THE EQUITY PREMIUM PUZZLE:
A SURVEY OF THE LITERATURE

A Master's Thesis

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To those who have faith in me

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The Institute of Economics and Social Sciences
of
Bilkent University

by

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In Partial Fulfillment of the Requirements for the Degree of
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I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

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ABSTRACT

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This thesis is a survey of the literature on the equity premium puzzle. The puzzle was introduced in 1985 by Mehra and Prescott, who noted that the huge premium of equities over bonds is not consistent with the predictions of the Lucas-Breeden representative agent paradigm that governs macroeconomic theory today. This thesis describes the equity premium puzzle, conveys the importance of its implications, and classifies and reviews the approaches to explaining it.

Keywords: Equity Premium Puzzle, Asset Pricing, Risk-free Rate Puzzle

ÖZET

HİSSE PRİMİ BİLMECESİ: BİR LİTERATÜR İNCELEMESİ

Tözün, Bahar
Yüksek Lisans, İktisat Bölümü
Tez Yöneticisi: Dr. Neil Arnwine

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Bu tez, hisse primi bilmecesi literatürünün bir incelemesidir. Bu bilmece, Mehra ve Prescott tarafından 1985 yılında literatüre kazandırılmış olup, hisse senetlerinin bonolara karşı priminin, modern makroekonomik kuramın en önemli bir parçası olan Lucas-Breeden paradigması ile uyumsuzluğunu ortaya koyar. Bu tezde hisse primi bilmecesi ve sonuçlarının önemi anlatılmış, bilmeceyi çözümleme yolundaki yaklaşımlar sınıflandırılmış ve gözden geçirilmiştir.

Anahtar Kelimeler: Hisse Primi Bilmecesi, Varlık Değerlemesi, Risksiz Oran Bilmecesi

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CHAPTER 1

INTRODUCTION

In this thesis, my goal is to describe the Equity Premium Puzzle (EPP), convey its deepness and the importance of its implications, and review the EPP literature. The equity premium puzzle literature is vast and I have made much use of a number of extensive surveys by Kocherlakota (1996), Mehra and Prescott (2003), and Campbell (2003).

The equity premium puzzle is perhaps the most striking empirical phenomenon in financial economic theory. The following stylized facts constitute the EPP:

> Over the last one hundred years, the average real return to stocks in the United States has been about six percent per year higher than that on Treasury bills. At the same time, the average real return on Treasury bills has been about one percent per year. (Kocherlakota, 1996: 42)

In their seminal paper, Mehra and Prescott (1985) find they cannot simultaneously account for an average equity premium higher than 0.35 percent per year and an average return on Treasury bills of less than 4 percent per year in a calibrated standard macroeconomic model under any values of their choice parameters within the proposed ranges. They have dubbed this inconsistency of real world data with the representative agent paradigm, the "equity premium puzzle". In addition to Mehra and Prescott's initial finding, the extent of the puzzle is widened by others: "Further, in econometric tests, the conditional Euler equation of per capita consumption is also rejected by Hansen and Singleton (1982), Hansen and Jagannathan (1991), Ferson and Constantinides (1991), and others." (Constantinides et al., 2002: 269, 270)

Mehra and Prescott (1985) employ a variation of the representative agent model. Because we base much of our economic intuition on the representative agent paradigm, our understanding of the macroeconomy will be impaired until we have explained the equity premium puzzle. The equity premium puzzle manifests the failure of paradigms central to financial and economic modeling to capture why individuals are so averse to the highly procyclical stock return risk. "Hence the viability of using this class of models for any quantitative assessment, say, for instance, to gauge the welfare implications of alternative stabilization policies, is thrown open to question." (Mehra and Prescott, 2003: 911) According to Atkeson and Phelan (1994), we will be able to answer R. Lucas' (1987) question about how costly individuals find business cycle fluctuations in consumption growth, only after we explain this unexpectedly high level of aversion to stock return risk. Grant and Quiggin (2005: 1, 2) summarizes the implications of the huge equity premium as:

- The macroeconomic variability associated with recessions is very expensive.
- Risk to corporate profits robs the stock market of most of its value.
- Corporate executives are under irresistible pressure to make shortsighted, myopic decisions.
- Policies—disinflation, costly reform—that promise long-term gains at the expense of short-term pain are much less attractive if their benefits are risky.
- Social insurance programs might well benefit from investing their resources in risky portfolios in order to mobilize additional risk-bearing capacity.
- There is a strong case for public investment in long-term projects and corporations, and for policies to reduce the cost of risky capital.

Since Mehra and Prescott coined the puzzle, financial economists have been trying to explain these sizable differences between the real returns on bonds and equities. These differences in average returns have been associated to differences in the covariance of return to each security with the typical investor's consumption: (Campbell 2003: 806)

> Finance theory explains the expected excess return on any risky asset over the riskless interest rate as the quantity of risk times the price of risk. In a standard consumption-based asset pricing model of the type studied by Rubinstein (1976), Lucas (1978), Grossman and Shiller (1981) and Hansen and Singleton (1983), the quantity of stock market risk is measured by the covariance of the excess stock return with consumption growth, while the price of risk is the coefficient of relative risk aversion of a representative investor.

'If covariance of return to a security *i* with the typical investor's consumption (growth) is high, then selling the security reduces the variance in the typical investor's consumption, so that the required (expected) return from the security is high to compensate for this risk.' To address the equity premium puzzle we must first address a serious problem with this statement that has long bothered financial economists:

What(ever) is the Typical Investor's Consumption?

Analogous to the problem of the non-existence of a hypothetical market portfolio, we cannot measure the typical investor's consumption. Economic models have come up with proxies for it that can be measured.

1.1. Theoretical Background

This section introduces the major theoretical frameworks in macroeconomics that have been applied to the study of the EPP.

