Heterogeneous Consumption and Asset Pricing in Global Financial Markets

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Abstract

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This dissertation studies the impact of heterogeneous consumption growth rates across countries on cross-country differences in expected asset returns and tests on the country level the implications of the Constantinides and Duffie (1996) CCAPM which accounts for the investors' heterogeneity and existence of incomplete markets. The inclusion of the cross-country dispersion of countries' per-capita consumption growth rates into the standard power utility model has a positive impact on the ability of the model to resolve the risk-free rate, equity premium, and forward premium puzzles. The estimates of the risk aversion parameter are lower, the standard errors are generally smaller, and the time preference parameter decreases towards unity. In addition, the consumption model with heterogeneity leads to a decrease in the estimates of the Hansen and Jagannathan (1997) distance measure for all types of assets and of most average pricing errors. The tests of the beta pricing relation derived from the original model reveal that more realistic parameter estimates and better overall fit of the new model are achieved primarily due to the negative relation between expected asset returns and the covariance of asset returns with the cross-country consumption dispersion.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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Chapter 1

Introduction

Empirical investigation of international financial markets by finance researchers in the last two decades has led to the following two important observations. First, there exist differences in expected returns on similar types of assets traded in different countries.[1] Second, the correlations of consumption growth rates across countries are low.[2]

It is natural to think that these two phenomena are related. There are two possible causes of this relation: global market imperfections and incomplete consumption risk sharing. For example, if investors in one country are unable to freely transact in securities of other countries, they will not be able to fully hedge their home country risk. The inability to hedge country-specific shocks may result in cross-country differences in asset returns and consumption growth rates. Many authors, however (e.g., see Devereux, Gregory and Smith (1992), Backus, Kehoe and Kydland (1992), Obstfeld (1994), and Lewis (1996)), do not find support for the idea that imperfect securities markets are the primary source of low cross-country correlation of consumption growth rates for major

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[1] For example, see Mishkin (1984) and Harvey (1991) for discussions on the cross-country differences in real rates of return and equity returns respectively.

[2] Obstfeld (1994) observes that the integration among most of the industrial countries increased after 1973, but the correlations of consumption growth rates still remain at levels which effectively preclude the mutual insurance against country-specific idiosyncratic risks.

industrial countries. Moreover, Evans and Karras (1997) argue that open markets without frictions can be consistent with a divergence in per-capita consumption across countries. Therefore, it seems plausible that the observed heterogeneity of consumption growth rates across countries is not a result of imperfect security markets but rather driven by incomplete consumption risk sharing, i.e., investors' inability to hedge against country-specific idiosyncratic risks.[3] Since some assets are non-tradable (e.g., human capital, wages, etc.), the composition of investors' portfolios in different countries may be different. As a results, consumption growth rates and expected asset returns across countries may vary.

This paper studies the interrelation between the low correlation of consumption growth rates for major industrial countries and cross-country differences in expected returns for three classes of assets: riskless securities, equities, and currencies. The objective here is two-fold: first, to investigate whether the heterogeneity of consumption growth rates across countries has a measurable impact on the cross-country differences in asset returns, and, second, to test on the country level the implications of the Constantinides and Duffie (1996) Consumption Capital Asset Pricing Model (CCAPM) which accounts for the investors' heterogeneity and existence of incomplete markets. It is of particular interest to look at the impact of consumption heterogeneity on the

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[3] Lewis (1996) presents a different view arguing that low cross-country correlations of consumption growth rates can be explained by the combination of capital market restrictions and nonseparabilities in investors utility function on tradable and nontradable consumption. However, as the author notices, the existence of capital market restrictions does not imply that investors are unable to circumvent them: investors only need to have unrestricted access to a single asset. Telmer (1993) and Heaton and Lucas (1996) provide more discussion on this issue.

resolution of the risk-free rate, equity premium, and forward premium anomalies across countries.[4]

The conclusions of earlier papers on the importance of incomplete markets and individual consumption growth rates for asset pricing was not encouraging. Several authors, most notably Telmer (1993) and Heaton and Lucas (1996) have shown using U.S. panel data on labor income that the outcome of risk allocation in incomplete markets may be very close to that of complete markets. These authors model the idiosyncratic risk of consumption as a transitory event. However, if there are no borrowing and lending constraints, then economic agents can effectively insure themselves against transitory shocks to their consumption. As a result, individual marginal rates of substitution in consumption are equated and the economy becomes similar to that of a representative agent or, equivalently, complete markets.

Contrary to those studies, recent empirical work supports the significance of individuals' consumption in asset pricing. Brav and Geczy (1997) test a simple CCAPM using disaggregate data and find economically reasonable estimates for the relative risk aversion.[5] Storesletten, Telmer and Yaron (1997) show that the idiosyncratic risk in income has not only a transitory but also a persistent component which significantly decreases agents' ability to diversify unsystematic risk. They also point out that the

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[4] The equity premium and the risk-free rate puzzles were first introduced by Mehra and Prescott (1985) and Weil (1989) respectively. For recent reviews of these puzzles see Kocherlakota (1996); for the foreign exchange risk premium puzzle see Engel (1996).

[5] Zeldes (1989) also uses disaggregate data from the Panel Study of Income Dynamics in testing for the importance of liquidity constraints. He finds that the value of the risk aversion parameter implied from the estimates of the personal risk-free rates is between two and three.

idiosyncratic risk, if it exists, should be measured at low frequencies; in fact, this is very convenient in tests with consumption data.

The impact of consumption heterogeneity and incomplete markets on asset pricing is likely to be of greater importance across countries than within a country. There is evidence that risk insurance is less efficient across countries than within a single country, including the U.S. (e.g., see Atkeson and Bayoumi (1993)). Indeed, investors in a given country are less subject to idiosyncratic consumption shocks because of the availability of certain common hedging mechanisms such as unemployment insurance. This type of risk hedging is not readily available across countries, and its absence is likely to induce the world market segmentation.[6] Harvey (1991), for example, finds that countries' sensitivities to the world risk factor cannot fully capture cross-country differences in average returns. Bansal and Dahlquist (1998) find that country-specific attributes such as credit risk, GDP per-capita, and others are more important than the systematic (world portfolio) risk in characterizing the cross-country differences in the currency risk premia. Therefore, the impact of the idiosyncratic risk on asset returns in a multi-country setting is potentially easier to detect than within a framework of a single country economy. Furthermore, international markets provide a good framework for estimating consumption asset pricing models which require disaggregate data, because available data on

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[6] One could possibly reach a similar conclusion based on the papers on 'home bias' such as those of French and Poterba (1991), Tesar and Werner (1995) and others, who provide evidence of insignificant international diversification of portfolio holdings of investors in developed countries. This implies that investors do not hold a globally diversified portfolio and may be subject to idiosyncratic country-specific risks. Note however, that an overinvestment in home equities cannot by itself lead to the cross-country consumption heterogeneity: Lewis (1998) shows that home bias in equities is neither necessary nor sufficient to induce different consumption growth rates across countries. Uppal (1993) finds that the

countries' consumption growth rates can form the basis of the cross-country heterogeneity.

Until now, there is little empirical research on international versions of the CCAPMs.[7] Most notable exceptions are papers by Wheatley (1988), Braun, Constantinides and Ferson (1993), and Campbell (1996) who test different forms of the CCAPMs in the international equity markets, and Mark (1985) and Backus, Gregory and Telmer (1993) who test the CCAPMs in the foreign currency markets. The apparent scarcity of such studies can be primarily attributed to the belief that the CCAPMs, which perform quite poorly on the U.S. data alone, would likely shed no additional light on the cross-country variation in asset pricing. Note that all previous papers in this area assume complete markets, that is, a representative agent economy. However, if incomplete risk sharing across countries is important, a non-representative agent CCAPM, may have the potential to perform better in explaining the cross-country than within-a-country differences in asset returns.

If markets are incomplete then the aggregation in the Constantinides (1982) sense is impossible.[8] Therefore, the Constantinides and Duffie (1996) model which, permits consumption heterogeneity across investors but nevertheless results in a closed form expression for the aggregate pricing kernel, suits the required setting well.

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reverse also holds; that is, a bias in consumption towards domestic goods within each country cannot lead to the high proportion of domestic securities in investors' portfolios.

[7] Stulz (1981) develops theoretically the international consumption based asset pricing model in complete markets. As a result, he attributes the low correlation of real consumption growth rates across countries not to the imperfect consumption risk-sharing but to different consumption opportunity sets.

Constantinides and Duffie assume that economic agents may experience persistent shocks to their consumption streams and show that under this assumption the heterogeneity of consumption growth across investors has important implications for asset pricing. They include the cross-sectional variance of individuals' consumption growth rates into the standard power utility CCAPM and argue that such a model may lead to more realistic estimates of the risk aversion parameter.

I estimate the extensions of the Constantinides and Duffie (1996) model applied at the country level for international money, equity, and foreign exchange markets under the assumptions of perfect global financial markets but incomplete consumption risk sharing across countries. I utilize the conditional asset pricing methodology and test the model using Hansen's (1982) Generalized Method of Moments (GMM). To compare the performances of the CCAPM with and without consumption heterogeneity, I also look at the characteristics of the implied pricing kernels and use the Hansen and Jagannathan (1997) distance measure for additional diagnostics.

The results show that: (i) theoretical implications of the CCAPM with heterogeneity are generally supported in the data; (ii) in its influence on asset pricing, the cross-country consumption heterogeneity is different from the variance of the world consumption growth; (iii) international markets simplify an empirical exploitation of the relation between consumption heterogeneity and cross-country differences in asset returns. I find that the inclusion of the cross-country dispersion of countries' per-capita

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[8] Constantinides (1982) shows that if investors have time-additive von Neumann-Morgenstern utility function and the derived utility of wealth is state-independent, then the complete market equilibrium results even without the assumption of homogeneity in their investors' preferences.

consumption growth rates into the standard power utility model has a positive impact on the ability of the model to resolve the risk-free rate, equity premium, and forward premium puzzles. The tests of the beta pricing relation derived from the original model reveal that more realistic parameter estimates and better overall fit of the new model are achieved primarily due to the negative relation between the expected asset returns and the covariance of asset returns with the cross-country consumption dispersion.

The remainder of the dissertation is organized as follows. Chapter 2 describes the Constantinides and Duffie (1996) model and extends it to an international setting.[9] In this chapter, I also discuss the implication of the model within the beta pricing framework and the potential ability of the model to resolve the risk-free rate, equity premium, and forward premium puzzles of the standard CCAPM. Chapter 3 describes the data, construction of the world consumption growth rate, cross-country dispersion of consumption growth rates and other variables and presents the summary statistics. Chapter 4 outlines the GMM procedures for three test specifications of the new model as well as its beta pricing formulation. Chapter 5 gives the preliminary test results on the business cycle properties for the new CCAPM and estimates of consumption growth and dispersion betas. The main test results are reported in chapter 6. In chapter 7, I construct the world consumption variance measure and compare it with the cross-country consumption dispersion to determine whether the two series are different in terms of their impact on asset returns. Chapter 8 makes the concluding remarks.

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[9] Ramchand (1993) extends the Constantinides and Duffie (1996) model theoretically to the two country, two-good framework and, using a calibration exercise, shows that accounting for the variability of

Chapter 2

The Model and Its Implications

Chapter 2 describes the Constantinides and Duffie (1996) model and extends it to the international setting. In this chapter, I also discuss the implications of the model in view of the beta pricing formulation and compare *a priori* the ability of the model to resolve the risk-free rate, equity premium, and forward premium puzzles of the standard CCAPM.

THE CONSUMPTION MODEL WITH HETEROGENEITY

The standard canonical asset pricing relation has the following form:

$$E_t\left[m_{t+1}R_{j,t+1}\right]=1, \qquad (2.1)$$

where $R_{j,t+1}$ is the real rate of return (plus one) to an investor from holding an asset *j* one period and m_{t+1} is the pricing kernel or the stochastic discount factor. In the intertemporal consumption-based asset pricing model of Lucas (1978), for example, each risk-averse investor has the same preferences and is seeking to maximize his life-time utility of consumption:

consumption in the CCAPM can lead to a better performance of the model. However, Ramchand's work does not include a direct empirical analysis of the model.

$$U(C) = \underset{C_t}{Max}\, E_0\left[\sum_{t=0}^{\infty} \rho^t u(C_t)\right],$$

where ρ ∈(0, 1), is the parameter of time preference (pure time discount factor). Within the framework of CCAPM, the pricing kernel m_{t+1} is equivalent to the intertemporal marginal rate of substitution in consumption (IMRS). In equilibrium, the Euler condition (2.1) establishes the relation between IMRS and the rate of return. If one further assumes that investors' preferences are expressed by the standard power utility function with risk aversion (concavity) parameter γ , then equation (2.1) becomes[10]:

$$\rho E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} R_{j,t+1}\right] = 1 . \qquad (2.2)$$

The Constantinides and Duffie (1996) Model

Constantinides and Duffie (1996) consider a model where investors have heterogeneous consumption growth patterns and relax the pricing kernel restriction on IMRS, namely,

$$m_{t+1} \geq \rho\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} .$$

This inequality says that the pricing kernel at any time *t*+1 is greater than the discounted IMRS in aggregate consumption from time *t* to time *t*+1. In other words, the current price of a given security that promises to pay $1 one-period from now may be higher than that implied by the marginal rate of substitution in aggregate consumption alone. This transforms the Euler equation (2.2) into an inequality:

$$\rho E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} R_{j,t+1}\right] \le 1 . \qquad (2.3)$$

Unlike the Euler equality (2.2), the Euler inequality (2.3) is a weaker relation between the marginal rate of substitution in consumption and asset returns.[11]

Constantinides and Duffie (1996) express the consumption of investor *i* at time *t* as $C_{i,t} = \delta_{i,t} C_t$, where $\delta_{i,t}$ is the proportion of aggregate consumption of investor *i*. The proportion $\delta_{i,t}$ is specified as follows:

$$\delta_{i,t} = \delta_{i,t-1} \exp\left(\eta_{i,t}\sqrt{d_t^w} - \frac{d_t^w}{2}\right),$$

where $\eta_{i,t} \sim N(0,\ 1)$ is the standard normal variable which denotes investor *i*'s consumption shock at time *t*, d_t^w is the cross-sectional variance of consumption growth among investors within a given country at time *t*, and $\eta_{i,t}$ and d_t^w are independent across all investors and time. The cross-sectional variation of individual investors' consumption growth, d_t^w is defined as:

$$d_t^w = Var\left[\ln\left(\frac{C_{i,t}}{C_{i,t-1}}\right)\right].$$

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[10] The utility function expressed above belongs to the class of time-separable functions for which the parameters of concavity and risk aversion are equivalent.

[11] He and Modest (1995) and Luttmer(1995) use condition (2.3) in testing the CCAPM with different market frictions.

Constantinides and Duffie (1996) then prove that private valuation of securities by heterogeneous investors under these conditions becomes equivalent to the prevailing market price; that is, prices aggregate. The new Euler equation takes the following form:

$$\rho E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[\frac{\gamma(\gamma+1)}{2}d_{t+1}^{w}\right]R_{j,t+1}\right]=1\,. \qquad (2.4)$$

Extension of the Constantinides and Duffie Model to a Cross-Country Setting

Within the scope of international asset pricing, the heterogeneity of investors' consumption may arise due to not only within-country but also cross-country differences in consumption growth rates. Different consumption growth rates across countries in effect imply that investors are unable to perfectly hedge themselves against single-country consumption shocks. We assume that financial markets of all countries are open but not complete. In other words, although investors in each country can freely trade in equities and riskless securities of other countries and engage in currency speculation, the set of all available assets is not sufficient to ensure a full consumption insurance. In this framework, C_t will denote the world aggregate consumption growth, while $C_{i,t}$ -- the consumption growth in country *i* at time *t*. Therefore, relation (2.4) will no longer be valid in the setting of global markets: under the assumption of no segmentation in the world capital markets (perfect integration is not necessary), asset returns in any country will be affected by not only within-country idiosyncratic consumption shocks but also cross-country.

Denote $d_{i,t}^{w}$ the consumption dispersion within country *i* (i.e., the heterogeneity of individuals' consumption growth rates in country *i*) at time *t*, $R_{i,t}$ the country *i* return on a particular type of asset at time *t*. Assuming that within country consumption dispersion is the same in all countries, i.e., $d_{i,t}^{w} = d_{t}^{w}$, one can obtain the new Euler equation:

$$\rho E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left(\frac{\gamma(\gamma+1)}{2}\left(d_{t+1}+d_{t+1}^{w}\right)\right)R_{i,t+1}\right]=1, \qquad (2.5)$$

where d_{t+1} denotes the cross-country dispersion of consumption growth rates.[12] Thus, the Euler equation (2.5) relates asset returns to consumption growth as well as the measures of the within-country and cross-country consumption heterogeneity.

Operational Formulations of the Model

While d_{t+1} can be obtained relatively easy for developed countries, measuring d_{t+1}^{w} is a more formidable task even for major industrialized nations. Therefore, restricting the total consumption heterogeneity to be expressed only through the cross-country consumption dispersion as $d_{t+1} + d_{t+1}^{w} = kd_{t+1}$, one can write (2.5) as follows:

$$\rho E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left(Kd_{t+1}\right)R_{i,t+1}\right]=1, \qquad (2.6)$$

where $K = 0.5k\gamma(\gamma+1)$ and $k = 1 + E\left[d_t^{w}/d_t\right]$. The time-invariant parameter *k* can be thought of as one plus the unconditional expected ratio of the consumption growth dispersion within-a-country relative to the cross-country consumption growth dispersion. Several values of *k* are of particular interest. When *k* = 1, it is convenient to think about the existence of a representative agent for each country *i*; that is, $d_{i,t}^{w} = 0$ for each *i* and model (2.6) essentially collapses to (2.4). The *k* = 2 case is equivalent to the assumption that $d_{i,t}^{w} = d_t$ for each country *i*; that is, to the situation when consumption dispersion is similar both within each country and across countries. In general, I implicitly account for the within-a-country consumption heterogeneity across all countries if $k > 1$. For example, $k = 1.5$ means that the relative consumption dispersion within each country is twice less than the cross-country consumption dispersion. Finally, if $d_t = 0$ for all *t*, then I arrive to the standard CCAPM framework, i.e., model (2.2).

Notice that the cross-country variation of consumption growth rates cannot be fully observable since the consumption data are available only for a limited set of countries. For instance, there is omitted cross-country variation can be attributed to the emerging market economies that are not in the data set. Therefore, it seems quite possible that the true world consumption dispersion is greater than the measure that can be obtained from the actual data.[13] This may justify the possibility of having values of *k* greater than two as well. I show below that the cross-country consumption dispersion increases dramatically during economic downturns. This implies that the higher values of *k* lead primarily to an increase in the influence of consumption dispersion on asset prices in the recession periods.

BETA PRICING FORMULATION

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[12] Appendix A provides a detailed derivation of equation (2.5).

[13] The average magnitude of the world consumption dispersion may not only increase but also decrease with the addition of consumption growth data from more countries. However, the data from a larger set of countries will most likely increase the world consumption dispersion during economic downturns -- precisely those periods when the impact of dispersion on asset prices should be the largest.

Following Hansen and Singleton (1983), Rotemberg (1984), Campbell (1993) and others, I assume that the joint conditional distribution of consumption growth and asset returns is lognormal but not necessarily homoskedastic. For simplicity I extend this assumption to consumption dispersion as well.[14] Then one can take the lognormal approximation of equation (2.6) for some risky asset *i* and a risk-free asset. The difference in the lognormal approximations will yield the following linear conditional asset pricing relation:

$$E_t\left[r_{i,t+1}\right] - r_{rf,t+1} = -0.5\sigma^2_{i,t} + \gamma\sigma_{ic,t} - K\sigma_{id,t}.$$ [15]

In this equation, $r_{i,t+1}$ and $r_{rf,t+1}$ are the logarithmic returns at time t+1 for asset *i* and risk-free asset respectively, $\sigma^2_{i,t} = Var_t\left(r_{i,t+1}\right)$ is the conditional variance of return *i*, $\sigma_{ic,t} = Cov_t\left(r_{i,t+1}, c_{t+1}\right)$ and $\sigma_{id,t} = Cov_t\left(r_{i,t+1}, d_{t+1}\right)$ are the conditional covariances of asset returns with consumption growth and consumption dispersion respectively, while $c_{t+1} = \ln\left(C_{t+1}\right) - \ln\left(C_t\right)$. This equation is equivalent to the following conditional beta-pricing relation:

$$E_t\left[r_{i,t+1}\right] - r_{rf,t+1} = \lambda_{0,t} + \lambda_{c,t}\beta_{i,c,t} - \lambda_{d,t}\beta_{i,d,t}, \qquad (2.7)$$

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[14] More precisely, I distinguish here between the distributional properties of d_t and $\exp(d_t)$.

[15] The lognormal approximation for the riskless asset is:

$$r_{rf,t+1} = -\log\rho + \gamma E_t c_{t+1} - KE_t d_{t+1} - 0.5\left(\gamma^2\sigma^2_{c,t} + K^2\sigma^2_{d,t} - 2K\gamma\sigma_{cd,t}\right),$$

while for the risky asset *i*:

$$r_{i,t+1} = -\log\rho + \gamma E_t c_{t+1} - KE_t d_{t+1} - 0.5\left(\sigma^2_{i,t} + \gamma^2\sigma^2_{c,t} + K^2\sigma^2_{d,t} - 2\gamma\sigma_{ic,t} + 2K\sigma_{id,t} - 2K\gamma\sigma_{cd,t}\right).$$

The resulting equation then follows.

where $\lambda_{0t} = -0.5\sigma_{i,t}^2$ is the Jensen's inequality term, $\lambda_{c,t} = \gamma\sigma_{c,t}^2$ and $\lambda_{d,t} = K\sigma_{d,t}^2$ are the time-varying coefficients which can be thought of as prices of risk for consumption growth and consumption dispersion respectively; $\sigma_{c,t}^2$ and $\sigma_{d,t}^2$ are the conditional variances of consumption growth and dispersion.[16] In this equation, $\beta_{i,c,t} = \sigma_{ic,t} / \sigma_{c,t}^2$ is the well-known consumption growth beta similar to that in Breeden (1979), while the new ratio, $\beta_{i,d,t} = \sigma_{id,t} / \sigma_{d,t}^2$, will be called the consumption dispersion beta. From equation (2.7) one can infer that due to the positive premium on consumption beta, an asset whose covariance with consumption growth is high will have a higher expected return than an asset whose covariance with consumption growth is low. However, due to the negative premium on dispersion beta, the relation of an asset's return with consumption dispersion beta has the opposite pattern; that is, an asset whose covariance with consumption dispersion is high will have a lower expected return than an asset whose covariance with consumption dispersion is low. Note that equation (2.7) is in the spirit of asset pricing models of Merton (1973) and Ross (1976). In this specification, the excess return on any asset *i* is determined by its covariance with two state variables -- consumption growth and its cross-sectional variation.

An alternative way of interpreting relation (2.7) is in terms of the types of risks that investors face. Investors are rewarded only for taking the risks which they don't like, i.e., which covary negatively with their marginal utility. That is, investors will demand

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[16] The implicit assumption in equation (2.7) is that the correlation between consumption growth and dispersion is zero; otherwise multiple regression betas should be used and the risk premiums, λ_c and λ_d, are transformed accordingly.

more compensation for taking a long position in a risky asset if it promises a higher return when the expected marginal utility of consumption is low and lower return when the expected marginal utility is high. However, investors will require less compensation if an asset's return is expected to be higher when the expected marginal utility of consumption is high and lower when the expected marginal utility is low.

Figure 2.1 helps visualize this logic.[17] Plot A depicts the standard power utility function of consumption, $U(C)$, so that $U_c(C) > 0$, $U_{cc}(C) < 0$ (diminishing marginal utility), and $U_{ccc}(C) > 0$ (decreasing absolute risk aversion). Plot B graphs the marginal utility of consumption, $U_c(C)$. Suppose the economy consists of two agents with equal weights in the social planning problem each of which consumes C_0. Then the aggregate marginal utility of consumption is $U_c(C_0)$. If the first agent's consumption is reduced by q, while the second one's is increased by q, the aggregate marginal utility is $0.5U_c(C_0-q) + 0.5U_c(C_0+q) > U_c(C_0)$. That is, the aggregate marginal utility of consumption increases in the cross-sectional variance of consumption. As a result, the higher an asset's beta with respect to consumption dispersion, the more of the asset's payoffs occur in high-valued states; thus, the *lower* its equilibrium expected rate of return.

IMPLICATIONS

Under certain conditions, the model described by equation (2.6) may be superior to the standard CCAPM from the perspective of resolving the risk-free rate, equity premium, and forward premium puzzles.

The Risk-Free Rate Puzzle

The risk-free puzzle can be formulated as follows: the observed average real consumption growth rates are substantially higher than the average real return on short-term riskless securities. Taking the lognormal approximation to the standard CCAPM, model (2.2), for some riskless asset yields:

$$r_{rf,t+1} = -\log\rho + \gamma E_t c_{t+1} - 0.5\gamma^2 \sigma^2_{c,t},$$

where $\sigma^2_{c,t}$ is the conditional variance of log consumption growth. Since the variation of consumption growth, $\sigma^2_{c,t}$, is small and, on average, $r_{rf,t+1} < E_t c_{t+1}$ in the U.S. and many other countries (e.g., see Campbell (1996)), the only way to match the observed low rate of real return on a risk-free security $\gamma > 1$, is to have the time preference parameter ρ greater than unity. In economic terms the negative rate of time preference implies that investors are unwilling to borrow from the future to smooth their consumption growth rates. This contradicts the standard power utility paradigm under which investors must have a great desire to substitute consumption intertemporally.

To understand what impact the CCAPM with heterogeneity may have on the resolution of this phenomena, let's now take the lognormal approximation of equation (2.7) for some riskless asset. After rearranging the terms, I obtain:

$$r_{rf,t+1} = -\log\rho + \gamma E_t c_{t+1} - K E_t d_{t+1} - 0.5\left(\gamma^2\sigma^2_{c,t} + K^2\sigma^2_{d,t} - 2K\gamma\sigma_{cd,t}\right), \quad (2.8)$$

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[17] See also Breeden (1979, 1986) for the intuition on the positive risk premium on consumption growth beta.

where $\sigma^2_{d,t}$ is the conditional variance of consumption dispersion and $\sigma_{cd,t}$ is the conditional covariance between consumption growth and dispersion. Equation (2.8) has three additional terms: two of them, namely, $KE_t d_{t+1}$ and $0.5K^2\sigma^2_{d,t}$ are always positive, while the third term, $K\gamma\sigma_{cd,t}$, can in principle be positive or negative.[18] If $\sigma_{cd,t} < 0$, then all three terms enter equation (2.8) with negative signs. If $\sigma_{cd,t} > 0$, then as long as the condition $KE_t d_{t+1} + 0.5K^2\sigma^2_{d,t} > \left|K\gamma\sigma_{cd,t}\right|$ holds, model (2.6) should outperform the traditional model (2.2) in explaining the risk-free rate puzzle. The economic intuition for the lower risk-free rate in this model can be described as follows. Investors desire to borrow intertemporally increases because now they are willing to smooth out not only their own consumption growth but also the variation of consumption growth rates among themselves. As figure 2.1 illustrates, the existence of cross-sectional differences in consumption among investors always increase the expected marginal utility of consumption and therefore increase the demand (prices) for riskless securities pushing the risk-free interest rate down. Thus, the average risk-free rate predicted by model (2.6) will be lower than that based on the standard CCAPM.

