabilities are presented in Table 1 below. In our sample, equity premium is 7.5 percent in mature markets and 10.5 percent in emerging markets during the period 1996–05. As Table 1 below shows, for a relatively low probability of winning ($p = 0.50$) at under a plausible degree of risk aversion ($\theta = 0.5$), the EUT simulation for the equity premium in our simulations comes fairly close to that observed in mature markets but it falls significantly short of the equity premium in emerging markets. However, the EUT simulations for equity premium are significantly lower but CPT simulations are significantly higher for what seems to be a more plausible probability range (p = 0.60-0.70). With less risk aversion ($\theta = 0.8$), the CPT simulations produce significantly high equity premia. Even with risk neutrality, the CPT simulation results for equity premia are two to three times higher than those resulting from EUT simulations.

Table 1: Ambiguity and Risk Premium Simulations at Different Probabilities of Winning (in percent)

				EUT	CPT		
p = qz	q	z	Safe asset return	Equity premium (R-C)/Y	Equity premium (A-C)/Y	Ambiguity premium (A-R)/Y	Risk premium (R-C)/Y
Risk aversion paramater: θ; $U(X) = X^{\theta}$; ambiguity aversion paramater, α = 0.65							
				Risk averse, θ = 0.5			
0.50	0.85	0.59	2.0	6.0	15.6	7.2	8.4
0.60	0.85	0.71	2.0	3.6	11.2	5.1	6.1
0.65	0.85	0.76	2.0	2.7	9.4	4.2	5.2
0.70	0.85	0.82	2.0	2.1	7.7	3.4	4.3
				Less risk averse, θ = 0.8			
0.50	0.85	0.59	2.0	2.8	5.8	2.2	3.6
0.60	0.85	0.71	2.0	1.8	4.5	1.7	2.8
0.65	0.85	0.76	2.0	1.4	3.9	1.5	2.4
0.70	0.85	0.82	2.0	1.1	3.4	1.3	2.1
				Risk neutral, θ = 1			
0.50	0.85	0.59	2.0	2.0	3.9	1.4	2.6
0.60	0.85	0.71	2.0	1.3	3.1	1.1	2.0
0.65	0.85	0.76	2.0	1.1	2.8	1.0	1.8
0.70	0.85	0.82	2.0	0.9	2.4	0.8	1.6

Source: Authors' simulations.

[37] Ten-year government bond yield is used for safe asset returns. The probability is calculated as the ratio of the number of observations (years) when equity premium is positive to the total number of observations.

Illustrative Simulations (Text Table 5)

Simple simulations in text Table 5, based on specifications for the text Equations (1)-(3), as well as on a specification for the CPT probability weighting function *w(.)* above, indicate that ambiguity premium can significantly augment the magnitude of equity premium. Experimental results suggest that, in ambiguity, the subjective probability weighting function becomes more sub additive, that is, the value of α decline (Tversky and Fox, 1995), whose impact on equity premium can be traced in text Table 5.

Safe Asset Return and the Risk-Free Rate Puzzle

Another observation that is illuminating concerns the assumed value of the safe asset return, which is 2 percent in all the foregoing simulations. Our example does not account for the relative size of the risk free rate (*C/Y*), which is a given constant. Weil (1989) uses a non-expected utility model in which risk aversion is separable from and independent of inter temporal substitution (Kreps-Porteus preferences); he stresses that this construction results in a "risk-free rate puzzle", that is, while such a model can account for a relatively high equity premium, at the same time, it produces a high risk free rate that may not be compatible with consumption volatility under certain assumptions. So, in addition to "too high" risky asset return resulting in "too high" equity premium, there may also be a puzzle that the predicted safe asset return is "too high" relative to what is actually observed. For example, in the context of the standard time-additive utility restriction, Mehra's (2003) simulations indicate a predicted safe asset return of about 13 percent (corresponding to an equity premium of 1.4 percent), which may be compared to the actual sample averages in text Table 1 (about 2–5 percent). Epstein and Zin (1990) use a probability weighting function specified as $w(p) = p^{\gamma}$, $0 < \gamma < 1$. This specification for *w(p)* may be compared to the empirically supported CPT specification for *w(p)* above. In the context of an asset pricing model with rank-dependent probability (as in CPT), Epstein and Zin's simulations can account for a low risk-free rate and a significant magnitude for the equity premium (2 percent). The simulations in Table 2 below shed some light on how the safe asset return might impact equity premium: if the safe asset return is in the 2–5 percent range (see text Table 1), the corresponding equity premium under EUT is also in the 2–5 percent range. Under CPT, however, risk premium is in the 4–11 percent range and equity premium, including ambiguity premium, is in the 8–19 percent range. Thus, the simple simulations indicate that a relatively low safe asset return can be compatible with a relatively high equity premium under CPT with ambiguity aversion.