1.1.1. The Capital Asset Pricing Model

The Capital Asset Pricing Model was developed by Sharpe (1964) and Lintner (1965), see also Black (1972). The CAPM is a single-period discrete-time model, which assumes that the typical investor's consumption is perfectly correlated with the stock market return. CAPM uses the stock market return as proxy for the typical investor's consumption in the above argument, and we get: 'If covariance of return to a security *i* with the stock market return is high, then the security does not have a hedge value so that the expected return from the security is high.' CAPM postulates for each security a beta coefficient that describes the linear relationship between the expected excess stock return and the excess return on the market portfolio. If the beta of a stock is smaller than one, then the stock pays off when the market is doing poorly. Low or negative beta securities have a hedge value, so they have a high price and a low expected return.

Higher risk aversion increases the risk-return tradeoff. This is measured by the Sharpe-ratio, $\left(E\left[r_M\right]-r_f\right)/\sigma_i$, the slope of the Capital Market Line.

1.1.2. Intertemporal CAPM and Consumption CAPM

The Intertemporal CAPM and Consumption CAPM extend the standard CAPM to a multi-period setting. An advantage of ICAPM over the standard CAPM is that utility can be state-dependent, although the assumption of time-separability remains. A key assumption in the CCAPM is additively separable preferences, which gives state independence of direct utility. According to Abel (1991), since bond returns are determinate in the CCAPM framework, how much higher an investor would value stocks over bonds depends quantitatively on two factors: (1) the covariance of expected consumption growth with expected stock return and the covariance of expected consumption growth with bond return, the comparison of which tells us the extent that bonds are preferable as a hedge against consumption risk, and (2) the coefficient of relative risk aversion, α.

1.1.3. The Lucas-Breeden Representative Agent Model

R. Lucas (1978) models a one-good endowment (pure exchange) economy with identical consumers. He assumes that the endowment *level* follows a Markov process. The Lucas-Breeden representative agent model is an integral part of modern macroeconomic theory. (R. Lucas 1978, Breeden 1979) It features per capita consumption that is perfectly correlated with the consumption stream of the typical investor. Therefore, the representative agent model uses per capita consumption as proxy for the typical investor's consumption. In this model, 'if covariance of return to security *i* with per capita consumption is high, then security *i* does not have a hedge value, so that the expected return from the security is high.'

The representative agent maximizes the expected sum of a stream of constant relative risk aversion (CRRA) discounted period utilities:

$$E_t \sum_{s=0}^{\infty} \frac{\beta^s \left(c_{t+s}\right)^{1-\alpha}}{1-\alpha}, \alpha \geq 0\,, \qquad (1)$$

where β is the discount rate (a higher β leads investors to save more), and,

> α captures two distinct attitudes toward consumption: a higher α would mean higher risk aversion (dislike of change in levels of consumption in different states of the economy) and a higher incentive for smoothing intertemporal consumption.

1.1.4. Real Business Cycle Models

The real business cycle model was introduced by Kydland and Prescott (1982) and Long and Plosser (1983). "Real business cycle theory uses the stochastic growth model augmented to include the labor-leisure decision." (Mehra and Prescott, 2003:

925) The theory provides another framework in which we can look at time-variation in the price of risk.

1.1.5. Overlapping-Generations Models

The overlapping-generations model was introduced by Allais in 1947 and popularized by Samuelson in 1958. It is a general-equilibrium model especially designed for dynamic analysis, in which sense it makes a good alternative to the Arrow (1964) - Debreu (1959) model. Generations born at different periods live finite lifetimes, but the economy (possibly) goes on forever. This brings about a natural heterogeneity across individuals at a point in time, as well as life-cycle considerations for a given individual across time.

1.2. A Closely Related Puzzle: That of the Risk-free Rate

Campbell (2003: 807) points out, "Some authors, including Kandel and Stambaugh (1991), have responded to the equity premium puzzle by arguing that risk aversion is indeed much higher than traditionally thought, but what this actually brings about is the "risk-free rate puzzle" of Weil (1989)." Within the framework of the preferences (1), when individuals are averse to risk, they are also averse to intertemporal differences in levels of consumption, because the two incentives are captured by a single parameter, α. The large equity premium implies that individuals are highly risk averse. In fact, the observed value of the equity premium is consistent with a very high value of the risk aversion parameter within the Mehra and Prescott (1985) framework. The preferences (1) in turn imply that they do not like consumption growth.[1] Although individuals have a big incentive to smooth intertemporal consumption, and although the risk-free rate is very low, they still save enough that per

[1] Generalized expected utility preferences, which do not make this implication, will be discussed later.

capita consumption grows rapidly. (Kocherlakota, 1996: 43) The question why people save so much that the average per capita consumption grows at around 2% per year when the risk free rate is so low is a second, closely related puzzle dubbed "the risk free rate puzzle". Another manifestation of the risk-free rate puzzle is that the rate of time preference which is around 4% is significantly higher than the risk-free rate. There is a risk-free rate puzzle only if α is required to be larger than one so as to match up with the high equity premium. (Kocherlakota, 1996: 50)

CHAPTER 2

MEHRA AND PRESCOTT (1985)

Recall that, in a representative agent framework, the covariance of return to security *i* with per capita consumption is a measure of the security's risk. An investor appreciates a security that has high return when per capita consumption is low, whereas he/she does not pay that sort of "hedge premium" for a security that pays off well in a "good state" when per capita consumption is high any way.

In equilibrium, an individual must not be able to Pareto improve his/her welfare by switching marginally from holding bonds to stocks or vice versa. Of course this statement underlies the assumption that asset trading is costless. Therefore an individual's consumption profile must satisfy the following two first order conditions:

$$E_t\left\{\left(\frac{c_{t+1}}{c_t}\right)^{-\alpha}\left(R^s_{t+1}-R^b_{t+1}\right)\right\}=0 \tag{2a}$$

$$\beta E_t\left\{\left(\frac{c_{t+1}}{c_t}\right)^{-\alpha}R^b_{t+1}\right\}=1 \tag{2b}$$

where $R^s{}_t$ is the gross return to stocks from period (t-1) to period t, and $R^b{}_t$ is the gross return to bonds from period (t-1) to period t.

The representative agent assumption (definition): is to assume that (2a) and (2b) are satisfied for per capita consumption as well as for each individual's consumption.