The Equity Premium Puzzle

The essence of the equity premium puzzle in the standard CCAPM framework is that with economically plausible values of the risk aversion (say less than 10), the difference in volatility between stocks and riskless securities is not sufficient to lead to the observed large discrepancy between their corresponding average returns. This

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[18] I show below that dispersion in consumption growth and aggregate consumption growth are inversely

phenomenon is due to the fact that consumption growth is mush less volatile than equity returns and its covariance with stock returns is small. Campbell (1996) shows that the equity premium puzzle can be observed in many countries.

To illustrate the point, consider an artificial case when consumption growth is zero and ρ = 1 (no pure time discount). Then, in order for equation (2.2) to be valid, the expected return on equity must be zero as well. In reality, the average quarterly gross growth rate of per-capita consumption is around 1.005, while the average gross equity return for the countries considered in this paper is around 1.019. As a result, the risk aversion parameter, γ, must be large to make equation (2.2) work, i.e., to equate the inverse of consumption growth to the equity return. In other words, if investors are not implausibly risk averse, the equity premium puzzle can be characterized as a finding:

$$E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} R^{ex}_{i,t+1}\right] > 0\,,$$

where $R^{ex}_{i,t+1}$ is the excess return on asset *i* at time *t*+1. Thus, model (2.6) will perform better than model (2.2) as it relates to the equity premium puzzle if the following condition should hold:

$$E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \left(\exp\left(Kd_{t+1}\right) - 1\right) R^{ex}_{i,t+1}\right] < 0\,, \qquad (2.9)$$

Since $\left(\exp\left(Kd_{t+1}\right) - 1\right) \geq 0$ for any $k > 0$, then clearly $\left(\exp\left(Kd_{t+1}\right) - 1\right) R^{ex}_{i,t+1} \geq 0$ if $R^{ex}_{i,t+1} \geq 0$, and $\left(\exp\left(Kd_{t+1}\right) - 1\right) R^{ex}_{i,t+1} \leq 0$ if $R^{ex}_{i,t+1} \leq 0$ for any asset *i*. Taking the lognormal

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related; evidence for the U.S. is also provided by Storesletten, Telmer and Yaron (1997).

approximation to inequality (2.9) and, after rearranging the terms, I obtain the following restriction:

$$\sigma_{id,t} < -\left(E_t d_t + 0.5K\sigma_{d,t}^2 - \gamma\sigma_{cd,t}\right). \tag{2.10}$$

This is approximately the inequality (2.9). The first two terms on the right-hand-side of this inequality are strictly positive, while the sign of the third conditional term, $\sigma_{cd,t}$, can in be positive or negative. Fixing $\sigma_{d,t}^2$ and $\sigma_{cd,t}$ to constants allows one to see that the higher the consumption dispersion, the stronger is the negative conditional covariance between it and excess returns. On the other hand, excess returns are positive when d_t is small while $\sigma_{cd,t}$ is positive. Therefore, in economic terms, inequality (2.10) implies that the cross-country dispersion of consumption growth must be higher at those times when excess returns are negative while lower dispersion coincides with large excess returns. Excess returns on equities become small and even negative during recessions and, as data shows, the magnitude of dispersion increases in economic downturns. Indeed, in the new model, one can associate recession periods with an increase in uncertainty of consumption that investors face along two dimensions. First is with respect to the level of consumption, second - the cross-sectional distribution of consumption. In this setting, investors are more willing to reallocate their portfolios towards riskless securities than when they face uncertainty in the level of consumption alone. As a result, returns on equities may decrease below those on riskless claims making excess returns negative. Thus, the new model may be able to provide more reasonable parameters of the risk aversion coefficient.

The Forward Premium Puzzle

The forward premium puzzle consists of two separate phenomena. The essence of the first one is similar to a conditional version of the equity premium puzzle; that is, studies find large and variable conditional risk premia in the forward currency markets. However, unlike equity returns, the average speculative returns (unconditional risk premiums) in forward currency markets are approximately zero.

To produce higher risk premiums, a model must generate a more variable IMRS or a higher covariance between IMRS and currency returns or both. Since $\exp(Kd_{t+1}) \geq 1$ for any positive risk aversion and k and, as data below suggest, $\left(C_{t+1}/C_t\right)^{-\gamma}$ and $\exp(Kd_{t+1})$ are not perfectly negatively correlated, model (2.6) will produce higher conditional variation of IMRS than the standard CCAPM. Furthermore, cross-country variation in consumption has a sizable correlation with most of the returns from speculation in foreign exchange markets. This should also produce a higher conditional covariance between IMRS and those returns. As a result, the time variation of risk premium can now be attributed to both the time variation of the world consumption growth and cross-country consumption dispersion. In other words, the observed highly variable conditional currency risk premium (positive or negative) in the new model is driven by investors' expectation that the foreign currency they hold may change its value relative to the domestic currency due to its sensitivity to changes in not only world consumption but also cross-country distribution of consumption. Therefore, I can expect that the CCAPM with heterogeneity will outperform the standard model in resolving this part of the forward premium puzzle.

The second phenomenon is that the forward premium is a very good predictor of future profits in the foreign exchange market.[19] Finding a plausible answer to the second part of the forward premium puzzle was believed to be more difficult. However, as Bansal (1997) and Bansal and Dahlquist (1998) show, this aspect of the puzzle manifests itself neither across all countries nor through the entire period of floating exchange rates. The authors relate this side of the puzzle to the existence of country specific idiosyncratic risks.

WEALTH BASED DISPERSION MEASURE

The assumption of non-diversifiable shocks to consumption is the main point in the Constantinides and Duffie (1996) model. In light of this, it is interesting to see whether permanent shocks to investors' wealth, which is defined as the sum of the present value of their income and portfolio holdings, can potentially lead to an alternative dispersion measure based on wealth rather than consumption.

Let's assume that the fundamental envelope relation between the marginal utility of consumption and the derived utility of wealth, $U_c = J_w$, holds in the Constantinides and Duffie (1996) model. It is also important in the that model that an investor's utility function of consumption satisfies the following two conditions: $U_{cc} < 0$ and $U_{ccc} > 0$. Therefore, an alternative empirical model may be possibly constructed if the second and third derivatives of the derived utility of wealth also have the similar signs. The second derivative of the utility of wealth, $J_{ww} = U_{cc}C_w < 0$, since C_w is positive. Then,

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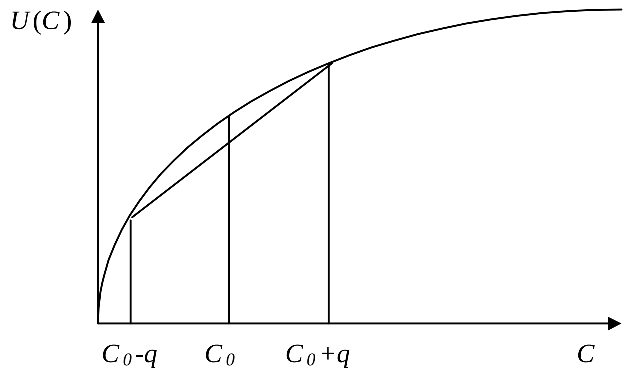
[19] For earlier evidence on predictability of returns in forward currency markets see papers by Bilson (1981),

$$J_{www} = U_{ccc}\,(C_w)^2 + U_{cc}C_{ww}.$$

The first term in this equation is positive. Since $U_{cc} < 0$, $J_{www} > 0$ if $C_{ww} < 0$. Is it plausible that C_{ww} is negative? Yes, because condition $C_{ww} < 0$ implies that as wealth increases, the sensitivity of consumption to wealth decreases.

Having the aforementioned signs on the second-, and third-order derivatives of the derived utility of wealth is a necessary but not sufficient condition for the wealth-based model to perform similar to the Constantinides and Duffie consumption based model. Another important condition is to specify that investors experience independent but persistent shocks to their wealth. Since the wealth is defined as the value of income plus portfolio holdings, and income shocks have a persistent component, wealth shocks also may have permanent effect on investors' future wealth. However, in spite of the apparent simplicity of this analysis, the detailed derivation and estimation of the wealth based asset pricing model is left for future research.

Cumby (1988), Fama (1984), and Hodrick and Srivastava (1984) among others.



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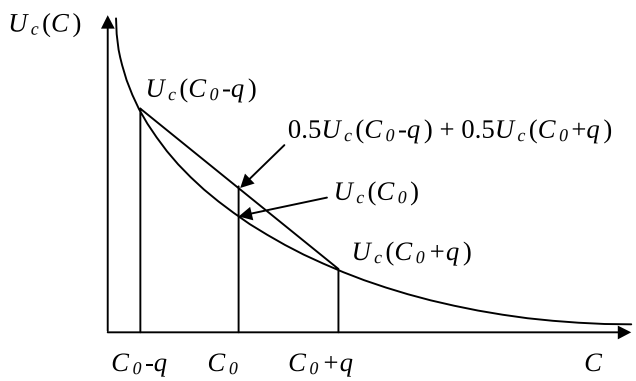

B

Figure 2.1. The Effect of Consumption Dispersion on Marginal Utility. Plot A depicts the utility function of consumption, $U(C)$ with $U_c > 0$ and $U_{cc} < 0$; Plot B - the marginal utility of consumption, $U_c(C)$ with $U_{cc} < 0$ and $U_{ccc} > 0$. If the economy consists of two agents with equal weights in the social planning problem each of which consumes C_0, the aggregate marginal utility is $U_c(C_0)$. If one agent's consumption is reduced by q, while the other's increased by q, the aggregate marginal utility is $0.5U_c(C_0\text{-}q) + 0.5U_c(C_0+q) > U_c(C_0)$.

Chapter 3

Data and Summary Statistics

DATA

The sampling interval of the data is quarterly and the data covers a period from 1973:2 to 1995:4, i.e., 91 observations. The global markets considered in this paper include financial markets of eight developed countries: Canada, France, Germany, Italy, Japan, Switzerland, the United Kingdom, and the United States, with the latter being the domestic (numeraire) country.

It is assumed that the global investor regards the U.S. financial market as domestic. Two types of riskless returns are considered. The first one is the U.S. Treasury bill return which is the nominal quarterly return to rolling over one month bills from *Ibbotson Associates*. The real quarterly T-bill return is obtained by deflating it with inflation rate. For this purpose, I use the quarterly Consumer Price Index (CPI) from *Ibbotson Associates*. The second one is the world risk-free return (WRF), which is the GDP-weighted average of countries' returns on riskless securities. These international money market rates are first compounded over the quarter for each country from the monthly one-month Eurocurrency rates reported in the *Harris Bank Weekly Review* (HBWR) and then deflated by the corresponding quarterly inflation rates from

Datastream.[20] Notice that I do not transform countries' risk-free rates of return into U.S. dollars because their variability is much lower than that of exchange rate changes. (In this regard, more intuition can be found below where I discuss the construction of the world consumption growth data.)

National stock market returns are the U.S. dollar denominated monthly returns obtained from *Data Resource Incorporated* (DRI). The U.S. dollar denominated quarterly gross stock market returns are obtained by compounding monthly returns over the quarter. The quarterly excess return for each country is the difference between the quarterly stock market return in that country and the corresponding three-month U.S. Treasury bill return.

The exchange rates used are Canadian Dollar, French Franc, German Mark, Italian Lira, Japanese Yen, Swiss Franc, and British Pound, all of which are relative to the U.S. dollar. The spot and one-month forward exchange rates are for the last Friday of the month and correspond to the HBWR quotes. The monthly one-month forward market return at time *t*+1 for country *i* is computed as $\left(S_{i,t+1} - F_{i,t}\right)/S_{i,t}$, where $S_{i,t}$ and $S_{i,t+1}$ are the spot exchange rates at time *t* and *t*+1 respectively between the U.S. dollar and one unit of currency *i*, $F_{i,t}$ is the forward exchange rate for a unit of currency *i* prevailing at time *t*, i.e., one month ago.[21] The forward premium on currency *i* is $\left(F_{i,t} - S_{i,t}\right)/S_{i,t}$, or

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[20] The HBWR starts reporting the Eurocurrency rates for Japan since 1975. To fill this gap, during 1973-1975, I use the call money rates from the International Monetary Fund.

[21] Bekaert and Hodrick (1993) argue that to correctly find the return on a forward contract one must take into account transactions costs induced by the bid-ask spread and subtract the ask price in the current

simply a ratio of the monthly one-month forward rate to the spot rate both observed at time *t*. The quarterly forward premia and foreign currency returns are obtained by compounding the corresponding monthly values over the quarter.[22] In the estimation that follows, the world measure of forward premium (WFP) is an equally weighted average of the corresponding forward premia in separate currency markets. Finally, since foreign exchange market returns are denominated in U.S. dollars, again the U.S. CPI data is used to obtain real returns.

CONSTRUCTION OF CONSUMPTION MEASURES

The seasonally adjusted real aggregate consumption data for all eight countries are from the *National Accounts*. To arrive at the per capita consumption in local currency units, the aggregate consumption for each country is divided by the quarterly population estimates. These estimates are obtained by linearly interpolating annual mid-year population figures as reported in *Datastream*. After obtaining the real per-capita consumption growth for all eight countries expressed in their local currency units, the world per-capita consumption growth rate is constructed as the GDP-weighted average of all real per-capita consumption growth rates. This construction is motivated by the following considerations. If national consumption data are expressed in U.S. dollars, then, since the volatility of consumption growth rates is much lower than that of exchange rates, the time-series properties of the changes in consumption will be dominated by the

forward market from the bid price in the future spot market. However, they found that the measurement error caused by this problem is extremely small in quarterly data.

changes in corresponding exchange rates. On the other hand, it is impossible to meaningfully aggregate consumption data expressed in different currency units. The aggregation of the national consumption growth rates rather than levels helps resolve these problems. The consumption growth rates, unlike consumption levels, are unitless. Nevertheless, the aggregation must somehow reflect the relative wealth distribution across countries. By taking the U.S. dollar denominated GDP weights of all countries considered in this paper, one can attach more weight to the consumption growth of the countries with higher GDP and less weight to those with lower GDP. Thus, the exchange rate fluctuations affect the world consumption growth only indirectly -- through the U.S. dollar denominated GDPs.[23]

The cross-country dispersion of the real per-capita consumption growth is calculated as the variance of the logarithmic changes in the real national per-capita consumption growth rates expressed in local currency units, i.e., without any weighting scheme. Figure 3.1 shows the time series of the quarterly real world per-capita

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[22] I do not use end-of-quarter exchange and forward rates because all available consumption data is averaged over the quarter.

[23] The method of constructing some world growth measure as a GDP-weighed average of the countries' corresponding growth rates was used in the literature before. Harvey (1990), for example, applies a similar technique to the construction of the world GDP measure. The method is justified by the fact that the purchasing power parity across countries does not hold in the short-run, although it may still hold in the long-run. In other words, a monetary shock has an immediate effect on exchange rate but a delayed yet a persistent effect on output, investment, and consumption. This implies that capital markets adjust much faster than commodities market to the exchange rate changes (see Dornbusch (1976)). Dumas (1992) also argues that in spite of the mean reversion in nominal prices across countries, the conditional probability of the price moving from the parity of unity is greater than the probability of it moving toward unity. Therefore, expressing quarterly consumption data from all countries in U.S. dollars and then aggregating them produces a measure completely irrelevant to the actual world consumption growth. The usage of a single currency would be more appropriate with much lower frequency economic data. Notice finally that the assumption of perfect integration of financial markets made earlier does not contradict the apparent segmentation (at least in the short-run) of the goods markets.

consumption growth (WCG) and the logarithmic transformation of the cross-country dispersion of the real per-capita consumption growth (WCD). For comparison purposes, it also depicts the U.S. per-capita consumption growth.[24] These plots illustrate that WCD tends to be higher when WCG is low and vice versa. For example, three largest peaks of the WCD occur within the periods of world-wide recessions of 1973-1975, 1980-1981, and at the beginning of nineties. The observed rather strong inverse relation between the cross-country dispersion in consumption growth and the world consumption growth rates coincides with the intuition of Mankiw (1986), Constantinides and Duffie (1996), Storesletten, Telmer and Yaron (1997), and Cochrane (1998). All these authors point out that idiosyncratic risk may have a measurable impact on the equity premium only if it depends on aggregate shocks.

SUMMARY STATISTICS

Table 3.1 reports the summary statistics of the data, including mean, standard deviation, minimum and maximum values, autocorrelations, and the Jarque-Bera statistics for normality. Panel A provides these statistics for the WCG, WCD, real quarterly U.S. Treasury bill, and the world risk-free return (WRF). In the table, the reported WCD measure, constructed based on chapter 2 definition of dispersion, has been transformed logarithmically. The first and second moments for the WCG, the mean growth rate of 0.0049 and standard deviation of 0.0057 are not surprisingly close to the corresponding

[24] The world consumption growth, being an averaged measure, is "smoother" than the consumption growth in the U.S. alone. Therefore, it would be more difficult to explain the equity premium in the U.S. based exclusively on the world consumption growth data.

values for the U.S. data, 0.0041 and 0.0069 respectively. Another noticeable feature of this panel is the relatively large third-order autocorrelation for the WCG series. A similar pattern of relatively small first- and second-order autocorrelations and a larger third-order autocorrelation on the U.S. data is observed by Ferson and Harvey (1992) in the seasonally adjusted consumption growth for nondurable goods. As for the WCD, its largest autocorrelation of about 0.4 is the first one. Panels B and C give descriptive statistics for the nominal U.S. dollar denominated national excess stock market returns for all eight countries and speculative returns in the forward currency markets respectively. Panel B shows that the excess returns for Italy and the United Kingdom are quite skewed. Overall, as expected, the amount of autocorrelation is small for the national stock market returns, and is high for currency returns and especially for the WFP.

Table 3.2 shows the contemporaneous correlation matrix of all the variables entering the Euler equations. As one can observe, the equity returns and especially speculative returns in forward currency markets are strongly correlated with each other. The relation between the WCG or WCD and national stock market returns is weak as well as that between the WCG and risk-free securities: the U.S. T-bill and WRF. The WCG and WCD show a correlation of opposite signs with respect to the world forward premium, and in general reveal a similar relation towards currency returns. However, the correlations between the WCD and T-bill or WRF are strong and negative. From the perspective of a world investor who is concerned only with the U.S. dollar denominated returns, this negative relation between the WCD and riskless returns seems quite intuitive. Indeed, as mentioned above, when the world becomes more heterogeneous, i.e., when the dispersion of the per-capita consumption growth rates across countries increases, a risk-averse investor would prefer reallocating his portfolio towards less risky securities like T-bills – a move that will decrease their returns.

It is interesting that there is an indication of a modest relation between WCG and WCD: the correlation coefficient between these two variables is –0.3. However, a linear relation captures only a part of the association between these two variables. A nonlinear relation can be approximately described by the second order polynomial. Within such a framework, the WCD is the lowest at some moderate consumption growth rates, usually around its mean of 0.005. As the consumption growth drops or moves up, the cross-country dispersion of consumption increases. While significant decreases in consumption growth are usually observed during recessions, the magnitude of these changes is different across the world's major economies. This leads to an increase in the cross-country dispersion of consumption growth. On the other hand, during strong expansions, the speed of expansions may again be different across countries. The result is the same – an increase in the WCD. Moderate world economic growth allows for the closest alignment of the consumption growth across countries thus ensuring the lowest cross-country dispersion of per-capita consumption growth rates. While this logic might appear intuitive, empirical use of the nonlinear relation will most likely be complicated by the small amount of data.

Table 3.3 shows correlations of asset returns with the lagged values of five major variables that are used as instruments for the information set of the global investor, namely, WCG, WCD, T-bill, the equally weighted average of exchange rate changes

(WEX), and WFP. The WEX can be obtained from the already constructed measures of speculative profits and forward premia in foreign exchange markets as:

$$\text{WEX}_t = \frac{1}{7}\sum_{i}^{7}\frac{S_{i,t}}{S_{i,t-1}} = \frac{1}{7}\sum_{i=1}^{7}\left(\frac{S_{i,t} - F_{i,t-1}}{S_{i,t-1}} + \frac{F_{i,t-1} - S_{i,t-1}}{S_{i,t-1}} + 1\right).$$

The most striking feature of the panel is that the WCD, unlike the WCG, has almost uniformly negative one-period ahead correlation with all returns: the notable exception is the relation of consumption dispersion with the Canadian stock and currency market returns. A particularly strong predictive power for the cross-country dispersion in consumption growth is observed with respect to the world riskless rate, WRF. Also, the correlation between the WEX and excess returns is large. Finally, it is interesting to observe that that the lagged world forward premium which should be negatively related to returns in currency markets, exhibits positive correlation again over the Canadian market.

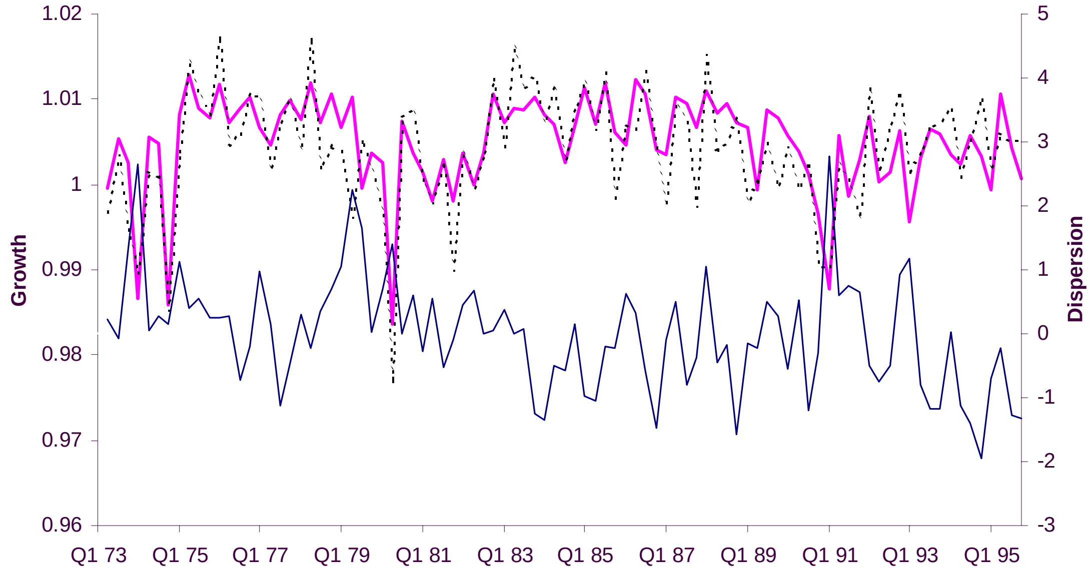

Figure 3.1. The U.S., World Consumption Growth Rates, and Cross-Country Dispersion of Consumption. The world consumption growth rate (bold solid line) is the GDP-weighted average of the real per-capita consumption growth rates from period *t*-1 to period *t* for Canada, France, Germany, Italy, Japan, Switzerland, the United Kingdom, and the United States all of which are expressed in local currency units. The U.S. consumption growth rate is the dashed line. The demeaned logarithmic transformation of the cross-country variance of the real per-capita consumption growth rates from period *t*-1 to period *t* expressed in local currency units is shown with the thin solid line.

Table 3.1

Summary Statistics

The table shows summary statistics, including mean (Mean), standard deviation (S.D.), maximum (Max.), minimum (Min.), autocorrelations (AC1, AC2, AC3, AC4, AC8), and Jarque-Bera statistics (J-B) for consumption and returns data for the sample which includes 91 quarterly observations: from 1973:2-1995:4. Panel A reports descriptive statistics for the world per-capita consumption growth rate (WCG), the log of the cross-country variance of consumption growth rate (WCD), the real three-month Treasury bill return (T-bill), and the world risk-free rate return (WRF). The WCG is the GDP-weighted average of the real consumption growth rates for G7 and Switzerland. The T-bill is the real U.S. three-month T-bill which is the nominal quarterly return to rolling over one month bills each month deflated by the U.S. three-month CPI changes. The WRF is the GDP-weighted average of the countries' risk-free rates.

Panel B reports descriptive statistics for the U.S. dollar denominated excess returns. The quarterly excess returns for each country is the difference between the quarterly stock market return in that country and the corresponding three-month U.S. T-bill return.

Panel C reports descriptive statistics for currency returns and the world forward premium (WFP). The WFP is the equally-weighed average of countries' forward premiums. For each quarter, the currency return is the average of the monthly one-month profits in the foreign exchange. The one-month currency return for each country is obtained as the ratio of the difference between the realized spot rate this period and the one-month forward rate last month over the spot rate last month.