Table 2: Ambiguity and Risk Premium at Different Rates of Return on the Safe Asset (in percent)

	EUT	CPT		
Rate of return on safe asset	Equity premium (R-C)/Y	Equity premium (A-C)/Y	Ambiguity premium (A-R)/Y	Risk premium (R-C)/Y
2.0	2.1	7.7	3.4	4.3
2.5	2.6	9.6	4.2	5.4
3.0	3.1	11.5	5.0	6.5
3.5	3.6	13.4	5.9	7.6
4.0	4.2	15.3	6.7	8.6
4.5	4.7	17.3	7.5	9.7
5.0	5.2	19.2	8.4	10.8
5.5	5.7	21.1	9.2	11.9

Risk aversion parameter, $\theta = 0.5$;
Probability weighting parameter, $\alpha = 0.65$
$p = qz = 0.7$; $q = 0.85$; $z = 0.82$

Source: Authors' simulations.

The Rietz-Barro "Disaster States" Hypothesis under CPT

Rietz (1988) and later Barro (2006) have argued that hedging against the possibility of a large loss of consumption with a small probability (a disaster state) can explain the equity premium puzzle for reasonable degrees of risk aversion. Barro examines disaster states whose magnitude is at least a 15 percent decline in real per capita GDP; from historical country data, he estimates the probability of such a decline in per capita income at 1.7 percent. With the probability weighting parameter, $\alpha = 0.65$, the CPT valuation of $1\text{-}p = 0.017$ is $w(0.017) = 0.065$ and of $w(p) = w(0.983) = 0.905$. As before, the implication is that the subjective valuation of the probability of a disaster state, $w(1\text{-}p)$, is significantly higher under CPT, while the subjective probability of a "normal" state, $w(p)$, is lower. Furthermore, some experimental results indicate that decision makers are risk averse for low probability losses and this choice pattern is more pronounced in ambiguity (Tversky and Fox, 1995). If the probability weighting function is more sub additive in ambiguity, that is, if the value of α is lower, then, for example, with $\alpha = 0.55$, we have $w(0.017) = 0.10$ and $w(0.983) = 0.837$. Consequently, in ambiguity, it may be possible that the subjective probabilities decision makers assign to low probability events can be quite high, and with high subjective probabilities, the associated losses need not be as high as a 15 percent drop in consumption. So, even anticipations of recessions, and not necessarily disasters, may be sufficient to generate relatively high equity premia.

The simulations in Table 3 corroborate the foregoing arguments in the CPT context. In our sample, we identify three ranges of percentage gains ($G_1 < G_2 < G_3$) and losses

($L_1 < L_2 < L_3$) in real per capita income and calculate the associated probabilities as shown in the upper panel of Table 3. Let probability p_i be associated with G_i or L_i. The CPT probabilities for gains and losses, shown in the lower panel, are calculated as $[w(p_1+p_2+p_3)-w(p_2+p_3)]$ for $U(G_1)$ or $U(L_1)$; $[w(p_2+p_3)-w(p_3)]$ for $U(G_2)$ or $U(L_2)$; and; $w(p_3)$ for $U(G_3)$ or $U(L_3)$.