The representative agent assumption is valid when asset markets are complete, "because after trading in complete markets, individuals become marginally homogeneous even though they are initially heterogeneous" (in preferences and levels of wealth). (Kocherlakota, 1996: 48) Indeed, the assumptions that asset markets are frictionless and complete imply that there is a representative consumer. (Kocherlakota, 1996: 53)

2.1. Mehra and Prescott (1985) – The Analysis

Mehra and Prescott (1985) "calibrate[d] an asset pricing model with time-separable isoelastic utility to see whether the model could deliver unconditional rates of return close to the historical average rates of return on stocks and Treasury bills. They use[d] a 2-point Markov process for consumption (endowment) growth." (Abel, 1990: 40) Letting endowment *growth* follow a Markov process as opposed to Lucas' (1978) assumption that endowment *level* follows a Markov process "enables [Mehra and Prescott] to capture the non-stationarity in the consumption series associated with the large increase in per capita consumption that occurred in the 1889-1978 period." (Mehra and Prescott, 1985: 150) Making use of their assumptions, Mehra and Prescott employ the first order conditions (2a) and (2b) to obtain a formula that expresses the population mean of the real return to the S & P 500 and the population mean of the real return to the three month Treasury bill in terms of α and β, which are the two exogenous parameters of the representative agent model.

2.2. What is the Level of Relative Risk Aversion?

Mehra and Prescott (1985) show that the value of the relative risk aversion parameter, α, is central to the existence of the equity premium puzzle. However, they do not include estimations of α or β in their paper. In quest of a good restriction on the parameter of relative risk aversion, Mehra and Prescott (1985: 154) review the following results: Arrow (1971) finds that α, with respect to wealth, is almost constant, should be approximately 1. Friend and Blume (1975), presenting evidence based upon the portfolio holdings of individuals, assert that α is approximately 2. Kydland and Prescott (1982), in their study of aggregate fluctuations, hold that α estimates lie between 1 and 2, to mimic the observed relative variabilities of consumption and investment. Altuğ (1983) concludes that α is near 0. Kehoe (1983), studying the response of small countries' balance of trade to terms of trade shocks, gets an α near 1. According to Hildreth and Knowles' (1982) study of the behavior of farmers, α estimates lie between 1 and 2. Tobin and Dolde (1971), studying life cycle savings behavior with borrowing constraints, find that α can best be approximated by 1.5. Mehra and Prescott (1985) argue that although these studies can be challenged individually, "together they constitute an *a priori* justification for [their] restricting" α to vary between 0 and 10.

Kocherlakota (1990c) shows that the estimation technique of Friend and Blume (1975) seriously underestimates α. Kocherlakota (1996) criticizes Mehra and Prescott (1985) on the grounds that this is the only estimate that they cite from financial market data.

Assuming constant relative risk aversion utility, Mankiw and Zeldes (1991: 105) construct an example and conclude that the α value equal to twenty is too large to be believable. Moreover, Mankiw and Zeldes (1991) perform various estimations of α. Using Mehra and Prescott (1985) data, they estimate α to be 26.3. They further note that "if consumption and the stock price index are each random walks, then the estimate of α should be multiplied by 2/3", which results in an estimate of α of 17.5. Using 1984 Panel Study of Income Dynamics data for all families (stockholders and nonstockholders), they get an α estimate of 100.4. Using PSID consumption data of only stockholders gives an α estimate of 35. (summarized in Table 3: 104) They argue that although 35 is an implausibly high estimate, looking only at the consumption of stockholders is a leap towards resolving the equity premium puzzle, the reasoning of which we will look into shortly.[2]

Eisenhauer and Ventura (2003) is a recent survey on estimations of values of absolute and relative risk aversion and prudence: "Estimates of the average value of relative risk aversion range from less than 1 to well over 40, and evidence of increasing, decreasing, and constant relative risk aversion has been obtained."

Mehra and Prescott (1985) restrict the intertemporal discount parameter β to be between 0 and 1. This restriction obviously does not call for as much justification as is necessary for the restriction on α. However, Kocherlakota (1990a) shows that the discount factor, β, can be greater than 1 when interest rates are positive.

Historical data tells that the covariance of (ex post) per capita consumption growth with (realized) stock returns is only slightly higher than the covariance of (ex post) per capita consumption growth with bond returns, therefore the small difference does not account for the large gap between stock and bond returns. (see Table 2 of Kocherlakota 1996: 50)

[2] Grossman, Melino, and Shiller (1987) show that time aggregation biases the estimate of α upward.

2.3. Mehra and Prescott (1985) – The Conclusion

Mehra and Prescott find that for any values of their choice parameters α and β within their restrictions, they cannot simultaneously account for an average equity premium higher than 0.35 percent per year and an average return on Treasury bills of less than 4 percent per year. For the average equity premium to be as large as the historically observed equity premium, the value of α would have to be extremely high, around 30 or 40, which is much higher than the conventionally accepted values for α.

2.4. Mehra and Prescott (1985) – The Assumptions

Mehra and Prescott's puzzle is that plausible parameter values in the standard dynamic macroeconomic model are not consistent with the observed rates of return on equities and bonds. To solve this puzzle, an obvious approach is to identify the modeling assumptions used by Mehra and Prescott and then weaken or find alternatives to these modeling assumptions. This has been the task of a multitude of papers since the puzzle was introduced. Below, I identify and address the key modeling assumptions:

- They assume time- and state-separable utility. Individuals maximize the expected sum of a stream of Constant Relative Risk Aversion discounted period utilities:

$$E_t \sum_{s=0}^{\infty} \frac{\beta^s \left(c_{t+s}\right)^{1-\alpha}}{1-\alpha}, \alpha \geq 0, \quad (1)$$

- Asset markets are complete, i.e., individuals can write insurance contracts against any possible contingency. In other words, individuals have a sufficiently large set of assets available for trade that they can diversify any idiosyncratic risk in consumption.

- Asset trading is costless, i.e., asset markets are frictionless.

The following three assumptions have been ruled out by Kocherlakota (1996) as causes of the equity premium puzzle:

- Per capita consumption growth follows a two state Markov chain constructed in such a way that the population mean, variance, and autocorrelation of consumption growth are equivalent to their corresponding sample means in the United States data.

- In period *t*, the only variables that individuals know are the realizations of current and past consumption growth.