					Autocorrelations					
	Mean	S.D.	Max	Min	AC1	AC2	AC3	AC4	AC8	J-B
Panel A: World Consumption Growth Rate, Log of the Cross-Country Consumption Variance, Real U.S.T-Bill Return and World Real Risk-Free Return										
WCG	0.0049	0.0057	0.0128	-0.0164	0.217	0.161	0.413	0.109	-0.050	85.57
lnWCD	-9.9014	0.8886	-7.1215	-11.859	0.396	0.121	0.181	0.236	0.101	6.62
T-Bill	0.0036	0.0083	0.0237	-0.0149	0.618	0.548	0.573	0.585	0.394	0.33
WRF	0.0063	0.0062	0.0172	-0.0104	0.929	0.866	0.834	0.766	0.674	8.44
Panel B: U.S. Dollar Denominated Excess Equity Returns										
Canada	0.0061	0.0934	0.2965	-0.2381	0.114	-0.047	0.000	-0.129	0.010	5.09
France	0.0183	0.1333	0.3950	-0.3980	0.148	-0.025	0.096	0.018	-0.074	6.04
Germ.	0.0164	0.1079	0.3391	-0.2668	0.210	-0.076	0.131	-0.004	-0.137	2.18
Italy	0.0076	0.1585	0.6957	-0.2767	0.074	0.250	0.044	0.143	0.051	42.19
Japan	0.0185	0.1274	0.3821	-0.3384	-0.015	0.095	0.153	0.163	0.013	1.24
Switz.	0.0202	0.1107	0.3773	-0.2384	0.057	-0.094	0.149	0.082	-0.098	2.16
U.K.	0.0232	0.1377	0.8096	-0.3093	0.029	-0.121	0.022	-0.191	0.198	450.6
U.S.	0.0144	0.0834	0.2169	-0.2783	0.119	-0.156	-0.072	-0.030	-0.028	13.81
Panel C: World Forward Premium and Currency Returns										
WFP	-0.0023	0.0067	0.0150	-0.0262	0.704	0.460	0.444	0.487	0.180	7.01
C$	0.0004	0.0220	0.0566	-0.0465	0.112	-0.045	0.244	0.026	-0.033	0.46
FF	0.0076	0.0596	0.1406	-0.1240	0.154	-0.061	0.065	0.169	0.111	0.93
DM	0.0047	0.0638	0.1487	-0.1191	0.084	-0.158	0.178	0.234	0.071	0.99
L	0.0074	0.0583	0.1419	-0.1848	0.143	-0.119	0.023	0.187	0.018	5.76
Y	0.0076	0.0633	0.1753	-0.1502	0.189	-0.077	0.072	0.151	0.022	1.03
SF	0.0060	0.0736	0.1749	-0.1445	0.048	-0.070	0.107	0.157	-0.014	1.69
£	0.0036	0.0557	0.1532	-0.1343	0.194	-0.109	0.171	0.038	0.050	0.56

Table 3.2

Unconditional Contemporaneous Cross-Correlations

The table shows the unconditional contemporaneous cross-correlations between consumption and returns data for the sample which includes 91 quarterly observations: from 1973:2-1995:4. The WCG is the world per-capita consumption growth rate. The WCD is the log of the cross-country variance of consumption growth rates. The T-bill is the real U.S. three-month T-bill which is the nominal quarterly return to rolling over one month bills each month deflated by the U.S. three-month CPI changes. The table shows the correlations for all national quarterly U.S. dollar denominated excess returns, the world forward premium, WFP, and returns in currency markets.

				Excess Equity Returns							
	WCD	T-Bill	WRF	Can.	Fran.	Germ.	Italy	Japan	Switz.	U.K.	U.S.
WCG	-0.307	0.154	0.001	-0.001	-0.008	0.012	-0.001	0.067	-0.021	0.060	-0.040
WCD	1	-0.322	-0.243	0.165	0.009	-0.072	0.076	0.094	-0.074	0.045	0.077
T-Bill		1	0.670	0.104	0.190	0.190	0.177	0.199	0.172	0.094	0.193
WRF			1	-0.134	-0.045	-0.054	0.059	-0.024	-0.118	-0.217	-0.046
Can.				1	0.373	0.331	0.284	0.381	0.471	0.485	0.758
Fran.					1	0.660	0.580	0.445	0.680	0.542	0.540
Germ.						1	0.472	0.372	0.784	0.421	0.468
Italy							1	0.497	0.463	0.357	0.342
Japan								1	0.491	0.408	0.444
Switz.									1	0.551	0.621
U.K.										1	0.596
U.S.											1

				Currency Returns:							
	WCD	T-Bill	WRF	C$	FF	DM	L	Y	SF	£	WFP
WCG	-0.307	0.154	0.001	-0.108	-0.022	-0.088	0.039	-0.053	-0.136	-0.045	0.229
WCD	1	-0.322	-0.243	0.125	-0.172	-0.145	-0.156	0.001	-0.179	-0.081	-0.135
T-Bill		1	0.670	0.056	-0.046	-0.002	0.013	-0.041	-0.009	-0.132	0.201
WRF			1	0.100	-0.069	-0.055	-0.033	-0.076	-0.114	-0.077	0.152
C$				1	0.044	0.062	0.029	0.076	0.083	0.129	-0.104
FF					1	0.933	0.807	0.623	0.848	0.660	-0.216
DM						1	0.723	0.638	0.878	0.665	-0.246
L							1	0.508	0.668	0.596	-0.167
Y								1	0.640	0.517	-0.295
SF									1	0.625	-0.285
£										1	-0.102
WFP											1

Table 3.3

Unconditional First-Order Cross-Correlations

The table shows the unconditional first-order cross-correlations between consumption and returns data for the sample which includes 91 quarterly observations: from 1973:2-1995:4. The WCG is the world per-capita consumption growth rate which is the GDP-weighted average of the real consumption growth rates for all countries each of which and is expressed in local currency units. The WCD is the log of the cross-country variance of consumption growth rates. The T-bill is the real U.S. three-month T-bill which is the nominal quarterly return to rolling over one month bills each month deflated by the U.S. three-month CPI changes. The table shows the correlations for all national quarterly U.S. dollar denominated excess returns, the world forward premium, WFP, and returns in currency markets.

	WCG(-1)	WCD(-1)	T-Bill(-1)	WEX(-1)	WFP(-1)
WCG	0.217	-0.059	0.162	-0.041	0.027
WCD	-0.178	0.396	-0.179	-0.156	-0.024
WRF	0.024	-0.244	0.720	-0.057	0.308
Excess Equity Returns:					
Canada	0.032	0.004	-0.075	0.127	0.207
France	0.134	-0.064	0.025	0.434	0.044
Germany	0.117	-0.067	0.001	0.374	-0.086
Italy	0.067	-0.080	0.054	0.303	0.086
Japan	0.008	-0.103	0.007	0.379	-0.029
Switzerland	0.083	-0.150	-0.061	0.460	-0.112
U.K.	-0.104	-0.189	-0.023	0.252	-0.068
U.S.	-0.096	-0.081	0.056	0.067	0.030
Currency Returns:					
C$	0.031	0.147	0.032	-0.127	0.132
FF	0.075	-0.111	-0.105	0.145	-0.181
DM	0.087	-0.131	-0.097	0.131	-0.203
L	0.071	0.007	-0.100	0.160	-0.135
Y	-0.031	-0.064	-0.136	0.028	-0.283
SF	0.125	-0.151	-0.171	0.046	-0.183
£	0.068	-0.071	-0.200	0.088	-0.144
WFP	0.158	0.117	0.172	0.059	0.702

Chapter 4

Estimation Methodology

In this chapter, I outline the estimation procedures for the tests of the beta pricing formulation of the world CCAPM with heterogeneity (equation (2.7)) and the general Euler equation (equation (2.6)). Both procedures are based on the Hansen's (1982) Generalized Method of Moments (GMM).

BETA PRICING SPECIFICATION

I am interested in testing whether the theoretical implications of the two-factor conditional asset pricing model described by equation (2.7) are supported by the data. Therefore, the first test is whether the global asset returns exhibit a measurable covariance with the world consumption growth, WCG, and the cross-country dispersion in consumption, WCD.

Many of the data series entering both the beta pricing and Euler equations fail the normality test (see the Jarque-Bera statistics in table 3.1). Consequently, testing these equations directly using the GMM is one way of ensuring the consistency of estimates. Due to the small sample size (90 observations if one lag is used in the information set), some caution must be taken with respect to the modeling and methodology of the estimation.[25] There are two groups of parameters of interest in equation (2.7): the first one consists of the betas of consumption growth and dispersion -- $\beta_{i,c,t}$ and $\beta_{i,d,t}$ respectively; the second includes the risk premia on mimicking portfolios for the two consumption risk factors -- growth and dispersion -- $\lambda_{c,t}$ and $\lambda_{d,t}$ respectively. If all these parameters are time-varying then their joint estimation might become infeasible with the current data. Previous research shows however that U.S. consumption growth betas do not exhibit measurable time-variation (see Ferson (1990)). Therefore, if a test conducted simultaneously on both $\beta_{i,c,t}$ and $\beta_{i,d,t}$ reveals that these two coefficients are time-invariant for every country specific asset *i*, then given the evidence on the constancy of $\beta_{i,c,t}$, one will be able to conclude that $\beta_{i,d,t}$ is also a constant.

I estimate the consumption growth and consumption dispersion betas simultaneously with the risk premia. First, I test whether $\beta_{i,c,t}$ and $\beta_{i,d,t}$ are constant for each asset *i*. I do so by adapting the approach of Ferson and Harvey (1993). Suppose that the conditional expectation of risk factors is linear in information variables, i.e., $E\left[\boldsymbol{F}_{t+1}|\boldsymbol{Z}_t\right]=\boldsymbol{Z}_t\eta$, where $\boldsymbol{F}_{t+1}=\left[\mathrm{WCG}_{t+1},\mathrm{WCD}_{t+1}\right]$, η is the $L\times 2$ coefficient matrix, and $\boldsymbol{Z}_t$ is the set of L instruments, $Z_{l,t}$, l = 1, ..., L, which is assumed to be known to the market at time *t*. This assumption defines a disturbance vector, $\boldsymbol{u}1_{i,t+1}=\boldsymbol{F}_{t+1}-\boldsymbol{Z}_t\gamma$, for

[25] For example, in the standard two-pass procedure of Fama and MacBeth (1973), the betas from the first pass time-series regressions are used as independent variables in the second pass estimation. Due to the small sample size, the estimated betas will most likely be biased. As a result, the errors-in-variables problem in the second pass regressions can potentially be very large.

each asset i at time t. The additional error term can be obtained from the definition of conditional beta, namely:

$$\beta_i = Cov(\boldsymbol{r}_i, \boldsymbol{F}|\boldsymbol{Z})Var(\boldsymbol{F}|\boldsymbol{Z})^{-1} = Cov(\boldsymbol{r}_i, \boldsymbol{u}1_i|\boldsymbol{Z})Var(\boldsymbol{u}1_i|\boldsymbol{Z})^{-1},$$

Here $\beta_i = [\beta_{i,c}, \beta_{i,d}]$ and is hypothesized to be time-invariant. Therefore, the second error term can be written as:

$$\boldsymbol{u}2_{i,t+1} = \beta_i(\boldsymbol{u}1'_{i,t+1}\boldsymbol{u}1_{i,t+1}) - \boldsymbol{u}1_{i,t+1}r_{i,t+1}.$$

Both disturbance vectors are put into the following system of equations:

$$\begin{cases} \boldsymbol{u}1_{i,t+1} = \boldsymbol{F}_{t+1} - \boldsymbol{Z}_t\gamma \\ \boldsymbol{u}2_{i,t+1} = \beta_i(\boldsymbol{u}1'_{i,t+1}\boldsymbol{u}1_{i,t+1}) - \boldsymbol{u}1_{i,t+1}r_{i,t+1} \end{cases}. \tag{4.1}$$

Thus, $E[\boldsymbol{u}_{i,t+1}|\boldsymbol{Z}_t] = 0$ and $E[\boldsymbol{u}_{i,t+1}\boldsymbol{Z}'_t] = 0$, where $\boldsymbol{u}_{i,t+1} = [\boldsymbol{u}1_{i,t+1}, \boldsymbol{u}2_{i,t+1}]$. This model is estimated by the GMM separately for each asset return i. Ferson and Harvey (1993) formulate a similar model but with time varying betas.[26] As a result, their system is exactly identified. Model (4.1) is overidentified as long as the instrument vector $\boldsymbol{Z}_t$ has one or more components (excluding a constant). The tests of model (4.1) can unveil the primary source of time variation in global asset returns. I find that the model is accepted for all assets. This implies that the primary source of time variation in international equity and currency returns is the time varying risk premia on constant consumption growth and dispersion betas.

[26] Ferson and Harvey (1993) also use $\boldsymbol{F}$ instead of $\boldsymbol{u}1_i$ in the second term and define an additional error term resulting from the linear projection of returns on instruments. While quantitatively the parameter estimates are sensitive to the specific model, qualitatively results are quite similar.

Given the assumption that $\beta_i = \left[\beta_{i,c}, \beta_{i,d}\right]$ is constant, I estimate the beta pricing form of the model. As before, I assume that each consumption-based risk factor can be represented as a linear combination of instrumental variables. The first disturbance term therefore is defined similar to that in (4.1):

$$\boldsymbol{u}1_{t+1} = \boldsymbol{F}_{t+1} - \boldsymbol{Z}_t \eta .$$

Assuming the time-varying risk-premia on mimicking portfolios, one can define them as functions of the instrument set $\boldsymbol{Z}$, namely:

$$\lambda(\boldsymbol{Z}_t) = \left[\lambda_0(\boldsymbol{Z}_t), \lambda_c(\boldsymbol{Z}_t), \lambda_d(\boldsymbol{Z}_t)\right] = \left[\boldsymbol{Z}_t\delta_0, \boldsymbol{u}1_{c,t+1} + \boldsymbol{Z}_t\delta_c, \boldsymbol{u}1_{d,t+1} + \boldsymbol{Z}_t\delta_d\right],$$

where $\boldsymbol{u}1_{c,t+1} = \mathrm{WCG}_{t+1} - \boldsymbol{Z}_t\eta_{\bullet,1}$ and $\boldsymbol{u}1_{d,t+1} = \mathrm{WCD}_{t+1} - \boldsymbol{Z}_t\eta_{\bullet,2}$ are the error terms for consumption growth and consumption dispersion factors respectively, $\eta_{\bullet,1}$ and $\eta_{\bullet,2}$ are the first and second column of the coefficient matrix η. In this representation, $\boldsymbol{Z}_t\delta_c$ and $\boldsymbol{Z}_t\delta_d$ constitute the expected part of the excess returns on the two factor mimicking portfolios at time *t*, while $\boldsymbol{u}1_{c,t+1}$ and $\boldsymbol{u}1_{d,t+1}$ are the unexpected innovations associated with consumption growth and dispersion respectively at time *t* + 1. The variable $\boldsymbol{Z}_t\delta_0$ is the expected return at time *t* on the global assets when both consumption and dispersion betas are zero. Taking into account equation (2.7) and the assumption that consumption growth and dispersion betas are constant, one can formulate the second disturbance term as follows:

$$\boldsymbol{u}2_{t+1} = \boldsymbol{r}_{t+1} - \boldsymbol{Z}_t\delta_0 - \left(\boldsymbol{u}1_{c,t+1} + \boldsymbol{Z}_t\delta_c\right)\beta_c - \left(\boldsymbol{u}1_{d,t+1} + \boldsymbol{Z}_t\delta_d\right)\beta_d .$$

I combine both error terms into the system of equations:

$$\begin{cases} \boldsymbol{u}1_{t+1} = \boldsymbol{F}_{t+1} - \boldsymbol{Z}_t \eta \\ \boldsymbol{u}2_{t+1} = \boldsymbol{r}_{t+1} - \boldsymbol{Z}_t \delta_0 - \left(\boldsymbol{u}1_{c,t+1} + \boldsymbol{Z}_t \delta_c\right)\beta_c - \left(\boldsymbol{u}1_{d,t+1} + \boldsymbol{Z}_t \delta_d\right)\beta_d \end{cases} . \quad (4.2)$$

Clearly, $E\left[\boldsymbol{u}_{t+1} | \boldsymbol{Z}_t\right] = 0$, where $\boldsymbol{u}_{t+1} = \left[\boldsymbol{u}1_{t+1}, \boldsymbol{u}2_{t+1}\right]$. The orthogonality conditions in this system are: $E\left[\boldsymbol{u}_{t+1}\boldsymbol{Z}_t'\right] = 0$, and, additionally, $E\left[\boldsymbol{u}2_{t+1}\boldsymbol{u}1_{t+1}'\right] = 0$. The last condition arises due to the fact that the residual term $\boldsymbol{u}2$ must be uncorrelated with regressors $\left(\boldsymbol{u}1_{c,t+1} + \boldsymbol{Z}_t\delta_c\right)$ and $\left(\boldsymbol{u}1_{d,t+1} + \boldsymbol{Z}_t\delta_d\right)$ and, therefore, with the first disturbance term, $\boldsymbol{u}1$. Model (4.2) is estimated jointly for excess equity and then speculative currency returns. Since there are eight excess equity returns and seven currency returns, system (4.2), similar to the system of equations (4.1), will be overidentified if the instrument vector $\boldsymbol{Z}_t$ has one or more components (excluding a constant). Such condition is quite useful given an ad-hoc process of the selection of interments.

EULER EQUATIONS

In the Euler equations, there are two parameters of interest, the risk aversion, γ, and time preference, ρ. I estimate the following three specifications of the CCAPM defined by (2.6):

(A) The model includes only the world risk-free returns;

(B) The model includes only excess equity returns;

(C) The model includes only speculative returns in the forward currency markets;

These three specifications correspond to the tests for risk-free rate puzzle, equity premium puzzle, and forward premium puzzle. Specifications (B) and (C) are estimated in the presence of pricing errors. This is done for two purposes. First, the estimation of the Euler equations with excess stock returns or *ex-post* currency returns usually produces very large values for the risk aversion parameter. The inclusion of the pricing errors allows one to make the unconditional mean of these returns unrestricted. This makes it possible to "decouple" the estimates of the risk aversion parameter and the pricing error. Second, the pricing errors would allow one to observe the direction and magnitude of change in the precision of the estimation for different values of the multiplicative factor *k*. The Euler equation (2.6) with pricing errors, i.e., for specifications (B) and (C) takes the following form:

$$E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[Kd_{t+1}\right]\left(R_{i,t+1}-\alpha_i\right)\right]=0\,, \tag{4.3}$$

where α_i is the average pricing error for asset *i*.

In effect, the Euler equations (2.6) and (4.3) define the error term from the estimation as

$$u_{i,t+1}=\rho\left(C_{t+1}/C_t\right)^{-\gamma}\exp\left(Kd_{t+1}\right)R_{i,t+1}-1$$

and

$$u_{i,t+1}=\left(C_{t+1}/C_t\right)^{-\gamma}\exp\left(Kd_{t+1}\right)\left(r_{i,t+1}-\alpha_i\right)$$

respectively for each asset *i*. Thus, $E\left[u_{i,t+1}\right]=0$ and $E\left[u_{i,t+1}\boldsymbol{Z}_t'\right]=0$ for all assets.. There is only one asset that enters the Euler equation under specification (A), eight under (B) and seven under (C). Clearly, all specifications of the model are overidentified when the number of components in the information set $\boldsymbol{Z}$ exceeds two. To derive consistent and asymptotically efficient GMM estimators, however, it is assumed that all explanatory variables entering the Euler equations are strictly covariance stationary. Ogaki (1993) points out that this assumption precludes deterministic trends, autoregressive unit root processes, and unconditional heteroskedasticity. The tests for unit roots conducted on the variable $\left(C_{t+1}/C_t\right)^{-\gamma}\exp\left(0.5k\gamma(\gamma+1)d_{t+1}\right)R_{t+1}$ with different asset returns support the assumption of stationarity at the 5% significance level (see Appendix F).

Since the model described by equation (2.6) is time-separable, the error term u_t must in theory follow an MA(0) process, so that $E\left[u_{t+s}|u_t\right]=0$, $s\geq 1$. However, this claim is valid only when data are not time averaged. An individual makes consumption and investment decisions at any day of the quarter but the reported consumption is the average consumption expenditure over the quarter. This temporal aggregation of consumption may induce a spurious correlation between the error terms and the information set for time *t*. Therefore, I adjust the GMM tests to account for time aggregation by imposing a first-order autocorrelation in the Newey-West hetero- and auto- consistent matrix, which is the inverse of a consistent estimate of the covariance matrix of orthogonality conditions (see Newey and West (1987)).

After estimating the parameters of the models, it is important to look at the implied pricing kernels and their characteristics such as means and standard deviations. I also use the Hansen-Jagannathan (HJ) distance measure to compare the performance of the model across their different specifications and various *k*. Here the issue of interest is to find the shortest distance between the estimated pricing kernel $\hat{\boldsymbol{m}}$ and the true pricing kernel $\boldsymbol{m}$ at which $E(\boldsymbol{mR}-\mathbf{1}|\boldsymbol{Z})$ is indeed equal to zero. The distance between $\hat{\boldsymbol{m}}$ and $\boldsymbol{m}$ can be measured as:

$$\text{HJ Distance} = \left[E(\hat{\boldsymbol{m}}\boldsymbol{r})-\mathbf{1}\right]' E(\boldsymbol{rr}')^{-1}\left[E(\hat{\boldsymbol{m}}\boldsymbol{r})-\mathbf{1}\right],$$

where $\mathbf{1}$ is the $1\times NL$ vector of ones, $\boldsymbol{r}=\boldsymbol{R}\otimes(\boldsymbol{Z}/E(\boldsymbol{Z}))$ is the $N\times L$ vector of augmented returns, $\otimes$ denotes the row-wise Kroneker product, and $E(\boldsymbol{Z})$ is the unconditional mean of the instrument vector.[27]

SELECTION OF INSTRUMENTS

As in any GMM-based test, a careful selection of the instrument vector is important. There are two considerations here. In most of the prior studies, the lagged values of variables entering the Euler equations are included into the instrument set. Other authors have argued that a limited set of variables such as dividend yields, T-bill returns, term spread, or exchange rate index possess major explanatory power for predicting future equity returns and thus should provide more powerful tests. Since this work is focused on the international version of the consumption based asset pricing model, first of all, it is natural to include in the instrument set of all of the specifications of the model the lagged consumption growth and the lagged cross-country dispersion of consumption growth.[28] To simplify the comparison of the results with those for the standard CCAPM, each specification is estimated also when the lagged cross-country

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[27] The details on the Hansen-Jagannathan distance measure can be found in Hansen and Jagannathan (1997).

dispersion of consumption does not enter the instrument vector. This is done to separately identify the importance of the consumption dispersion term in the Euler equations (2.6) and (4.3) and its value as an instrument. Below, I advocate the inclusion of additional instruments into the information set of the global investor, relating it to the corresponding specifications of the model. Note, however, that due to the small sample size, having too many instruments is not desirable. Large number of instruments also leads to finite sample biases.

For the estimation of specification (A) of the model, that is, in dealing with the risk-free puzzle, a natural choice for the additional instrument is either the lagged real U.S. Treasury bill return or the lagged real world riskless return, WRF. Due to the similar nature of these two instruments, only the lagged U.S. T-bill returns is used. As for the specification (B) of the model, that is, for the empirical analysis of the equity premium puzzle, the choice of either the lagged U.S. Treasury bill return, or WRF, or WEX is appropriate. Since the world exchange rate changes exhibit moderate positive correlation with excess returns (see Table 3.2), I evaluate specification (B) of the model when one of the components in the global investor's information set is WEX. For the estimation of specification (C) of the model, that is, for the forward premium puzzle analysis, the choice of the additional instrument is natural -- the lagged world forward premium, WFP.

As mentioned above, the original cross-country dispersion of consumption has skewed distribution. To make the range of changes and the average mean of the WCD

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[28] For the U.S. data, Hall (1978) and Hansen and Singleton (1983) show that lagged consumption growth is

term consistent with other variable entering the information set ***Z***, in all tests, the following normalized representation of the WCD is used in the information set:

$$\mathrm{WCD}_t \; = \; \log(d_t) \big/ \left| mean(\log(d_t)) \right| .$$

I do not differentiate notationally between the original and transformed consumption dispersion measures.

The above shows that the length L of the instrument vector ***Z*** is $L \in \{3, 4\}$. L = 3 when WCD does not enter the instrument set; L = 4 when it does. Given N assets and L instruments, there are NL orthogonality conditions. Therefore, there are 4(3) orthogonality conditions under specification (A), 32(24) under (B), and 28(21) under (C). (The figures in parentheses indicate the number of orthogonality conditions corresponding to L = 3 case.)

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useful in predicting future consumption growth.

Chapter 5

Preliminary Results

BUSINESS CYCLES

Before moving to the main test results, I first examine the impact of the inclusion of the cross-country dispersion of the per-capita consumption growth rates on the sensitivity of the CCAPM to the stages of the world business cycles. In other words, I estimate the predictive power of the lagged world business cycle indicator, D_t, for the pricing kernel $m_{t+1} = \left(C_{t+1}/C_t\right)^{-\gamma} \exp\left(0.5k\gamma(\gamma+1)d_{t+1}\right)$ times the return vector R_{t+1}.[29] First, I construct a variable, D_t, as the GDP-weighted average of the countries' business cycles indicators, $D_{i,t}$, each of which takes the value of 0 if t is a non-recession quarter for country i and the value of 1 if t is a recession quarter. Whether a given country is in the recession or non-recession quarter is determined based on the work of Kontolemis, Artis and Osborn (1997).[30] Thus,

$$D_t = \sum_i \left(\frac{GDP_{i,t}}{\sum_i GDP_{i,t}} \right) D_{i,t} \,,$$

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[29] Ferson and Merrick (1987) perform similar tests on the business cycle effects on asset pricing using the U.S. data.

so that $D_t \in [0, 1]$.

Notice that in practice the world business cycle dummy, D_t, is not public information at time t and therefore cannot be in an investor's information set; it becomes public only three-to-six month later. To alleviate this problem, I use instrumental variables method. In the true model, the error term $\left(m_{t+1}R_{t+1} - 1\right)$ must be orthogonal to the expected stage of the business cycle rather than to the contemporaneous value of the business cycle indicator itself. Assuming that $E\left[D_{t+1}|\boldsymbol{Z}_t\right] = \boldsymbol{Z}_t\eta$, where $\boldsymbol{Z}_t$ is the information set of an investor at time t and η is the $L \times 1$ coefficient vector, I can define the following two error terms:

$$\begin{cases} u1_{t+1} = D_{t+1} - \boldsymbol{Z}_t\eta \\ u2_{t+1} = \psi + \theta\boldsymbol{Z}_t\eta - \left(m_{t+1}R_{t+1} - 1\right) \end{cases}, \tag{5.1}$$

where ψ and θ are scalars. The second equation is the instrumental variables regression of $\left(m_{t+1}R_{t+1} - 1\right)$ on the business cycle indicator. If model (5.1) is correctly specified, then θ must be zero.

I estimate (5.1) by the GMM for the U.S. real gross equity returns and the world speculative returns in the currency markets, which are just the equally weighted average of profits from trading in forward markets of individual currencies. Parameters γ and k are ranging between 0 and 10. This range is chosen based on the economic plausibility of both the risk aversion parameter and the degree of omitted world consumption dispersion, though, the values of k greater than five are not likely. The instrument set $\boldsymbol{Z}$ consists of a

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[30] Kontolemis, Artis and Osborn (1997) use monthly data. Therefore, in my study, a country is considered

constant and the world term spread (WTS). The WTS is the GDP-weighted average of countries' term spreads expressed in local currency units. In these tests, the WTS is included into the information set of an investor based on the empirical results of Fama and French (1989) and Harvey (1990) who find that the term spread alone is a very good predictor of the stages of the business cycles for both the U.S. and other industrial countries. Indeed, while the world business cycle is of comparable frequency with the world term spread movements, the returns data on most types of assets do not show any significant persistence (see Table 3.1).