Table 3: Estimated and Simulated Sample Probabilities for Gains and Losses in Real Per Capita Income (in percent)

	Gains [1]			Losses [1]		
	G_1 < 0-5	G_2 < 5-10	G_3 >10	L_1 < 0-5	L_2 < 5-10	L_3 >10
	Sample probability *(p)*					
All	69.5	14.8	0.6	12.6	1.5	0.9
Emerging	57.6	23.1	0.7	14.8	2.4	1.4
Mature	84.0	4.8	0.4	10.0	0.4	0.4
	w(p)					
All	46.1	19.3	3.3	14.3	3.5	4.5
Emerging	36.7	24.8	3.7	14.6	4.7	5.7
Mature	61.1	9.8	2.7	14.5	1.4	2.7
	Probability weighting parameter, $\alpha = 0.65$.					

Source: Authors' simulations.

[1] Percent increase or decrease in per capita GDP measured in 2000 U.S. dollars.

In addition, mixed prospects involve *loss aversion*.[38] Benartzi and Thaler (1995) show that *myopic* loss aversion, along with CPT probability weighting, may account for equity premium. Myopic loss aversion refers to frequent or short-term (12–month) evaluation of losses and gains, as opposed to longer-term evaluation. If the time horizon for portfolio evaluation were longer (20 years), stocks may become more attractive relative to safe assets and risk premium may decline to a negligible level (from 6.5 to 1.4 percent, according to those authors' simulations). Barberis and others (2001) provide a formal model of the impact of loss aversion on asset prices, which can explain high mean and variance of equity prices and their low correlation with consumption growth. If the case for the impact of ambiguity were extended to mixed prospects, which involve both losses and gains, loss aversion combined with ambiguity aversion may account for an even higher equity premium.[39]

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[38] Table 3 and the associated subjective probability calculations are based on CPT evaluation of mixed prospects involving both gains and losses; see Kahneman and Tversky (1992) for the CPT formulation of mixed prospects.

[39] The example in Table 3 does not represent an extension of ambiguity to mixed prospects; this is left for future research.

We ran the same regressions shown in text Tables 8 and 9 for the period 1996–05 after substituting real per capita income growth rate for real growth rate. In terms of significance of the independent variables, the results were the same (available from the authors).

Appendix III

Table 1: Summary of Other Uncertainty Proxies in the Sample Countries

	1996-00	2001-05	1996-05	1996-00	2001-05	1996-05	1996-00	2001-05	1996-05
	All sample countries			**Emerging markets**			**Mature markets**		
Heritage indexes [1]									
Overall index	2.6	2.6	2.6	3.0	3.0	3.0	2.2	2.1	2.1
Trade	3.0	2.9	3.0	3.6	3.5	3.6	2.3	2.2	2.2
Fiscal Burden	3.8	3.6	3.7	3.6	3.4	3.5	3.9	3.8	3.9
Government intervention	2.8	2.7	2.8	3.1	2.9	3.0	2.5	2.5	2.5
Monetary policy	2.4	1.7	2.1	3.2	2.2	2.7	1.4	1.2	1.3
Foreign investment	2.2	2.3	2.3	2.5	2.8	2.6	2.0	1.8	1.9
Banking	2.5	2.5	2.5	2.8	2.9	2.8	2.1	1.9	2.0
Wages and prices	2.4	2.3	2.4	3.0	3.0	3.0	2.2	2.1	2.1
Property rights	1.9	2.2	2.1	2.4	2.9	2.7	1.3	1.3	1.3
Regulation	2.8	2.9	2.8	3.0	3.3	3.1	2.5	2.5	2.5
Informal market	2.4	2.5	2.4	3.2	3.3	3.3	1.4	1.5	1.5
Sample size	*53*	*53*	*53*	*29*	*29*	*29*	*24*	*24*	*24*
Transparency International) [2]	5.7	5.7	5.7	3.7	3.8	3.8	7.8	7.9	7.8
Sample size	*53*	*53*	*53*	*29*	*29*	*29*	*24*	*24*	*24*
International Country Risk Guide [3]	76	77	76	70	72	71	82	83	83
Sample size	*53*	*53*	*53*	*29*	*29*	*29*	*24*	*24*	*24*
Global Competitiveness Index [4]			34			51			16
Sample size	*51*	*51*	*51*	*27*	*27*	*27*	*24*	*24*	*24*
World Bank Enterprise Surveys [5]									
Crime [a]			2						
Confidence in the judiciary [b]			65						
Regulatory consistency [c]			50						
Finance [d]			48						
Informal sales [e]			86						
Infrastructure [f]			15						
Innovation [g]			18						
Employment growth [h]			11						
Tax burden [i]			3						
Trade [j]			8						
Sample size			*21-24*						
World Bank Doing Business [6]									
Average			56			74			34
Ease of doing business			47			69			21
Starting a business			58			79			33
Dealing with licenses			63			88			33
Hiring and firing			75			85			64
Registration of property			58			66			49
Getting credit			50			70			27
Protection of investors			57			68			44
Paying taxes			66			82			46
Trading across borders			45			66			21
Enforcement of contracts			51			74			24
Closing a business			43			66			18
Sample size			*52*			*28*			*24*

