# Asset Pricing with Heterogeneous Consumers and Limited Participation: Empirical Evidence*

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**Abstract**

The Euler equations of consumption are tested on the household consumption of non-durables and services, reconstructed from the CEX database. The estimated relative risk aversion coefficient of the representative household decreases, and the estimated unexplained mean equity premium decreases, as infra marginal asset holders are eliminated from the sample. These results provide evidence of limited capital market participation. The estimated unexplained mean equity premium decreases when the assumption of complete consumption insurance is relaxed. The estimated correlation between the equity premium and the cross-sectional variance of the households' consumption growth is negative, as required, if the relaxation of market completeness is to contribute towards the explanation of the premium. The overall evidence from asset prices in favor of relaxing the assumption of complete consumption insurance is weak. An extensive Monte Carlo investigation highlights the relationship between the economic implications of limited participation and the resulting statistical properties of commonly used test statistics. The simulation results provide direct evidence relating observation error in consumption and the resulting small-sample properties of the test statistics.

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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 events,[2] incomplete markets,[3] market imperfections[4] and the survival bias of the US capital markets.[5] Cochrane and Hansen (1992) and Kocherlakota (1996) provide excellent surveys of this literature.

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. Attanasio and Weber (1995) argue that food consumption is a dubious proxy for total consumption.

The first goal of our paper is to re-examine the asset pricing implications of the limited participation of households in the capital markets, through the Euler equations of consumption.

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[1] For example, Abel (1990), Benartzi and Thaler (1995), Boldrin, Christiano and Fisher (1996), Campbell and Cochrane (1999), 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), Detemple and Serrat (1996), Lucas (1994), Mankiw (1986), Mehra and Prescott (1985), Storesletten, Telmer and Yaron (1998) and Telmer (1993). Heaton and Lucas (1997b) investigate empirically the risk factors and demographic variables that explain cross-sectional differences in portfolio composition and identify the important role of entrepreneurial risk.
[4] For example, Aiyagari and Gertler (1991), Alvarez and Jerman (1997), Bansal and Coleman (1996), Basak and Cuoco (1998), Brav and Geczy (1995), Constantinides, Donaldson and Mehra (1999), Danthine, Donaldson and Mehra (1992), He and Modest (1995), Heaton and Lucas (1996) and Luttmer (1996).
[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.

We define as *asset holders* the households that report total assets exceeding a certain threshold value ranging from $0 to $40,000. We use *per capita* consumption of non-durables and services (NDS), reconstructed from the Consumer Expenditure Survey (CEX) database. We find that the estimated RRA coefficient decreases, as the threshold is raised and infra marginal asset holders are eliminated from the sample. Also, the estimated unexplained mean equity premium decreases, as infra marginal asset holders are eliminated from the sample. These results provide evidence of limited capital market participation and confirm the Mankiw and Zeldes (1991) results.[6]

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.[7] 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.[8] With the exception of Constantinides and Duffie (1996), hereafter CD, the extant research suggests that the potential enrichment is largely illusory.[9] CD (1996) find that incomplete consumption insurance enriches 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 aggregate) consumption must hold.

The second 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

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[6] 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. Sections 4.5 and 5 of the current paper contain an updated and extended version of Brav and Geczy (1995) and subsume the 1995 draft. Related results are presented in Attanasio, Banks and Tanner (1998) and Vissing-Jorgensen (1999).

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

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

[9] 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, 1997a) 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.

set of Euler equations of *household* consumption, as opposed to the Euler equations of *per capita* consumption.[10] We estimate the unexplained equity premium and the unexplained risk-free rate under the assumption of incomplete consumption insurance. We find that the estimated unexplained mean equity premium decreases when the assumption of complete consumption insurance is relaxed. We also find that the correlation between the equity premium and the cross-sectional variance of the households' consumption growth is negative, as required, if the relaxation of the assumption of complete consumption insurance is to contribute towards the explanation of the premium.

The overall evidence in favor of the asset pricing implications in relaxing the assumption of complete consumption insurance is weak. We report the results of an extensive Monte Carlo investigation that suggest that the weakness of the evidence may be attributed to observation error in consumption and to the small-sample properties of the statistics.

Observation error in the consumption data is a major problem both in our investigation and in related ones. For example, when investigating the limited participation of households in the capital markets, with threshold level of asset holdings set at $10,000, the minimum number of households in the sample is merely 95. With such a small number of households, the resulting estimate of the *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 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.

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.