Figure 5.1 shows the *t*-statistics for θ from the above model for the U.S. real gross equity returns (plot A), and the world speculative returns in the currency markets (plot B). The plots indicate that the explanatory power of the recession dummy does not decrease in k for a given γ. It seems to suggest that incorporating heterogeneity into the standard CCAPM will not improve the sensitivity of the model to the business-cycle related changes in global asset returns. The issue is not however as simple. I have already mentioned that the standard CCAPM produces large values of the risk aversion parameter in tests on the equity premium and forward premium puzzles. Suppose that after accounting for the cross-country variation of consumption, γ decreases. Figure 5.1 shows that there are many combinations of the pairs (γ, k) which have lower *t*-statistics than some pair (γ, 0) for both the U.S. excess equity and world speculative currency returns.[31]

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in recession at time t, if quarter t encompasses a recession month.

[31] The same pattern holds when the new pricing kernel, m_t, is tested for an increase in predictability based on the instruments which are used to address the equity premium and forward premium puzzles. I have regressed m_t with different values of γ and k on the lagged values of the world consumption growth and

CONSUMPTION GROWTH AND DISPERSION BETAS

Table 5.1 shows the consumption growth and dispersion betas, their *t*-statistics and the Hansen's goodness-of-fit J-statistics from estimating system (4.1) for every excess equity return (panel A) and currency return (panel B). The instrument vector $\boldsymbol{Z}$ is composed of three components: a constant and the lagged values of WCG and WEX in the case of excess equity returns, and the constant, and the lagged values of WCG and WFP in the case of currency returns. This implies eight parameters, twelve orthogonality conditions, and four degrees of freedom in the GMM estimation. The reported J-statistics therefore show that the model is accepted for all assets since the 5% critical value for the chi-square test at four degrees of freedom is 9.49. Thus, the betas on the world consumption growth and dispersion are conditionally constant. The estimation results show that β_c and β_d are statistically significant for some assets. However, these estimates are not free from the errors-in-variables (EIV) problem. More consistent estimates of β_c and β_d can be obtained from estimating system (4.2).

Figures 5.2 and 5.3 visualize the outcome of the estimation of betas on the world consumption growth and dispersion based on model (4.2). Figure 5.2 depicts the scatter plots of eight mean excess stock market returns and seven mean forward currency market returns versus the estimates of β_c and β_d. It also shows unconditional mean risk premiums on consumption growth beta, $\lambda_c = E(\boldsymbol{Z}\delta_c)$, and consumption dispersion beta, $\lambda_d = E(\boldsymbol{Z}\delta_d)$ together with their corresponding OLS estimates. Based on the OLS

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world exchange rate changes and also on the lagged values of the world consumption growth and world forward premium. In both cases, I observe that m_t becomes more predictable (as *t*-statistics indicate) *only* estimates of the risk premiums on consumption growth, plots A allows one to observe a positive tendency for higher mean excess equity and currency returns to have a larger consumption growth beta, β_c. However, the unconditional mean risk premiums on consumption growth beta obtained simultaneously with the betas are more positive for both types of assets. The difference is especially profound for speculative currency returns. This qualitative difference between the estimates of slopes obtained based on the OLS framework and model (4.2) supports the importance of estimating the betas on both consumption measures and risk premiums simultaneously.

The relation between mean excess equity and currency returns and consumption dispersion beta, β_d, shown on plot B is negative based both on the OLS estimation and model (4.2). However, the estimates of the unconditional risk premiums on consumption dispersion are more negative for both types of returns, thus providing yet an additional support for the specification of model (4.2). Therefore, in accordance with the theoretical prediction of equation (2.7) and economic intuition, assets with higher average expected returns have smaller consumption dispersion beta than assets with lower mean returns. This means that the marginal utility of consumption is high when either the aggregate consumption is low or consumption dispersion is high or both. Therefore, while most of the parameter estimates in the coefficient vectors δ_c and δ_d are not statistically significant for excess equity and currency returns, the sign of the average risk premiums associated with the cross-country consumption dispersion for both types of assets is nevertheless consistent with the theoretical implications of model (2.7).

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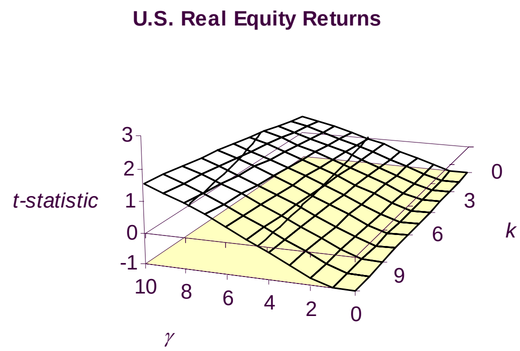
when higher values of *k* are accompanied by the smaller values of γ.

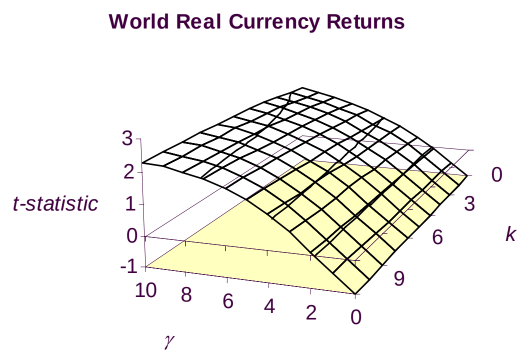
Figure 5.3 provides an additional perspective on the interrelation between β_c and β_d. Plots A and B reveal that there is some positive functional dependence between β_c and β_d. This means that if a country has more exposure to the world consumption growth risk, it has a higher exposure to the world consumption dispersion risk as well. This observation supports the argument of Storesletten, Telmer and Yaron (1997) who indicate that there must be some dependence between aggregate and idiosyncratic shocks since, otherwise, investors will be able to diversify them away. Thus, figure 5.3 confirms that a diversification of the consumption dispersion risk may pose a challenge.

SUMMARY

The objective of this chapter was to provide the first empirical evidence on the consistency of the world consumption dispersion measure, WCD, with the following two theoretical implications of the international version of the Constandinides and Duffie (1996) model. The first implication is that the inclusion of consumption dispersion into the standard CCAPM framework will allow assets to be more sensitive to the stage of the world business cycle. The second one is the negative relation between expected asset returns and consumption dispersion beta as formalized by equation (2.7). In testing these implications I used the Generalized Method of Moments (GMM) procedure of Hansen (1982). The test results confirm both implications.



A



B

Figure 5.1. Business Cycle Effects. The three-dimensional plots show the results from estimating the system:

$$\begin{cases} u1_{t+1} = D_{t+1} - \mathbf{Z}_t \eta \\ u2_{t+1} = \psi + \theta \mathbf{Z}_t \eta - \left(m_{t+1} R_{t+1} - 1 \right) \end{cases},$$

where ψ and θ are the scalars, $\mathbf{Z}_t$ is the instrument set, η is the vector of coefficients, and D_t, $D_t \in [0, 1]$, is the world recession dummy. It is the GDP-weighted average of the countries' recession dummies $D_{i,t}$ each of which takes the value of 0 in a non-recession and 1 in a recession quarter for country *i*. The pricing kernel $m_{t+1} = \left(C_{t+1}/C_t \right)^{-\gamma} \exp\left(0.5k\gamma(\gamma+1)d_{t+1} \right)$. The figure reports the *t*-statistics of θ for the gross real U.S. equity returns (Plot A) and world real returns in the forward currency markets (Plot B).

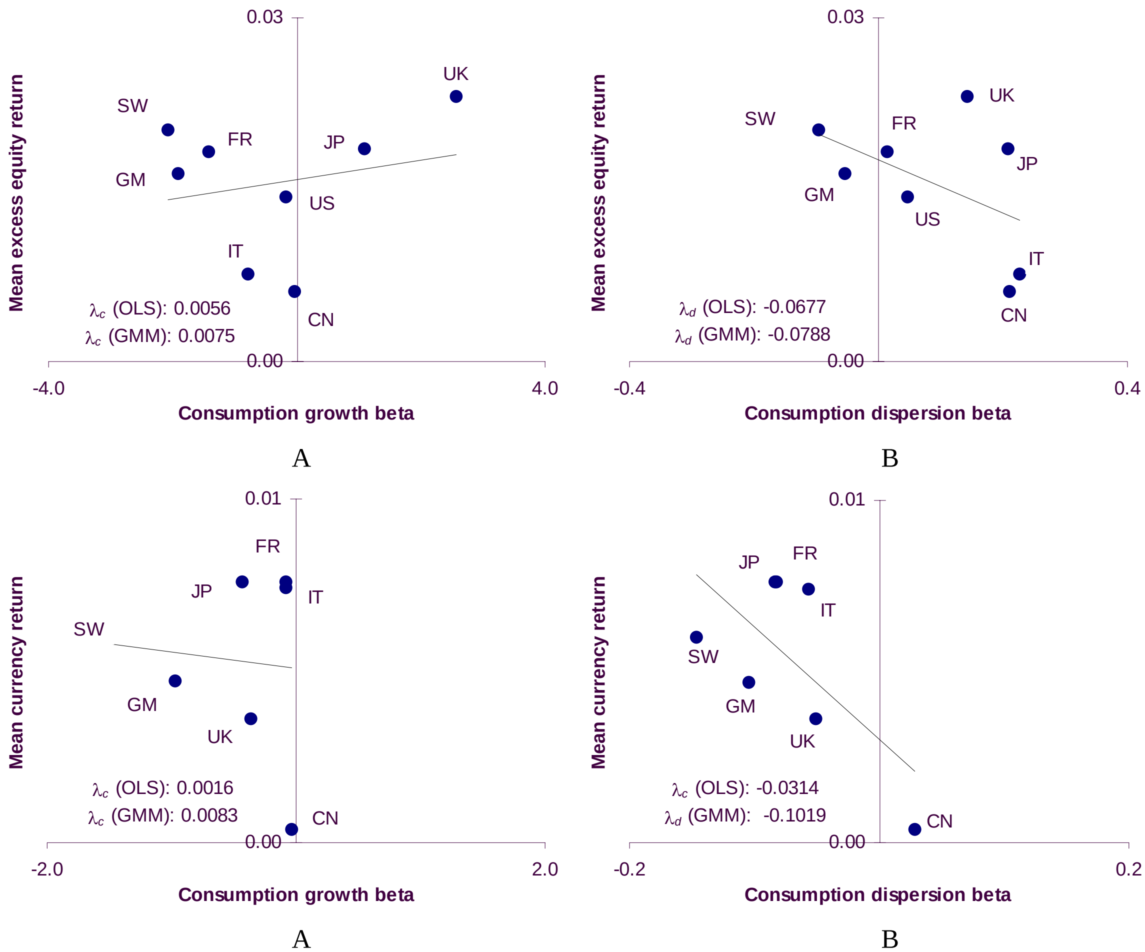


Figure 5.2. Consumption Growth and Consumption Dispersion Betas. The results are from the GMM estimation of the following system of equation jointly for eight excess equity returns and then for seven speculative currency returns:

$$\begin{cases} \boldsymbol{u}1_{t+1} = \boldsymbol{F}_{t+1} - \mathbf{Z}_t\eta \\ \boldsymbol{u}2_{t+1} = \boldsymbol{r}_{t+1} - \mathbf{Z}_t\delta_0 - \left(\boldsymbol{u}1_{c,t+1} + \mathbf{Z}_t\delta_c\right)\beta_c - \left(\boldsymbol{u}1_{d,t+1} + \mathbf{Z}_t\delta_d\right)\beta_d \end{cases},$$

where $\boldsymbol{F} = [\mathrm{WCG}, \mathrm{WCD}]$, $\boldsymbol{Z}$ is the $T \times L$ instrument set, η is the $L \times 2$ coefficient vector, δ_0, δ_c, and δ_d are $L \times 1$ coefficient vectors, β_c and β_d are $N \times 1$ vectors of the world consumption growth and consumption dispersion betas respectively, and N is the number of assets. The instruments vector is composed of a constant and the lagged values of the world consumption growth and either exchange rate change (for equities) or forward premium (for currencies). The scatter plots show the means of the eight quarterly excess equity returns (upper plots) and seven quarterly forward currency markets returns (lower plots) versus the estimates of the consumption growth betas (Plots A) and consumption dispersion betas (Plots B). The unconditional mean risk premiums on consumption growth beta, $\lambda_c = E\left(\boldsymbol{Z}\delta_c\right)$, and consumption dispersion beta, $\lambda_d = E\left(\boldsymbol{Z}\delta_d\right)$, are shown together with their corresponding OLS estimates. The OLS regression lines are displayed for visualization purposes.

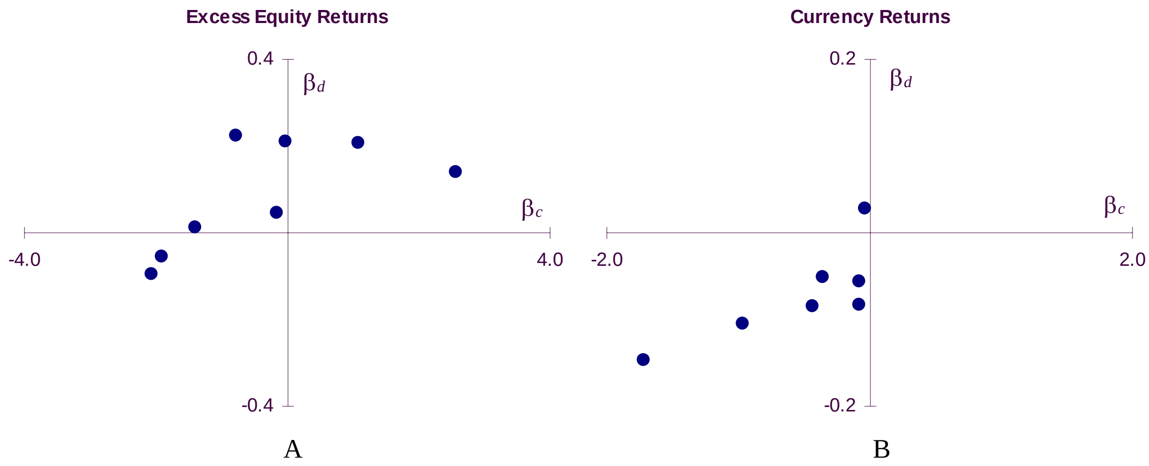


Figure 5.3. Consumption Growth and Dispersion Betas Space. The plot shows the consumption growth beta, β_c, and the consumption dispersion beta, β_d, for eight excess equity returns (Plot A) and seven currency returns (Plot B).

Table 5.1

Tests for the Time-Variation in Consumption Growth and Dispersion Betas

The results are from the GMM estimation of the following system of equation for each asset *i*:

$$\begin{cases} \boldsymbol{u}1_{i,t+1} = \boldsymbol{F}_{t+1} - \boldsymbol{Z}_t \eta \\ \boldsymbol{u}2_{i,t+1} = \beta_i \left(\boldsymbol{u}1'_{i,t+1} \boldsymbol{u}1_{i,t+1} \right) - \boldsymbol{u}1_{i,t+1} r_{i,t+1} \end{cases},$$

where $\boldsymbol{F} = [\text{WCG}, \text{WCD}]$, $\boldsymbol{Z}$ is the $T \times L$ instrument set, η is the $L \times 2$ coefficient vector, and $\beta_i = \left[\beta_{i,c}, \beta_{i,d} \right]$ is the asset's *i* vector of the world consumption growth and consumption dispersion betas. The table reports the estimates of β_c and β_d , their corresponding *t*-statistics (shown in parentheses) as well as the goodness-of-fit J-statistics (J) for each excess equity and currency returns.

	CN	FR	GM	IT	JP	SW	UK	US
				Panel A: Excess Equity Returns				
β_c	0.00913	-0.03354	-0.01776	-0.00145	0.02433	-0.01538	0.00518	-0.02606
	(0.73)	(-1.36)	(-0.66)	(-0.05)	(1.08)	(-0.69)	(0.26)	(-1.82)
β_d	0.00160	-0.00095	-0.00211	0.00037	0.00204	-0.00216	0.00091	0.00072
	(1.40)	(-0.56)	(-1.61)	(0.14)	(1.18)	(-1.52)	(0.66)	(-0.71)
J	6.30	9.12	11.10	10.85	7.09	7.58	6.74	7.65
				Panel B: Currency Returns				
β_c	-0.00079	-0.00423	-0.00254	-0.00124	-0.00226	-0.00591	-0.00286	--
	(-0.67)	(-1.15)	(-0.65)	(-0.32)	(-0.62)	(-1.02)	(-0.86)	
β_d	-0.00003	-0.00035	-0.00038	-0.00035	-0.00006	-0.00056	-0.00018	--
	(-0.31)	(-1.49)	(-1.49)	(-1.44)	(-1.25)	(-1.86)	(-0.75)	
J	3.57	8.09	6.07	5.21	3.94	7.16	7.48	--

Chapter 6

Main Results

The results in the previous chapter suggest that the cross-country consumption dispersion may have an impact on the cross-country variation of asset returns. In this chapter, I address this question directly by estimating and testing the Euler equations introduced in chapters 2 and 4 on international money, excess equity, and speculative currency returns.

ESTIMATION OF EULER EQUATIONS

The estimation of all the specifications of the models defined by the Euler equations (2.6) and (4.3) are conducted first for the standard and Constantinides and Duffie (1996) CCAPMs (d_t = 0 and k = 1 respectively), and then for the more general version of the world CCAPM with heterogeneity model allowing for a greater influence of the multiplicative factor k (k > 1). Two different information sets are used in each estimation: one includes a sole measure of consumption - the world aggregate consumption growth (WCG); the second includes both measures - the world aggregate consumption growth, WCG, and the cross-country dispersion of consumption (WCD). This approach makes the inference about the impact of the dispersion term as a risk factor versus an instrument easier to assess.

CD Model vs. Standard CCAPM: {$d_t = 0, k = 1$}

Table 6.1 shows the results of estimating model (2.6) using the world real risk-free return, WRF. The instrument vector ***Z*** is composed of a constant and the lagged values of WCG, and the U.S. T-bill in panel A, and the constant and the lagged values of WCG, WCD, and the U.S. T-bill in panel B. Even though the estimates of the risk aversion parameter γ and time preference parameter β as well as their standard errors are almost the same for both models and both instrument sets, these estimates for the new model are marginally smaller. All point estimates are significant. Panel A shows that both models are rejected when ***Z*** includes only the WCG and T-bill. The models are not rejected though when the WCD also enters the instrument set (panel B). Finally, the Hansen-Jagannathan distance measure is approximately the same for both implied pricing kernels.

Table 6.2 presents the estimation outcomes for the model with included pricing errors as described by the Euler equation (4.3). The instrument vector ***Z*** now is composed of a constant and the lagged values of WCG and WEX in panel A, and the constant and the lagged values of WCG, WCD and WEX in panel B. Besides reporting the point estimates and standard errors of the risk aversion parameter, the table also displays those characteristics of the pricing errors associated with all eight excess equity returns. The estimates of the risk aversion parameter decrease sharply from about 89 for the standard CCAPM to 21 for the new model in panel A and from 116 to 24 respectively in panel B. The standard errors of γ also decrease. The mean of the implied pricing kernel for the standard CCAPM is unrealistically low and approximately equals 0.77.

The new model brings this mean to a much higher value of 0.92 though still distant from a realistic estimate.[32] In both cases the models are not rejected but it appears that the overall fit of the standard CCAPM is better. This is a misleading observation however: the higher *p*-values of the J-statistics for the standard CCAPM are solely the result of high volatility of the pricing kernel. The Hansen-Jagannathan distance measure suggests a large decrease in the distance between the implied pricing kernels and the true ones for the Constantinides and Duffie (1996) model.[33] Note that the main distinction between the HJ distance and the chi-square statistic (J-statistics) is that the former does not reward the variability of the pricing kernel. In other words, *ceteris paribus*, a pricing kernel with higher standard deviation will be less likely rejected by the chi-square test, though it may still have the same HJ distance as the one with lower standard deviation.[34] Finally, as table shows, five out of eight average pricing errors decrease substantially when the model accounts for consumption heterogeneity. This results indicate that the variation in cross-country consumption growth rates improves the performance of the standard model.

Table 6.3 gives the estimation results for model (4.3) with pricing errors when the asset returns are the real speculative profits in the forward currency markets. The instrument set here is composed of a constant and the lagged values of WCG and WFP in

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[32] Kocherlakota's (1996) estimate of the mean of the pricing kernel for the quarterly U.S. excess equity returns is approximately 0.97.

[33] Even though the numbers reported for the Hansen-Jagannathan distance in Table 6.2 are about 10000 times bigger than those in Table 6.1, it does not imply by itself that the estimated pricing kernels are now 10000 times away from the true ones as compared with the pricing kernels shown in Table 6.1. The fact is that other things equal, the Hansen-Jagannathan distance increases with an increase in the number of assets entering the estimation equation and number of variables in the instrument vector.

panel A, and the constant and the lagged values of WCG, WCD and WFP in panel B. As in the case with excess equity returns, the estimates of the risk aversion parameter and its standard error are lower for the Constantinides and Duffie model. Notably, almost all average pricing errors and corresponding standard errors decrease substantially once the model accounts for the cross-country heterogeneity in consumption growth rates. Moreover, one can again observe that the conventional CCAPM produces unrealistically low mean and very large standard deviation for the implied pricing kernel. These estimates for the new model are much closer to economically reasonable values. As table shows, this model again markedly reduces the HJ distance between the implied and true pricing kernels. The above provides strong support for the importance of investors heterogeneity for explaining the time-variation in returns in the world currency markets.

Extended World CCAPM with Heterogeneity: k > 1

Table 6.4 aging shows the results of estimating model (2.6) using the world real risk-free returns but for $k > 1$. Similar to the results in table 6.1, the estimates of the risk aversion parameter are economically reasonable and significant. On both panels, one can see that the introduction of a higher degree of variation into the cross-country consumption dispersion noticeably reduces the estimates of the risk aversion and time preference parameters and their corresponding standard errors. The point estimates of γ drop to about 1.57 at $k = 10$ and are always significant. The standard errors of γ and those of the time preference parameter β decrease steadily with an increase in the value of k.

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[34] Balduzzi and Kallal (1997) propose a different pricing kernel misspecification measure which, similar to the Hansen-Jagannathan distance, does not reward an increase in the variability of the pricing kernel.

The point estimates of β become quite sensitive to the increases in the cross-country heterogeneity of per-capita consumption growth and, like those of γ, drop with increases in k staying reaching a level below unity for values of $k = 10$. As before, the model is rejected when dispersion term doesn't enter the information set of an investor. The mean and volatility of the estimated pricing kernel do not change much with changes in k. The inverse of the average mean value (1/0.9930=0.0070) is close to the mean quarterly return of 0.0063 on the world riskless security. The HJ distance decreases with an increase in k.

Table 6.5 shows the results of estimating model (4.3) with international excess equity returns for $k > 1$. As k increases, the point estimate of γ decreases fast and at $k = 5$ reaches the value of 5.4 when WCD is not in information set $\boldsymbol{Z}$ (panel A) and 6.0 when it is (panel B). A noticeable feature of both panels is that in spite of the decrease in the volatility of the estimated pricing kernel at large k and increase in the estimates of some of the average pricing errors, the HJ distance shows that the implied pricing kernel moves closer to the true one at $k > 1$. As its mean indicates, it appears that at $k = 5$, the estimated pricing kernel is better aligned with the one implied by the data.

Table 6.6 presents the results from re-estimating model (4.3) using real speculative returns in the forward currency markets. As in the case with excess equity returns, the estimates of the risk aversion parameter decrease markedly at $k > 1$. Again, the mean of the estimated discount factor becomes more aligned with the one from the data at $k > 5$. This is more visible on panel B, since at that value of k the estimate of HJ distance measure achieves its lowest value. This should imply that a possible acceptance of the implied pricing kernel can most likely occur when k approximately equals 5 and γ

is somewhat around 10. Unlike excess returns however, almost all average pricing errors and their standard errors decrease with an increase in k. The above provides a rather strong evidence of the importance of investors heterogeneity for explaining the time-variation in returns in the world currency markets.

Simultaneous Estimation of γ and k

At this point, the reader could raise a question on whether the multiplicative factor k can be reliably estimated along with other parameters. However, the importance of having an explicit relation between the consumption growth and dispersion terms in the intertemporal marginal rate of substitution through the risk aversion parameter γ is high. Table 6.7 shows the results of estimating γ and $K = k\gamma(1+\gamma)/2$ simultaneously on excess equity and currency returns using the unconditional version of the model. I employ the principle component analysis and use the residuals from regressing the world consumption dispersion on the world consumption growth instead of dispersion series.[35] As one can see, while the estimates of k are slightly bigger than unity, the estimates of γ are approximately as big as those for the standard CCAPM. The estimated pricing kernel is also far from being realistic. This apparently occurs because the time variation of consumption growth is higher than that of consumption dispersion. Since under separate parameter estimation γ is associated with consumption growth and $K(k)$ with dispersion, the estimated values of γ are much larger than those of k.

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[35] Due to the fact that the relation between consumption growth and dispersion is not exactly linear, the correlation between residuals and dispersion is high and equals 0.89.

HANSEN-JAGANNATHAN BOUNDS AND BIAS CORRECTION

Hansen and Jagannathan (1991) show that the estimated variance of the minimum-variance pricing kernel m (satisfying equation (2.1)) with expected value $E(m)$ can be found as follows:

$$\hat{\sigma}_m^2 = [\boldsymbol{1} - E(m)\overline{\boldsymbol{R}}]'\, S^{-1}[\boldsymbol{1} - E(m)\overline{\boldsymbol{R}}]\,,$$

where $\overline{\boldsymbol{R}}$ is the N-dimensional vector of mean asset returns and S is the sample variance-covariance matrix of asset returns. Ferson and Siegel (1998) derive a bias-adjusted estimate of the variance of the pricing kernel with the following form:

$$\hat{\sigma}_{m,adj}^2 = C\hat{\sigma}_m^2 - \frac{N}{T}\left[E(m)\right]^2,$$

where T is the sample size and $C = (T - N - 2)/(T - 1)$. This formulation, unfortunately, does not preclude negative values for the bias-adjusted variance estimate.