- The growth rate of the total dividends paid by the stocks included in the S & P 500 is perfectly correlated with the growth rate of per capita consumption, and the real return to the (nominally risk free) Treasury bill is perfectly correlated with the return to a bond that is risk free in real terms.

2.5. A More Robust Restatement of the Puzzle

According to Kocherlakota (1996), of the six assumptions of the original Mehra and Prescott paper, three are necessary - and sufficient - to imply the puzzle. The other three more technical assumptions about the statistical behavior of consumption and asset returns are thus shown to be relatively unimportant. Hence, Kocherlakota (1996) makes “a more robust restatement of the puzzle” and argues that any attempt to explain the puzzle must involve the relaxing of at least one of the above mentioned first three assumptions.

CHAPTER 3

APPROACHES TO EXPLAINING THE PUZZLE

A stylized fact observed by Campbell (2003: 806) is that "excess returns on U.S. stock over Treasury bills are highly forecastable. The log price-dividend ratio forecasts 10% of the variance of the excess return at a 1-year horizon, 22% at a 2-year horizon, and 38% at a 4-year horizon." Because predictable variation in excess stock returns is an important component of equity volatility, researchers have developed models in which the quantity of stock market risk or the price of risk change through time. ARCH and other econometric models show that the conditional variance of stock returns is highly variable. "If this conditional variance is an adequate proxy for the quantity of stock market risk, then perhaps it can explain the predictability of excess stock returns." Campbell (2003: 808) argues that this approach is problematic.

A more likely possibility is that the price of risk varies over time. Some modeling strategies aim to incorporate this feature. "Time-variation in the price of risk arises naturally in a model with a representative agent whose utility displays habit-formation." "Time-variation in the price of risk can also arise from the interaction of heterogeneous agents." (Campbell, 2003: 809) Another possible source of time-variation in the price of risk is irrational expectations of investors.

Attempts to resolve the puzzle

> include alternative assumptions on preferences, modified probability distributions to admit rare but disastrous events, survival bias, incomplete markets, and market imperfections. They also include attempts at modeling limited participation of consumers in the stock market, problems of temporal aggregation and behavioral explanations. (Mehra and Prescott, 2003: 911)

I examine some of these efforts below:

3.1 Is It Due to the Data Set?

Huge differences between the returns on bonds and equities are observed, even with the returns averaged over long periods of time. Several attempts to explain away the puzzle using a different data set than Mehra and Prescott's (1985) serve only to confirm the existence of an equity premium. Mehra and Prescott (2003: 892-894) provide a good summary of these studies. Hansen and Singleton (1983), Siegel (1992), Aiyagari (1993), Roy (1994), Kocherlakota (1994) and Siegel (1998) are some prominent papers. Siegel's (1998) data pertaining to years from 1802-1998 reveal a somewhat smaller premium of 4.1%. Ibbotson Associates 2000 Yearbook gives an equity premium value as high as 8.4% for the years from 1926-2000. See Mehra and Prescott (2003: 894, Table 1)

3.2 The Expected (Ex-ante) Equity Premium Vs. the Ex-post Equity Premium

Another way to examine the reliability of the historical average rates of return is to estimate how close the historical (realized) average rates of return are to those levels of return investors expected when making their portfolio decisions. Applying statistical techniques to data from 1892 to 1988, Cecchetti, Lam, and Mark (1990) find that the average equity premium was 6.03 percent, but that the equity premium expected by investors could have been anywhere from 2.35 percent to 9.71 percent.

Even the low value of 2.35 percent for the equity premium is higher than what Mehra and Prescott (1985) can explain. (Abel, 1991)

3.3 New Utility Functions

Researchers have studied new utility functions in order to alleviate the "failure of simple log or power utility models to account for basic features of asset pricing data". (Cochrane and Hansen, 1993: 2)

3.3.1. Generalized Expected Utility

is a generalization of (1) which separates the intertemporal elasticity of substitution from the parameter of relative risk aversion. Current utility, U_t, is described *recursive*ly using the formula:

$$U_t = \left\{ c_t^{1-\rho} + \beta \left(E_t U_{t+1}^{1-\alpha} \right)^{\frac{1-\rho}{1-\alpha}} \right\}^{\frac{1}{1-\rho}} \qquad (3)$$

where a higher α would mean higher risk aversion (dislike of change in levels of consumption in different states of the economy),

1/ρ is the elasticity of intertemporal substitution. A high 1/ρ means that, consumption in different periods – with levels adjusted for the investor's time preference – are good substitutes to each other.

U_t is a constant elasticity function of current consumption and future utility. Note that (1) can be obtained as a special case of (3) by setting α = ρ.

Epstein and Zin (1989) point out that an important characteristic of these generalized expected utility (GEU) preferences is that they permit the degree of risk aversion to be disentangled from the degree of intertemporal substitutability. As observed by Hall (1985), Zin (1987), and Attanasio and Weber (1989), in the preferences (1), the coefficient of relative risk aversion is constrained to be equal to the reciprocal of the elasticity of intertemporal substitution (1/1/ρ). Therefore, highly risk-averse consumers must view consumption in different time periods as being highly complementary. This is not the case with GEU preferences (3) in which two different parameters exist for these two independent tendencies to be captured by the model associated. Kocherlakota (1990b: 186) asserts that, with data on asset prices and aggregate consumption, the GEU preferences (3) and the 'standard' preferences (1) are observationally equivalent (i.e., impose the same restrictions on the data) because such data only provide information on first order conditions. When the assumption that the growth rates of aggregate endowment (consumption) is i.i.d. over time is satisfied, the preferences (1) are enlarged to GEU preferences (3) by relaxing state-separability (while preserving state independence). "State-separability is a second-order restriction; thus, to the first order," the preferences (1) and (3) "look the same." Epstein and Zin (1990), and Kocherlakota (1996), on the other hand, hold that disentangling risk aversion and intertemporal substitution can help explain the risk-free rate puzzle that appears within the preferences (1) framework by allowing intertemporal substitution and relative risk aversion to be high simultaneously. The problem with this is that Campbell (2000) finds evidence that the elasticity of intertemporal substitution is small.

