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ASSET PRICING WITH HETEROGENEOUS CONSUMERS AND LIMITED PARTICIPATION: EMPIRICAL EVIDENCE

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Asset Pricing with Heterogeneous Consumers and Limited Participation:
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ABSTRACT

We present evidence that the equity premium and the premium of value stocks over growth stocks are explained in the 1982–1996 period with a stochastic discount factor (SDF) calculated as the weighted average of individual households' marginal rate of substitution with low and economically plausible values of the relative risk aversion (RRA) coefficient. Household consumption of non-durables and services is reconstructed from the CEX database. Since the above premia are not explained with a SDF calculated as the per capita marginal rate of substitution with low value of the RRA coefficient, the evidence supports the hypothesis of incomplete consumption insurance. We also present evidence is that a SDF calculated as the per capita marginal rate of substitution is better able to explain the equity premium and does so with a lower value of the RRA coefficient, as the definition of asset holders is tightened to recognize the limited participation of households in the capital market.

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1. Introduction and Summary

In a representative-consumer exchange economy, one set of implications of the equilibrium are the Euler equations of *per capita* consumption. In tests of the conditional Euler equations of the *per capita* consumption, Hansen and Singleton (1982), Hansen and Jagannathan (1991), Ferson and Constantinides (1991) and others reject the model.

A related set of equilibrium implications that take into account both the Euler equations of *per capita* consumption *and* the market-clearing conditions are the predictions of a calibrated economy on the unconditional mean and standard deviation of the market return and the risk-free rate. Mehra and Prescott (1985) demonstrate that the equilibrium of a reasonably parameterized representative-consumer exchange economy is able to furnish a mean annual premium of equity return over the risk-free rate of, at most, 0.35%. This contrasts with the historical premium of 6% in U.S. data. Furthermore, as stressed in Weil (1989), the equilibrium annual risk-free rate of interest is consistently too high, about 4%, as opposed to the observed 1% in U.S. data.

Several generalizations of essential features of the model have been proposed to mitigate its poor performance. They include alternative assumptions on preferences,[1] modified probability distributions to admit rare but disastrous market-wide events,[2] incomplete markets,[3] market imperfections,[4] and the survival bias of the US

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[1] For example, Abel (1990), Benartzi and Thaler (1995), Boldrin, Christiano and Fisher (2001), Campbell and Cochrane (1999, 2000), Constantinides (1990), Daniel and Marshall (1997), Epstein and Zin (1991), and Ferson and Constantinides (1991).

[2] See Rietz (1988), and Mehra and Prescott (1988).

[3] For example, Bewley (1982), Constantinides and Duffie (1996), Heaton and Lucas (1997, 2000), Krebs (2000), Lucas (1994), Mankiw (1986), Mehra and Prescott (1985), Storesletten, Telmer and Yaron (1999), and Telmer (1993).

[4] For example, Aiyagari and Gertler (1991), Alvarez and Jerman (2001), Bansal and Coleman (1996), Basak and Cuoco (1998), Brav and Geczy (1995), Constantinides, Donaldson and Mehra (2002), Danthine, Donaldson and Mehra (1992), He and Modest (1995), Heaton and Lucas (1996) and Luttmer (1996).

capital markets.[5] Cochrane and Hansen (1992), Kocherlakota (1996), and Cochrane (1997) provide excellent surveys of this literature.

Full consumption insurance implies that heterogeneous consumers are able to equalize, state by state, their marginal rate of substitution. Therefore, the equilibrium in a heterogeneous-consumer, full-information economy is isomorphic in its pricing implications to the equilibrium in a representative-consumer, full-information economy, if consumers have von Neumann-Morgenstern preferences.[6] The strong assumption of full consumption insurance is indirectly built in asset pricing models in finance and neoclassical macroeconomic models through the assumption of the existence of a representative consumer.

Bewley (1982), Mankiw (1986), and Mehra and Prescott (1985) suggest the potential of enriching the asset-pricing implications of the representative-consumer paradigm, by relaxing the assumption of complete consumption insurance.[7] With the exception of Constantinides and Duffie (1996), hereafter CD, the extant research suggests that the potential enrichment is largely illusory.[8] CD (1996) find that incomplete consumption insurance enriches

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[5] However, Jorion and Goetzmann (1999, Table 6) find that the average real capital gain rate of a US equities index exceeds the average rate of a global equities index that includes both markets that have and have not survived by merely one percent per year.

[6] See Wilson (1968) and Constantinides (1982).

[7] There is an extensive literature on the hypothesis of complete consumption insurance. See, Altonji, Hayashi and Kotlikoff (1992), Attanasio and Davis (1997), Cochrane (1991), Mace (1991), and Townsend (1992).

[8] Lucas (1994) and Telmer (1993) calibrate economies in which consumers face uninsurable income risk and borrowing or short-selling constraints. They conclude that consumers come close to the complete-markets rule of complete risk sharing although consumers are allowed to trade in just one security in a frictionless market. Aiyagari and Gertler (1991) and Heaton and Lucas (1996, 1997) add transaction costs and/or borrowing costs and reach a similar negative conclusion, provided that the supply of bonds is not restricted to an unrealistically low level. The primary reason why CD (1996) find that incomplete consumption insurance enriches substantially the asset-pricing implications of the representative-consumer model is their assumption that the idiosyncratic income shocks are persistent and their conditional variance is related to the state variables in a particular way, in contrast to earlier work which assumes that the idiosyncratic income shocks are transient and homoscedastic.

substantially the implications of the representative-consumer model. Their main result is a proposition demonstrating, by construction, the existence of household income processes, consistent with a given aggregate income process such that equilibrium security and bond price processes match the given security and bond price processes. Since the proposition demonstrates the existence of equilibrium in frictionless markets, it implies that the Euler equations of household (but not necessarily of *per capita*) consumption must hold.

The first goal of our paper is to examine the asset pricing implications of the relaxation of the assumption of complete consumption insurance. The basis of our empirical investigation is the set of Euler equations of *household* consumption, as opposed to the Euler equations of *per capita* consumption.[9] The set of Euler equations of household consumption imply that any household's marginal rate of substitution and any convex combination thereof is a valid *stochastic discount factor* (SDF). Since individual consumption data are reported with substantial error, it is difficult to test directly the hypothesis that each household's marginal rate of substitution is a valid SDF. Therefore, we test the hypothesis that the SDF given by the equally weighted sum of the households' marginal rate of substitution is a valid SDF.

The bulk of our tests are on the premium of the value-weighted and the equally weighted market portfolio return over the risk-free rate. We do not reject the hypothesis that the equally weighted sum of the households' marginal rate of substitution is a valid SDF with RRA coefficient between two and four. We perform several robustness tests that reinforce the conclusion. A RRA coefficient between two and four is economically plausible.

We investigate the properties of the cross-sectional distribution of the household consumption growth that drive the SDF. We find that a Taylor expansion of the SDF that captures the skewness, in addition to the mean and variance, of the cross-sectional distribution explains the equity premium. However, a Taylor expansion of the SDF that captures the mean and variance (but not the skewness) of the cross-sectional distribution of the household consumption growth does not fare as well. A Taylor expansion of the SDF, in terms of the *logarithm* of the household consumption growth, that captures the mean, variance, and skewness of the cross-sectional distribution of the household consumption growth does not fare well either. These results underscore the importance of the

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[9] Related studies include Jacobs (1999), who studies the PSID database on food consumption; and Cogley (1999), and Vissing-Jorgensen (2002) who study the CEX database on broad measures of consumption.

skewness, combined with the first two moments of the cross-sectional distribution. They also suggest that empirical findings based on log-linearized Euler equations of individual households should be treated with caution.

The second goal of our paper is to re-examine the asset pricing implications of the *limited participation* of households in the capital markets. Mankiw and Zeldes (1991), Blume and Zeldes (1993), and Haliassos and Bertaut (1995) present evidence of limited participation of households in the capital markets. Specifically, they observe that only a small fraction of individuals and households hold equities either directly or indirectly. Furthermore, Mankiw and Zeldes (1991) calculate the *per capita* food consumption of a subset of households, designated as *asset holders* according to a criterion of asset holdings above some threshold. They find that the implied relative risk aversion (RRA) coefficient decreases, as the threshold is raised.[10] Attanasio and Weber (1995) argue that food consumption is a dubious proxy for total consumption.

We recognize the fact that only a subset of households is marginal in the stock market by defining as *asset holders* the subset of households that report total assets exceeding a certain threshold value ranging from \$0 to \$40,000. From the subset of households defined as asset holders, we express the SDF in terms of the *per capita* growth rate, and test whether this SDF explains the equity premium. We find that the model is better able to explain the equity premium and does so with a decreasing value of the RRA coefficient as the definition of asset holders is tightened. The results are sensitive to empirical design.