To provide another perspective on the behavior of the pricing kernel with incorporated heterogeneity in investors’ consumption growth rates, figure 6.1 shows the Hansen-Jagannathan volatility bounds for equity returns and speculative profits in the currency markets. These returns are taken gross, i.e., the actual real returns. The figure also shows the same bounds adjusted for the small sample size. The plot demonstrates that the mean-standard deviation bound for currency returns is much tighter and is situated generally higher than that for equity returns except for the narrow region in the neighborhood of the mean value of 0.999. This suggests that it should be harder for a pricing kernel implied by any asset pricing model to satisfy currency returns bounds.[36] The implied mean-standard deviation pairs of the pricing kernel are shown for two values 5 and 10 of the risk aversion parameter γ when $d_t = 0$ and for the values of $k = 2$, 5, and 10. In fact, the choice of 5 and 10 for the risk aversion parameter is not arbitrary: a closer look at tables 6.5 and 6.6 can suggest that the best performance of the pricing kernel in the case of excess equity returns might be expected when γ is above 5 while that in the case of speculative currency returns -- when γ is above 10. Figure 6.1 shows that with the above values of γ, while still outside the mean-standard deviation "cup", the implied pricing kernel appears closer to the bounds when k approximately equals 5. Interestingly enough, though not surprisingly, this is true for both international equity and currency returns. Thus, the plot gives additional evidence that at moderate values of k, the performance of the CCAPM with heterogeneity must improve.

SUMMARY

The objective of this chapter was a direct estimation of the Constantinides and Duffie (1996) model using Euler equations (2.6) and (4.3). The test results showed that the inclusion of the cross-country dispersion of countries' per-capita consumption growth rates into the standard power utility model has a positive impact on the ability of the model to resolve the risk-free rate and equity premium puzzles as well as forward

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[36] Backus, Gregory and Telmer (1993) also point out that the Hansen-Jagannathan lower bound on standard deviation for currency returns is tighter than that for equity returns, while Cecchetti, Lam and Mark (1994) find that higher values of risk aversion are needed to satisfy restrictions imposed by foreign currency returns than equity returns.

premium puzzle in its general equilibrium formulation. The estimates of the risk aversion parameter are lower, the standard errors are generally smaller, and the time preference parameter decreases towards unity. In addition, the new model leads to a decrease in the estimates of the Hansen-Jagannathan distance measure for all types of assets even when the Hansen's goodness-of-fit J-statistic increases. Most average pricing errors also decrease.

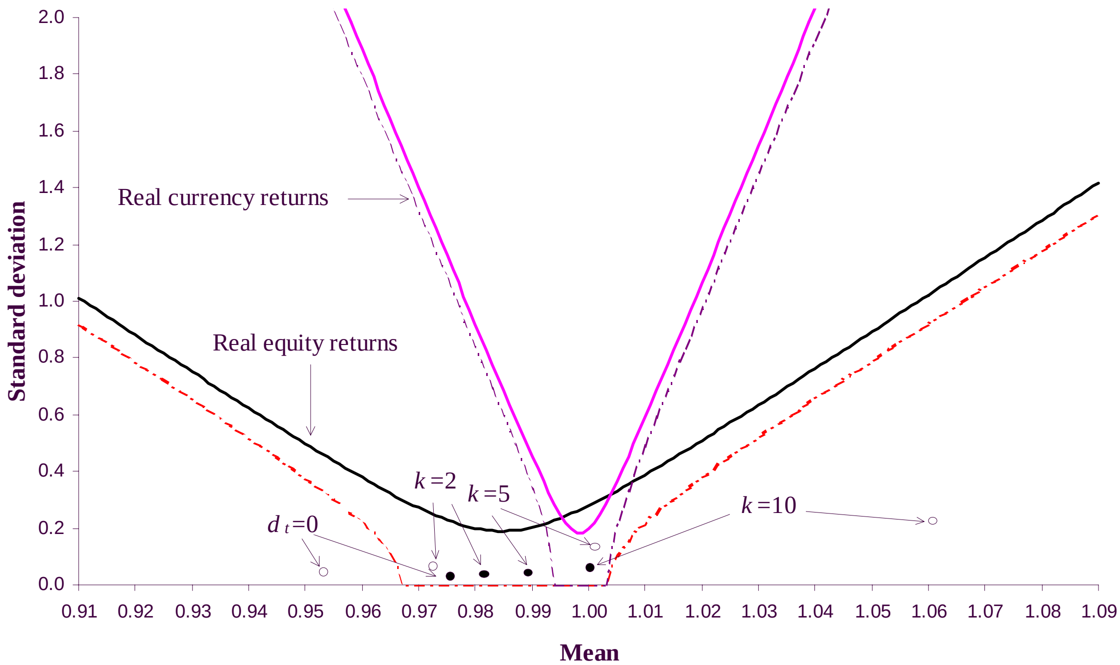

Figure 6.1. Hansen-Jagannathan Bounds with Bias Correction. The plot shows the Hansen-Jagannathan lower bounds for volatility for the gross real international stock market and forward currency market returns (solid curves). It also shows the bias-adjusted bounds (dashed curves). The filled dots depict the sample mean and standard deviation of the implied pricing kernel when the risk aversion parameter, γ, equals 5. The unfilled dots depict the sample mean and standard deviation of the implied pricing kernel when the risk aversion parameter, γ, equals 10. The results are shown when d_t = 0 and for the values of k = 2, 5, and 10.

Table 6.1
Tests of the Model Using the World Real Risk-Free Returns: d_t = 0 or k = 1

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country consumption dispersion is the variance of the logarithmic changes in the real national per-capita consumption growth rates also expressed in local currency units. All consumption data are from the National Accounts. The real U.S. Treasury bill is the nominal quarterly return to rolling over one month bills each month deflated by the U.S. three-month consumer price index (CPI) changes. Both the nominal one-month T-bill returns and CPI changes are from Ibbotson Associates. The world riskless rate is the GDP-weighted average of the one-month Eurocurrency rates from eight countries compounded over the quarter. The results are obtained by estimating the Euler equation:

$$\rho E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]R_{t+1}^{wrf}\middle|Z_t\right]-1=0\,,$$

where γ is the concavity parameter, ρ is the time preference parameter, and k is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1. R_{t+1}^{wrf} is the world real riskless return. C_{t+1}/C_t is the world real consumption growth from time t to time t+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, lagged world consumption growth, lagged cross-country variance of national consumption growth rates, and lagged real U.S. Treasury bill return. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

					Pricing Kernel		
k	γ	ρ	J	*p*	Mean	S.D.	HJ
Panel A: Instrument Set: *Z* = [1, WCG, T-bill]							
NH	1.92	1.0023	4.00	0.045	0.9929	0.0109	0.0016
	(0.78)	(0.0045)					
1	1.89	1.0019	4.03	0.045	0.9929	0.0109	0.0016
	(0.75)	(0.0042)					
Panel B: Instrument Set: *Z* = [1, WCG, WCD, T-bill]							
NH	1.86	1.0019	4.18	0.124	0.9928	0.0106	0.0017
	(0.76)	(0.0044)					
1	1.84	1.0016	4.18	0.124	0.9929	0.0106	0.0017
	(0.73)	(0.0041)					

Table 6.2
Tests of the Model Using International Excess Equity Returns: $d_t = 0$ or k = 1

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country consumption dispersion is the variance of the logarithmic changes in the real national per-capita consumption growth rates also expressed in local currency units. All consumption data are from the National Accounts. The real U.S. T-bill is the nominal quarterly return to rolling over one month bills each month deflated by the U.S. three-month CPI changes. Both the nominal one-month T-bill returns and CPI changes are from Ibbotson Associates. The results are obtained by estimating the Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(R_{i,t+1} - R_{rf,t+1} - \alpha_i\right)\middle| Z_t\right] = 0 \ ,$$

where γ is the concavity parameter, α_i is the pricing error for asset *i*, and *k* is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for *k* = 1. $R_{j,t+1} - R_{rf,t+1}$ are the quarterly U.S. dollar denominated excess returns in national equities markets. C_{t+1}/C_t is the real world consumption growth from time *t* to time *t*+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, the lagged world consumption growth, the lagged cross-country variance of national consumption growth rates, and the lagged world exchange rate changes. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

		Pricing Errors										Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	α_{US}	J	*p*	Mean	S.D.	HJ
Panel A: Instrument Set: *Z* = [1, WCG, WEX]														
NH	88.29	0.0004	-0.0020	0.0037	-0.0174	0.0010	0.0120	0.0262	0.0109	11.69	0.702	0.7654	0.6527	65.000
	(27.21)	(0.0083)	(0.0126)	(0.0107)	(0.0107)	(0.0099)	(0.0092)	(0.0128)	(0.0067)					
1	20.98	0.0033	-0.0029	0.0014	-0.0178	0.0005	0.0092	0.0207	0.0124	13.85	0.536	0.9277	0.1452	46.287
	(23.28)	(0.0086)	(0.0109)	(0.0083)	(0.0114)	(0.0100)	(0.0090)	(0.0114)	(0.0070)					
Panel B: Instrument Set: *Z* = [1, WCG, WCD, WEX]														
NH	115.72	0.0028	-0.0117	-0.0005	-0.0181	0.0172	0.0066	0.0341	0.0106	15.11	0.891	0.7762	1.0307	110.19
	(25.13)	(0.0066)	(0.0116)	(0.0102)	(0.0100)	(0.0080)	(0.0079)	(0.0126)	(0.0052)					
1	23.97	0.0096	-0.0014	0.0017	-0.0126	0.0161	0.0093	0.0254	0.0149	17.92	0.762	0.9226	0.1737	69.090
	(18.94)	(0.0077)	(0.0106)	(0.0077)	(0.0107)	(0.0085)	(0.0086)	(0.0107)	(0.0063)					

Table 6.3

Tests of the Model Using Speculative Returns in the Forward Currency Markets: d_t = 0 or k = 1

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country consumption dispersion is the variance of the logarithmic changes in the real national per-capita consumption growth rates also expressed in local currency units. All consumption data are from the National Accounts. The consumer price index (CPI) is from Ibbotson Associates. The estimation results are obtained by estimating the Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(\frac{S_{i,t+1}-F_{i,t}}{S_{i,t}}-\alpha_i\right)\middle|Z_t\right]=0\ ,$$

where γ is the concavity parameter, α_i is the pricing error for asset *i*, and *k* is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1. $\left(S_{i,t+1}-F_{i,t}\right)/S_{i,t}$ are the real quarterly U.S. dollar denominated profits in the national currency markets that are obtained by deflating the corresponding nominal returns by the U.S. quarterly CPI changes. C_{t+1}/C_t is the real world consumption growth from time *t* to time *t*+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, the lagged world consumption growth, the lagged cross-country variance of national consumption growth rates, and the lagged world forward premium. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

		Pricing Errors									Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	J	p	Mean	S.D.	HJ
Panel A: Instrument Set: Z = [1, WCG, WFP]													
0	118.89	0.0015	0.0219	0.0203	0.0132	0.0265	0.0211	0.0170	14.10	0.367	0.7805	1.0847	60.776
	(33.65)	(0.0016)	(0.0075)	(0.0084)	(0.0053)	(0.0051)	(0.0126)	(0.0049)					
1	23.33	-0.0005	0.0160	0.0123	0.0098	0.0209	0.0150	0.0098	15.74	0.263	0.9235	0.1673	45.618
	(34.80)	(0.0023)	(0.0058)	(0.0062)	(0.0058)	(0.0061)	(0.0076)	(0.0058)					
Panel B: Instrument Set: Z = [1, WCG, WCD, WFP]													
0	177.89	0.0065	-0.0121	-0.0237	0.0127	0.0344	-0.0731	0.0178	22.30	0.324	1.0164	2.7373	271.40
	(28.01)	(0.0008)	(0.0030)	(0.0038)	(0.0022)	(0.0026)	(0.0073)	(0.0020)					
1	48.29	0.0036	0.0149	0.0099	0.0165	0.0135	0.0108	0.0157	21.66	0.359	0.9527	0.6336	64.942
	(12.48)	(0.0017)	(0.0054)	(0.0055)	(0.0052)	(0.0044)	(0.0070)	(0.0047)					

Table 6.4
Tests of the Model Using the World Real Risk-Free Returns: k > 1

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country consumption dispersion is the variance of the logarithmic changes in the real national per-capita consumption growth rates also expressed in local currency units. The results are obtained by estimating the Euler equation:

$$\rho E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]R_{t+1}^{wrf}\middle|Z_t\right]-1=0,$$

where γ is the concavity parameter, ρ is the time preference parameter, and k is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 2, 5, 10. R_{t+1}^{wrf} is the world real riskless return. C_{t+1}/C_t is the world real consumption growth from time t to time t+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, lagged world consumption growth, lagged cross-country variance of national consumption growth rates, and lagged real U.S. Treasury bill return. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

					Pricing Kernel		
k	γ	ρ	J	*p*	Mean	S.D.	HJ
Panel A: Instrument Set: *Z* = [1, WCG, T-bill]							
2	1.85	1.0015	4.08	0.043	0.9929	0.0108	0.0016
	(0.71)	(0.0039)					
5	1.79	1.0008	4.03	0.045	0.9931	0.0109	0.0016
	(0.65)	(0.0034)					
10	1.66	0.9996	4.01	0.045	0.9932	0.0110	0.0015
	(0.56)	(0.0027)					
Panel B: Instrument Set: *Z* = [1, WCG, WCD, T-bill]							
2	1.87	1.0017	4.04	0.133	0.9930	0.0109	0.0016
	(0.71)	(0.0039)					
5	1.74	1.0006	4.25	0.119	0.9931	0.0106	0.0016
	(0.62)	(0.0033)					
10	1.57	0.9993	4.68	0.096	0.9932	0.0103	0.0015
	(0.52)	(0.0026)					

Table 6.5
Tests of the Model Using International Excess Equity Returns: k > 1

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country consumption dispersion is the variance of the logarithmic changes in the real national per-capita consumption growth rates also expressed in local currency units. The results are obtained by estimating the Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(R_{i,t+1}-R_{rf,t+1}-\alpha_i\right)\middle|Z_t\right]=0\ ,$$

where γ is the concavity parameter, α_i is the pricing error for asset *i*, and *k* is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for *k* = 2, 5, 10. $R_{j,t+1}-R_{rf,t+1}$ are the quarterly U.S. dollar denominated excess returns in national equities markets. C_{t+1}/C_t is the real world consumption growth from time *t* to time *t*+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, the lagged world consumption growth, the lagged cross-country variance of national consumption growth rates, and the lagged world exchange rate changes. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

		Pricing Errors										Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	α_{US}	J	*p*	Mean	S.D.	HJ
Panel A: Instrument Set: *Z* = [1, WCG, WEX]														
2	12.30	0.0038	-0.0037	0.0004	-0.0192	-0.0002	0.0085	0.0199	0.0135	14.42	0.494	0.9569	0.0850	44.649
	(23.81)	(0.0086)	(0.0108)	(0.0082)	(0.0115)	(0.0100)	(0.0090)	(0.0114)	(0.0070)					
5	5.39	0.0042	-0.0042	-0.0003	-0.0204	-0.0007	0.0080	0.0193	0.0144	14.81	0.465	0.9812	0.0375	43.661
	(24.48)	(0.0086)	(0.0107)	(0.0081)	(0.0116)	(0.0100)	(0.0091)	(0.0113)	(0.0070)					
10	2.62	0.0043	-0.0043	-0.0005	-0.0209	-0.0009	0.0078	0.0191	0.0148	14.93	0.456	0.9911	0.0185	43.348
	(24.82)	(0.0086)	(0.0107)	(0.0081)	(0.0116)	(0.0100)	(0.0091)	(0.0113)	(0.0070)					
Panel B: Instrument Set: *Z* = [1, WCG, WCD, WEX]														
2	13.83	0.0108	-0.0016	0.0002	-0.0138	0.0150	0.0087	0.0240	0.0160	19.07	0.697	0.9540	0.0987	66.634
	(19.30)	(0.0077)	(0.0105)	(0.0075)	(0.0108)	(0.0086)	(0.0086)	(0.0106)	(0.0064)					
5	6.00	0.0119	-0.0019	-0.0010	-0.0150	0.0140	0.0082	0.0229	0.0172	20.00	0.641	0.9799	0.0427	65.228
	(19.78)	(0.0077)	(0.0105)	(0.0075)	(0.0108)	(0.0086)	(0.0086)	(0.0106)	(0.0064)					
10	2.92	0.0123	-0.0020	-0.0015	-0.0156	0.0136	0.0081	0.0224	0.0177	20.36	0.620	0.9905	0.0210	64.797
	(20.01)	(0.0077)	(0.0105)	(0.0075)	(0.0108)	(0.0086)	(0.0086)	(0.0105)	(0.0064)					

Table 6.6
Tests of the Model Using Speculative Returns in the Forward Currency Markets: k > 1

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country consumption dispersion is the variance of the logarithmic changes in the real national per-capita consumption growth rates also expressed in local currency units. The estimation results are obtained by estimating the Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(\frac{S_{i,t+1}-F_{i,t}}{S_{i,t}}-\alpha_i\right)\middle|Z_t\right]=0\ ,$$

where γ is the concavity parameter, α_i is the pricing error for asset *i*, and *k* is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for *k* = 2, 5, 10. $\left(S_{i,t+1}-F_{i,t}\right)/S_{i,t}$ are the real quarterly U.S. dollar denominated profits in the national currency markets that are obtained by deflating the corresponding nominal returns by the U.S. quarterly CPI changes. C_{t+1}/C_t is the world real consumption growth from time *t* to time *t*+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, and the lagged values of the world consumption growth, consumption dispersion, and world forward premium. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

		Pricing Errors									Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	J	*p*	Mean	S.D.	HJ
Panel A: Instrument Set: *Z* = [1, WCG, WFP]													
2	13.28	-0.0007	0.0153	0.0115	0.0091	0.0206	0.0142	0.0091	16.03	0.247	0.9549	0.0937	45.012
	(37.34)	(0.0023)	(0.0056)	(0.0060)	(0.0058)	(0.0061)	(0.0074)	(0.0058)					
5	5.70	-0.0007	0.0149	0.0109	0.0087	0.0201	0.0136	0.0087	16.26	0.235	0.9805	0.0401	44.748
	(39.52)	(0.0023)	(0.0055)	(0.0058)	(0.0057)	(0.0061)	(0.0072)	(0.0058)					
10	2.75	-0.0009	0.0148	0.0108	0.0085	0.0204	0.0134	0.0086	16.32	0.232	0.9908	0.0196	44.704
	(40.41)	(0.0024)	(0.0055)	(0.0058)	(0.0057)	(0.0060)	(0.0071)	(0.0058)					
Panel B: Instrument Set: *Z* = [1, WCG, WCD, WFP]													
2	26.45	0.0032	0.0136	0.0079	0.0153	0.0099	0.0097	0.0131	21.54	0.366	0.9547	0.2737	56.534
	(13.05)	(0.0018)	(0.0054)	(0.0055)	(0.0055)	(0.0049)	(0.0068)	(0.0051)					
5	10.78	0.0027	0.0128	0.0067	0.0141	0.0079	0.0084	0.0119	22.10	0.335	0.9766	0.0955	57.230
	(15.71)	(0.0019)	(0.0053)	(0.0053)	(0.0055)	(0.0051)	(0.0066)	(0.0051)					
10	5.26	0.0025	0.0127	0.0066	0.0138	0.0076	0.0082	0.0118	22.37	0.321	0.9883	0.0451	58.025
	(17.05)	(0.0019)	(0.0052)	(0.0052)	(0.0054)	(0.0052)	(0.0065)	(0.0051)					

Table 6.7
Simultaneous Estimation of the Risk Aversion Parameter and Multiplicative Factor

The table reports the estimates of γ, $k = 2K/(\gamma+\gamma^2)$, the correlation between γ and k, $\rho(\gamma, k)$, Hansen's J-statistic (J), and the characteristics of the implied pricing kernel such as mean (Mean), standard deviation (S.D.), and the Hansen-Jagannathan distance (HJ). The HJ distance is multiplied by 10^4.

					Pricing Kernel		
Asset Return	γ	k	$\rho(\gamma, k)$	J	Mean	S.D.	HJ
Excess Equity	38.62	1.27	-0.59	5.54	0.85	0.32	4.87
Currency	48.94	1.02	-0.45	3.44	0.84	0.45	6.12

Chapter 7

Consumption Variance versus Dispersion

In this chapter, I address an important question on whether the results reported in the preceding chapters could have been obtained by substituting the world consumption variance for the cross-country consumption dispersion. The usefulness of such an analysis is motivated by the work of Kandel and Stambaugh (1990) who find that both conditional mean and variance of the U.S. consumption growth are related to the business cycle. The previous chapters of the dissertation have shown that the world consumption dispersion varies with the stage of the world business cycle. Therefore, if the cross-country dispersion and world consumption variance capture essentially the same information, their impact on asset prices must be also the same. To investigate this issue, I construct the conditional variance of the world consumption growth and then conduct tests similar to those reported in the previous chapter using the new series in lieu of the world consumption dispersion. In addition, I also test the unconditional version of the model with both world consumption variance and dispersion.

CONSTRUCTION OF CONSUMPTION VARIANCE

Model Formulation

Following Kandel and Stambaugh (1990), I model the conditional expectation and variance of consumption as a linear function of instruments but formulate the dynamics of the first two moments of consumption as follows:

$$\begin{aligned} c_t &= p\boldsymbol{Z}_{t-1} + u_t \\ \ln\left(\sigma_{u,t}^2\right) &= q\boldsymbol{Z}_{t-1} + a\left(\left|\varphi_{t-1}\right| - E_{t-2}\left[\left|\varphi_{t-1}\right|\right]\right) \end{aligned}, \tag{7.1}$$

where c_t is the consumption growth rate, $\boldsymbol{Z}_{t-1}$ is, as usual, the vector of L interments at time t–1, a is a scalar, p and q are the L-dimensional coefficient vectors, $\sigma_{u,t}^2 = E\left[u_t^2 \middle| \boldsymbol{Z}_{t-1}\right]$ is the conditional variance of c_t, and $\varphi_{t-1} = u_{t-1}/\sigma_{u,t-1}$ is the innovation to $\sigma_{u,t}^2$.[37] Model (7.1) is a modification to a conventional E-ARCH (exponential autoregressive conditional heteroscedasticity) model.[38] The difference between model (7.1) and the standard E-ARCH formulation is in the presence of the regressor vector $\boldsymbol{Z}_{t-1}$ in both equations for the conditional first and second moments, c_t and $\sigma_{u,t}^2$ respectively. In fact, the dependence of $\sigma_{u,t}^2$ on $\boldsymbol{Z}_{t-1}$ motivates the choice of the E-ARCH model as opposed to the standard ARCH(1) formulation since in the former case, there is no need to restrict the right-hand-side of the second equation of (7.1) to be positive. Notice also that in model (7.1), the reaction of the conditional variance of consumption, $\sigma_{u,t}^2$, to the lagged innovation in consumption, φ_{t-1}, is symmetric.

Model (7.1) can be estimated using the quasi-maximum likelihood (QML) method. QML allows for simultaneous estimation of the parameters entering both conditional mean and conditional variance equations. As with the standard maximum likelihood estimation, QML estimates are obtained by maximizing the log likelihood function over the parameter space $\Theta = [a, p, q]$, i.e.,

$$\underset{\Theta}{\mathrm{Max}} \sum_{t=1}^{T} \ell_t(\Theta),$$

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[37] The normality assumption implies that for any s and t, $s < t$,

$$E_{t-s-1}\left[\left|\varphi_{t-s}\right|\right] = \sqrt{2/\pi}.$$

[38] The ARCH model was developed by Engel (1982). Nelson (1991) introduces the exponential family of autoregressive processes.

where

$$\ell_t(\Theta) = -\frac{1}{2}\ln\left(\hat{\sigma}_{u,t}^2\right) - \frac{1}{2}\left(\frac{\hat{u}_t^2}{\hat{\sigma}_{u,t}^2}\right).$$

As shown by Bollerslev and Wooldridge (1992), the QML estimates obtained in this fashion are consistent when $E_{t-1}[\varphi_t] = 0$, $E_{t-1}[\varphi_t^2] = 1$ and other technical conditions are satisfied. These authors have also shown that the standard errors from the QML estimation must be corrected for the departure from normality in the data. I employ the Berndt, Hall, Hall and Hausman (BHHH, 1974) optimization algorithm to obtain the parameter vector Θ. Since BHHH algorithm is an iterative procedure, I assume that $u_1 = 0$ and estimate the initial value of the conditional variance, $\sigma_{u,1}^2$, as a separate parameter assigning it at the end the mean value of the constructed series.

To complete the specification of model (7.1), the regressor vector of instrumental variables must be specified. Unlike the tests of the beta pricing and Euler equations, where the instrument set $\boldsymbol{Z}_{t-1}$ is set to reflect a particular relation with returns, here $\boldsymbol{Z}_{t-1}$ includes the constant and the lagged values of the world consumption growth, WCG, and world term spread, WTS. In other words, model (7.1) can be rewritten more specifically as:

$$\begin{aligned} \mathrm{WCG}_t &= p_0 + p_1\mathrm{WCG}_{t-1} + p_2\mathrm{WTS}_{t-1} + u_t \\ \ln\left(\mathrm{WCV}_t\right) &= q_0 + q_1\mathrm{WCG}_{t-1} + q_2\mathrm{WTS}_{t-1} + a\left(\left|\varphi_{t-1}\right| - E_{t-2}\left[\left|\varphi_{t-1}\right|\right]\right), \end{aligned} \qquad (7.2)$$

where WCV_t denotes the conditional variance of the world consumption growth at time t. I do not include the world consumption dispersion into the to instrument set for the following two reasons. First, I want to obtain the conditional variance of the world consumption growth based on the consumption growth series itself and the most powerful financial variable known to predict the world GDP and, therefore, the world consumption growth. (In this respect, the choice of instruments is similar to the one used in chapter 5 to model the world business cycles.) Secondly, I want to preclude any possible manifestation of the weak non-linear relation between WCG and WCD series in the estimation results since otherwise WCD would be an independent variable while WCG a dependent.

Estimation Results

Table 7.1 shows the test results for system (7.2). I report the point estimates from the QML estimation and Bollerslev and Wooldridge (1992) standard errors. The intercept p_0 is insignificant but other point estimates except for p_2 are significant. As expected, the slope coefficients on both lagged world consumption growth and world term spread are positive for the conditional first moment of consumption; they are however, negative for the conditional consumption variance. Figure 7.1 depicts the time series of the demeaned log transformations of the world consumption dispersion, WCD, and conditional variance of the world consumption growth, WCV. Not surprisingly, WCV, like WCD, shows noticeable time variation with the stage of the world business cycle. However, as the scatterplot on figure 7.2 reveals, the contemporaneous relation between these two series is only weakly positive with the correlation coefficient of about 0.31.

The estimation results of Euler equations (2.6) and (4.3) with the world consumption variance measure in lieu of the world consumption dispersion are reported in tables 7.2, 7.3, and 7.4. As before, the multiplicative factor *k* takes the values of 1, 2, 5, and 10.[39] Table 7.2 shows the results of estimating model (2.6) with the world real risk-free returns, WRF. The instrument vector ***Z*** is composed of the constant and the lagged values of WCG, and the U.S. T-bill. As in the case with consumption dispersion, the estimates of the risk aversion parameter γ are low, the standard errors of the point estimates decrease, while the time preference parameter ρ drops even to a level below unity at k = 10. However, one can easily observe, that the introduction of consumption variance into the standard CCAPM has actually only worsened the performance of the model. The Hansen's goodness-of-fit J-statistics increases steadily leading to the rejection of the model at k = 10. Moreover, the Hansen-Jagannathan distance also increases taking the value of 0.0021 at k = 5 as opposed to 0.0016 for the standard CCAPM.