The small size of the database, both in cross-section and in time-series, is another major problem both in our investigation and the related ones. At first sight, this may appear not to be a problem because the database consists of 64 quarters with typically well over 100 households in each quarter. However, the uninsurable idiosyncratic shocks to the households' income growth that the theory attempts to capture, such as job loss or divorce, are infrequent events relative to the size of the cross-section and the length of the time-series.

In conducting the simulation, we first investigate our ability to reject the pricing implications of the ubiquitous complete consumption insurance model when the alternative is the incomplete consumption insurance model. We examine the power of simple statistical tests both for the

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

equity premium and the risk-free rate under the complete consumption insurance null against the alternative of incomplete consumption insurance. We find that the power is low. Doubling the number of households and the number of periods in the sample does not mitigate the problem. Furthermore, plausible observation error in the recorded consumption of the households has a major impact on the test statistics.

Second, we investigate the size characteristics for the same statistics under the incomplete consumption insurance null against an unspecified alternative. We identify major problems in the size of tests of the asset pricing implications of the incomplete consumption insurance hypothesis. The simple t-test over-rejects the true null of incomplete consumption insurance against an unspecified alternative. The problem is much more severe in testing the Euler equation of the risk-free rate than in testing the Euler equation of the equity premium. Doubling the number of households and the number of periods in the sample does not mitigate the problem. Furthermore, plausible observation error in the recorded consumption of the households has a major impact on the test statistics.

Finally, the interpretation of the estimated correlation between the market premium and the cross-sectional variance of the households' consumption growth is problematic. Observation error biases strongly this statistic towards zero. Doubling the number of households and the number of periods in the sample does not mitigate the problem.

The paper is organized as follows. In Section 2, we discuss the theory that motivates the empirical investigation. In Section 3, we report the results of a Monte Carlo investigation of observation error and of the small-sample properties of the statistics. In Section 4, we describe the data sources and the data selection procedure. We also display summary statistics and present a preview of the equity premium puzzle. The test results under *complete* consumption insurance are presented and discussed in Section 5. The test results under *incomplete* consumption insurance are presented and discussed in Section 6. In Section 7, we provide extensions and concluding remarks.

## 2. Theoretical Considerations

### 2.1 The Model

Our dual goal is to investigate the pricing implications of the limited participation of households in the capital markets and the incompleteness of markets that insure against idiosyncratic income shocks. We focus on the stated goals by making conventional assumptions about other aspects of the economy.

We consider a set of households, i = 1,...,I, that participate in the capital markets. The households have time- and state-separable von Neumann-Morgenstern homogeneous preferences

$$E\left[(1-a)^{-1}\sum_{t=0}^{\infty} b^{t}\left(c_{it}^{1-a}-1\right) \mid F_0\right] \qquad (1)$$

where $a$, $a > 0$, is the constant RRA coefficient; $b$ is the constant subjective discount factor; $c_{it}$ is the dollar consumption of the $i^{th}$ household at date t; and $F_0$ is the date-zero information set that is assumed common across the households. We assume that the 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 (one-plus) return $R_{jt}$ between dates t – 1 and t.

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

$$E[\, b(c_{it}/c_{i,t-1})^{-a} R_{jt} \mid F_{t-1} \,] = 1, \quad i = 1,\ldots, I; \quad j = 1,\ldots,J, \tag{2}$$

where $c_{it}/c_{i,t-1}$ is the *consumption growth* of the $i^{th}$ household. In principle, this set of equations may be tested directly. Since individual consumption data are reported with substantial error, we mitigate this problem by adding these equations across households, dividing by I, and obtaining the following set of equations instead:

$$E\left[ b \left\{ I^{-1} \sum_{i=1}^{I} \left( \frac{c_{it}}{c_{i,\,t-1}} \right)^{-a} \right\} R_{jt} \mid F_{t-1} \right] = 1, \quad j=1,\ldots,J. \tag{3}$$

In Section 6, we test the Euler equations (3). Specifically, we test the unconditional Euler equation for the excess market return, $R_{Mt} - R_{Ft}$, as

$$E\left[ b \left\{ I^{-1} \sum_{i=1}^{I} \left( \frac{c_{it}}{c_{i,\,t-1}} \right)^{-a} \right\} (R_{Mt} - R_{Ft}) \right] = 0 \tag{4}$$

and for the (one–plus) real return on a one-month, rolled-over T-bill, $R_{Ft}$, as

$$E\left[ b \left\{ I^{-1} \sum_{i=1}^{I} \left( \frac{c_{it}}{c_{i,\,t-1}} \right)^{-a} \right\} R_{Ft} \right] - 1 = 0. \tag{5}$$

If we further assume that 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.[11] Then equations (3) simplify into

$$E[\, b\, (c_t/c_{t-1})^{-a} R_{jt} \mid F_{t-1}] = 1, \quad j = 1,\ldots,J, \tag{6}$$

where $c_t$ is the *per capita* consumption defined as $c_t = I^{-1} \sum c_{it}$ .