3.3.2. (Internal) Habit Formation

Time-variation in the price of risk arises naturally when preferences exhibit habit formation. (Campbell, 2003: 809) This approach integrates the previous period's consumption to the temporal utility function in order to take into account the "inertia" consumers might feel. If last period's consumption is higher, then the temporal marginal utility is higher, meaning consuming one more unit at the margin adds more to this period's utility vis-à-vis the case with lower consumption during the last period. A generic period utility function and the corresponding marginal utility are as follows: (Kocherlakota, 1996: 56)

$$E_t \sum_{s=0}^{\infty} \frac{\beta^s \left(c_{t+s} - \lambda \, c_{t+s-1}\right)^{1-\alpha}}{1-\alpha}, \lambda > 0 \tag{4}$$

$$MU_t = \left(c_t - \lambda \, c_{t-1}\right)^{-\alpha} - \beta \, \lambda \, E_t \left(c_{t+1} - \lambda c_t\right)^{-\alpha} \tag{5}$$

Major references on the asset pricing implications of habit formation in preferences are Constantinides (1990), Abel (1990), Heaton (1995), Campbell and Cochrane (1999), and Boldrin et al (2001).

Kocherlakota's (1996: 56) finding is that with preferences (4) that exhibit habit formation, the first order conditions are satisfied by choosing β equal to 0.99, α equal to 15.384 and λ equal to 0.174. Kocherlakota (1996) further observes that in the 'standard' preference case (1), the first order conditions cannot be simultaneously satisfied by picking a β value less than or equal to 1. Due to the high value of the coefficient of relative risk aversion that satisfies the first order conditions, this implies that habit formation does not resolve the equity premium puzzle.

Constantinides (1990), on the other hand, studying a model with internal habit where utility is defined over the difference between current consumption and lagged past consumption, holds that the equity premium puzzle is resolved by means of a habit-formation specification but only by assuming negative time preference.

Preferences that exhibit habit formation make the agent extremely averse to consumption risk even when the risk aversion parameter is small. For small changes in consumption, changes in marginal utility can be large. Therefore, while this approach cannot resolve the equity premium puzzle without assuming extreme aversion to consumption risk, it can address the risk-free rate puzzle. The induced aversion to consumption risk increases the demand for bonds, thereby reducing the risk-free rate. One problem is that if the growth rate of consumption is assumed to be i.i.d., the model implies that the risk-free rate will vary considerably (and counterfactually) over time. Constantinides (1990) gets around this problem since the growth rate in his model is not i.i.d. (Mehra and Prescott 2003: 915)

Campbell and Cochrane (1999) feature

> a representative agent whose utility is a power function of the difference between consumption and "habit", where habit is a slow-moving nonlinear average of past aggregate consumption. This utility function makes the agent more risk-averse in bad times, when consumption is low relative to its past history, than in good times, when consumption is high relative to its past history. (Campbell 2003: 809)

The model can generate a high equity premium through high stock market volatility together with a high average level of risk aversion.

> Since risk aversion increases precisely when consumption is low, it generates a precautionary demand for bonds that helps lower the risk-free rate. This model is consistent with both consumption and asset market data. However, it is an open question whether investors actually have the huge time varying countercyclical variations in risk aversion postulated in the model. (Mehra and Prescott 2003: 915)

Equilibrium business-cycle models feature both asset returns and allocations as endogenous. Boldrin et al (2001) construct an equilibrium business-cycle model with habit persistence, which is consistent both with key asset-return facts and with key business-cycle facts. In standard Real Business Cycle models, the volatility of capital gains is constant because the supply of capital is perfectly elastic at a constant price. The volatility of capital gains is an important component of the volatility of the rate of return on equity. Simply introducing habit persistence into the standard

RBC model, amplifies the fluctuations in the demand for capital over the business cycle. But because capital supply is perfectly elastic, this has no impact on capital gains and negligible effect on the volatility of the return on equity. Ceteris paribus, an increase in the volatility of the return on equity is an important positive factor on the equity premium. Not having the desired effect of increasing the volatility of return on equity, the bare introduction of habit persistence fails to obtain an increased level of equity premium. In their model, Boldrin et al (2001: 150) "incorporate factor-market inflexibilities which have the effect of reducing the elasticity of capital supply" in addition to habit persistence. They do this "by replacing the standard one-sector production technology with a two-sector specification in which adjusting factors of production takes time." They show that their model is consistent with the key features of asset returns.

3.3.3. "Catching/Keeping up with the Joneses"

James Duesenberry (1949) is the first to put forward that an individual's utility is more a function of societal levels of (or per capita) consumption than of his/her own consumption. Therefore, the individual's attitude toward the variability in societal consumption, as well as his/her aversion to own-consumption risk, has implications on his/her saving and consumption decision. Intuitively, consumers in fast growing countries should be borrowing against their future income, or at least saving marginally less, than consumers in slowly growing countries. But this is not the case according to empirical studies. Actually, there is a strong positive correlation between income growth and savings rates. While this brings to mind that high savings rates may be the factor inducing fast growth, this strong positive correlation manifests itself with rapid income growth preceding rise in savings rates according to empirical work. Duesenberry attempted to explain why the savings rate of individuals rises with income but the national savings rate does not. He asserted that it's the relative rise in individual income that affects the individual's savings decision. When there is a rise in national income, the individuals' relative income need not be affected, thus individuals' savings decision stays the same. Duesenberry's relative consumption model, according to which rising incomes would induce excessive consumption as individual's try to "catch up with the Joneses", is unlikely to explain the growth-savings paradox. Harbaugh (1996: 1) takes another perspective in relative consumption: "Rather than increasing consumption, concern for relative consumption can induce a fear of falling behind which raises precautionary savings. As societal income growth increases this fear intensifies, allowing for a positive effect of growth on savings rates and potentially explaining the growth-savings paradox."