We also report the correlation of the *per capita* consumption growth with the equity premium. There is a pattern of increasing correlation as the definition of asset holders is tightened. These results are in line with earlier results reported by Mankiw and Zeldes (1991) and Brav and Geczy (1995). In summary, we find some evidence that the SDF driven by the *per capita* consumption growth can explain the equity premium with a relatively high value of the RRA coefficient, once we recognize the fact that only a subset of households is marginal in the stock market.

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[10] Brav and Geczy (1995) provide the first confirmation of the Mankiw and Zeldes (1991) results, by using the NDS *per capita* consumption, reconstructed from the CEX database. Section 5 of the current paper contains an updated and extended version of Brav and Geczy (1995) and subsumes the 1995 draft. Related results are presented in Attanasio, Banks and Tanner (2002) who study the UK Family Expenditure Survey database; and Vissing-Jorgensen (2002) who studies the CEX database.

All the tests reported so far, whether under the hypothesis of complete or incomplete consumption insurance, focus on explaining the equity premium. Finally, we report results of tests with the unconditional Euler equation on the excess return of high book-to-market "value" stocks over low book-to-market "growth" stocks. This may be viewed as a test of the *conditional* Euler equation, where the attribute of book-to-market is the conditioning variable. In addition, both parts of this spread between value and growth are, like the market portfolio, typically available to investors through brokerage and retirement accounts in the form of mutual fund investments. (We do not attempt to explain the premium of small- versus large-capitalization stocks, because there is no size premium in our sample period.) We conclude that the SDF implied by a model of incomplete consumption insurance is consistent with the value premium while the SDF implied by a model of complete consumption insurance is not. The results reinforce our earlier findings on the equity premium.

The paper is organized as follows. In Section 2, we discuss the theory that motivates the empirical investigation. The data sources, the data selection procedure, summary statistics are described in Section 3. In Section 4, we present the empirical results on the equity premium under the hypothesis of *incomplete* consumption insurance. In Section 5, we present the empirical results on the equity premium under the hypothesis of *complete* consumption insurance and examine the extent to which the equity premium is better explained by taking into consideration the limited participation of the households in the capital markets. In Section 6, we report evidence that the premium of value stocks over growth stocks is consistent with Euler equations of consumption, under the hypothesis of *incomplete* consumption insurance. In Section 7, we provide extensions and concluding remarks.

2. The Model

2.1 The Economy and Equilibrium

We make conventional assumptions about the markets and preferences in order to focus on our stated dual goal to investigate the pricing implications of the *incompleteness* of markets that insure against idiosyncratic income shocks and the *limited participation* of households in the capital markets.

We consider a set of households, i = 1,..., I, that participate in the capital markets. We assume that these households trade in perfect capital markets, without frictions, short sale restrictions, or taxes. They trade a set of securities subscripted by j = 1,…, J, with total return $R_{j,t}$ between dates t – 1 and t. We assume that the households have time- and state-separable von Neumann-Morgenstern homogeneous preferences

$$E\left[\left(1-\alpha\right)^{-1} \sum_{t=0}^{\infty} \beta^{t} \left(c_{i,t}^{1-\alpha} - 1\right) \mid F_0 \right] \tag{1}$$

where α, $\alpha > 0$, is the constant RRA coefficient; β is the constant subjective discount factor; $c_{i,\ t}$ is the dollar consumption of the ith household at date t; and F_t is the date-t information set that is common across the households.

In equilibrium, we obtain the set of I x J Euler equations of consumption between dates t - 1 and t:

$$E\left[\beta\, g_{i,t}^{-\alpha}\, R_{j,t} \mid F_{t-1}\right] = 1\ , \quad i = 1,\ldots, I;\ \ j = 1,\ldots, J, \tag{2}$$

where $g_{i,\ t} = c_{i,\ t}/c_{i,\ t-1}$ is the *consumption growth* of the ith household.

2.2 Stochastic Discount Factors

A *stochastic discount factor* (SDF) or *pricing kernel*, m_t , is defined by the property

$$E\left[m_t\, R_{j,t} \mid F_{t-1}\right] = 1\ , \qquad j=1,\ldots, J. \tag{3}$$

We note that each household's marginal rate of substitution, $\beta(c_{it}/c_{i,t-1})^{-\alpha}$, is a valid SDF and any weighted sum of the households' marginal rate of substitution is a valid SDF also. Since individual consumption data are reported with substantial error, it is difficult to test directly the hypothesis that each household's marginal rate of substitution is a valid SDF.

We may be able to mitigate the observation error in reported household consumption by testing the hypothesis that the equally weighted sum of the households' marginal rate of substitution is a valid SDF:

$$m_t = \beta \left\{ I^{-1} \sum_{i=1}^{I} \left(\frac{c_{i,t}}{c_{i,\ t-1}} \right)^{-\alpha} \right\}. \tag{4}$$

This SDF is still susceptible to observation error because each term in the sum is raised to a high power, if the risk aversion coefficient is high.

We expand equation (4) as a Taylor series up to cubic terms. We obtain the following approximation for the SDF

$$m_t = \beta\, g_t^{-\alpha} \left\{ 1 + \frac{1}{2} \alpha\, (\alpha+1)\, I^{-1} \sum_{i=1}^{I} \left(\frac{g_{i,t}}{g_t} - 1 \right)^2 - \frac{1}{6} \alpha\, (\alpha+1)\, (\alpha+2)\, I^{-1} \sum_{i=1}^{I} \left(\frac{g_{i,t}}{g_t} - 1 \right)^3 \right\} \tag{5}$$

in terms of the cross-sectional mean, $g_t = I^{-1} \sum_{i=1}^{I} g_{i,t}$, variance, $I^{-1} \sum_{i=1}^{I} \left(\frac{g_{i,t}}{g_t} - 1 \right)^2$, and skewness, $I^{-1} \sum_{i=1}^{I} \left(\frac{g_{i,t}}{g_t} - 1 \right)^3$ of the consumption growth rate. We may further mitigate the observation error if the estimation of these cross-sectional moments is less susceptible to observation error than the SDF in equation (4). In testing the hypothesis that the SDF is given by equation (5) against the alternative hypothesis that the SDF is given by equation (4), we also investigate whether the cross-sectional variance and skewness of the consumption growth rate capture most of the cross-sectional variation.

If we expand equation (4) as a Taylor series up to quadratic terms, we obtain the SDF

$$m_t = \beta\, g_t^{-\alpha} \left\{ 1 + \frac{1}{2} \alpha\, (\alpha+1)\, I^{-1} \sum_{i=1}^{I} \left(\frac{g_{i,t}}{g_t} - 1 \right)^2 \right\} \tag{6}$$

in terms of the average consumption growth rate and the cross-sectional variance of the consumption growth rate. In testing the hypothesis that the SDF is given by equation (6), we investigate whether the cross-sectional variance of the consumption growth rate alone captures most of the cross-sectional variation.

If we assume that the idiosyncratic income shocks are multiplicative and i.i.d. lognormal, then CD (1996) show that the SDF in equation (4) simplifies into

$$m_t = \beta \left\{ \frac{\sum_{i=1}^{I} c_{i,t}}{\sum_{i=1}^{I} c_{i,t-1}} \right\}^{-\alpha} \exp\left\{ \frac{1}{2}\alpha(\alpha+1)\, I^{-1} \sum_{i=1}^{I} \left(\log\,(g_{i,t}) - I^{-1} \sum_{i=1}^{I} \log\,(g_{i,t}) \right)^2 \right\}. \tag{7}$$

In testing the hypothesis that the SDF is given by equation (7), we investigate whether multiplicative and i.i.d. *lognormal* idiosyncratic income shocks capture most of the cross-sectional variation of the consumption growth rate.[11]

If a complete set of markets exists that enables households to insure against idiosyncratic income shocks, then the heterogeneous households are able to equalize, state by state, their marginal rates of substitution. Therefore, the equilibrium of a heterogeneous-household, full-information economy is isomorphic in its pricing implications to the equilibrium of a representative-household, full-information economy.[12] In particular, the consumption growth rate is identical across households and the SDF in equations (4) simplifies into

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[11] Krebs (2000) generalizes the lognormal idiosyncratic income process of consumers by introducing a process that assigns probability p to an event of near personal bankruptcy: a consumer's permanent income drops close to zero with probability p. By making the permanent income sufficiently close to zero in the event of near bankruptcy, the prospect of near bankruptcy does affect equilibrium prices, even if p is made arbitrarily small. Then idiosyncratic income shocks can have an important effect on prices, even though we can make the covariance between the equity premium and the cross-sectional variance of log ($g_{i,t}$) arbitrarily small.

[12] See Constantinides (1982).

$$m_t = \beta\, g_t^{-\alpha} \quad . \tag{8}$$

Market completeness also implies that the SDF in equations (4) simplifies into

$$m_t = \beta \left(\frac{\sum_{i=1}^{I} c_{i,t}}{\sum_{i=1}^{I} c_{i,t-1}} \right)^{-\alpha} \quad . \tag{9}$$

We expect that the SDF given by equation (9) is less susceptible to observation error than the SDF given by equation (8).