Table 7.3 presents the results of estimating model (4.3) with the excess equity returns. The instrument vector ***Z*** is composed of the constant and the lagged values of WCG, and the world exchange rate changes, WEX. Increase in k leads to a decrease in the point estimates of γ. The HJ distance also decreases. However, a simple comparison of tables 7.2 with 6.2 and 6.5, panels A, reveals that a decrease in the estimate of the risk aversion parameter is not as profound as with consumption dispersion. For example, at k = 5, the point estimate of γ when consumption dispersion enters the Euler equation is 5.25, while the same estimate is almost three-fold higher (15.16) when consumption

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[39] Notice that in this setting, any value of k different from unity cannot be supported on economic grounds. However, I conduct the tests with the values of k greater than one as well in order to compare the results with those based on the world consumption dispersion measure.

variance is used instead of dispersion. The HJ distances for different values of *k* are also higher in table 7.3 as compared to the corresponding ones in tables 6.2 and 6.5.

Table 7.4 presents the results of estimating model (4.3) with the speculative returns in the forward currency market. The instrument vector ***Z*** is composed of the constant and the lagged values of WCG and the world forward premium, WFP. Again, as in the case of excess equity returns, while the general picture of the estimation results is similar to that reported in panels A of tables 6.3 and 6.6, the major distinction is that the point estimates of the risk aversion parameter, γ, are now more than three-fold higher than before.

So far, all the estimation results were obtained based on the conditional version of the models (2.6) and (4.3). However, the classical result of the equity premium puzzle of Mehra and Prescott (1985) is that the variance of aggregate consumption is too small to explain the unconditional mean of the equity returns. Within the framework of conditional consumption based asset pricing, Hansen and Singleton (1983), Ferson and Constantinides (1991), and Ferson and Harvey (1992) have tested different Euler equations implied by the unconditional mean excess returns. Given these studies, the unconditional tests of the new CCAPM on both excess equity and currency returns look natural.

Unconditional Tests of the CCAPM with Heterogeneity

Table 7.5 reports the results of estimating model (4.3) without pricing errors for excess equity returns. The tests are conducted with both world consumption dispersion and world consumption variance. The table profoundly shows the difference between the

WCD and WCV series. When the WCD enters the Euler equation, the estimates of the risk aversion parameter γ drop from 34.03 for the standard CCAPM to 6.28 at k = 5, though, similar to the results in previous studies, the estimates of γ are very imprecise. Notice, however, that an increase in k does not lead to a decrease in the estimates of γ when WCD is substituted by WCV. The implied mean of the pricing kernel is unrealistic at for the standard CCAPM but takes a much more reasonable value at k = 5. The HJ distance also is much smaller with the WCD series, reaching its minimum also at k = 5.

Table 7.6 reports the results of estimating model (4.3) without pricing errors for speculative currency returns. The tests are conducted with both world consumption dispersion and world consumption variance. The table again illustrates an existence of a substantial difference between the WCD and WCV series. When the WCD enters the Euler equation, the estimates of the risk aversion parameter γ drop from 55.51 for the standard CCAPM to 19.57 at k = 5, unlike 25.90 for the WCV. Probably more importantly, an increase in k leads to a sharp increase in the precision of the estimation of the risk aversion parameter based on the WCD series but not WCV: the standard error of γ at k = 5 is only 1.94. The HJ distance is again smaller with the WCD series, reaching its minimum at k = 5.

Finally, taken jointly, the results of the estimation of Euler equations (2.6) and (4.3) indicate that apart from adding an additional variation to the pricing kernel, the variance of the world consumption growth and cross-country dispersion of consumption growth have quite different influences on the returns data. The results also show that the new CCAPM with heterogeneity outperforms its standard counterpart along several dimensions within both conditional and unconditional frameworks.

WAVELET ANALYSIS

Foundations of the Method

Since this chapter deals with the analysis of differences in the impact on global asset returns by the cross-country consumption dispersion and world consumption variance, the wavelet-based analysis of time-frequency properties of these data series is useful. An important advantage of the wavelet approach over traditional Fourier methods of analyzing time series is that it allows for not only nonstationary fluctuations, but also, what is more important in the current research, variations in both the intensity and timing of the seasonal cycle. The resulting patterns of variations which, unlike Fourier transforms, are extremely robust to changes in the values of a single data point or even of a small proportion of data points may display some features which are not apparent in the original time series.

In this research, I use the D(4) wavelet which is a “four-term” member of the class of discrete Daubechies wavelets (e.g., see Daubechies (1992)). This simple finite-length wavelet is chosen because it is well suited for most of the practical applications. In this case, the four-component filter vector h has the following values:

$$h = \begin{bmatrix} h_1 \\ h_2 \\ h_3 \\ h_4 \end{bmatrix} = \begin{bmatrix} \left(1-\sqrt{3}\right)/4\sqrt{2} \\ \left(-3+\sqrt{3}\right)/4\sqrt{2} \\ \left(3+\sqrt{3}\right)/4\sqrt{2} \\ \left(-1-\sqrt{3}\right)/4\sqrt{2} \end{bmatrix}.$$

Then, the scaling filter vector *g* is just the “mirror” image of vector *h*, namely: $g = [g_1, g_2, g_3, g_4] = [h_4, h_3, h_2, h_1]$. I decompose the data using the Maximal Overlap Discrete Wavelet Transform (MODWT) of the time series by implementing the "pyramid" algorithm of Mallat (1989). I report the first-, second, and third-order wavelet coefficients, W_1, W_2, and W_3 since they cover the quarterly, six-month, and annual frequencies of the data. The MODWT wavelet coefficients are vectors of size *T*, where *T* is the length of the original data series, *X*. The element *t* of the wavelet coefficient $W_{j,t}$ of order *j* is defined as

$$W_{j,t} \equiv \frac{1}{\sqrt{2^j}} \sum_{l=1}^{L_j} h_{j,l} X_{t-l \bmod T},$$

where *L* is the length of the wavelet filter (*L* = 4 for D(4)), $X_{t-l \bmod T}$ is $t-l \bmod T$ -th observation from the original data series *X*, and $h_{j,l}$ is the wavelet filter of order *j*. It can be found as:

$$h_{j,l} = \sum_{n=1}^{L} h_n g_{j-1,l-n2^{j-1}},$$

where

$$g_{j,l} = \sum_{n=1}^{L} g_n g_{j-1,l-n2^{j-1}},$$

and $l = 1, ..., L_j$. To correct for the exact timing of events, scale-dependent shifts of the wavelet coefficients must be introduced. Therefore, the resulting series, i.e., W_1, W_2, and W_3, are shifted by –2, –5 and –11 data points respectively.[40]

Results

Figure 7.3 reports the first, second, and third-order wavelet coefficients for the conditional variance of the world consumption growth, WCV, and the cross-country dispersion of the real per-capita consumption growth rates, WCD. These wavelet coefficients correspond to the quarterly, six-month, and annual time scales respectively. The figure also depicts the stage of the world business cycle based on my world recession dummy D_t. I now assign it a value of 1 if $D_t > 0.5$, and 0 otherwise. The plots make it easy to see that there exists at least one potential source of differences between the WCV and WCD series. The conditional variance of consumption matches well the world recessions of 1973-1975 and 1980-1982, but it completely fails to respond to the recession of the beginning of the nineties. The world consumption dispersion however, responds profoundly to all three recession periods, albeit with some mismatch in the phase for the 1980-1982 recession. Moreover, on the six-months and especially annual time scales, one can observe that the WCV exhibits less variation through time, while that of the WCD series is almost uniform across all frequencies. One possible explanation to this observation may come from the fact that the world consumption variance is a GDP-weighted measure, while the cross-country consumption dispersion is not. Over time, the

[40] Percival and Walden (1998) provide a very good description of these and other issues related to the discrete wavelet transformation used here.

dominance of the U.S. economy has decreased, and since major industrial countries may be at different stages of their business cycles, the world variation in consumption growth smoothes out. However, country-specific consumption shocks continue to exist.

SUMMARY

The objective of this chapter was to examine whether the world consumption variance if used instead of the cross-country consumption dispersion can produce the same results as those reported in chapters 5 and 6. I used the exponential autoregressive conditional heteroscedasticity (E-ARCH(1)) model and quasi-maximum likelihood (QML) method to obtain the conditional variance of the world consumption growth. Similar to Kandel and Stambaugh (1990), I modeled conditional first and second moments of consumption as linear functions of the same lagged instrumental variables.

Overall, the results reveal that consumption variance and consumption dispersion are not the same series. Even though both series exhibit time variation consistent with the stage of the world business cycle, their contemporaneous unconditional correlation is only about 0.3. Moreover, significant differences in their impact on asset returns are obtained. The estimation of Euler equations (2.6) and (4.3) with consumption variance instead of consumption dispersion produces two important differences with the previous results. First of all, for the world riskless returns, the inclusion of consumption variance into the standard CCAPM model increases rather than decreases the Hansen-Jagannathan distance measure and significantly worsens the overall fit of the model leading to its complete and very strong rejection. Secondly, even though the estimates of the risk aversion parameter obtained from Euler equation (4.3) with consumption variance decrease for both excess equity and speculative currency returns, their values are on average three-fold higher than the corresponding ones reported in chapter 6.

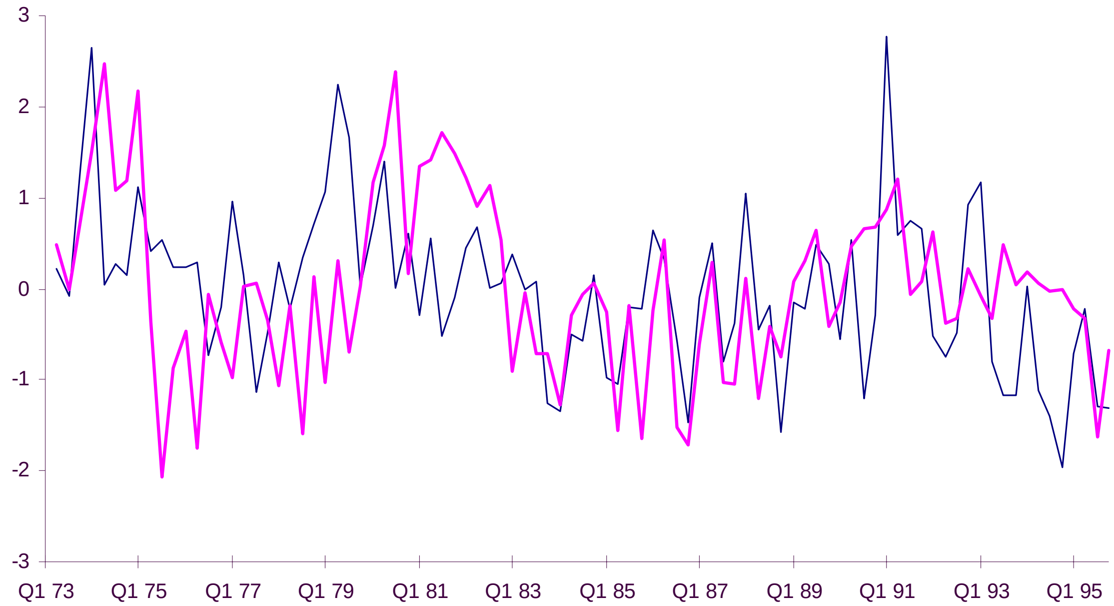


Figure 7.1. Time Series of Consumption Dispersion and Consumption Variance. The plot shows the demeaned log world consumption growth variance, WCV (bold line), and log world consumption dispersion, WCD (thin line).

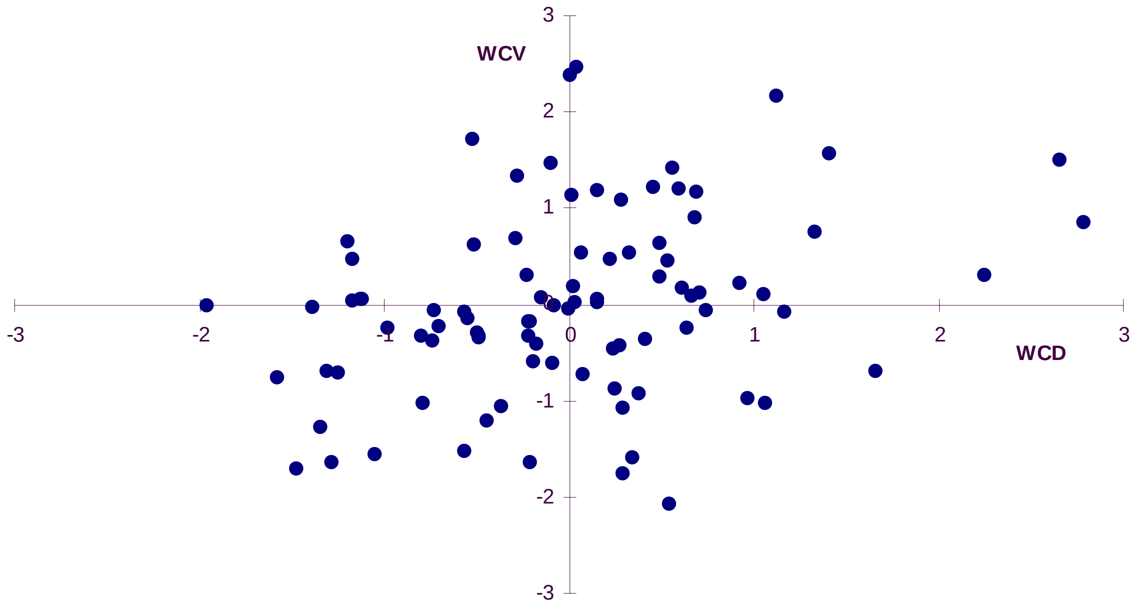
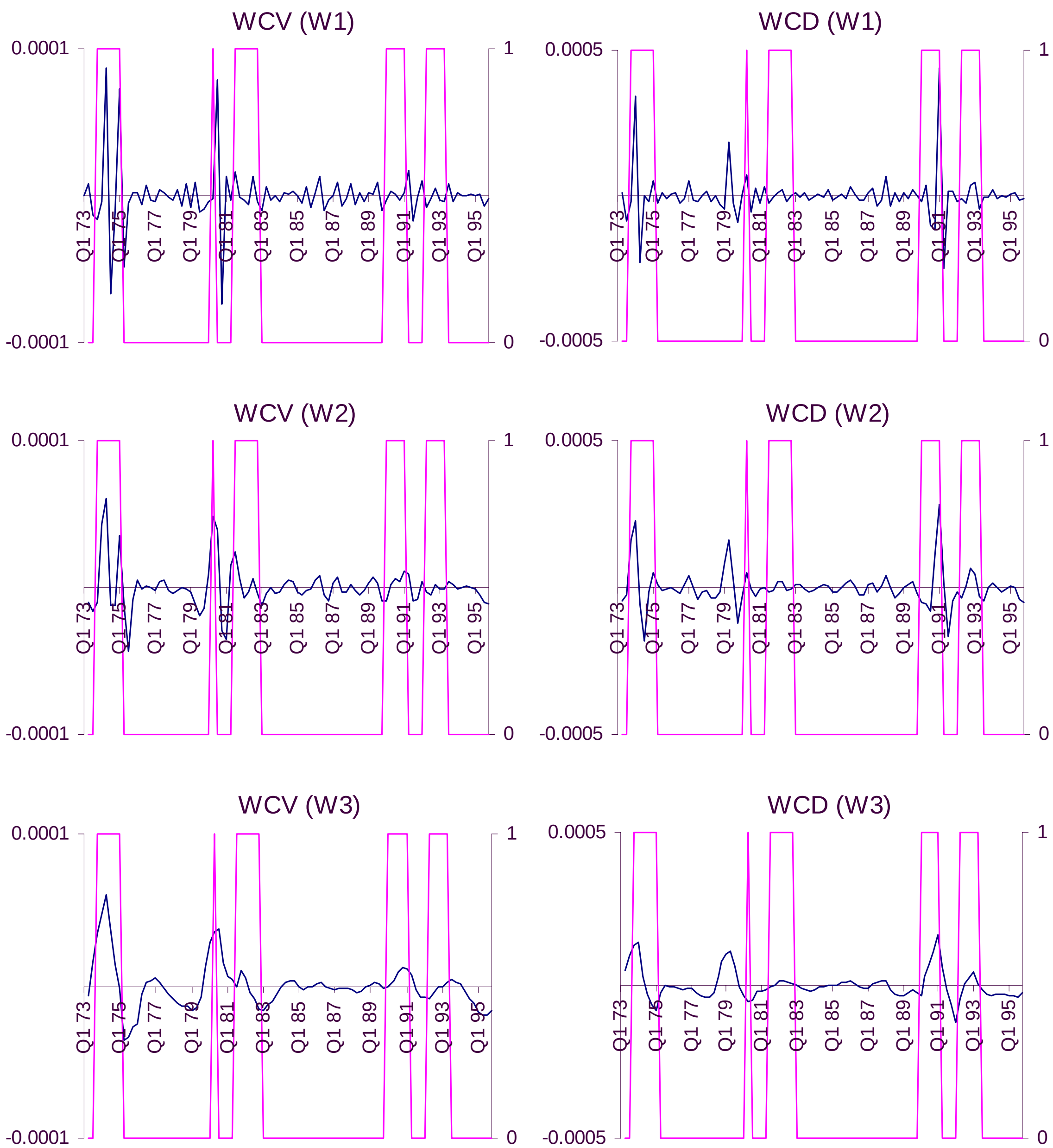


Figure 7.2. Contemporaneous Relation between Dispersion and Variance of the World Consumption. The scatterplot depicts the contemporaneous relation between the log world consumption growth variance, WCV, and log world consumption dispersion, WCD.



A B

Figure 7.3. **Wavelet Decomposition and World Business Cycles.** First- (W1), second- (W2) and third-order (W3) wavelet coefficients of the variance of the world consumption growth, WCV (Plot A), and the cross-country dispersion of consumption growth rates, WCD (Plot B). It also depicts the stage of the world business cycle based on the world recession dummy D_t. It is assigned the value of 1 if $D_t > 0.5$, and 0 otherwise.

Table 7.1
Quasi-Maximum Likelihood Estimates of the World Consumption Growth

The table shows the point estimates, Bollerslev and Wooldridge (1992) robust *t*-statistics, and the value of the log likelihood function, *logL*, from estimating the following E-ARCH model:

$$\mathrm{WCG}_t = p_0 + p_1 \mathrm{WCG}_{t-1} + p_2 \mathrm{WTS}_{t-1} + u_t$$
$$\ln\left(\mathrm{WCV}_t\right) = q_0 + q_1 \mathrm{WCG}_{t-1} + q_2 \mathrm{WTS}_{t-1} + a\left(\left|\varphi_{t-1}\right| - \sqrt{2/\pi}\right),$$

where WCG_t is the world consumption growth at time *t*, WCV_t is the variance of the world consumption growth at time *t*, and WTS_t is the world term spread at time *t*. The WTS is computed as the GDP-weighted average of countries' term spreads expressed in local currency units. All variables except the WCV series are demeaned.

First moment parameters			Second moment parameters				
p_0	p_1	p_2	q_0	q_1	q_2	a	*logL*
0.0001	0.2938	0.0421	-10.9087	-138.1748	-18.9975	-0.8630	404.21
(0.07)	(4.09)	(1.32)	(-114.87)	(-5.24)	(-2.41)	(-4.46)	

Table 7.2
Tests of the Model Using the World Real Risk-Free Returns and Conditional Variance of the World Consumption Growth

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. All consumption data are from the National Accounts. The real U.S. Treasury bill is the nominal quarterly return to rolling over one month bills each month deflated by the U.S. three-month consumer price index (CPI) changes. Both the nominal one-month T-bill returns and CPI changes are from Ibbotson Associates. The world riskless rate is the GDP-weighted average of the one-month Eurocurrency rates from eight countries compounded over the quarter. The results are obtained by estimating the Euler equation:

$$\rho E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]R^{wrf}_{t+1}\middle|Z_t\right]-1=0,$$

where γ is the concavity parameter, ρ is the time preference parameter, and k is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1, 2, 5, 10. R^{wrf}_{t+1} is the world real riskless return. C_{t+1}/C_t is the world real consumption growth from time t to time t+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, lagged world consumption growth, lagged world consumption variance, and lagged real U.S. Treasury bill return. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. HJ distance is multiplied by 10^4.

					Pricing Kernel		
k	γ	ρ	J	p	Mean	S.D.	HJ
NH	1.86	1.0019	4.18	0.124	0.9928	0.0106	0.0017
	(0.76)	(0.0044)					
1	1.45	1.0000	7.98	0.019	0.9930	0.0082	0.0021
	(0.56)	(0.0034)					
2	1.43	0.9998	8.01	0.018	0.9930	0.0081	0.0021
	(0.54)	(0.0032)					
5	1.38	0.9994	8.13	0.017	0.9929	0.0079	0.0021
	(0.49)	(0.0029)					
10	1.29	0.9987	8.39	0.015	0.9929	0.0075	0.0022
	(0.42)	(0.0025)					

Table 7.3

Tests of the Model Using International Excess Equity Returns and Conditional Variance of the World Consumption Growth

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The results are obtained by estimating the Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(R_{i,t+1}-R_{rf,t+1}-\alpha_i\right)\middle| Z_t\right]=0\ ,$$

where γ is the concavity parameter, and k is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1, 2, 5, 10. $R_{j,t+1}-R_{rf,t+1}$ are the quarterly U.S. dollar denominated excess returns in national equities markets. C_{t+1}/C_t is the real world consumption growth from time t to time t+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, the lagged world consumption growth, the lagged cross-country variance of national consumption growth rates, and the lagged world exchange rate changes. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding p-values (p). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. HJ distance is multiplied by 10^4.

		Pricing Errors										Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	α_{US}	J	p	Mean	S.D.	HJ
NH	88.57	-0.0000	-0.0025	0.0033	-0.0178	0.0007	0.0120	0.0262	0.0109	11.94	0.683	0.7653	0.6555	68.806
	(27.21)	(0.0083)	(0.0126)	(0.0108)	(0.0107)	(0.0098)	(0.0092)	(0.0128)	(0.0067)					
1	44.37	0.0029	-0.0020	0.0018	-0.0171	0.0002	0.0100	0.0225	0.0120	13.18	0.588	0.8621	0.2948	52.165
	(27.63)	(0.0086)	(0.0110)	(0.0087)	(0.0112)	(0.0099)	(0.0089)	(0.0119)	(0.0069)					
2	30.13	0.0035	-0.0028	0.0006	-0.0183	-0.0002	0.0090	0.0213	0.0129	13.86	0.536	0.9030	0.1961	48.756
	(27.83)	(0.0086)	(0.0108)	(0.0083)	(0.0113)	(0.0099)	(0.0089)	(0.0117)	(0.0069)					
5	15.16	0.0040	-0.0038	-0.0003	-0.0199	-0.0008	0.0081	0.0200	0.0140	14.54	0.485	0.9495	0.0975	46.096
	(27.71)	(0.0086)	(0.0106)	(0.0081)	(0.0115)	(0.0099)	(0.0090)	(0.0115)	(0.0069)					
10	8.09	0.0042	-0.0041	-0.0006	-0.0206	-0.0009	0.0079	0.0195	0.0146	14.79	0.466	0.9728	0.0521	45.191
	(27.75)	(0.0086)	(0.0108)	(0.0083)	(0.0113)	(0.0099)	(0.0089)	(0.0117)	(0.0069)					

Table 7.4

Tests of the Model Using Speculative Returns in the Forward Currency Markets Conditional Variance of the World Consumption Growth

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The estimation results are obtained by estimating the Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(\frac{S_{i,t+1}-F_{i,t}}{S_{i,t}}-\alpha_i\right)\middle|Z_t\right]=0\ ,$$

where γ is the concavity parameter, and k is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1, 2, 5, 10. $\left(S_{i,t+1}-F_{i,t}\right)/S_{i,t}$ are the real quarterly U.S. dollar denominated profits in the national currency markets that are obtained by deflating the corresponding nominal returns by the U.S. quarterly CPI changes. C_{t+1}/C_t is the real world consumption growth from time t to time t+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, the lagged world consumption growth, the lagged cross-country variance of national consumption growth rates, and the lagged world forward premium. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding p-values (p). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. HJ distance is multiplied by 10^4.

		Pricing Errors									Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	J	p	Mean	S.D.	HJ
NH	118.37	0.0005	0.0074	0.0068	0.0044	0.0087	0.0070	0.0056	13.92	0.380	0.7798	1.0757	60.803
	(34.05)	(0.0005)	(0.0025)	(0.0028)	(0.0018)	(0.0017)	(0.0042)	(0.0017)					
1	56.03	-0.0001	0.0060	0.0050	0.0036	0.0076	0.0058	0.0042	15.14	0.299	0.8527	0.4057	47.301
	(39.45)	(0.0007)	(0.0021)	(0.0023)	(0.0019)	(0.0020)	(0.0032)	(0.0019)					
2	36.15	-0.0002	0.0055	0.0044	0.0032	0.0072	0.0052	0.0037	15.55	0.274	0.8958	0.2469	45.612
	(43.35)	(0.0008)	(0.0020)	(0.0022)	(0.0019)	(0.0020)	(0.0028)	(0.0019)					
5	17.47	-0.0003	0.0052	0.0040	0.0030	0.0070	0.0048	0.0033	15.90	0.254	0.9459	0.1155	44.738
	(44.43)	(0.0008)	(0.0019)	(0.0020)	(0.0019)	(0.0020)	(0.0025)	(0.0019)					
10	9.26	-0.0003	0.0051	0.0038	0.0028	0.0070	0.0046	0.0031	16.02	0.248	0.9708	0.0610	44.636
	(43.50)	(0.0008)	(0.0018)	(0.0019)	(0.0019)	(0.0020)	(0.0024)	(0.0019)					

Table 7.5
Tests of the Model Using International Excess Equity Returns: Unconditional Version

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The real U.S. T-bill is the nominal quarterly return to rolling over one month bills each month deflated by the U.S. three-month CPI changes. The results are obtained by estimating the Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(R_{i,t+1}-R_{rf,t+1}\right)\right]=0,$$

where γ is the concavity parameter, and k is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1, 2, 5, 10. $R_{j,t+1}-R_{rf,t+1}$ are the quarterly U.S. dollar denominated excess returns in national equities markets. C_{t+1}/C_t is the real world consumption growth from time t to time t+1. The instrument used in the GMM estimation is a constant. Besides parameter estimates and their standard errors (S.E.), the table shows the goodness-of-fit J-statistics (J). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. HJ distance is multiplied by 10^4. The first line for each k > 0 corresponds to the estimation of the model with the world consumption dispersion, the second line (shown in italics) - with the world consumption variance.