Abel (1990) and Gali (1994) are two major references on the asset pricing implications of various classes of preferences that feature relative consumption outlook. Gali (1994) studies "consumption externatilities" in which agents' utility depends on temporal levels of both his/her own consumption and per capita consumption in both a CAPM framework and a multi-period model. Abel (1990) defines utility as the *ratio* of own consumption relative to *lagged*[3] per capita consumption in a Lucas (1978) pure exchange economy framework. The utility function introduced by Abel (1990) nests (1) time-separable utility, (2) "catching up with the Joneses" utility, (3) utility that displays internal habit formation, under the assumption that consumption growth is i.i.d. When an individual's marginal utility of own consumption is highly sensitive to variations in per capita consumption, it is also strongly negatively related to stock returns. Therefore, even if α is small, i.e., the investor is not

[3] Hence Abel (1990) uses the phrase "catching up with the Joneses" rather than "keeping up with the Joneses". (Abel, 1990: 38, footnote 1)

averse to own-consumption risk, stocks will not be appealing because he/she is highly averse to per capita consumption risk. This is the case for any specification of α and β. In both habit formation and relative consumption (catching or keeping up with the Joneses) models, effective risk aversion and prudence (i.e., convex marginal utility and strong precautionary motive) become implausibly large, letting the equity premium puzzle remain unsolved. (Mehra and Prescott, 2003: 918)

3.4 Incomplete Markets, Heterogeneous Agents and Market Frictions

Market completeness implies that the individual can write insurance contracts against any idiosyncratic risk, leaving aggregate risk as the only risk that affects individual consumption. If, moreover, individuals have identical Constant Relative Risk Aversion preferences, individual consumption is proportional to (i.e., is a fraction of) aggregate consumption. (Atkeson and Phelan, 1994: 1) "Full consumption insurance implies that heterogeneous consumers are able to equalize their marginal rates of substitution state by state." (Constantinides and Duffie, 1996: 220) The equilibrium in a heterogeneous full-information economy is isomorphic in its pricing implications to the equilibrium in a representative-household, full-information economy, if households have von Neumann-Morgenstern preferences. (Mehra and Prescott, 2003: 918) With incomplete insurance markets, on the other hand, variability of individual consumption may exceed that of aggregate consumption, and asset prices may differ substantially from those predicted by a representative consumer model. (Heaton and D. Lucas, 1996: 444)

This strand of literature tries to explain the equity premium puzzle by relaxing Mehra and Prescott's (1985) assumption that asset markets are complete, by introducing transaction costs, borrowing constraints, persistence of idiosyncratic shocks and market segmentation. I preferred not to discuss the implications of adding transaction costs besides other sources of market incompleteness in a separate section. The problems of this section are necessarily general equilibrium as opposed to the problem of a representative consumer.

3.4.1. Dynamic Self-insurance, the Persistence of Idiosyncratic Shocks (and Transactions Costs)

In a two-period model in which financial markets are incomplete, Weil (1992) shows that the additional variability in consumption growth induced by market incompleteness helps to explain - the risk free rate puzzle, if individuals exhibit prudence, and - the equity premium puzzle, if individuals exhibit not just prudence but decreasing absolute prudence ("see Kimball 1990"). (Kocherlakota, 1996: 59)

Two period models do not allow for *dynamic self-insurance* against income risk, which is the smoothing of consumption through borrowing against future income that can be done in longer-period or infinite horizon settings. If, on the other hand, the individual knows that he/she will live for many more years, he/she need not absorb income risk fully into current consumption, he/she can partially offset it by saving relatively more when his/her income is high and less during lower income periods. The extra demand for savings due to the absence of insurance markets will typically be smaller in the infinite horizon economy than in a two-period model. If individuals can dynamically self-insure, the induced interest rate will not be much less than the complete markets interest rate. As long as the interest rate is well-approximated by the complete markets interest rate, and the persistence of shocks to income are sufficiently low (i.e., income shocks have an autocorrelation sufficiently less than one), then the equity premium puzzle cannot be explained by market incompleteness. (Kocherlakota, 1996: 61-63)

> Current financial paradigms postulate that idiosyncratic income shocks must exhibit three properties in order to explain the returns on financial assets: uninsurability, persistence, heteroscedasticity and countercyclical conditional variance. (Mehra and Prescott, 2003: 918)

Telmer (1993) and D. Lucas (1994) study models with transitory idiosyncratic shocks and borrowing or short-selling constraints. They conclude that:

> even though agents cannot insure against idiosyncratic shocks, predicted asset prices are similar to those with complete markets. This occurs because when idiosyncratic shocks are transitory, consumption can be effectively smoothed by accumulating financial assets after good shocks and selling assets after bad shocks. (Heaton and D. Lucas, 1996: 444)

Aiyagari and Gertler (1991) add transaction costs to a related model where agents trade to offset transitory idiosyncratic shocks and predicted asset prices are similar to complete-markets asset prices, *provided that the supply of bonds is not unrealistically low*. (Heaton and D. Lucas, 1996: 444 and Mehra and Prescott, 2003: 918, 919)

Heaton and D. Lucas (1996) use data from the Panel Study of Income Dynamics to find that undiversifiable shocks to individual income are not persistent. (Kocherlakota, 1996: 61) They study an incomplete markets economy with individuals unable to write contracts contingent on future labor income. There are three types of uncertainty, the first two of which are aggregate: (1) systematic labor income risk, (2) dividend income risk, (3) idiosyncratic labor income risk. There exists trade in financial securities, but frictions such as borrowing constraints, short-sales constraints, and transactions costs also exist. In their paper, they decompose the effect of transactions costs on the equity premium into two components: (1) the direct effect that occurs "because individuals equate the net-of-cost margins", (2) the indirect effect; that individual consumption correlates more with individual income. “In the simulations, [they] find that the direct effect dominates and that the model can produce a sizable equity premium only if transactions costs are large or the assumed quantity of tradable assets is limited.” (Heaton and D. Lucas, 1996: 443)

Constantinides and Duffie (1996) study the case of many agents with identical utility functions but permanent idiosyncratic labor income shocks. They point out that when idiosyncratic income shocks are persistent (i.e., have an autocorrelation more than one) instead of transitory, the individual cannot dynamically self-insure but must absorb them fully into consumption. (Kocherlakota 1996: 61) They provide an explanation of the countercyclical behavior of the equity risk premium; the investors require a larger equity premium in a recession, because they expect stocks to perform poorly in recessions, when the risk of job loss increases. (Mehra and Prescott, 2003: 919)

Storesletten, Telmer and Yaron (2001a), use empirical evidence from the Panel Study on Income Dynamics to show that idiosyncratic income shocks are persistent and have countercyclical conditional variance.