Tests of the SDFs given by either one of equations (8) and (9) against the SDFs given by any of equations (4) - (7) are tests of the hypothesis of complete consumption insurance against the alternative hypothesis of incomplete consumption insurance. These tests are the focus of the paper.

2.3 Tests of Stochastic Discount Factors

In most of our tests, we test each candidate SDF with the unconditional Euler equation on the excess market return, $R_{M,t} - R_{F,t}$ (both the equally weighted and value weighted), as

$$E\Big[m_t \, (R_{M,t} - R_{F,t}) \Big] = 0 \, . \tag{10}$$

Specifically, we calculate the statistic *u* as

$$u = T^{-1} \sum_{t=1}^{T} m_t \, (R_{M,t} - R_{F,t}) \tag{11}$$

and interpret it as the unexplained mean premium.[13]

We also test some SDFs with the unconditional Euler equation on the excess return of high book-to-market "value" stocks over low book-to-market "growth" stocks, $R_{H,t} - R_{L,t}$, as $E\left[m_t \,(R_{H,t} - R_{L,t}) \right] = 0$, and calculate the corresponding unexplained-premium statistic as $u = T^{-1}\sum_{t=1}^{T} m_t \,(R_{H,t} - R_{L,t})$. This may be viewed as a test of the *conditional* Euler equation (3), where the attribute of book-to-market is the conditioning variable. We do not test the SDFs with the unconditional Euler equation on the excess return of small- versus large-capitalization stocks, because there is no size premium in our sample period.

2.4 Observation Error in the Consumption Data

Observation error in the consumption data is a major problem both in our investigation and in related ones. In testing the Euler equations of consumption under the assumption of complete consumption insurance and limited capital market participation, we calculate the *per capita* consumption in a quarter as the average consumption of households that are classified as *asset holders*, based on a certain threshold of household assets holdings. The number of households in each subsample sample is small and the estimated *per capita* consumption is noisy.

Observation error is even more problematic when we test the Euler equations of consumption under the assumption of incomplete consumption insurance. The individual household's marginal rate of substitution is calculated by raising the individual household's consumption growth to a power equal to the negative of the RRA coefficient. If the reported consumption growth of even *one* household out of many is substantially smaller than one, this household's marginal rate of substitution is large and may dominate the weighted average of the marginal rates of substitution.

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[13] We motivate the interpretation of the statistic u as the unexplained mean premium by writing equation (11) as $0 = T^{-1} \sum_{t=1}^{T} m_t \left\{ R_{M,t} - R_{F,t} - \left(T^{-1} \sum_{t=1}^{T} m_t \right)^{-1} u \right\} \approx T^{-1} \sum_{t=1}^{T} m_t \left\{ R_{M,t} - R_{F,t} - u \right\}$, since $\left(T^{-1} \sum_{t=1}^{T} m_t \right)^{-1}$ is approximately equal to $E\,[R_{F,t}]$, which is approximately equal to one.

The standard remedy of trimming the sample of household consumption growth rates is a double-edged sword that we apply with caution. The potentially interesting events that help distinguish between the pricing implications of models of complete and incomplete consumption insurance are the major uninsurable shocks to a household's income, such as job loss or divorce. If these shocks are uninsurable, they result in household consumption growth in the tails of the distribution.

We illustrate the implications of a multiplicative and unbiased observation error in the consumption *level*, in the context of the hypothesis of complete consumption insurance. The SDF is given by equation (9). We assume that the observed *per capita* consumption is $c_t\, w_t$, where the observation error, w_t, has the following properties: $w_t > 0$; $E\,[w_t] = 1$; w_t is identically distributed, but possibly serially correlated; and w_t is independent of all other variables in the Euler equation. The unexplained premium statistic, u, in equation (11), is

$$u = \beta\, T^{-1} \sum_{t=1}^{T} \left(\frac{c_t}{c_{t-1}} \right)^{-\alpha} (R_{M,\,t} - R_{F,\,t})\, w_t^{-\alpha}\, w_{t-1}^{\alpha}. \tag{12}$$

Under the null hypothesis that the Euler equation holds, the mean value of the statistic is zero. Therefore, observation error of the particular form assumed here does not bias the unexplained risk premium statistic.

We also test the Euler equation on the risk-free rate, $R_{F,t}$, as the real return on a one-month, rolled-over T-bill rate, by testing whether the implied subjective discount factor, β, is close to but less than one. The estimated subjective discount factor is

$$\hat{\beta} = \left\{ T^{-1} \sum_{t=1}^{T} \left(\frac{c_t}{c_{t-1}} \right)^{-\alpha} w_t^{-\alpha}\, w_{t-1}^{\alpha}\, R_{F,\,t} \right\}^{-1} \tag{13}$$

and is biased downwards by the multiplicative factor $\left\{E\left[w_t^{-\alpha}\, w_{t-1}^{\alpha}\right]\right\}^{-1} \le 1$.[14] As predicted, the estimated subjective discount factor is severely biased downwards. The bias renders the estimates meaningless and, therefore, they are not reported in the paper.

In the case of incomplete consumption insurance, similar arguments lead to the conclusion that observation error of the particular form assumed here does not bias the unexplained risk premium statistic but biases downwards the estimated subjective discount factor. This bias is more severe than in the case of incomplete consumption insurance because the observed *household* consumption has substantially higher error than the observed *per capita* consumption.

2.5 Small-Sample Properties of the Statistics

The second major problem in both our investigation and in related ones is the small size of the database, both in the time series and in the number of households in the cross-section. The database consists of returns and household consumption data for 60 quarters. With such a short time series, the standard error of the estimated mean equity premium is large and we may be unable to reject the hypothesis that the mean equity premium is zero. Furthermore, we may be unable to detect the incremental contribution of relaxing the assumption of complete consumption insurance in explaining the equity premium.

Finally, the uninsurable idiosyncratic shocks to the households' income that the theory attempts to capture, such as job loss or divorce, are infrequent events relative to both the length of the time series and the number of households in the cross-section.

In the empirical section, we address these problems by calculating the small-sample distribution of the F-statistic by the bootstrap method and adjusting the p-value accordingly.

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[14] This inequality follows from the fact that $w_t^{-\alpha}\, w_{t-1}^{\alpha}$ and its inverse are symmetrically distributed and

$$1 = E\left[\left\{w_t^{-\alpha}\, w_{t-1}^{\alpha}\right\}\left\{w_t^{-\alpha}\, w_{t-1}^{\alpha}\right\}^{-1}\right] \le E\left[w_t^{-\alpha}\, w_{t-1}^{\alpha}\right] E\left[\left\{w_t^{-\alpha}\, w_{t-1}^{\alpha}\right\}^{-1}\right] = \left\{E\left[w_t^{-\alpha}\, w_{t-1}^{\alpha}\right]\right\}^{2}.$$

3. Description of the Data

3.1 The Consumption Data

The source of the household-level quarterly consumption data is the Consumer Expenditure Survey (CEX), produced by the Bureau of Labor Statistics (BLS)[15]. This series of cross-sections covers the period 1980q1 - 1999q4. Each quarter, roughly 5,000 U.S. households are surveyed, chosen randomly according to stratification criteria determined by the U.S. Census.

Each household participates in the survey for five consecutive quarters, one training quarter and four regular ones, during which their recent consumption and other information is recorded. At the end of its fifth quarter, another household, chosen randomly according to stratification criteria determined by the U.S. Census replaces the household. The cycle of the households is staggered uniformly across the quarters, such that new households replace approximately one-fifth of the participating households each quarter.[16,17] If a household moves away from the sample address, it is dropped from the survey. The new household that moves into this address is screened for eligibility and is included in the survey. The number of households in the database varies from quarter to quarter.

The survey attempts to account for an estimated 95% of all quarterly household expenditures in each consumption category from a highly disaggregated list of consumption goods and services. At the end of the fourth

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[15] Among the uses of the survey is the calculation of weights on individual components of the market basket of goods used in creating the consumer price index.

[16] If we were to exclude the training quarter in classifying a household as being in the panel, then each household would stay in the panel for *four* quarters and new households would replace *one-fourth* of the participating households each quarter.

[17] The constant rotation of the panel makes it impossible to test hypotheses regarding a specific household's behavior through time for more than four quarters. A longer time series of individual households' consumption is available from the PSID database, albeit only on *food* consumption.

regular quarter, data is also collected on the demographics and financial profiles of the households, including the value of asset holdings as of the month preceding the interview. We use consumption data only from the regular quarters, as we consider the data from the training quarter unreliable. In a significant number of years, the BLS failed to survey households not located near an urban area. Therefore, we consider only urban households.