[11] See Constantinides (1982).

In Section 5, we test the Euler equations (6), under the maintained hypothesis of complete consumption insurance. Specifically, we test the unconditional Euler equation for the excess market return, $R_{Mt} - R_{Ft}$, as

$$E\left[ b\left( \frac{c_t}{c_{t-1}} \right)^{-a} (R_{M\,t} - R_{F\,t}) \right] = 0 \tag{7}$$

and for the (one–plus) real return on a one-month, rolled-over T-bill, $R_{Ft}$, as

$$E\left[ b\left( \frac{c_t}{c_{t-1}} \right)^{-a} R_{F\,t} \right] - 1 = 0. \tag{8}$$

**2.2 The Unexplained Premium and the Unexplained Risk-Free Return**

In testing the Euler equation (7) on the excess market return, we calculate the statistic $u$ as

$$u = T^{-1} \sum_{t=1}^{T} \left( \frac{c_t}{c_{t-1}} \right)^{-a} (R_{M\,t} - R_{F\,t}). \tag{9}$$

We rewrite this equation as

$$T^{-1} \sum_{t=1}^{T} \left( \frac{c_t}{c_{t-1}} \right)^{-a} \left\{ R_{M\,t} - R_{F\,t} - \left( T^{-1} \sum_{t=1}^{T} \left( \frac{c_t}{c_{t-1}} \right)^{-a} \right)^{-1} u \right\} = 0\,, \tag{10}$$

Since the coefficient of $u$ is approximately equal to one, we interpret $u$ as the unexplained mean premium.

In testing the Euler equation (8) on the risk-free rate, we calculate the statistic $u$ as

$$u = T^{-1} \sum_{t=1}^{T} \left( \frac{c_t}{c_{t-1}} \right)^{-a} R_{F\,t} - 1. \tag{11}$$

We rewrite this equation as

$$T^{-1} \sum_{t=1}^{T} \left( \frac{c_t}{c_{t-1}} \right)^{-a} \frac{R_{F\,t}}{1+u} - 1 = 0\,, \tag{12}$$

and interpret $u$ as approximating the unexplained risk-free return, if $b = 1$. The unexplained risk-free rate is modified as $u - (1 - b)$, if $b < 1$.

In testing the Euler equations (4) and (5), we calculate the corresponding statistics

$$u' = T^{-1} \sum_{t=1}^{T} \left( I^{-1} \sum_{i=1}^{I} \left( \frac{c_{it}}{c_{i,t-1}} \right)^{-a} \right) (R_{M\,t} - R_{F\,t}) , \tag{13}$$

and

$$u' = T^{-1} \sum_{t=1}^{T} \left( I^{-1} \sum_{i=1}^{I} \left( \frac{c_{it}}{c_{i,t-1}} \right)^{-a} \right) R_{F\,t} - 1 \tag{14}$$

and interpret them as the unexplained mean premium and the unexplained risk-free rate, respectively.

### 2.3 The Cross-Sectional Variance of the Households' Consumption Growth

The cross-sectional variance of the households' consumption growth and the time-series *correlation* of this covariance with the equity premium play a major role in the determination of asset prices. Whereas the Euler equations (3) reduce into the Euler equations (6) in the special case of complete consumption insurance, in the general case of *incomplete* consumption insurance, the pricing kernel is a function of both the *per capita* consumption growth and the *variance* of the households' consumption growth. We illustrate these concepts in the context of the model studied in CD (1996).