(continued)

Table 1: Summary of Other Uncertainty Proxies in the Sample Countries (concluded)

	1996-00	2001-05	1996-05	1996-00	2001-05	1996-05	1996-00	2001-05	1996-05
	All sample countries			**Emerging markets**			**Mature markets**		
World Values Survey Confidence Index [7]									
Overall index [a]			108			115			100
Overall index [b]			105			110			100
Average of categories 1-7 [c]			117			134			97
Average of categories 2-7 [d]			109			119			97
Sample size			*45*			*24*			*21*

Sources: As indicated in the table.

[1] Higher value indicates lower (worse) ranking.

[2] Corruption perception index. Higher value indicates higher (less corruption) ranking.

[3] Composite risk index. Higher value indicates lower (riskier) ranking.

[4] 2005 ranking. Higher value indicates lower (less competitive) ranking.

[5] Interpretation as explained in notes a-j:

[a] Average of security costs and losses due to crime in percent of sales.

[b] Percentage of firms that agree with the statement "I am confident that the judicial system will enforce my contractual and property rights in business disputes."

[c] Percentage of firms who agree with the statement "In general, government officials' interpretations of regulations affecting my establishment are consistent and predictable."

[d] Average of all finance indicators.

[e] Average percentage of total sales that firms estimated they reported for tax purposes.

[f] Average actual delay, in days, that firms experience when obtaining a telephone connection, measured from the day the establishment applied to the day they received the service or approval.

[g] Percentage of firms that have received ISO certification.

[h] Employment growth over the last 3 years (%); percentage increase of employment in the year prior to the survey compared to 2 years before that.

[i] Time spent in meetings with tax officials (days); average time firms spent in meetings with tax officials (days).

[j] Average of all trade indicators.

[6] Higher value indicates lower (worse) ranking.

[7] Higher value indicates higher (more confidence) ranking. The categories 1-7 are: churches; armed forces; the press; labor unions; police; parliament; and civil services. For categories including 1-7, see World Values Survey website. The indexes are calculated as follows: average the survey results for the categories 1-7; add the percentage in total of the answers: "trusting" (i) a great deal and (ii) quite a lot; this sum indicates high confidence; add the percentage in total of the answers: "trusting" (iii) not very much and (iv) not at all; this sum indicates low confidence. Divide the first (i+ii) sum by the second sum (iii+iv) to calculate the index.

[a] All confidence index categories average for which survey results are reported.

[b] All confidence index categories average for which survey results are reported, excluding religion.

[c] Confidence index categories 1-7 average for which survey results are reported.

[d] Confidence index categories 1-7 average for which survey results are reported, excluding religion.

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