The CEX survey reports are categorized in three tranches that we term the *January*, *February*, and *March* tranches. For a given year, the first quarter consumption of the January tranche corresponds to consumption over January, February, and March; for the February tranche, first quarter consumption corresponds to consumption over February, March, and April; for the March tranche, first quarter consumption corresponds to consumption over, March, April, and May; and so on for the second, third, and fourth quarter consumption. Whereas the CEX consumption data are presented on a monthly frequency, for some consumption categories, the numbers reported as monthly are simply quarterly estimates divided by three.[18] Thus, utilizing monthly consumption is not an option.

Following Attanasio and Weber (1995), we discard from our sample the consumption data for the years 1980 and 1981 because they are of questionable quality. Starting in interview period 1986q1, the BLS changed its household identification numbering system without providing the correspondence between the 1985q4 and 1986q1 identification numbers of households interviewed in both quarters. This change in the identification system makes it impossible to match households across the 1985q4-1986q1 gap and results in the loss of some observations. This problem recurs between 1996q1 and 1997q1. In this instance, we opt to end our sample in 1996q1. Thus our sample covers the period 1982q1 – 1996q1.

3.2 Definition of the Consumption Variables

For each tranche, we calculate each household's quarterly *nondurables and services* (NDS) consumption by aggregating the household's quarterly consumption across the consumption categories that comprise the definition of nondurables and services. We employ aggregation weights that adhere to the National Income and Product Accounts (NIPA) definitions of NDS consumption. In addition, we deflate each household's consumption to the 1996q1 level, using the CPI for NDS consumption. We obtain the CPI series from the BLS through CITIBASE.

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[18] See Attanasio and Weber (1995) and Souleles (1999) for further details regarding the database.

A household's consumption *growth* between quarters t - 1 and t is defined as the *ratio* of the household's consumption in quarters t and t - 1. The household's consumption growth is seasonally adjusted by using the additive adjustments obtained from the *per capita* consumption growth, as described above.

The *per capita* consumption of a set of households is calculated as follows. First, the consumption of each household is normalized, by dividing it with the number of family members in the household. Second, the normalized household consumptions are averaged across the set of households. The *per capita* consumption *growth* between quarters t - 1 and t is defined as the *ratio* of the *per capita* consumption in quarters t and t - 1. For each tranche, the *per capita* consumption growth is seasonally adjusted by using *additive* adjustments obtained from regression on all the quarterly consumption growths.

3.3 Household Selection Criteria

In any given quarter, we delete from the sample households that report in that quarter as zero either their total consumption, or their consumption of nondurables and services, or their food consumption. In any given quarter, we also delete from the sample households with missing information on the above items.

We define a household's beginning *total assets* as the sum of the household's market value of stocks, bonds, mutual funds, and other securities *at the beginning of the first regular quarter*.[19] We define as *asset holders* the households that report total assets exceeding a certain threshold. We present results for threshold values ranging from \$0 to \$20,000 in 1996q1 dollars. The number of households that are included as asset holders in our sample varies across quarters and across thresholds.

We mitigate observation error by subjecting the households to a *consumption growth filter*. The filter consists of the following four selection criteria. First, we delete from the sample households with consumption reported in fewer than three consecutive quarters. Second, we delete the consumption growth $c_{i,t} / c_{i,t-1}$, if $c_{i,t} / c_{i,t-1} < ½$ *and* $c_{i,t+1} / c_{i,t} > 2$. Third, we delete the consumption growth $c_{i,t} / c_{i,t-1}$, if it is greater than five. The surviving sub-sample of households is substantially smaller than the original one.

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[19] During the fifth and last interview, the household is asked to report both the end-of-period asset holdings and the change of these asset holdings relative to a year earlier. From this, we calculate the household's asset holdings at the beginning of the first regular quarter.

In Table 1, we present summary statistics on the quarterly, *per capita*, nondurables and services consumption, for the period 1982q1 through 1996q1, in 1996q1 dollars, for a variety of definitions of asset holders. Given that we drop quarters for which the consumption growth filter is undefined, there are about 52 usable quarters in the 1982q1 - 1996q1 period. *Per capita* consumption is obtained from CEX, with asset holders defined as the households in the database that report total assets, in 1996q1-adjusted dollars, satisfying the criterion stated in the first column and satisfying the consumption-growth filter. We present summary statistics separately for each of the three tranches, January, February, and March.

Among all the tranches, the total number of households with any amount of assets ranges between 533 and 825. The number of households that are classified as asset holders diminishes rapidly as the threshold value is raised. Among all the tranches and across time, the number of households with assets exceeding $2,000 ranges between 30 and 113, while the number of households with assets exceeding $20,000 ranges between 13 and 71. A high threshold in the definition of asset holders eliminates households that are infra marginal in the capital markets, but decreases the number of households in the database. We recognize this tradeoff by presenting empirical results for a wide range of threshold values.

The standard deviation of the *per capita* consumption growth rate is large, reflecting the fact that the number of households in each subsample is small. For some subsamples, the sample mean of the *per capita* consumption growth is negative but well within one standard deviation from zero.

3.4 The Returns Data

Our measure of the nominal, monthly risk-free rate of interest is the 1-month, T-bill return. We calculate the 3-month nominal return as the compounded buy-and-hold, three-month return. The *real* quarterly risk-free rate is calculated as the nominal risk-free rate, divided by the 3-month (one-plus) inflation rate, based on the deflator defined for nondurables and services.

The value-weighted (VW) nominal, monthly market return (capital gain plus dividends) is an arithmetic return. It is calculated from the pooled sample of the NYSE- and AMEX-listed stocks, obtained from the Center for Research in Security Prices of the University of Chicago. We calculate the nominal, *quarterly* market return as the compounded buy-and-hold, three-month investment. We calculate the *real,* quarterly market return as the nominal market return, divided by the 3-month (one-plus) rate of inflation. Finally, we calculate the quarterly *premium* on the value-weighted portfolio as the difference between the real quarterly market return and the real quarterly interest rate. We also report results using the equally weighted (EW) market return.

We calculate the excess return of high book-to-market versus low book-to-market stocks as in Fama and French (1993). The excess return is the difference of the return of the high-book-to-market and low-book-to-market portfolios.

4. Empirical Results on the Equity Premium under Incomplete Consumption Insurance

4.1 The Main Results

We begin by testing the hypothesis that the equally weighted sum of the households' marginal rate of substitution is a valid stochastic discount factor. Specifically, we test the hypothesis that the SDF, given by equation (4), satisfies equation (10) on the equally weighted and on the value-weighted market premia. We set the subjective discount factor equal to one and consider values of the RRA coefficient in the range zero to nine. We calculate the unexplained premium statistic, *u*, as in equation (11) over the period 1982q1 - 1996q1 and test the hypothesis that the unexplained premium equals zero.

In Table 2, panel A, we report the unexplained premium of the value-weighted market portfolio for each of the three tranches separately and for the combined tranches. We discuss first the results for the three tranches separately. We calculate the standard error of the unexplained premium as the sample STD of the time-series observations of the quantity $m_t \, (R_{M,t} - R_{F,t})$. We report the p-value of the null hypothesis $u = 0$ against an unspecified alternative, based on the t-statistic.

In the first row, the RRA coefficient is set equal to zero and, therefore, the SDF is identically equal to one. The unexplained premium is the sample mean of the entire market premium. For the January tranche, the premium is 2.10% per quarter and is statistically significant with p-value 2%. The premium is significant for the February and March tranches also. Thus, there is a premium that needs to be explained in the sample period, and this observation motivates the search for a suitable SDF.

In the second to tenth rows, we report the unexplained premium and the p-value of the null hypothesis $u = 0$. For each of the tranches, the unexplained premium becomes statistically insignificant when the RRA coefficient becomes three and crosses zero between the values of three and four. The sign of the unexplained premium becomes negative for RRA coefficient four or higher. Therefore, we do not reject the hypothesis that the equally weighted sum of the households' marginal rate of substitution is a valid SDF with RRA coefficient equal to three. A RRA coefficient of this order of magnitude is economically plausible.

A standard generalized method of moments (GMM) estimate of risk aversion in the exactly identified case can be inferred from Table 2 and others that report unexplained premia for various levels of risk aversion. In an exactly identified GMM risk-aversion estimation, the weighting matrix essentially plays no role. The sole determinant of the risk aversion estimate then is pricing error, the squared function of which GMM minimizes. This same estimate can be read off of our unexplained premium tables with a negligible amount of eyeball interpolation. For instance, the value-weighted premium unexplained under complete consumption insurance in Panel A of Table 2 crosses a value of zero (for the combined tranches) for a relative risk aversion between 3 and 4. For the equally weighted case, the unexplained premium crosses zero between values of 2 and 3 for the RRA, although probably closer to 3 than 2.