We consider an economy with an infinite number of distinct households with uninsurable, persistent, and idiosyncratic income shocks. Since these shocks are uninsurable, they are transmitted to the households' consumption processes. We define the households' consumption processes as

$$\frac{c_{it}}{c_{i,t-1}} = \frac{c_t}{c_{t-1}} \exp\left\{ y_t h_{it} - \frac{y_t^2}{2} \right\} , \tag{15}$$

where the shocks $\{h_{it}\}$ have the following properties: (a) distinct subsets of $\{\eta_{it}\}$ are independent; and (b) for all i and t, $h_{it}$ is standard normal and independent of $F_{t-1}$ and $y_t$.[12] From equation (15), we see that $y_t^2$ is the variance of $\log(c_{it}/c_{i,t-1}) - \log(c_t/c_{t-1})$ and is interpreted as the cross-sectional variance of the households' consumption growth. In the context of the economy with an infinite number of distinct households, CD (1996) show that

[12] In CD (1996), the set of consumers is chosen in a mathematically careful way such that the *per capita* consumption equals $c_t$ with probability one.

$$I^{-1}\sum_{i=1}^{I}\left(\frac{c_{it}}{c_{i,t-1}}\right)^{-a} = \left(\frac{c_t}{c_{t-1}}\right)^{-a} \exp\left\{\frac{1}{2}a\,(a+1)y_t^2\right\}, \qquad (16)$$

where the summation across the consumers is interpreted as an integral.

In the special case of complete consumption insurance, the idiosyncratic income shocks are insured away and are not transmitted to the households' consumption processes. Then $y_t^2 = 0$, and each household's consumption growth equals the *per capita* consumption growth. The pricing kernel is a function of the *per capita* consumption growth alone.

In the general case of incomplete consumption insurance, the pricing kernel is a function of both the *per capita* consumption growth and the *variance* of the idiosyncratic income shocks transmitted to the households' consumption processes. This richer representation of the pricing kernel, implied by the assumption of incomplete consumption insurance, contributes towards the explanation of the mean equity premium only if the correlation between the equity premium and $y_t^2$ is sufficiently *large and negative*. This correlation is one of the targets of our empirical investigation.

## 3. Observation Error and the Small-Sample Properties of the Statistics: Monte Carlo Investigation

### 3.1 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 (7) and (8) 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*. Households are classified as asset holders based on a certain threshold of household assets holdings. For example, when the threshold level of asset holdings is $10,000, the minimum number of households in the sample is 95. With such a small number of households, the resulting estimate of the *per capita* consumption is noisy.

Observation error is even more problematic when we test the Euler equations of consumption (4) and (5) 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 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.

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 provide a preview of the implications of a multiplicative and unbiased observation error in the consumption growth. In the case of *per capita* consumption, we assume that the observed consumption growth is $(c_t/c_{t-1})\, w_t$ , where the observation error, $w_t$ , has the properties $w_t > 0$, $E[w_t] = 1$, is i.i.d , and is independent of all other variables in the Euler equation. Likewise, in the case of *household* consumption, we assume that the observed consumption growth is $(c_{it} / c_{i,t-1})\, w_{it}$, where the observation error, $w_{it}$ , has the properties $w_{it} > 0$, $E[w_{it}] = 1$, is i.i.d , and is independent of all other variables in the Euler equation.

Consider first the unexplained premium statistic, $u$, in equation (9). The observation error does not bias this statistic because $E\,[u\, w^{-a}] = 0$. Consider next the unexplained risk-free rate statistic, $u$, in equation (11). The observation error biases this statistic from its mean-zero value under the null to the value $E[w^{-a}] - 1 > 0$. The bias is increasing in the standard deviation of $w$ and in the RRA coefficient. In recognizing limited participation in the capital markets, we report the unexplained risk-free rate in progressively smaller subsets of the households. In the smaller subsets, we anticipate the standard deviation of $w$ to be higher and, therefore, the bias in the unexplained risk-free rate to be higher.

The observation error increases the standard error of the statistic $u$ by the multiplicative factor $\{E[w^{-2a}\,]\}^{1/2} > 1$. Therefore, it biases downwards the t-statistic of the unexplained premium. It also increases the standard error of the statistic $u$ and may bias the t-statistic of the unexplained risk-free rate.

The observation error in household consumption is substantially larger than the observation error in *per capita* consumption. Therefore, we expect larger biases in testing the pricing implications of the model of incomplete consumption insurance than in testing the model of complete consumption insurance.

The quantitative effects of observation error on the size and power of our empirical tests are explored through Monte Carlo simulation in this section. The results of the Monte Carlo investigation are summarized in Section 3.3 for the reader who wishes to proceed to the empirical results of the paper without delay.

### 3.2 The 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 64 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.

The quantitative effects of the small-sample properties of the statistics on the size and power of our empirical tests are explored through Monte Carlo simulation in this section. The reader who wishes to proceed to the empirical sections of the paper will find a summary of the results of the Monte Carlo investigation in Section 3.3.