Krebs (2000), Constantinides (2002), and Levine and Zame (2002) are other important contributions to this area of research.

“Dumas (1989), Grossman and Zhou (1996), Wang (1996), Sandroni (1999) and Chan and Kogan (2002) move in a somewhat different direction by exploring the interactions of agents who have different levels of risk aversion.” (Campbell, 2003: 809) Chan and Kogan (2002: 1256) study an economy with heterogeneous agents who have relative risk aversion that is constant over time but is varied across the population:

> The aggregate risk premium in such an economy exhibits countercyclical variation due to endogenous changes in the cross-sectional distribution of wealth. Relatively risk-tolerant agents hold a higher proportion of their wealth in stocks. Therefore, a decline in the stock market reduces the fraction of aggregate wealth controlled by such agents and hence their contribution to the aggregate risk aversion. Thus the equilibrium risk premium rises as a result of a fall in stock prices.

3.4.2. Borrowing and Short Sales Constraints

Constantinides et al. (2002) study a 3-period overlapping-generations model to see the implications of heterogeneity of consumers across generations and borrowing constraints on the equity premium puzzle and the risk-free rate puzzle.

Of the 3 generations, the young are born with a modest endowment income. The middle-aged, earn stochastic wage income. The senior citizen earns no wage income, but sells the bonds and equity accumulated in the previous period in order to consume. Consumers are assumed to be homogeneous within a generation; in fact, they model each generation of consumers with a representative consumer. They ignore the possible income heterogeneity within a generation (a type of market incompleteness) in order to see the implications of heterogeneity across generations induced by the nature of overlapping-generations. The model has two forms of market incompleteness. First, consumers of one generation (the young) may not trade claims against their future wage earnings with consumers of another generation (the middle-aged). Note that the old are to dissave, as there is no bequest. "Second, consumers of one generation are prohibited from trading bonds and equity with consumers of an unborn generation." (Constantinides et al., 2002: 272)

The authors explore the implications of a borrowing constraint by contrasting the stationary equilibria in the borrowing-constrained and borrowing-unconstrained versions of the economy. If borrowing is constrained, the young cannot borrow against their future earnings from the middle-aged who would like to save, and thus equity is exclusively priced by the middle-aged. The middle-aged hold a diversified portfolio of bonds and stocks in each case.

"A key insight of [their] paper is that as the correlation of equity income with consumption changes over the life cycle of an individual, so does the attractiveness of equity as an asset." (Constantinides et al., 2002: 270) For the young generation looking forward, the correlation of equity income with consumption will not be high, as Davis and Willen (2000) empirical study shows. Therefore equity has hedge value against the fluctuations of uncertain future wage for the young. The middle-aged have their wage uncertainty resolved and will not be receiving retirement wage income, so the fluctuations in their consumption occur from fluctuations in equity income. Correlation of equity income with consumption is high, so that the middle-aged require a higher return to equity than the young do.

With complete markets and no frictions, the young, who have low endowment income and expect higher wages next period, should borrow from the middle-aged, consume a part of the loan and invest the rest in higher return equity. However, "they are prevented from doing so because human capital alone does not collateralize major loans in modern economies for reasons of moral hazard and adverse selection." (Constantinides et al., 2002: 271)

> If the borrowing constraint is relaxed, the young will borrow to purchase equity, thereby raising the bond yield. The increase in the bond yield induces the middle-aged to shift their portfolio holdings from equity to bonds. …. On balance, the effect is to increase both the equity and the bond return while simultaneously shrinking the equity premium. (Constantinides et al., 2002: 271,272)

Furthermore, with the relaxation of the borrowing constraint, the net demand for bonds declines, and the bond return roughly doubles. The borrowing constraint, they argue, goes a long way toward explaining the risk-free rate puzzle.

Pavlov (2006) is a follow-up to Constantinides et al. (2002). Pavlov asserts that there is a problem with the interpretation of the Constantinides et al. (2002) results: it is not clear whether it is the life-cycle or the other sources of market incompleteness that is responsible for the conclusions. According to Pavlov, the economy of Constantinides et al. (2002) is incomplete along a number of dimensions: First, the young face income risks against which they have no insurance. Second, the structure of the economy with the implied time period between trades of 25 years imposes severe limitations on portfolio rebalancing. Finally, for an economy to be dynamically complete the number of independent assets must match the number of uncertainty states. The Constantinides et al. (2002) economy is driven by an exogenous Markov process with four possible states every period, but only two independent assets available. By modifying the asset structure to make insurance markets conditionally complete, [Pavlov (2006)] shows that the asset structure by itself imposes significant restrictions on the composition of available trades, leading to an over-concentration of risks when the borrowing restriction is imposed. (Pavlov, 2006: 156)

3.4.3. Market Segmentation

In an attempt to respond to objections to empirical work done to estimate the size of the equity premium regarding their reliance on consumption data aggregated across stockholding and nonstockholding households, Mankiw and Zeldes (1991) put forward a model with two groups of consumers, stockholders and nonstockholders.

They use 1984 Panel Study of Income Dynamics data "to construct a time series of the consumption of stockholders and a time series of the consumption of nonstockholders". They conclude that "nonstockholding consumers are unlikely to satisfy the first-order conditions for the optimal holding of assets that underlie the Consumption CAPM". (Mankiw and Zeldes, 1991: 98)

Bekaert and Harvey (1995) find evidence of a time-varying world price of risk related to the business cycle, taking market integration into consideration. Haliassos and Bertaut (1995), Brav, Constantinides and Geczy (2002), and Vissing-Jørgensen (2002) are other research efforts worth mentioning in this strand of literature.