Note that each household in the sample is represented in only one of the three tranches. If a household's consumption growth is an outlier, this outlier cannot influence the results in more than one of the tranches. The fact that the estimated unexplained premia and the p-values are very similar for the three tranches is evidence that the results are robust to observation error on the households' consumption growth.

We also report the unexplained premium for the combined tranches. The unexplained premium is calculated as the weighted average of the unexplained premia of the three tranches, where the weights are determined from the weighted least squares quadratic form, $(1_3{}'V^{-1}1_3)^{-1}1_3{}'u_3$, where u_3 is a 3x1 vector of estimated unexplained premia for the three tranches, V is the diagonal of the 3x3 covariance matrix, and 1_3 is a 3x1 unit vector.[20] We thus weigh each mean by a measure of its volatility. Un-weighted arithmetic means produce

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[20] We note that the ID problem that hampers the ability to match households between 1985q4 and 1986q1 results in individual tranches having different time-series lengths. This difference affects the calculation of the combined average unexplained premia and the F-statistic and bootstrap p-values reported. These quantities are calculated for

qualitatively similar results as do means calculated using the entire covariance matrix (GLS). We calculate the F-statistic and report the p-value of the null hypothesis that the combined unexplained premium is zero. We also calculate the small-sample distribution of the F-statistic by the bootstrap method and report the p-value. Specifically, the F-statistic is the Hotelling T2 test of the null that the mean unexplained premia are jointly zero: $u = T^{-1} \sum_{t=1}^{T} \left(\frac{c_t}{c_{t-1}} \right)^{-\alpha} (R_{Mt} - R_{F,t-1})$. We utilize a block bootstrap with a block size of four quarters.

In the first row of Table 2, panel A, the sample mean of the entire premium for the combined tranches is 1.85% per quarter and is marginally significant. In the second to tenth rows, we report the unexplained premium and the p-value of the null hypothesis $u = 0$ for increasing values of the RRA coefficient. The unexplained premium becomes statistically insignificant when the RRA coefficient becomes three and the sign of the unexplained premium becomes negative for RRA coefficient four or higher, consistent with the results for the individual tranches.

In Table 2, panel B, we report the unexplained premium of the equally weighted market portfolio for each of the three tranches separately and for the combined tranches. The sample mean of the entire premium for the combined tranches is 1.78% per quarter, but with a p-value of about 20%, it is not significant. For the individual tranches, the premium is significant at the 10% level. For the three tranches separately and for the combined tranches, the unexplained premium reverses sign when the RRA coefficient is either three or four. Overall, the pattern of the unexplained premia of the equally weighted market portfolio is consistent with the earlier results on the value-weighted market portfolio. This suggests that the results are robust to outliers in the portfolio returns and to the composition of the market portfolio.

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the combined cases using the time frame common for all tranches. This explains why, in some cases, the combined premia fall outside the range of the individual tranche estimates. An alternative would be to truncate ex ante the time series for all tranches to a common time frame. We eschew this approach however since it disregards information unnecessarily.

4.2 Robustness of the Results

We explore further the robustness of the empirical results presented in Table 2. We expand the SDF as a Taylor series up to cubic terms, as in equation (5), and test the hypothesis that the expanded SDF satisfies equation (10) on the value-weighted and on the equally weighted market premia. The SDF is expressed in terms of the cross-sectional mean, variance, and skewness of the household consumption growth rate. The motivation for this procedure is that the estimation of the cross-sectional moments may be less susceptible to outliers than the estimation of the SDF in equation (4): the estimates of the cross-sectional moments are independent of the RRA coefficient while the SDF in equation (4) is very sensitive to outliers in the household consumption growth when the RRA coefficient is large.

The results are reported in Table 3 and are similar to the results presented in Table 2. For each of the three tranches separately and for the combined tranches, the unexplained, value-weighted equity premium is negative for RRA coefficient four or higher. We obtain similar results for the equally weighted equity premium. For the January tranche and for the combined tranches, the sign change occurs for RRA coefficient equal to four; for the January and February tranches, the sign change occurs for RRA coefficient equal to five.

For high RRA coefficient, the unexplained premium in Table 3 is negative but not as negative as in Table 2. This is consistent with the explanation that the estimation of the cross-sectional moments is less susceptible to outliers than the estimation of the SDF in equation (4).

The finding that the SDF as in equation (5) explains the equity premium with only slightly higher RRA coefficient than the SDF as in equation (4) suggests that the cross-sectional variance and skewness of the household consumption growth rate capture most of the cross-sectional variation of the households' consumption growth rates.

4.3 The Role of the Cross-Sectional Skewness of the Consumption Growth Rate

We investigate the role of the cross-sectional skewness of the household consumption growth rate in explaining the equity premium by expanding the SDF as a Taylor series up to quadratic terms, as in equation (6), and testing the hypothesis that the expanded SDF satisfies equation (10) on the value-weighted and on the equally weighted market premia. The SDF is expressed in terms of the cross-sectional mean and variance, but not skewness, of the household consumption growth rate. Thus, the SDF differs from the SDF of equation (5) only in that the skewness of the cross-sectional consumption growth rate is suppressed.

The results are reported in Table 4, panels A and B, under the column labeled SDF equation (6). The unexplained value-weighted equity premium not only remains positive for all values of the RRA coefficient between zero and nine, but also increases as the RRA coefficient increases. However, the unexplained premium is insignificant at the 5% level for RRA coefficient 2 or higher with p-values ranging to 10% for RRA coefficient equal to nine. The unexplained equally weighted equity premium also remains positive and increasing for all values of the RRA coefficient between zero and nine, but is not statistically significant. These results underscore the importance of the skewness of the household consumption growth rate, combined with the first two moments of the cross-sectional distribution, in explaining the equity premium.

We explore further the importance of the skewness by testing a variant of the expansion of the SDF, given by equation (5). We define $G_{i,\,t} = \log(c_{i,\,t}) - \log(c_{i,\,t-1})$ as the *logarithmic* consumption growth of the i^{th} household. We expand equation (4) as a Taylor series up to cubic terms. We obtain the following approximation for the SDF

$$m_t = \beta\, e^{-\alpha G_t} \left\{ 1 + \frac{1}{2}\alpha^2\, I^{-1} \sum_{i=1}^{I} \left(G_{i,t} - G_t \right)^2 - \frac{1}{6}\alpha^3\, I^{-1} \sum_{i=1}^{I} \left(G_{i,t} - G_t \right)^3 \right\}, \tag{14}$$

in terms of the cross-sectional mean, $G_t = I^{-1} \sum_{i=1}^{I} G_{i,t}$, variance, $I^{-1} \sum_{i=1}^{I} \left(G_{i,t} - G_t \right)^2$, and skewness, $I^{-1} \sum_{i=1}^{I} \left(G_{i,t} - G_t \right)^2$, of the logarithmic consumption growth rate. In empirical results that we do not display here, we find that the SDF given by equation (14) fails to explain the equity premium. These results contrast with the results reported in Section 4.2 that the SDF given by equation (5) explains the equity premium. We surmise that, in expanding the SDF in terms of the logarithmic consumption growth rate, we suppress the effect of outliers, and in particular suppress the effect of the skewness on the SDF.[21] These results underscore further the importance of the skewness on the SDF.

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[21] We explore this assertion by calculating the simple correlation between the cross-sectional mean, variance, and skewness based on g_i, the simple consumption growth of the i^{th} household, and, G_i, the logarithm of the consumption growth of the i^{th} household. For both the cross-sectional mean and variance, we find correlations that, in general,

4.4 The Role of the Log-Normality Assumption of the Household Consumption Growth Rate

We investigate whether multiplicative and i.i.d. *lognormal* idiosyncratic income shocks capture most of the cross-sectional variation of the consumption growth rate. Under this assumption, the SDF is given by equation (7). We test the hypothesis that this SDF satisfies equation (10) on the value-weighted and on the equally weighted market premia.

The results are reported in Table 4, panels A and B, under the column labeled SDF equation (7). The unexplained value-weighted equity premium remains positive for all values of the RRA coefficient between zero and nine and increases as the RRA coefficient increases. However, the unexplained premium is marginally insignificant at the 5% level for RRA coefficient 1 or higher. The unexplained equally weighted equity premium also remains positive for all values of the RRA coefficient between zero and nine, but is not statistically significant. Contrasted with the results on the SDF given by equations (4) and (5), these results again underscore the importance of the skewness of the household consumption growth rate, combined with the first two moments of the cross-sectional distribution, in explaining the equity premium.