### 3.3 Summary of the Simulation Results

We simulate two versions of an economy with incomplete consumption insurance and with idiosyncratic income shocks, as in CD (1996). The first version captures shocks to the economy that increase the variance of the households' consumption growth, where these shocks occur with frequency of the order of that of business cycles. The second version captures shocks less frequent than business cycles. In either version, the simulated data support the model of incomplete consumption insurance by construction. The model and its calibration are described in the appendix.

First, we investigate our ability to reject the pricing implications of the ubiquitous complete consumption insurance model when the alternative is the incomplete consumption insurance model.[13] We examine the power of simple statistical tests both for the equity premium and the risk-free rate under the complete consumption insurance null against the alternative of incomplete consumption insurance. We find that the power is low. Doubling the number of households and the number of periods in the sample does not mitigate the problem. Furthermore, plausible observation error in the recorded consumption of the households has a major impact on the test statistics.

Second, we investigate the size characteristics for the same statistics under the incomplete consumption insurance null against an unspecified alternative.[14] We identify major problems in the size of tests of the asset pricing implications of the incomplete consumption insurance hypothesis. The simple t-test over-rejects the true null of incomplete consumption insurance against an unspecified alternative. The problem is much more severe in testing the Euler equation of the risk-free rate than in testing the Euler equation of the equity premium. Doubling the number of households and the number of periods in the sample does not mitigate the problem. Furthermore, plausible observation error in the recorded consumption of the households has a major impact on the test statistics.

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[13] We do not address the power of tests to reject the null of the pricing implications of the complete consumption insurance model against an *unspecified* alternative. See Ferson and Foerster (1994) and Kocherlakota (1990).
[14] Note that the converse question of whether it is possible to reject the pricing implications of the incomplete consumption insurance model in favor of the complete consumption insurance model does not arise because the complete consumption insurance model is nested within the incomplete consumption insurance model.

Finally, the interpretation of the estimated correlation between the market premium and $y_t^2$ , is problematic. Observation error biases strongly this statistic towards zero. Doubling the number of households and the number of periods in the sample does not mitigate the problem.

### 3.4 Detailed Results of the Simulation on the Power of the Tests

We calibrate the model as explained in the appendix. We generate 10,000 sample paths of the market return and of the consumption of 500 households for 64 quarters. For each path, we calculate *u* and *u*, with parameter values $a$ = 4 and $r$ = 0. Recall that *u* and *u* are interpreted as the unexplained equity premium and the unexplained risk-free rate, respectively, under the assumption of *complete* consumption insurance. The value $a$ = 4 matches the value of the RRA coefficient used as input in generated the data. We consider both cases, *k* = 0 (zero observation error) and *k*= 0.5 (moderate observation error). The simulation allows us to derive the sample distribution of these statistics. It also allows us to derive the sample distribution of the t-statistics and explore the power of the tests. We also present results for the case in which the number of households and the length of the time series are doubled.

In Table 1, we present results on the power of tests of the Euler equation applied to the market premium, when the null hypothesis is the complete consumption insurance. First, we set the value of the parameter *s* at 2.43. Effectively, we model the frequency of occurrence of periods when the variance of the households' consumption growth is high to be comparable to the frequency of business cycles. We also assume that the consumption growth of households is observed without error (*k*=0). By construction, the null is false in the simulated data. In fact, the covariance of the market premium with the *per capita* consumption growth accounts for only about one-third of the mean premium.

We calculate the unexplained premium (*u)* under the null. In the fourth row of Table 1, Panel A, we report the mean and tail values of the distribution of the unexplained premium. The reported mean is 0.01 because the expected unexplained premium is about 1% per quarter, by construction. The fifth row presents the theoretical cutoff rates of a Student-t distribution with 60 d.f. , as an approximation for the correct 62 d.f. The sixth row presents the simulated rejection rates. Since most of our empirical estimates of the unexplained premium are positive, we focus on the right-hand tail of the distribution.

At the 5% level, the false null is rejected only with frequency 15% and, at the 1% level, the false null is rejected only with frequency 4%. The frequency of rejection of the false null is even lower when we account for observation error with *k* = 0.5. The right-hand side of the panel considers the potential increase in the power of the test if we were to double the number of households *and* wait for 26 years to double the length of the time series. The increase in the power would be modest: at the 5% level, the frequency of rejection would increase from 15% to 21% ; and at the 1% level, the frequency of rejection would increase from 4% to 7% .

In Panel B of Table 1, we set the value of the parameter *s* at 5.94. Effectively, we model the frequency of occurrence of periods when the variance of the households' consumption growth is high to be substantially lower than the frequency of business cycles. The results are remarkably similar to those in Panel A. We conclude that the results are robust to assumptions on the frequency of events that increase the variance of the households' consumption growth.