3.5 Models Incorporating a Disaster State and Survivorship Bias

Rietz (1988) proposes a solution to the equity premium puzzle that incorporates a very small probability of a very large negative consumption shock. He finds that the equity premium is much larger in such a scenario. The model requires a 1-in-100 probability of a 25% decline in consumption to reconcile the equity premium with a risk aversion parameter of 10. Such a scenario has not been observed in the USA for the years for which we have economic data. One important implication of this model is that the real interest rate and the perceived probability of occurrence of a disastrous event move inversely. But empirically, such inverse movement has not been observed. (Mehra and Prescott, 2003: 920)

Another idea aimed at solving the equity premium puzzle that focuses on survival bias was suggested by Brown et al. (1995). They draw attention to the phenomenon that empirical studies include in their sample only the stocks that survive (i.e., provide return data) throughout the period of study. "In general this conditioning induces a spurious relationship between observed return and total risk for those securities that survive to be included in the sample." (Brown et al, 1995: 853) Also, they note that the US stock market has successfully withstood the financial fluctuations, whereas many other exchanges were unsuccessful and therefore the ex-ante equity premium was low.

> Since it is not known a priori which exchanges would survive, for this explanation to work, stock and bond markets must be differentially impacted by a financial crisis. Governments have expropriated much of the real value of nominal debt by the mechanism of unanticipated inflation. (Mehra and Prescott, 2003: 920)

In financial crises, bonds are as likely to lose value as stocks. Although a survival bias may affect the levels of both the return on stocks and bonds, there is no evidence that these crises have an impact on the equity premium. (Mehra and Prescott, 2003: 921)

3.6 Liquidity Premium

Bansal and Coleman (1996), and Heaton and D. Lucas (1996) have argued that the risk-free rate is low because short-term Treasury bills are more liquid than long-term equities. Short-term debt is "moneylike" in that it facilitates transactions and can be traded at minimal cost. The liquidity advantage of debt reduces its required return and therefore increases the equity premium. Return data of long-term government bonds weaken this argument. Long-term government bonds are not moneylike and the liquidity premium argument implies that they should offer a high return. Yet, historically the term premium has been many times smaller than the equity premium. Moreover, the excess return on stocks over long-term government bonds is as severe a premium as the standard equity premium. (Campbell, 2003: 827)

3.7 Taxes and Regulation

McGrattan and Prescott (2000, 2001) look at whether changes in the tax and regulatory systems in the USA account for the high return on equity for the period 1960-2000. (Mehra and Prescott, 2003: 924) In 1962, debt and not equity could be held tax free. (Mehra and Prescott, 2003: 925)

> The important changes in the legal-regulatory system, most of which occurred in the late 1970s and early 1980s, were that corporate equity was permitted to be held as pension fund reserves and that people could invest on a before-tax basis in individual retirement accounts that could include equity. (Mehra and Prescott, 2003: 925)

> Evidence of the importance of these changes is that the share of corporate equity held in retirement accounts and pension fund reserves increased from essentially zero in 1962 to slightly over 50% in 2000. This is important because it means half of corporate dividends are now subject to zero taxation. (Mehra and Prescott, 2003: 927)

3.8 Irrational Expectations

There is a strand of literature that investigates the results of relaxing the assumption that investors have rational expectations and understand the time-series behavior of dividend and consumption growth. Many of the papers in this area work in partial equilibrium. Examples of papers that assume stocks are priced by discounting expected future dividends at a constant rate are Chow (1989), Barsky and De Long (1993), Barberis, Shleifer and Vishny (1998), Hansen, Sargent and Tallarini (1999), and Cecchetti, Lam and Mark (2000). Modigliani and Cohn (1979), Ritter and Warr (2002) and Sharpe (2003) are papers featuring investors that suffer a failure to understand the difference between real and nominal magnitudes. (Campbell, 2003: 876, 877)

3.9 Stochastic Discount Factors (Pricing Kernel Approach)

Campbell (2003: 807) points out that:

> Shiller (1982), Hansen and Jagannathan (1991), and Cochrane and Hansen (1993), building on the work of Rubinstein (1976), have related the equity premium puzzle to the volatility of the stochastic discount factor, or equivalently the volatility of the intertemporal marginal rate of substitution of a representative investor. Expressed in these terms, the equity premium puzzle is that an extremely volatile stochastic discount factor is required to match the ratio of the equity premium to the standard deviation of stock returns (the Sharpe ratio of the stock market).

According to Cochrane and Hansen (1993), "the predictability of returns is only an anomaly given evidence that this predictability is at odds with the time series behavior of marginal rates of substitution or transformation". "Market frictions can loosen the link between asset markets and measured intertemporal marginal rates of substitution [and transformation] based on aggregate data". (Cochrane and Hansen, 1993: 37) These include short-sale constraints, transaction costs, imperfect markets and borrowing constraints.

A stochastic discount factor is any random variable that satisfies the equality of portfolio prices and expected value of discounted portfolio payoffs, for every portfolio payoff. "One theoretical device for generating a stochastic discount factor from an underlying model is to use the implied intertemporal marginal rate of substitution of consumers in the model". (Cochrane and Hansen, 1993: 8) Therefore, "alternative models can imply differing stochastic discount factors". (Cochrane and Hansen, 1993: 3) Cochrane and Hansen (1993) aim to characterize the properties of the discount factors, through which "models generate asset price predictions", that are consistent with the behavior of asset market data. One conclusion they make is that "A successful discount factor must be either highly correlated with asset returns, or have even higher variance than indicated by the original bounds derived in Hansen and Jagannathan (1991)." Their "second extension used conditioning information to split the unconditional variance of discount factors into two components: on average conditional variance and variation in conditional means." (Cochrane and Hansen, 1993: 55)

CHAPTER 4

CONCLUSION

The EPP is perhaps the most important empirical puzzle that represents the failure of paradigms central to financial and economic modeling to explain the dynamics of asset pricing. Because we base our economic intuition on these frameworks, our understanding of the macroeconomy will be impaired until the EPP gets resolved. The EPP, according to many sources, has not been resolved and continues to challenge financial economists along the lines of research I talked about and definitely on others as well. Kocherlakota (1996: 66, 67) suggests that among the various approaches to explain away the EPP, arbitrage between equities and bonds being ruled out by trading frictions and individuals having a value of the relative risk aversion larger than ten are the more promising. Mehra and Prescott (2003: 911) conclude that none of the research efforts covered in their survey "have fully resolved the anomalies".

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