				Pricing Kernel		
k	γ	S.E.	J	Mean	S.D.	HJ
NH	44.05	60.56	6.45	0.8341	0.2657	6.4128
1	25.52	59.88	5.98	0.9205	0.1897	4.1593
	33.92	*74.25*	*6.33*	*0.8803*	*0.2120*	*5.2503*
2	19.09	39.86	5.88	0.9484	0.1555	3.8486
	27.28	*101.31*	*6.26*	*0.9078*	*0.1739*	*4.7855*
5	11.50	11.12	5.86	0.9772	0.1058	3.7828
	16.90	*37.34*	*6.17*	*0.9467*	*0.1110*	*4.3795*
10	7.10	3.25	5.90	0.9903	0.0708	3.8776
	10.23	*9.81*	*6.13*	*0.9695*	*0.0686*	*4.2601*

Table 7.6
Tests of the Model Using Speculative Returns in the Forward Currency Markets: Unconditional Version

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The estimation results are obtained by estimating the Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(\frac{S_{i,t+1}-F_{i,t}}{S_{i,t}}\right)\right]=0\ ,$$

where γ is the concavity parameter, and k is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1, 2, 5, 10. $\left(S_{i,t+1}-F_{i,t}\right)/S_{i,t}$ are the real quarterly U.S. dollar denominated profits in the national currency markets that are obtained by deflating the corresponding nominal returns by the U.S. quarterly CPI changes. C_{t+1}/C_t is the real world consumption growth from time t to time t+1. The instrument vector used in the GMM estimation is a constant. Besides parameter estimates and their standard errors (S.E.), the table shows the goodness-of-fit J-statistics (J). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. HJ distance is multiplied by 10^4. The first line for each k > 0 corresponds to the estimation of the model with the world consumption dispersion, the second line (shown in italics) - with the world consumption variance.

				Pricing Kernel		
k	γ	S.E.	J	Mean	S.D.	HJ
NH	55.51	35.64	3.64	0.8069	0.3484	8.1008
1	36.64	33.57	3.48	0.9192	0.3426	4.1680
	45.63	*36.84*	*3.65*	*0.8605*	*0.3057*	*6.1744*
2	29.01	17.78	3.46	0.9618	0.3312	3.5493
	38.66	*35.91*	*3.70*	*0.8941*	*0.2701*	*5.3436*
5	19.57	1.94	3.49	1.0096	0.2989	3.4399
	25.90	*20.74*	*3.85*	*0.9428*	*0.1928*	*4.7146*
10	13.85	0.10	3.54	1.0342	0.2645	3.6684
	16.29	*4.80*	*4.00*	*0.9695*	*0.1259*	*4.7053*

Chapter 8

Conclusions

This dissertation investigates the interrelation between low correlation of consumption growth rates for major industrial countries and cross-country differences in returns for three classes of assets: riskless securities, equities, and currencies. My objective is two-fold: (1) to investigate whether the heterogeneity of consumption growth rates across countries has a measurable impact on the cross-country differences in asset returns, and (2) to test on the country level the implications of the Constantinides and Duffie (1996) CCAPM which accounts for the investors' heterogeneity and existence of incomplete markets.

Recent studies on incomplete consumption risk sharing suggest that the idiosyncratic risk may be an important component responsible for the failure of the standard CCAPM to resolve the risk premium, equity premium, and forward premium puzzles. While the opportunities for regional diversification of income and consumption streams within a single country are greater than those across countries, all the empirical work so far was limited to the United States. This implies that even if the unsystematic risk associated with the partial consumption risk sharing exists, its detection on a single country data is quite complicated. This paper overcomes this difficulty by searching for evidence of incomplete markets within a multi-country framework. I conclude that:

- Theoretical implications of the CCAPM with heterogeneity are generally supported in the data.
- In its influence on asset pricing, the cross-country consumption heterogeneity is different from the variance of the world consumption growth.
- International markets simplify an empirical exploitation of the relation between consumption heterogeneity and the cross-sectional differencies in returns on financial assets.

The major contribution of this dissertation is the empirical valuation of the importance of consumption dispersion - the cross-sectional variance of consumption growth rates - on asset pricing. This is achieved by extending the Constantinides and Duffie (1996) model to an international setting in which aggregate consumption is the GDP-weighted average of national real per-capita consumption growth rates, while consumption dispersion is just the cross-sectional variance of the log consumption growth. I find that the expected asset returns are *negatively* related to the covariance of returns with the cross-country consumption dispersion. In comparison with the standard CCAPM, I also find that:

1. The estimates of the risk aversion parameter γ decrease markedly for excess equity and speculative currency returns and slightly for the world riskless rate.
2. The estimates of the time preference parameter ρ decrease and reach levels even below unity when the contribution of consumption dispersion is reinforced by the multiplicative factor k of about 5-10.

3. All of the average pricing errors for currency returns and most of those for excess returns decrease.
4. The Hansen and Jagannathan (1997) distance measure between the true pricing kernel and the one implied by the model decreases.

I also analyze the sensitivity of major empirical results to: (i) the choice of the number of countries contributing to the measures of the world consumption growth and cross-country consumption dispersion, (ii) the extreme data points in the consumption dispersion series, (iii) averaged rather than compounded returns data. These tests show that the qualitative findings of the dissertation are robust to some alterations in the data.

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Appendix A

Derivation of the World CCAPM with Heterogeneity

Let C_t and $C_{i,t}$ are the world and country *i* consumption at time *t* respectively. Suppose $C_{i,t} = \delta_{i,t} C_t$, where $\delta_{i,t}$ is the country *i*'s proportion of the world consumption and $\sum \delta_{i,t} = 1$ over all *i*. I specify $\delta_{i,t}$ as in Constantinides and Duffie (1996), namely:

$$\delta_{i,t} = \delta_{i,t-1} \exp\left(\eta_{i,t} \sqrt{d_t} - \frac{d_t}{2} \right),$$

where $\eta_{i,t} \sim N(0,\ 1)$ is the standard normal variable which denotes in this setting the country *i*'s consumption shock at time *t*, d_t denotes the cross-country consumption dispersion, and $\eta_{i,t}$ and d_t are independent across all countries and time. The process for d_t is defined as follows:

$$d_t = \frac{2}{\gamma(\gamma+1)} \left(\ln m_t - \ln \rho + \gamma \ln \frac{C_t}{C_{t-1}} \right) - d_t^w .$$

where m_t is the pricing kernel and d_t^w is the within-a-country consumption dispersion at time *t*. Then, the intertemporal marginal rate of substitution in consumption for investors in country *i* is:

$$
\begin{aligned}
m_{i,t+1} &= \left(\frac{C_{i,t+1}}{C_{i,t}}\right)^{-\gamma} \exp\left(\frac{\gamma(\gamma+1)}{2} d^w_{t+1}\right) \\
&= \left(\frac{\delta_{i,t+1} C_{t+1}}{\delta_{i,t} C_t}\right)^{-\gamma} \exp\left(\frac{\gamma(\gamma+1)}{2} d^w_{t+1}\right) \\
&= \left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \exp\left(\frac{\gamma(\gamma+1)}{2} d^w_{t+1}\right) \exp\left(-\gamma\left(\eta_{i,t+1}\sqrt{d_{t+1}} - \frac{d_{t+1}}{2}\right)\right).
\end{aligned}
$$

Using the law of iterated expectations as well as assumptions of independence for $\eta_{i,t}$ and d_t and perfect financial markets, the Euler equation for each country *i* takes the form:

$$
\begin{aligned}
&\rho E_t\left[\left(\frac{C_{i,t+1}}{C_{i,t}}\right)^{-\gamma} \exp\left(\frac{\gamma(\gamma+1)}{2} d^w_{t+1}\right) R_{i,t+1}\right] \\
&= \rho E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \exp\left(\frac{\gamma(\gamma+1)}{2} d^w_{t+1}\right) \exp\left(-\gamma\left(\eta_{i,t+1}\sqrt{d_{t+1}} - \frac{d_{t+1}}{2}\right)\right) R_{i,t+1}\right] \\
&= \rho E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \exp\left(\frac{\gamma(\gamma+1)}{2} d^w_{t+1}\right) E_t\left[\exp\left(-\gamma\left(\eta_{i,t+1}\sqrt{d_{t+1}} - \frac{d_{t+1}}{2}\right)\right)\right] R_{i,t+1}\right] \\
&= \rho E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \exp\left(\frac{\gamma(\gamma+1)}{2} d^w_{t+1}\right) \exp\left(\frac{\gamma(\gamma+1)}{2} d_{t+1}\right) R_{i,t+1}\right],
\end{aligned}
$$

where the last line follows from the fact that for any standard normal variable *x* and constants *c* and α:

$$
E\left[\exp\left(-x\alpha c + \alpha c^2 / 2\right)\right] = \exp\left(\alpha c^2 / 2\right) E\left[\exp(-x\alpha c)\right] = \exp\left(\alpha c^2 / 2\right) \exp\left(\alpha^2 c^2 / 2\right).
$$

Thus, the Euler equation for the world CCAPM with heterogeneity is:

$$
\rho E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \exp\left(\frac{\gamma(\gamma+1)}{2}\left(d_{t+1} + d^w_{t+1}\right)\right) R_{i,t+1}\right] = 1,
$$

that is, relation (2.5).

Appendix B

Alternative Measures of Consumption Dispersion

When testing the beta pricing formulation (2.7) and Euler equations (2.5) and (4.3) on actual data I constructed the world consumption growth, WCG, and consumption dispersion, WCD, measures from the data on eight industrial countries. Naturally, it seems necessary to see whether the major test results are qualitatively different with other measures of dispersion. At the initial stage of my dissertation research, I constructed WCD series from consumption data of only five industrial countries: France, Germany, Japan, the United Kingdom, and the United States. Later I also tested the model with another dispersion measure which was based on the cross-country variance of the per-capita GDP rates using data from all eight developed countries. The purpose of this appendix is to report my findings which in fact provide a useful information on the robustness of test results reported in chapter 6.

EMPIRICAL RESULTS FOR FIVE DEVELOPED COUNTRIES

Table B.1 shows the results of estimating model (2.5) using the world real risk-free returns, WRF. The instrument vector ***Z*** is composed of a constant, the lagged values of the WCG, and U.S. T-bill returns. Qualitatively, the results are similar to the ones reported in panels A of tables 6.1 and 6.4. An increase in the multiplicative factor *k* leads to a decrease in the estimates of the risk aversion parameter γ, time preference parameter ρ, and the Hansen-Jagannathan (HJ) distance. Interestingly, the overall with of the model now is even better: both the Hansen's J-statistic and HJ distance measure are smaller for any given value of k as compared to those in tables 6.1 and 6.4, panels A. Finally, one can observe a simultaneous increase in the estimates of the mean and standard deviation of the implied pricing kernel.

Table B.2 shows the results of estimating model (4.3) using the excess equity returns. The instrument vector ***Z*** is composed of a constant, the lagged values of WCG, and the world exchange rate changes, WEX. The results are very similar to those reported in panels A of tables 6.2 and 6.5: as k increases, the estimate of γ drops markedly reaching the value of 2.14 at k = 10.

Table B.3 presents the results of estimating model (4.3) using the real speculative returns in the forward currency market. The instrument vector ***Z*** is composed of a constant, the lagged values of WCG, and world forward premium, WFP. The test results are very close numerically to those reported in panels A of tables 6.3 and 6.6 for any given value of k.

EMPIRICAL RESULTS FOR THE GDP BASED MEASURE OF DISPERSION

The quarterly GDP data for all eight countries are from *Datastream* and cover the same period of 1973:Q2-1995:Q4. To arrive at the per capita GDP in local currency units, the GDP for each country is divided by the quarterly population estimates. Similar to the construction of the world consumption dispersion measure, the cross-country dispersion of the real per-capita GDP growth is calculated as the variance of the logarithmic changes in the real national per-capita GDP growth rates expressed in local currency units, i.e., without any weighting scheme.

Table B.4 shows the results of estimating model (2.5) using the world real risk-free returns, WRF. The instrument vector ***Z*** is composed of a constant, the lagged values of the WCG, and U.S. T-bill returns. Qualitatively, the results are similar to the ones reported in panels A of tables 6.1 and 6.4. An increase in the multiplicative factor k leads to a decrease in the estimates of the risk aversion parameter γ, time preference parameter ρ. Most importantly, unlike the world consumption variance, the GDP-based measure of dispersion leads to the decrease in the Hansen-Jagannathan distance. The overall with of the model is again better now than with the WCD: the Hansen's J-statistic becomes smaller as k increases, and, at k =10, the model is no longer rejected. As before, one can observe a simultaneous increase in the estimates of the mean and standard deviation of the implied pricing kernel at higher values of k.

Table B.5 shows the results of estimating model (4.3) using the excess equity returns. The instrument vector ***Z*** is composed of a constant, the lagged values of WCG, and the world exchange rate changes, WEX. The results are very similar to those reported in panels A of tables 6.2 and 6.5: as k increases, the estimate of γ drops markedly reaching the value of 4.59 at k = 10. While J-statistics marginally increases, the HJ distance decreases when the impact of dispersion on the pricing kernel increases.

Table B.6 presents the results of estimating model (4.3) using the real speculative returns in the forward currency market. The instrument vector ***Z*** is composed of a constant, the lagged values of WCG, and world forward premium, WFP. Again, the test results are close numerically to those reported in panels A of tables 6.3 and 6.6 for any given value of *k*.

Table B.1
Tests of the Model Using the World Real Risk-Free Returns: Five Developed Countries

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for France, Germany, Japan, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country consumption dispersion is the variance of the log of the real national per-capita consumption growth rates also expressed in local currency units. The results are obtained by estimating the following Euler equation:

$$\rho E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]R_{t+1}^{wrf}\middle|Z_t\right]-1=0,$$

where γ is the concavity parameter, ρ is the time preference parameter, and k is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1, 2, 5, 10. R_{t+1}^{wrf} is the world real riskless return. The ratio C_{t+1}/C_t is the world real consumption growth from time t to time t+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, lagged world consumption growth, lagged cross-country dispersion of national consumption growth rates, and lagged real U.S. Treasury bill return. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding p-values (p). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

					Pricing Kernel		
k	γ	ρ	J	p	Mean	S.D.	HJ
NH	1.92	1.0023	4.00	0.045	0.9929	0.0109	0.0016
	(0.78)	(0.0045)					
1	1.89	1.0019	4.00	0.045	0.9929	0.0109	0.0016
	(0.75)	(0.0042)					
2	1.86	1.0016	3.99	0.045	0.9930	0.0109	0.0016
	(0.73)	(0.0039)					
5	1.82	1.0009	3.82	0.051	0.9932	0.0113	0.0016
	(0.67)	(0.0034)					
10	1.75	0.9997	3.50	0.112	0.9935	0.0119	0.0015
	(0.61)	(0.0027)					

Table B.2
Tests of the Model Using International Excess Equity Returns: Five Developed Countries

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for France, Germany, Japan, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country consumption dispersion is the variance of the log of the real national per-capita consumption growth rates also expressed in local currency units. The results are obtained by estimating the following Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(R_{i,t+1}-R_{rf,t+1}-\alpha_i\right)\middle|Z_t\right]=0\,,$$

where γ is the concavity parameter, α_i is average the pricing error for country *i*, and *k* is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for *k* = 1, 2, 5, 10. The difference $R_{i,t+1}-R_{rf,t+1}$ is the quarterly U.S. dollar denominated excess equity return for country *i*. The ratio C_{t+1}/C_t is the real world consumption growth from time *t* to time *t*+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, the lagged world consumption growth, the lagged cross-country dispersion of national consumption growth rates, and the lagged world exchange rate changes. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

		Pricing Errors										Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	α_{US}	J	*p*	Mean	S.D.	HJ
NH	88.29	0.0004	-0.0020	0.0037	-0.0174	0.0010	0.0120	0.0262	0.0109	11.69	0.702	0.7654	0.6527	65.000
	(27.21)	(0.0083)	(0.0126)	(0.0107)	(0.0107)	(0.0099)	(0.0092)	(0.0128)	(0.0067)					
1	18.31	0.0027	-0.0015	0.0017	-0.0165	0.0005	0.0095	0.0211	0.0117	13.36	0.574	0.9385	0.1352	44.710
	(21.89)	(0.0085)	(0.0110)	(0.0082)	(0.0115)	(0.0100)	(0.0091)	(0.0113)	(0.0069)					
2	10.52	0.0032	-0.0022	0.0006	-0.0178	-0.0002	0.0087	0.0203	0.0128	13.99	0.526	0.9637	0.0779	43.376
	(22.56)	(0.0085)	(0.0109)	(0.0082)	(0.0116)	(0.0100)	(0.0091)	(0.0113)	(0.0069)					
5	4.52	0.0037	-0.0027	-0.0001	-0.0189	-0.0007	0.0082	0.0198	0.0138	14.44	0.492	0.9845	0.0335	42.541
	(23.32)	(0.0085)	(0.0108)	(0.0081)	(0.0116)	(0.0100)	(0.0091)	(0.0112)	(0.0069)					
10	2.14	0.0039	-0.0025	-0.0001	-0.0192	-0.0008	0.0083	0.0198	0.0143	14.59	0.481	0.9929	0.0161	42.269
	(23.69)	(0.0085)	(0.0108)	(0.0081)	(0.0116)	(0.0100)	(0.0092)	(0.0112)	(0.0069)					

Table B.3
Tests of the Model Using Speculative Returns in the Forward Currency Markets: Five Developed Countries

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for France, Germany, Japan, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country consumption dispersion is the variance of the log of the real national per-capita consumption growth rates also expressed in local currency units. The estimation results are obtained by estimating the following Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(\frac{S_{i,t+1}-F_{i,t}}{S_{i,t}}-\alpha_i\right)\middle|Z_t\right]=0\,,$$

where γ is the concavity parameter, α_i is the average pricing error for country *i*, and *k* is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for *k* = 1, 2, 5, 10. The standardized ratio $\left(S_{i,t+1}-F_{i,t}\right)/S_{i,t}$ is the real quarterly U.S. dollar denominated profits in currency *i* that are obtained by deflating the corresponding nominal returns by the U.S. quarterly CPI changes. The ratio C_{t+1}/C_t is the real world consumption growth from time *t* to time *t*+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, the lagged world consumption growth, the lagged cross-country dispersion of national consumption growth rates, and the lagged world forward premium. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

		Pricing Errors									Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	J	*p*	Mean	S.D.	HJ
NH	118.89	0.0015	0.0219	0.0203	0.0132	0.0265	0.0211	0.0170	14.10	0.367	0.7805	1.0847	60.776
	(33.65)	(0.0016)	(0.0075)	(0.0084)	(0.0053)	(0.0051)	(0.0126)	(0.0049)					
1	18.69	-0.0003	0.0054	0.0043	0.0031	0.0072	0.0049	0.0034	16.28	0.234	0.9374	0.1406	47.940
	(34.00)	(0.0008)	(0.0019)	(0.0021)	(0.0019)	(0.0020)	(0.0026)	(0.0020)					
2	10.68	-0.0004	0.0053	0.0041	0.0029	0.0071	0.0048	0.0033	16.49	0.223	0.9634	0.0794	47.167
	(35.31)	(0.0008)	(0.0019)	(0.0020)	(0.0019)	(0.0020)	(0.0025)	(0.0020)					
5	4.55	-0.0004	0.0051	0.0039	0.0028	0.0070	0.0046	0.0032	16.63	0.216	0.9854	0.0338	46.743
	(36.21)	(0.0008)	(0.0018)	(0.0020)	(0.0019)	(0.0020)	(0.0024)	(0.0020)					
10	2.15	-0.0004	0.0051	0.0039	0.0027	0.0070	0.0046	0.0031	16.70	0.213	0.9929	0.0162	46.617
	(36.51)	(0.0008)	(0.0018)	(0.0019)	(0.0019)	(0.0020)	(0.0024)	(0.0020)					

Table B.4

Tests of the Model Using the World Real Risk-Free Returns: GDP Based Dispersion Measure

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for France, Germany, Japan, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country consumption dispersion is proxied by the variance of the log of the real national per-capita GDP growth rates also expressed in local currency units. The results are obtained by estimating the following Euler equation:

$$\rho E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]R_{t+1}^{wrf}\middle|Z_t\right]-1=0,$$

where γ is the concavity parameter, ρ is the time preference parameter, and k is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1, 2, 5, 10. R_{t+1}^{wrf} is the world real riskless return. The ratio C_{t+1}/C_t is the world real consumption growth from time t to time t+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, lagged world consumption growth, lagged cross-country dispersion of national GDP growth rates, and lagged real U.S. Treasury bill return. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

					Pricing Kernel		
k	γ	ρ	J	p	Mean	S.D.	HJ
NH	1.92	1.0023	4.00	0.045	0.9929	0.0109	0.0016
	(0.78)	(0.0045)					
1	1.90	1.0020	4.00	0.045	0.9929	0.0109	0.0016
	(0.76)	(0.0043)					
2	1.89	1.0018	3.99	0.045	0.9929	0.0109	0.0016
	(0.75)	(0.0041)					
5	1.83	1.0011	3.98	0.046	0.9930	0.0109	0.0016
	(0.70)	(0.0036)					
10	1.78	1.0003	3.82	0.051	0.9932	0.0111	0.0015
	(0.65)	(0.0030)					

Table B.5

Tests of the Model Using International Excess Equity Returns: GDP Based Dispersion Measure

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for France, Germany, Japan, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country consumption dispersion is proxied by the variance of the log of the real national per-capita GDP growth rates also expressed in local currency units. The results are obtained by estimating the following Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(R_{i,t+1}-R_{rf,t+1}-\alpha_i\right)\Big|Z_t\right]=0,$$

where γ is the concavity parameter, α_i is average the pricing error for country *i*, and *k* is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for *k* = 1, 2, 5, 10. The difference $R_{i,t+1}-R_{rf,t+1}$ is the quarterly U.S. dollar denominated excess equity return for country *i*. The ratio C_{t+1}/C_t is the real world consumption growth from time *t* to time *t*+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, the lagged world consumption growth, the lagged cross-country dispersion of national consumption growth rates, and the lagged world exchange rate changes. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

		Pricing Errors										Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	α_{US}	J	*p*	Mean	S.D.	HJ
NH	88.29	0.0004	-0.0020	0.0037	-0.0174	0.0010	0.0120	0.0262	0.0109	11.69	0.702	0.7654	0.6527	65.000
	(27.21)	(0.0083)	(0.0126)	(0.0107)	(0.0107)	(0.0099)	(0.0092)	(0.0128)	(0.0067)					
1	29.64	0.0031	-0.0019	0.0023	-0.0169	0.0007	0.0095	0.0212	0.0116	12.98	0.604	0.9083	0.2078	46.989
	(23.48)	(0.0086)	(0.0110)	(0.0085)	(0.0113)	(0.0110)	(0.0089)	(0.0117)	(0.0070)					
2	18.58	0.0037	-0.0029	0.0010	-0.0182	0.0001	0.0086	0.0203	0.0127	13.71	0.548	0.9424	0.1295	44.617
	(23.97)	(0.0086)	(0.0108)	(0.0083)	(0.0115)	(0.0100)	(0.0090)	(0.0116)	(0.0070)					
5	8.82	0.0043	-0.0036	0.0001	-0.0197	-0.0006	0.0081	0.0195	0.0139	14.36	0.498	0.9732	0.0614	43.051
	(24.88)	(0.0086)	(0.0107)	(0.0082)	(0.0116)	(0.0101)	(0.0090)	(0.0115)	(0.0070)					
10	4.59	0.0046	-0.0038	-0.0002	-0.0204	-0.0009	0.0079	0.0193	0.0145	14.60	0.481	0.9866	0.0322	42.546
	(25.44)	(0.0085)	(0.0107)	(0.0082)	(0.0117)	(0.0101)	(0.0091)	(0.0115)	(0.0070)					

Table B.6

Tests of the Model Using Speculative Returns in the Forward Currency Markets: GDP Based Dispersion Measure

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for France, Germany, Japan, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country consumption dispersion is proxied by the variance of the log of the real national per-capita GDP growth rates also expressed in local currency units. The estimation results are obtained by estimating the following Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(\frac{S_{i,t+1}-F_{i,t}}{S_{i,t}}-\alpha_i\right)\middle|Z_t\right]=0,$$

where γ is the concavity parameter, α_i is the average pricing error for country *i*, and *k* is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for *k* = 1, 2, 5, 10. The standardized ratio $\left(S_{i,t+1}-F_{i,t}\right)/S_{i,t}$ is the real quarterly U.S. dollar denominated profits in currency *i* that are obtained by deflating the corresponding nominal returns by the U.S. quarterly CPI changes. The ratio C_{t+1}/C_t is the real world consumption growth from time *t* to time *t*+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, the lagged world consumption growth, the lagged cross-country dispersion of national consumption growth rates, and the lagged world forward premium. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

		Pricing Errors									Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	J	*p*	Mean	S.D.	HJ
NH	118.89	0.0015	0.0219	0.0203	0.0132	0.0265	0.0211	0.0170	14.10	0.367	0.7805	1.0847	60.776
	(33.65)	(0.0016)	(0.0075)	(0.0084)	(0.0053)	(0.0051)	(0.0126)	(0.0049)					
1	32.63	-0.0003	0.0167	0.0132	0.0103	0.0212	0.0161	0.0105	15.47	0.279	0.9053	0.2374	45.834
	(33.84)	(0.0022)	(0.0059)	(0.0063)	(0.0058)	(0.0061)	(0.0081)	(0.0058)					
2	19.28	-0.0006	0.0157	0.0120	0.0095	0.0207	0.0148	0.0095	15.86	0.257	0.9415	0.1359	44.909
	(36.71)	(0.0023)	(0.0057)	(0.0060)	(0.0058)	(0.0060)	(0.0076)	(0.0058)					
5	8.63	-0.0008	0.0151	0.0112	0.0089	0.0205	0.0139	0.0089	16.17	0.240	0.9735	0.0598	44.612
	(36.71)	(0.0023)	(0.0055)	(0.0058)	(0.0057)	(0.0059)	(0.0073)	(0.0057)					
10	4.35	-0.0009	0.0149	0.0109	0.0086	0.0204	0.0136	0.0087	16.28	0.234	0.9869	0.0301	44.613
	(40.98)	(0.0023)	(0.0055)	(0.0057)	(0.0057)	(0.0059)	(0.0072)	(0.0057)					

Appendix C

Trimmed Consumption Dispersion

The world consumption dispersion data, WCD, has several distinct spikes. Even though it would be incorrect to regard these data points as outliers, it is informative to learn how these dispersion data affect the empirical results reported in chapters 5 and 6. While working on my dissertation research, I have tested the Euler equations (2.5) and (4.3) with consumption dispersion measure trimmed at the 95-th percentile. The purpose of this appendix is to report my findings and provide yet additional information on the robustness of major results to changes in WCD.