5. Empirical Results on the Equity Premium under Complete Consumption Insurance

5.1 Tests of Complete Consumption Insurance

If a complete set of markets exists that enables households to insure against idiosyncratic income shocks, then the heterogeneous households are able to equalize, state by state, their marginal rates of substitution. Then the SDF may be expressed in terms of the cross-sectional mean, but not skewness and variance, of the household consumption

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exceed 90% between the two possible ways of computing these sample moments. However, the time-series sample estimates of skewness have a much lower correlation (31%, 49%, and 18% for the January, February, and March tranches, respectively).

growth rate, as in equation (8). It may also be expressed in terms of the *per capita* growth rate, as in equation (9). We test the hypothesis of complete consumption insurance by testing whether these two SDFs satisfy equation (10) on the value-weighted and on the equally weighted market premia.

The results are reported in Table 4, panels A and B, under the columns labeled SDF equations (8) and (9). The unexplained value-weighted equity premium remains positive and statistically significant for all values of the RRA coefficient between zero and nine. This particular SDF fails to explain the equity premium.

5.2 Tests of Complete Consumption Insurance with Limited Stock Market Participation

We recognize the fact that only a subset of households is marginal in the stock market by defining as *asset holders* the subset of households that report total assets exceeding a certain threshold value ranging from $0 to $40,000. >From the subset of households defined as asset holders, we express the SDF in terms of the *per capita* growth rate, as in equation (9), and repeat the tests of complete consumption insurance.

For threshold values $0, $2,000, $10,000, $20,000, $30,000, and $40,000, the unexplained *quarterly,* value-weighted equity premium remains positive and statistically significant for all values of the RRA coefficient between zero and twenty. These results, not reported here, suggest that the assumption of complete consumption insurance that suppresses the cross-sectional variation of the households' consumption growth rate fails to explain the quarterly equity premium even after we take in account the limited stock market participation.

We repeat the tests but now switch the holding period from three to six months. The results are reported in Table 5. For threshold value $0, the unexplained six-month, value-weighted equity premium is 5.18% and is statistically significant at all levels of the RRA coefficient. For threshold value $2,000, the unexplained premium drops to 3.37% and becomes statistically insignificant when the RRA coefficient equals ten. For threshold value $10,000, the unexplained premium drops to 3.07% and becomes statistically insignificant when the RRA coefficient equals ten. For threshold values $20,000 and $40,000, the unexplained premium flips sign for RRA coefficient between 10 and 15; for threshold value $30,000, the unexplained premium flips sign for RRA coefficient between 15 and 20. We interpret these results as evidence of complete consumption insurance when limited market participation is taken into account, if one considers these values of the RRA coefficient economically plausible. We repeat the tests but shift the start of the 6-month holding period by one quarter. In results not reported here, we find that we are unable to explain the equity premium for any threshold value between $0 and $40,000 and for any RRA coefficient between zero and 20. We conclude that, while we uncover *prima facie* evidence in favor of complete consumption insurance with limited participation, the results are sensitive to the empirical design.

In Table 6, we report the correlation of the *per capita* consumption growth with the equity premium on the value-weighted and the equally weighted market indices at the six-month frequency. For each threshold value, we report the correlation for each of the January, February, and March tranches separately, as there is no obvious way to combine these correlation estimates across tranches. Whereas the correlation estimates differ widely across the tranches, there is a pattern of increasing correlation as the definition of asset holders is tightened. We stress that we make no claim of statistical significance in this pattern, as we do not report p-values in Table 6. We make statements backed with statistical significance in the context of the unexplained premium statistic. Nevertheless, these results are in line with earlier results reported by Mankiw and Zeldes (1991) and Brav and Geczy (1995), and recent results by Attanasio, Banks, and Tanner (2002), and Vissing-Jorgensen (2002).

In summary, we find some evidence that the SDF driven by the *per capita* consumption growth can explain the equity premium with a relatively high value of the RRA coefficient, once we recognize the fact that only a subset of households is marginal in the stock market.

6. Explaining the Premium of Value Stocks over Growth Stocks

All the tests reported so far are on the equity premium. In this section, we report results of tests with the unconditional Euler equation on the excess return of high book-to-market "value" stocks over low book-to-market "growth" stocks, $R_{H,t} - R_{L,t}$, as $E\left[m_t \,(R_{H,t} - R_{L,t})\right] = 0$, and calculate the corresponding unexplained-premium statistic as $u = T^{-1}\sum_{t=1}^{T} m_t \,(R_{H,t} - R_{L,t})$. This may be viewed as a test of the *conditional* Euler equation (3), where the attribute of book-to-market is the conditioning variable. We do not attempt to explain the premium of small- versus large-capitalization stocks, because there is no size premium in our sample period.

The results are reported in Table 7 for the combined tranches. In the first row, the RRA coefficient is set equal to zero and, therefore, the SDF is identically equal to one. The unexplained premium is the sample mean of the entire value premium. The unexplained value premium is 1.19% and is significant at the 10% level.

In the second to tenth rows, we report the unexplained premium and the p-value of the null hypothesis $u = 0$ under different assumptions on the SDF. In the second column, we report the unexplained value premium when the SDF is given by equation (4), under the assumption of incomplete consumption insurance. The sign of the unexplained premium is reversed when the RRA coefficient lies between 3 and 4. In the fifth column, we report the unexplained value premium when the SDF is expressed in terms of the cross-sectional mean, variance, and skewness of the household consumption growth, as given by equation (5). The sign of the unexplained premium is reversed when the RRA coefficient lies between 4 and 5.

By contrast, in the eighth column, we report the unexplained value premium when the SDF is expressed in terms of the *per capita* consumption growth, as implied by the hypothesis of complete consumption insurance and as given by equation (9). The unexplained premium is positive, although marginally insignificant, and increases as the value of the RRA coefficient increases. We conclude that the SDF implied by a model of incomplete consumption insurance is consistent with the value premium while the SDF implied by a model of complete consumption insurance is not. The results reinforce our earlier findings on the equity premium.

7. Extensions and Concluding Remarks

In this paper, we presented evidence that the equity premium and the premium of value stocks over growth stocks are explained with a SDF calculated as the weighted average of the individual households' marginal rate of substitution with low and economically plausible value of the RRA coefficient. Since the above premia are not explained with a SDF calculated as the *per capita* marginal rate of substitution with low value of the RRA coefficient, the evidence supports the hypothesis of incomplete consumption insurance. The results are robust across the value-weighted equity premium, the equally weighted equity premium, and the value-over-growth premium. The results are robust across the three distinct cohorts of households that we refer to as the January, February, and March tranches.

Having identified the importance of the cross-sectional variance and, particularly, the cross-sectional skewness of the households' consumption growth rates as important components of the SDF, it is of interest to investigate the co-movement of these moments with macro-economic variables.

We also tested the implications of the ubiquitous complete consumption insurance model, the "representative consumer" model, when the limited participation of households in the capital markets is taken into account. Consistent with earlier results, we reject the model when no provision is made for the limited participation. We also presented some evidence that a SDF calculated as the *per capita* marginal rate of substitution is better able to explain the equity premium and does so with a lower value of the RRA coefficient as the definition of asset holders is tightened to recognize the limited participation of households in the capital market. Our evidence that the representative consumer model can account for the equity premium when limited participation is taken into account is sensitive to the experimental design. It is of interest to explore further the robustness of this evidence.

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TABLE 1: Summary Statistics on Per Capita Quarterly Consumption

We present summary statistics on the quarterly per capita consumption of nondurables and services (NDS) by households for the period 1982q1 through 1996q1. The household's NDS consumption is calculated by aggregating the household's quarterly consumption across the consumption categories that comprise the definition of nondurables and services. We employ aggregation weights that adhere to the National Income and Product Accounts (NIPA) definitions of NDS consumption. The household consumption data is filtered using the methods described in Section 3.3 and is deflated to the 1996q1 level, using the CPI for NDS consumption. We obtain the CPI series from the BLS through CITIBASE. We report sample means and standard deviations for both the level of consumption and consumption growth for a variety of definitions of asset holders as well as summary statistics on the number of observations in the particular asset holding layer. Asset holders are defined as the households in the database that report total assets, in 1996-adjusted dollars, satisfying the criterion stated in the first column. We present summary statistics separately for each of the three tranches (interview groups) labeled January, February, and March.

		Number of Households			Household Consumption Level		Household Consumption Growth Rate	
		Min	Median	Max	Mean	Std	Mean	Std
≥ 0	January	552	692	825	2,437	368	-0.01	0.06
	February	569	682	761	2,466	370	-0.01	0.07
	March	533	688	794	2,436	378	-0.01	0.06
≥ 2,000	January	31	80	108	3,351	528	0.00	0.08
	February	30	81	104	3,426	554	-0.01	0.09
	March	39	81	113	3,469	606	0.00	0.09
≥ 10,000	January	22	53	80	3,541	560	0.00	0.10
	February	18	54	76	3,621	583	-0.02	0.10
	March	23	56	83	3,665	631	-0.01	0.11
≥ 20,000	January	14	40	69	3,657	605	0.00	0.10
	February	13	40	63	3,764	606	-0.02	0.10
	March	16	40	71	3,773	681	-0.01	0.12

TABLE 2: The Unexplained Equity Premium under Incomplete Consumption Insurance

We calculate the unexplained premium statistic, *u*, based on the SDF in equation (4) over the period 1982q1 - 1996q1 and test the hypothesis that the unexplained premium equals zero. In panel A, we report the unexplained premium of the value-weighted market portfolio for each of the three tranches separately and for the combined tranches. Panel B provides similar tests but for the equally weighted market. We consider values of the RRA coefficient in the range zero to nine and report the corresponding values of the statistic *u* both for the individual tranches as well as the combined portfolio of tranches. P-values of the null hypothesis $u = 0$ against an unspecified alternative are based either on asymptotic normality or bootstrapped distribution (see Section 4.1).