DATA

After constructing the world consumption dispersion measure, WCD, I trim the series at its 95-th percentile value. I have chosen this cut-off level because of the following two reasons: (i) there are only five data points in the WCD series that have significantly higher magnitude than others and (ii) trimming 5% of the data points fits well into the context of "outliers". This percentile corresponds to the value of 0.0002 of the series or -8.49 for its logarithmic transformation (as opposed to -7.1215 in the original series). In other words, five values of the WCD, namely: 0.000204, 0.000262, 0.000474, 0.000710, and 0.000806 are being assigned the value of 0.0002. All other data remain unchanged.

EMPIRICAL RESULTS

Table C.1 shows the results of estimating model (2.5) using the world real risk-free returns, WRF. The instrument vector ***Z*** is composed of the constant, the lagged values of the world consumption growth, WCG, and the U.S. T-bill returns. All the results are very similar to the ones reported in panels A of tables 6.1 and 6.4. As before, an increase in the multiplicative factor k leads to a steady decrease in the estimates of the risk aversion parameter γ, time preference parameter ρ, and Hansen-Jagannathan distance.

Table C.2 shows the results of estimating model (4.3) using the excess equity returns. The instrument vector ***Z*** is composed of the constant, the lagged values of WCG, and the world exchange rate changes, WEX. Qualitatively the results are same as those reported in panels A of tables 6.2 and 6.5: as k increases, the risk aversion parameter drops. At $k = 10$, for example, $\gamma = 5.25$. The decrease in γ however is somewhat less profound than that found for the untrimmed WCD series. In spite of this, the values of the risk aversion parameter obtained by substituting the world consumption variance, WCV, for WCD and reported in table 7.3, are still on average 50% larger than the corresponding ones with the trimmed WCD. This provides an additional piece of evidence of a crucial distinction between WCD and WCV data.

Table C.3 presents the results of estimating model (4.3) using the real speculative returns in the forward currency market. The instrument vector ***Z*** is composed of the constant, the lagged values of WCG, and the world forward premium, WFP. Again, all the test results are similar to those reported in panels A of tables 6.3 and 6.6. The most notable distinction, as in the case of excess equity returns, is less profound drop in γ for higher values of k. The corresponding estimates of γ reported in table 7.4 are, nevertheless, more than 50% larger, which gives yet another support that the differences in the impact on asset returns between WCD and WCV hold across various classes of securities. Finally, the estimated Hansen-Jagannathan distance is even smaller than that in tables 6.3 and 6.6 for any given value of k.

Table C.1

Tests of the Model Using the World Real Risk-Free Returns: Trimmed Consumption Dispersion

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country dispersion of the per-capita consumption growth is the variance of the logarithmic changes in the real national per-capita consumption growth rates also expressed in local currency units. The consumption dispersion is trimmed at the 95-th percentile. The results are obtained by estimating the following Euler equation:

$$\rho E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]R_{t+1}^{wrf}\middle|Z_t\right]-1=0\,,$$

where γ is the concavity parameter, ρ is the time preference parameter, and k is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1, 2, 5, 10. R_{t+1}^{wrf} is the world real riskless return. The ratio C_{t+1}/C_t is the world real consumption growth from time t to time t+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, lagged world consumption growth, lagged cross-country dispersion of national consumption growth rates, and lagged real U.S. Treasury bill return. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding p-values (p). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

					Pricing Kernel		
k	γ	ρ	J	p	Mean	S.D.	HJ
NH	1.86	1.0015	3.05	0.081	0.9924	0.0106	0.0017
	(0.67)	(0.0041)					
1	1.85	1.0013	3.05	0.081	0.9924	0.0105	0.0017
	(0.65)	(0.0040)					
2	1.83	1.0010	3.06	0.081	0.9924	0.0104	0.0017
	(0.64)	(0.0038)					
5	1.78	1.0004	3.06	0.081	0.9925	0.0103	0.0016
	(0.60)	(0.0034)					
10	1.70	0.9994	3.06	0.081	0.9926	0.0101	0.0016
	(0.54)	(0.0029)					

Table C.2

Tests of the Model Using International Excess Equity Returns: Trimmed Consumption Dispersion

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country dispersion of the per-capita consumption growth is the variance of the logarithmic changes in the real national per-capita consumption growth rates also expressed in local currency units. The consumption dispersion is trimmed at the 95-th percentile. The results are obtained by estimating the following Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(R_{i,t+1}-R_{rf,t+1}-\alpha_i\right)\Bigg|Z_t\right]=0\,,$$

where γ is the concavity parameter, α_i is average the pricing error for country i, and k is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1, 2, 5, 10. The difference $R_{i,t+1}-R_{rf,t+1}$ is the quarterly U.S. dollar denominated excess equity return for country i. The ratio C_{t+1}/C_t is the real world consumption growth from time t to time t+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, the lagged world consumption growth, the lagged cross-country dispersion of national consumption growth rates, and the lagged world exchange rate changes. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding p-values (p). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

		Pricing Errors										Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	α_{US}	J	p	Mean	S.D.	HJ
NH	88.29	0.0004	-0.0020	0.0037	-0.0174	0.0010	0.0120	0.0262	0.0109	11.69	0.702	0.7654	0.6527	65.000
	(27.21)	(0.0083)	(0.0126)	(0.0107)	(0.0107)	(0.0099)	(0.0092)	(0.0128)	(0.0067)					
1	33.98	0.0029	-0.0025	0.0024	-0.0164	0.0011	0.0099	0.0217	0.0118	13.34	0.576	0.8998	0.2289	49.377
	(24.66)	(0.0086)	(0.0111)	(0.0086)	(0.0113)	(0.0100)	(0.0091)	(0.0116)	(0.0070)					
2	21.72	0.0035	-0.0034	0.0010	-0.0178	0.0005	0.0088	0.0206	0.0128	14.05	0.521	0.9364	0.1440	46.885
	(25.36)	(0.0086)	(0.0109)	(0.0083)	(0.0115)	(0.0099)	(0.0090)	(0.0114)	(0.0070)					
5	10.23	0.0040	-0.0041	-0.0001	-0.0196	-0.0003	0.0081	0.0196	0.0140	14.66	0.476	0.9706	0.0668	45.289
	(27.76)	(0.0086)	(0.0108)	(0.0082)	(0.0116)	(0.0099)	(0.0090)	(0.0113)	(0.0070)					
10	5.25	0.0043	-0.0043	-0.0004	-0.0205	-0.0007	0.0079	0.0192	0.0145	14.86	0.461	0.9853	0.0343	44.819
	(27.61)	(0.0086)	(0.0107)	(0.0081)	(0.0116)	(0.0099)	(0.0090)	(0.0112)	(0.0070)					

Table C.3

Tests of the Model Using Speculative Returns in the Forward Currency Markets: Trimmed Consumption Dispersion

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country dispersion of the per-capita consumption growth is the variance of the logarithmic changes in the real national per-capita consumption growth rates also expressed in local currency units. The consumption dispersion is trimmed at the 95-th percentile. The estimation results are obtained by estimating the following Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(\frac{S_{i,t+1}-F_{i,t}}{S_{i,t}}-\alpha_i\right)\middle| Z_t\right]=0\,,$$

where γ is the concavity parameter, α_i is the average pricing error for country *i*, and *k* is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for *k* = 1, 2, 5, 10. The standardized ratio $\left(S_{i,t+1}-F_{i,t}\right)/S_{i,t}$ is the real quarterly U.S. dollar denominated profits in currency *i* that are obtained by deflating the corresponding nominal returns by the U.S. quarterly CPI changes. The ratio C_{t+1}/C_t is the real world consumption growth from time *t* to time *t*+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, the lagged world consumption growth, the lagged cross-country dispersion of national consumption growth rates, and the lagged world forward premium. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

		Pricing Errors									Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	J	p	Mean	S.D.	HJ
NH	118.89	0.0015	0.0219	0.0203	0.0132	0.0265	0.0211	0.0170	14.10	0.367	0.7805	1.0847	60.776
	(33.65)	(0.0016)	(0.0075)	(0.0084)	(0.0053)	(0.0051)	(0.0126)	(0.0049)					
1	35.86	-0.0001	0.0056	0.0045	0.0034	0.0073	0.0054	0.0037	15.30	0.289	0.8991	0.2456	45.772
	(45.33)	(0.0008)	(0.0020)	(0.0022)	(0.0019)	(0.0021)	(0.0029)	(0.0020)					
2	21.31	-0.0002	0.0053	0.0041	0.0031	0.0071	0.0050	0.0033	15.65	0.269	0.9368	0.1406	45.064
	(52.39)	(0.0008)	(0.0020)	(0.0021)	(0.0019)	(0.0021)	(0.0027)	(0.0021)					
5	9.45	-0.0003	0.0051	0.0038	0.0029	0.0070	0.0047	0.0031	15.93	0.253	0.9715	0.0609	44.799
	(57.08)	(0.0008)	(0.0019)	(0.0021)	(0.0019)	(0.0021)	(0.0026)	(0.0021)					
10	4.72	-0.0003	0.0050	0.0037	0.0028	0.0070	0.0046	0.0030	16.03	0.275	0.9859	0.0304	44.779
	(57.98)	(0.0008)	(0.0019)	(0.0020)	(0.0019)	(0.0021)	(0.0025)	(0.0021)					

Appendix D

Mimicking Portfolios

During my dissertation research, I also constructed the maximum correlation mimicking portfolios for the world consumption growth and dispersion measures to gain an additional insight on the interpretation of the model and the tests. The purpose of this appendix is to report my findings.

CONSTRUCTION OF MIMICKING PORTFOLIOS

The maximum correlation mimicking portfolio method is introduced by Breeden, Gibbons and Litzenberger (1989) who construct a portfolio whose returns track the U.S. consumption growth. It is quite a useful tool in the analysis of the relation between macroeconomic variables and asset prices. There are two main reasons for the usefulness of this approach. First of all, since economic variable are not traded directly, the risk associated with them cannot be hedged or diversified away. However, a portfolio which mimics the risk embedded in those economic variable can be traded. Secondly, economic variables are observable at lower frequencies than traded assets. As a result, the maximum correlation mimicking portfolio method allows one to form a new larger data sample.

In this research, I use the approach of Lamont (1998) and look at the unexpected returns by projecting the two measures of consumption on both the contemporaneous asset returns and the set of lagged instruments. The regression model can be formulated as follows:

$$\text{CM}_t = \boldsymbol{bR}_t + \boldsymbol{cZ}_{t\text{-}1} + \xi_t,$$

where CM is one of the two measures of consumption, i.e., either the world consumption growth, WCG, or cross-country consumption dispersion, WCD, ***R*** is the set of base asset returns (excess equity and currency), and ***Z*** is the instrument set. The instruments that I use here are the lagged world consumption growth, cross-country consumption dispersion, world term spread, U.S. T-bill return, world exchange rate change, and world forward premium.

RESULTS

Figure D.1 shows the weights of the mimicking portfolios for the world consumption growth and cross-country consumption dispersion. These weights sum to one and are obtained from the estimated slope coefficients on the base assets, ***R***. The figure depicts these weights when the base assets are eight excess equity returns and seven speculative currency returns. These plots reveal that: (i) there is some positive relation between the weights on the assets for the mimicking portfolios of consumption growth and consumption dispersion, and (ii) no single asset weight exceeds 30%. Notice that several assets have negative weights on either consumption growth or dispersion or both. This means that an investor should short those asset and invest the proceeds into remaining assets with positive weights.

Figure D.2 shows the scatterplot of the contemporaneous relation between the constructed mimicking portfolios. A positive correlation suggests that it may be difficult to disentangle the effects of consumption growth and cross-country consumption dispersion on asset prices. More research in this area may be warranted.

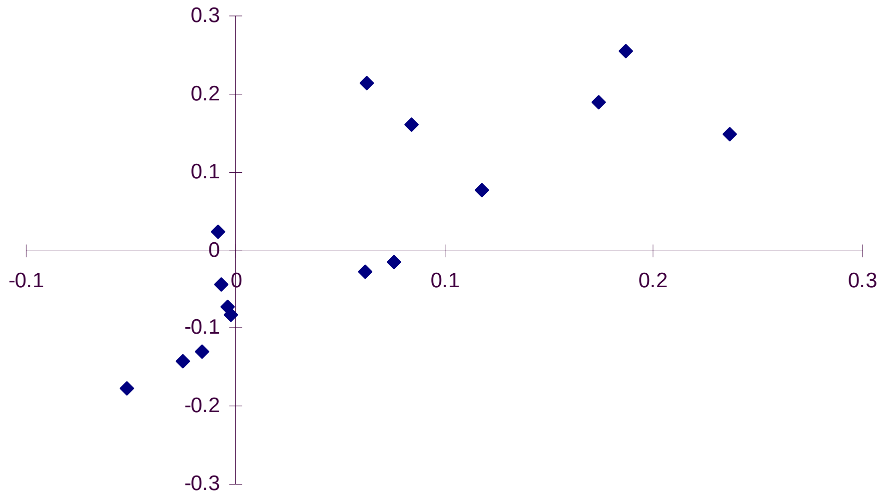

Figure D.1. Weights of the Assets for the Mimicking Portfolios. The figure shows the weights of the mimicking portfolios for the world consumption growth and cross-country consumption dispersion using eighth excess equity and seven currency returns.

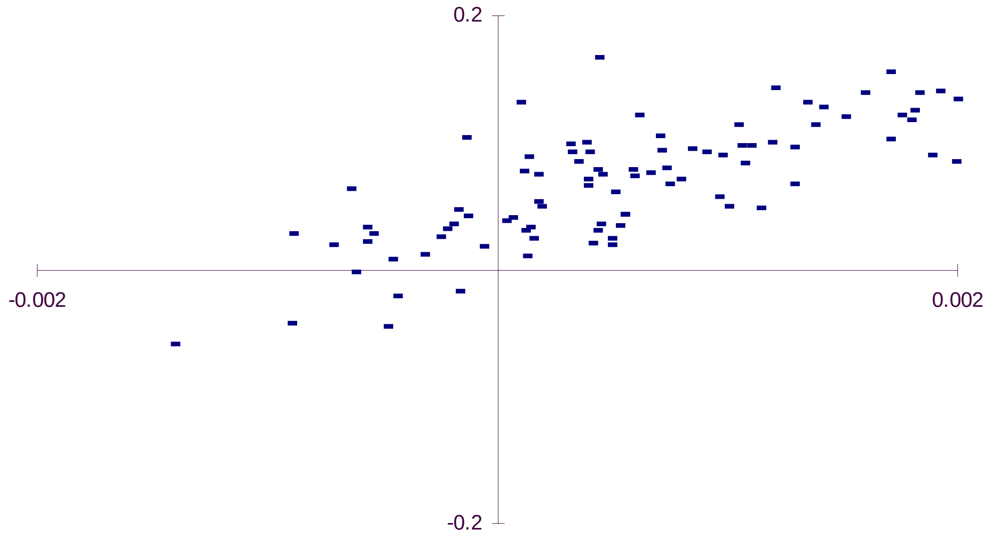

Figure D.2. Relation between Contemporaneous Returns on Mimicking Portfolios. The figure depicts the contemporaneous relation between maximum correlation mimicking portfolios for the two measures of consumption constructed using eight excess equity and seven currency returns.

Appendix E

Averaged Returns Data

In the dissertation, I have tested the model with quarterly returns data which were constructed based on the monthly data compounded over the three-month periods. However, the consumption data is averaged over the quarter. To provide a further robustness check on the main results of the dissertation, I also tested the Euler equations (2.5) and (4.3) using averaged rather than compounded quarterly returns data. The purpose of this appendix is to report these findings.

DATA

Unlike the returns data used previously, here I average all the monthly returns over the quarter. Taking the average rates of return is not new in the literature. For example, Harvey (1988) uses quarterly averages of the monthly data on yields on Treasury bills and bonds.

EMPIRICAL RESULTS

Table E.1 shows the results of estimating model (2.5) using the world real risk-free returns, WRF. The instrument vector ***Z*** is composed of the constant, the lagged values of the WCG, and U.S. T-bill returns. The resulting pattern of estimation is quite similar to the one in panels A of tables 6.1 and 6.4. An increase in the multiplicative factor k leads to a decrease in the estimates of the risk aversion parameter γ, time preference parameter ρ, and the Hansen-Jagannathan (HJ) distance. Interestingly, the overall with of the model now is even better: both the Hansen's J-statistic and HJ distance measure are smaller for any given value of k as compared to those in tables 6.1 and 6.4, panels A. Finally, one can observe a simultaneous increase in the estimates of the mean and standard deviation of the implied pricing kernel.

Table E.2 shows the results of estimating model (4.3) using the excess equity returns. The instrument vector ***Z*** is composed of a constant, the lagged values of WCG, and the world exchange rate changes, WEX. The results are very similar to those reported in panels A of tables 6.2 and 6.5: as k increases, the estimate of γ drops markedly reaching the value of 2.14 at $k = 10$.

Table E.3 presents the results of estimating model (4.3) using the real speculative returns in the forward currency market. The instrument vector ***Z*** is composed of a constant, the lagged values of WCG, and world forward premium, WFP. The test results are very close numerically to those reported in panels A of tables 6.3 and 6.6 for any given value of k.

Table E.1
Tests of the Model Using the World Real Risk-Free Returns: Averaged Returns Data

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country dispersion of the per-capita consumption growth is the variance of the logarithmic changes in the real national per-capita consumption growth rates also expressed in local currency units. The results are obtained by estimating the following Euler equation:

$$\rho E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]R_{t+1}^{wrf}\middle|Z_t\right]-1=0,$$

where γ is the concavity parameter, ρ is the time preference parameter, and k is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1, 2, 5, 10. R_{t+1}^{wrf} is the world real riskless return. The ratio C_{t+1}/C_t is the world real consumption growth from time t to time t+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, lagged world consumption growth, lagged cross-country dispersion of national consumption growth rates, and lagged real U.S. Treasury bill return. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding p-values (p). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

					Pricing Kernel		
k	γ	ρ	J	p	Mean	S.D.	HJ
NH	0.58	1.0004	4.67	0.031	0.9975	0.0033	0.0018
	(0.25)	(0.0014)					
1	0.57	1.0003	4.69	0.030	0.9975	0.0033	0.0018
	(0.25)	(0.0014)					
2	0.57	1.0002	4.68	0.030	0.9975	0.0033	0.0018
	(0.24)	(0.0014)					
5	0.57	1.0002	4.37	0.036	0.9976	0.0034	0.0018
	(0.23)	(0.0013)					
10	0.57	1.0001	4.27	0.039	0.9976	0.0035	0.0017
	(0.22)	(0.0011)					

Table E.2

Tests of the Model Using International Excess Equity Returns: Averaged Returns Data

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country dispersion of the per-capita consumption growth is the variance of the logarithmic changes in the real national per-capita consumption growth rates also expressed in local currency units. The results are obtained by estimating the following Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(R_{i,t+1}-R_{rf,t+1}-\alpha_i\right)\middle|Z_t\right]=0,$$

where γ is the concavity parameter, α_i is average the pricing error for country *i*, and *k* is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1, 2, 5, 10. The difference $R_{i,t+1}-R_{rf,t+1}$ is the quarterly U.S. dollar denominated excess equity return for country *i*. The ratio C_{t+1}/C_t is the real world consumption growth from time *t* to time *t*+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, the lagged world consumption growth, the lagged cross-country dispersion of national consumption growth rates, and the lagged world exchange rate changes. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding *p*-values (*p*). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

		Pricing Errors										Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	α_{US}	J	p	Mean	S.D.	HJ
NH	92.52	0.0007	0.0003	0.0017	-0.0056	0.0001	0.0044	0.0096	0.0043	11.96	0.682	0.7642	0.7021	73.397
	(27.27)	(0.0027)	(0.0041)	(0.0035)	(0.0034)	(0.0032)	(0.0030)	(0.0042)	(0.0022)					
1	22.17	0.0021	-0.0001	0.0005	-0.0057	-0.0001	0.0031	0.0079	0.0048	14.41	0.495	0.9255	0.1562	52.241
	(22.81)	(0.0036)	(0.0027)	(0.0037)	(0.0033)	(0.0029)	(0.0030)	(0.0037)	(0.0023)					
2	13.09	0.0023	-0.0003	0.0002	-0.0062	-0.0004	0.0028	0.0077	0.0052	15.05	0.448	0.9553	0.0919	50.266
	(23.28)	(0.0036)	(0.0027)	(0.0037)	(0.0033)	(0.0029)	(0.0030)	(0.0037)	(0.0023)					
5	5.80	0.0025	-0.0004	0.0000	-0.0066	-0.0006	0.0027	0.0075	0.0055	15.47	0.418	0.9803	0.0410	49.018
	(24.12)	(0.0036)	(0.0027)	(0.0037)	(0.0033)	(0.0029)	(0.0030)	(0.0037)	(0.0023)					
10	2.85	0.0026	-0.0004	0.0000	-0.0067	-0.0006	0.0026	0.0074	0.0056	15.60	0.409	0.9906	0.0204	48.606
	(24.50)	(0.0035)	(0.0027)	(0.0037)	(0.0033)	(0.0029)	(0.0030)	(0.0037)	(0.0023)					

Table E.3

Tests of the Model Using Speculative Returns in the Forward Currency Markets: Averaged Returns Data

The world per-capita consumption growth rate is the GDP-weighted average of the real per-capita consumption growth rates for Canada, France, Germany, Italy, Japan, Switzerland, the U.K., and the U.S. all of which are expressed in local currency units. The cross-country dispersion of the per-capita consumption growth is the variance of the logarithmic changes in the real national per-capita consumption growth rates also expressed in local currency units. The estimation results are obtained by estimating the following Euler equation:

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\exp\left[k\frac{\gamma(\gamma+1)}{2}d_{t+1}\right]\left(\frac{S_{i,t+1}-F_{i,t}}{S_{i,t}}-\alpha_i\right)\middle|Z_t\right]=0,$$

where γ is the concavity parameter, α_i is the average pricing error for country i, and k is the multiplicative factor for the world consumption variance, d_{t+1}. The estimation is conducted for the standard CCAPM with no heterogeneity (NH) and for k = 1, 2, 5, 10. The standardized ratio $\left(S_{i,t+1}-F_{i,t}\right)/S_{i,t}$ is the real quarterly U.S. dollar denominated profits in currency i that are obtained by deflating the corresponding nominal returns by the U.S. quarterly CPI changes. The ratio C_{t+1}/C_t is the real world consumption growth from time t to time t+1 and Z_t is the instrument vector used in the GMM estimation which is composed of a constant, the lagged world consumption growth, the lagged cross-country dispersion of national consumption growth rates, and the lagged world forward premium. Besides parameter estimates and their standard errors (shown in parentheses), the table shows the goodness-of-fit J-statistics (J) with corresponding p-values (p). It also reports the mean (Mean), standard deviation (S.D.), and the Hansen-Jaganathan distance measure (HJ) of the estimated pricing kernel. The HJ distance is multiplied by 10^4.

		Pricing Errors									Pricing Kernel		
k	γ	α_{CN}	α_{FR}	α_{GM}	α_{IT}	α_{JP}	α_{SW}	α_{UK}	J	p	Mean	S.D.	HJ
NH	118.37	0.0005	0.0074	0.0068	0.0044	0.0087	0.0070	0.0056	13.92	0.380	0.7798	1.0757	60.803
	(34.05)	(0.0005)	(0.0025)	(0.0028)	(0.0018)	(0.0017)	(0.0042)	(0.0017)					
1	23.15	-0.0002	0.0054	0.0041	0.0032	0.0071	0.0050	0.0034	15.59	0.272	0.9238	0.1655	44.829
	(36.85)	(0.0008)	(0.0019)	(0.0021)	(0.0019)	(0.0021)	(0.0026)	(0.0020)					
2	13.27	-0.0003	0.0051	0.0039	0.0030	0.0070	0.0047	0.0032	15.85	0.257	0.9550	0.0935	45.426
	(39.26)	(0.0008)	(0.0019)	(0.0020)	(0.0019)	(0.0021)	(0.0025)	(0.0020)					
5	5.73	-0.0003	0.0050	0.0037	0.0029	0.0069	0.0046	0.0030	16.02	0.248	0.9805	0.0403	45.032
	(41.17)	(0.0008)	(0.0018)	(0.0020)	(0.0019)	(0.0020)	(0.0024)	(0.0020)					
10	2.77	-0.0003	0.0050	0.0036	0.0028	0.0069	0.0045	0.0030	16.08	0.245	0.9908	0.0198	44.934
	(41.90)	(0.0008)	(0.0018)	(0.0019)	(0.0019)	(0.0020)	(0.0024)	(0.0020)					

Appendix F

Unit Root Tests

I do not reject the hypothesis of unit root when I test the world risk-free rate or the U.S. T-bill returns series. However, what is more important for the GMM estimation, the tests must reject the unit root hypothesis for the variable $m_t = \left(C_t / C_{t-1}\right)^{-\gamma} \exp\left(0.5k\gamma(\gamma+1)d_t\right)$, where c_t and d_t are the world consumption growth and consumption dispersion respectively at time t, while R_t is the asset return at time t. In specifying my unit root tests, I use the augmented Dickey-Fuller method, include two lags of the variable, and assume all my series are trend stationary. I use two lags because the second lag of the pricing kernel, m_t, becomes significant in tests for the unit root.

RESULTS

The test results shown in table F.1 correspond to the case when the risk aversion parameter, $\gamma = 10$, and the multiplicative factor $k = 5$. The results are not qualitatively different for a much larger set of values of γ and k. The 5% critical value is -2.89, while the 1% critical value is -3.50. As one can observe, the hypothesis of unit root is rejected everywhere at the 5% level and in most of the cases at the 1% level as well.

Table F.1
Unit Root Tests

The table reports the Augmented Dickey-Fuller statistic (ADF) for the unit root test on the variable $\left(C_{t+1}/C_t\right)^{-\gamma}\exp\left(0.5k\gamma(\gamma+1)d_{t+1}\right)R_t$. The table reports the test results when the risk aversion parameter, γ = 10, and the multiplicative factor k = 5.

	ADF
WRF	-3.48
Canada	-5.19
France	-4.82
Germ.	-4.78
Italy	-4.27
Japan	-4.61
Switz.	-4.94
U.K.	-5.52
U.S.	-5.85
C$	-4.11
FF	-5.02
DM	-4.70
L	-5.34
Y	-4.80
SF	-5.03
£	-4.39