Panel A: Value-Weighted Equity Premium

	Combined Tranches			January Tranche		February Tranche		March Tranche	
RRA	Average Unexplained Premium	F Statistic P-value	F Statistic Bootstrap P-value	Average Unexplained Premium	T Statistic P-value	Average Unexplained Premium	T Statistic P-value	Average Unexplained Premium	T Statistic P-value
0	1.85	0.04	0.06	2.10	0.02	2.07	0.02	2.46	0.01
1	1.95	0.04	0.06	2.33	0.01	2.12	0.02	2.56	0.02
2	2.32	0.06	0.07	3.02	0.01	2.42	0.05	2.99	0.02
3	1.88	0.74	0.69	3.85	0.11	2.36	0.20	1.50	0.31
4	< - 10	0.52	0.59	< - 10	0.60	< - 10	0.74	< - 10	0.84
5	< - 10	0.28	0.52	< - 10	0.67	< - 10	0.91	< - 10	0.88
6	< - 10	0.24	0.54	< - 10	0.64	< - 10	0.95	< - 10	0.91
7	< - 10	0.23	0.53	< - 10	0.65	< - 10	0.94	< - 10	0.89
8	< - 10	0.24	0.58	< - 10	0.69	< - 10	0.94	< - 10	0.89
9	< - 10	0.26	0.63	< - 10	0.69	< - 10	0.94	< - 10	0.90

Panel B: Equally Weighted Equity Premium

	Combined Tranches			January Tranche		February Tranche		March Tranche	
RRA	Average Unexplained Premium	F Statistic P-value	F Statistic Bootstrap P-value	Average Unexplained Premium	T Statistic P-value	Average Unexplained Premium	T Statistic P-value	Average Unexplained Premium	T Statistic P-value
0	1.78	0.21	0.22	2.09	0.06	1.98	0.07	2.27	0.04
1	1.83	0.24	0.24	2.38	0.04	1.95	0.08	2.28	0.06
2	2.00	0.36	0.29	3.05	0.04	2.04	0.12	2.31	0.10
3	-0.20	0.86	0.81	2.53	0.28	0.77	0.39	-4.63	0.74
4	< - 10	0.31	0.57	< - 10	0.70	< - 10	0.88	< - 10	0.95
5	< - 10	0.20	0.56	< - 10	0.76	< - 10	0.96	< - 10	0.99
6	< - 10	0.18	0.55	< - 10	0.83	< - 10	0.95	< - 10	0.99
7	< - 10	0.17	0.59	< - 10	0.84	< - 10	0.97	< - 10	1.00
8	< - 10	0.19	0.57	< - 10	0.86	< - 10	0.97	< - 10	1.00
9	< - 10	0.21	0.59	< - 10	0.87	< - 10	0.97	< - 10	1.00

TABLE 3: Arithmetic Expansion of the SDF under Incomplete Consumption Insurance

We calculate the unexplained premium statistic, u, based on the SDF in equation (5) over the period 1982q1 - 1996q1 and test the hypothesis that the unexplained premium equals zero. The SDF employed here is expressed in terms of the cross-sectional mean, variance, and skewness of the household consumption growth rate. In panel A, we report the unexplained premium of the value-weighted market portfolio for each of the three tranches separately and for the combined tranches. Panel B provides similar tests but for the equally weighted market. We consider values of the RRA coefficient in the range zero to nine and report the corresponding values of the statistic u both for the individual tranches as well as the combined portfolio of tranches. P-values of the null hypothesis $u = 0$ against an unspecified alternative are based either on asymptotic normality or bootstrapped distribution (see Section 4.1).

Panel A: Value-Weighted Equity Premium

	Combined Tranches			January Tranche		February Tranche		March Tranche	
RRA	Average Unexplained Premium	F Statistic P-value	F Statistic Bootstrap P-value	Average Unexplained Premium	T Statistic P-value	Average Unexplained Premium	T Statistic P-value	Average Unexplained Premium	T Statistic P-value
0	1.85	0.04	0.05	2.10	0.02	2.07	0.02	2.46	0.01
1	1.76	0.03	0.05	2.07	0.01	1.91	0.02	2.32	0.01
2	1.51	0.02	0.03	1.80	0.01	1.56	0.04	1.98	0.01
3	0.90	0.05	0.03	1.05	0.01	0.86	0.07	1.21	0.01
4	-0.22	0.96	0.97	-0.40	0.77	-0.30	0.68	-0.15	0.57
5	-1.85	0.44	0.43	-2.74	0.96	-1.99	0.89	-2.26	0.79
6	-4.12	0.32	0.26	-6.16	0.98	-4.27	0.90	-5.23	0.83
7	-7.12	0.27	0.27	< - 10	0.98	-7.16	0.90	-9.22	0.83
8	< - 10	0.26	0.21	< - 10	0.99	< - 10	0.89	< - 10	0.84
9	< - 10	0.25	0.24	< - 10	0.99	< - 10	0.88	< - 10	0.87

Panel B: Equally Weighted Equity Premium

	Combined Tranches			January Tranche		February Tranche		March Tranche	
RRA	Average Unexplained Premium	F Statistic P-value	F Statistic Bootstrap P-value	Average Unexplained Premium	T Statistic P-value	Average Unexplained Premium	T Statistic P-value	Average Unexplained Premium	T Statistic P-value
0	1.78	0.21	0.20	2.09	0.06	1.98	0.07	2.27	0.04
1	1.68	0.21	0.21	2.11	0.04	1.80	0.08	2.12	0.05
2	1.46	0.15	0.17	1.84	0.04	1.50	0.08	1.84	0.02
3	0.97	0.12	0.07	1.02	0.06	0.98	0.08	1.32	0.02
4	-0.15	0.87	0.90	-0.64	0.81	0.17	0.44	0.48	0.40
5	-1.59	0.65	0.57	-3.38	0.94	-0.96	0.67	-0.73	0.61
6	-3.61	0.56	0.53	-7.46	0.97	-2.44	0.71	-2.31	0.67
7	-6.29	0.51	0.45	< - 10	0.98	-4.29	0.73	-4.29	0.69
8	< - 10	0.48	0.40	< - 10	0.98	-6.53	0.71	-6.67	0.68
9	< - 10	0.46	0.39	< - 10	0.98	-9.22	0.68	-9.47	0.68

TABLE 4: Additional Tests under Incomplete Consumption Insurance

We calculate the unexplained premium statistic, *u*, based on the four different SDFs over the period 1982q1 - 1996q1 and test the hypothesis that the unexplained premium equals zero. The first SDF, given in equation (6), is expressed in terms of the cross-sectional mean and variance of the household consumption growth rate. The second SDF is based on the assumption that idiosyncratic income shocks that are multiplicative and i.i.d *lognormal* drive the cross-sectional variation of the households' consumption growth rates. (See equation (7)). The third and fourth SDFs are based on the complete markets assumption and are given by equations (8) and (9), respectively. In panel A, we report the unexplained premium of the value-weighted market portfolio for the combined tranches. Panel B provides similar tests but for the equally weighted market. We consider values of the RRA coefficient in the range zero to nine and report the corresponding values of the statistic *u* for the combined portfolio of the three tranches. P-values of the null hypothesis *u* = 0 against an unspecified alternative are based either on asymptotic normality or bootstrapped distribution (see Section 4.1).

Panel A: Value-Weighted Equity Premium

	SDF: equation (6)			SDF: equation (7)			SDF: equation (8)			SDF: equation (9)		
RRA	Average Unexplained Premium	F Stat P-value	F Stat Bootstrap P-value	Average Unexplained Premium	F Stat P-value	F Stat Bootstrap P-value	Average Unexplained Premium	F Stat P-value	F Stat Bootstrap P-value	Average Unexplained Premium	F Stat P-value	F Stat Bootstrap P-value
0	1.85	0.04	0.05	1.85	0.04	0.05	1.85	0.04	0.05	1.85	0.05	0.019
1	1.97	0.04	0.04	1.94	0.04	0.06	1.73	0.04	0.04	1.85	0.04	0.019
2	2.32	0.05	0.07	2.30	0.05	0.06	1.62	0.04	0.06	1.87	0.05	0.019
3	2.84	0.06	0.09	3.09	0.07	0.08	1.53	0.04	0.07	1.90	0.07	0.019
4	3.53	0.07	0.09	4.70	0.10	0.10	1.46	0.04	0.04	1.93	0.04	0.019
5	4.35	0.07	0.08	8.08	0.16	0.15	1.39	0.04	0.04	1.98	0.05	0.020
6	5.30	0.08	0.10	> 10	0.22	0.22	1.33	0.04	0.06	2.04	0.06	0.020
7	6.37	0.08	0.10	> 10	0.30	0.29	1.28	0.04	0.06	2.11	0.06	0.021
8	7.54	0.08	0.09	> 10	0.36	0.39	1.23	0.04	0.07	2.19	0.06	0.022
9	8.81	0.08	0.10	> 10	0.39	0.46	1.20	0.04	0.06	2.28	0.06	0.023

Panel B: Equally Weighted Equity Premium

	SDF: equation (6)			SDF: equation (7)			SDF: equation (8)			SDF: equation (9)		
RRA	Average Unexplained Premium	F Stat P-value	F Stat Bootstra p P-value	Average Unexplained Premium	F Stat P-value	F Stat Bootstrap P-value	Average Unexplained Premium	F Stat P-value	F Stat Bootstrap P-value	Average Unexplained Premium	F Stat P-value	F Stat Bootstrap P-value
0	1.78	0.21	0.22	1.78	0.21	0.23	1.78	0.21	0.20	1.78	0.21	0.20
1	1.87	0.24	0.23	1.83	0.24	0.25	1.65	0.22	0.22	1.77	0.22	0.24
2	2.15	0.27	0.25	2.11	0.29	0.23	1.54	0.22	0.22	1.78	0.22	0.22
3	2.60	0.30	0.27	2.69	0.35	0.29	1.45	0.22	0.21	1.80	0.22	0.21
4	3.19	0.31	0.30	3.81	0.44	0.33	1.38	0.21	0.19	1.83	0.22	0.22
5	3.90	0.32	0.28	5.94	0.51	0.40	1.31	0.21	0.20	1.87	0.21	0.20
6	4.73	0.32	0.28	> 10	0.55	0.43	1.26	0.20	0.17	1.92	0.21	0.21
7	5.67	0.31	0.24	> 10	0.54	0.47	1.21	0.20	0.18	1.98	0.20	0.21
8	6.71	0.30	0.28	> 10	0.49	0.48	1.17	0.19	0.17	2.05	0.19	0.17
9	7.85	0.29	0.25	> 10	0.42	0.44	1.13	0.18	0.15	2.12	0.19	0.17

TABLE 5: Unexplained Equity Premium under Complete Consumption Insurance and Limited Participation

We calculate the unexplained premium statistic, *u*, based on the SDF in equation (9) over the period 1982q1 - 1996q1 and test the hypothesis that the unexplained premium equals zero. We report the unexplained premium based on the value-weighted market portfolio and a semi-annual compounding frequency for the combined three tranches. We conduct our test on the subset of households that report total assets exceeding a certain threshold value ranging from all asset holders (≥0), to households whose asset holdings exceed $2,000, $10,000, $20,000, $30,000, and $40,000, respectively. We consider values of the RRA coefficient equal to 0, 1,5, 10, 15, and 20, and report the corresponding values of the statistic *u* for the combined portfolio of tranches. P-values of the null hypothesis *u* = 0 against an unspecified alternative are based either on asymptotic normality or bootstrapped distribution (see Section 4.1).

	≥ 0			≥ 2,000			≥ 10,000		
RRA	u Statistic	F Statistic P-value	F Statistic Bootstrap P-value	u Statistic	F Statistic P-value	F Statistic Bootstrap P-value	u Statistic	F Statistic P-value	F Statistic Bootstrap P-value
0	5.18	0.00	0.00	5.18	0.00	0.00	5.18	0.00	0.00
1	5.21	0.00	0.00	4.91	0.00	0.00	4.89	0.00	0.00
5	5.29	0.00	0.07	4.08	0.02	0.02	3.97	0.03	0.03
10	5.00	0.01	0.30	3.37	0.20	0.34	3.07	0.31	0.47
15	4.86	0.02	0.31	2.84	0.57	0.64	2.09	0.81	0.83
20	4.83	0.04	0.37	2.50	0.79	0.83	0.51	0.94	0.93

	≥ 20,0000			≥ 30,000			≥ 40,000		
RRA	u Statistic	F Statistic P-value	F Statistic Bootstrap P-value	u Statistic	F Statistic P-value	F Statistic Bootstrap P-value	u Statistic	F Statistic P-value	F Statistic Bootstrap P-value
0	5.18	0.05	0.03	5.18	0.00	0.00	5.18	0.00	0.00
1	4.82	0.00	0.00	4.82	0.00	0.00	4.71	0.00	0.00
5	3.65	0.06	0.05	4.00	0.09	0.07	3.21	0.18	0.15
10	2.02	0.77	0.80	3.48	0.50	0.57	1.49	0.82	0.83
15	-0.74	0.98	0.97	2.31	0.70	0.78	-0.38	0.92	0.90
20	-5.80	0.80	0.85	-2.43	0.65	0.74	-3.87	0.88	0.87

TABLE 6: Calibration Results under Complete Consumption Insurance and Limited Participation

We calculate the correlation and implied risk aversion parameter, as in Mankiw and Zeldes (1991), of the per capita consumption growth with the equity premium on the equal and value weight market indices at the six-month frequency over the period 1982q1 - 1996q1. We conduct our test on the subset of households that report total assets exceeding a certain threshold value ranging from all asset holders (≥0), to households whose asset holdings exceed \$2,000, \$10,000, \$20,000, \$30,000, and \$40,000, respectively. Results are reported separately for each tranche.

	≥ 0			≥ 2,000			≥ 10,000		
	January Tranche	February Tranche	March Tranche	January Tranche	February Tranche	March Tranche	January Tranche	February Tranche	March Tranche
Corr with VW market	0.07	0.22	-0.15	0.22	0.54	0.32	0.21	0.47	0.25
Corr with EW market	0.07	0.19	-0.21	0.09	0.52	0.25	0.12	0.45	0.20
RRA: VW market	269	98	-35	28	14	28	26	13	25
RRA: EW market	184	73	-18	53	9	26	35	9	22

	≥ 20,0000			≥ 30,000			≥ 40,000		
	January Tranche	February Tranche	March Tranche	January Tranche	February Tranche	March Tranche	January Tranche	February Tranche	March Tranche
Corr with VW market	0.38	0.52	0.18	0.26	0.52	0.08	0.44	0.55	0.16
Corr with EW market	0.23	0.48	0.11	0.10	0.47	0.04	0.31	0.48	0.09
RRA: VW market	14	10	28	16	8	51	9	7	23
RRA: EW market	17	7	34	30	6	79	9	5	30

TABLE 7: The Unexplained Premium of Value Stocks over Growth Stocks

We calculate the unexplained premium statistic, *u*, based on the SDFs given in equations (4), (5), and (9) over the period 1982q1 - 1996q1 and test the hypothesis that the unexplained premium equals zero. We report the unexplained premium on the excess return of high book-to-market "value" stocks over low book-to-market "growth" stocks for the combined tranches. We consider values of the RRA coefficient in the range zero to nine and report the corresponding values of the statistic *u* both for the combined portfolio of tranches. P-values of the null hypothesis $u = 0$ against an unspecified alternative are based either on asymptotic normality or bootstrapped distribution (see Section 4.1).

	SDF: equation (4)			SDF: equation (5)			SDF: equation (9)		
RRA	Average Unexplained Premium	F Stat P-value	F Stat Bootstrap P-value	Average Unexplained Premium	F Stat P-value	F Stat Bootstrap P-value	Average Unexplained Premium	F Stat P-value	F Stat Bootstrap P-value
0	1.19	0.05	0.10	1.19	0.05	0.10	1.19	0.05	0.10
1	1.30	0.05	0.11	1.19	0.05	0.10	1.22	0.05	0.12
2	1.67	0.05	0.11	1.13	0.04	0.06	1.26	0.05	0.09
3	2.93	0.21	0.24	0.91	0.04	0.07	1.29	0.05	0.11
4	-0.15	0.73	0.79	0.50	0.57	0.54	1.33	0.06	0.12
5	< - 10	0.68	0.79	-0.22	0.98	0.97	1.38	0.06	0.12
6	< - 10	0.63	0.77	-1.26	0.78	0.71	1.43	0.07	0.11
7	< - 10	0.59	0.75	-2.68	0.63	0.58	1.48	0.08	0.12
8	< - 10	0.56	0.75	-4.52	0.55	0.52	1.54	0.08	0.12
9	< - 10	0.54	0.73	-6.82	0.51	0.46	1.61	0.09	0.15