We summarize these findings as follows. The test of the unconditional Euler equation of the market premium has low power to reject the null of complete consumption insurance, against the alternative hypothesis of either of the two specific models of incomplete consumption insurance that we simulated. One may not draw conclusions regarding the power to reject the null of complete consumption insurance against an unspecified alternative.

In Table 2, we present results on the power of tests of the Euler equation applied to the risk-free rate, when the null hypothesis is the complete consumption insurance. This table is organized as Table 1. Consider first Panel A, without observation error ($k$=0) and with sample size specifications N = 500 and T = 64. The mean unexplained risk-free rate is - 0.038 (negative 3.8% per quarter). This illustrates the risk-free rate puzzle, generated in calibrated models and in empirical estimation using the *per capita* consumption from the National Income and Product Accounts. Essentially, the risk-free rate appears to be too large, if one ignores the uninsurable idiosyncratic income shocks. If we were to adjust the mean unexplained risk-free rate downwards by 0.005 to account for the subjective discount rate of $r = -\log b = 0.005$, we would be exacerbating the risk-free rate puzzle. For negative t-statistics, we reject the false null with frequency 22% at the 1% significance level, and with frequency 45% at the 5% significance level. The power of the test is high. The power is even higher when the sample size specifications double. For positive t-statistics, we hardly ever reject the false null.

The above results are reversed when we introduce observation error, with $k = 0.5$. As anticipated, multiplicative observation error induces a strong positive bias to the mean unexplained risk-free rate. The mean unexplained risk-free rate is 0.95 (95% per quarter). The t-statistics are so large and positive that, for positive t-statistics, we reject the false null with frequency 65% at the 1% significance level, and with frequency 93% at the 5% significance level. For negative t-statistics, we hardly ever reject the false. It is premature to rejoice in the high power of the test when the t-statistic is positive. In the next section, we find that the bias is so large that we even reject with very high frequency the true null of *incomplete* consumption insurance.

In Panel B, with the value of the parameter $s$ set at 5.94, the results are remarkably similar to those in Panel A. We conclude that the results are robust to assumptions on the frequency of events that increase the variance of the households' consumption growth.

### 3.5 Detailed Results of the Simulation on the Size of the Tests

As in the last section, we generate 10,000 sample paths of the market return and of the consumption of 500 households for 64 quarters. For each path, we calculate the unexplained premium (*u¢*) and the unexplained risk-free rate (*u¢*), both under the assumption of *incomplete* consumption insurance and with parameter values $a = 4$ and $r = 0$. We consider both cases, $k = 0$ and $k = 0.5$.

In Table 3, we present results on the size of tests of the Euler equation applied to the market premium, when the null hypothesis is the incomplete consumption insurance. We calibrate the model as explained above. First, we set the value of the parameter *s* at 2.43 and assume that the consumption growth of households is observed without error. By construction, the null is true in the simulated data. We calculate the unexplained premium (*u¢)* under the null. In the fourth row of Table 3, Panel A, we report the mean and tail values of the distribution of the unexplained premium. It is not surprising that the reported mean is zero because the expected unexplained premium is zero by construction. The fifth row presents the theoretical cutoff rates of a Student-t distribution. The sixth row presents the size of the tests for different p-values. The seventh row presents the size-adjusted cut-off values of the t-statistic.

It is clear from the panel that the unexplained premium has a skewed distribution in which the first percentile value is - 6.4%, while the ninety-ninth value is only 3.4%. The fifth and ninety-fifth percentiles are closer to symmetric with values of - 2.9% and 2.5%, respectively. More astonishing than the distortion of the distribution of *u¢* under the null are the rejection rates presented in the second line of the panel. In the right tail of the distribution, where are empirical t-statistics typically lie, we reject the null 9.38% of the time when we expect to reject it only 5% of the time. In addition, the 1% expected rejection rate is more than double with a value of about 2.5%. In the left tail of the distribution, at the 1% level, the simulated rejection frequency is 0.19% and at the 5% level, the simulated rejection frequency is 2.21%.

The pattern of empirical rejection frequencies is not surprising given the shape of the distribution of *u¢*. The left-skewness of this distribution leads to a negative correlation between the sample mean and sample standard deviation. By taking the ratio of the former to the latter, the resulting distribution of the test statistic is not Student-t and in fact leads to an estimator distribution that is centered away from the null zero value and instead on a positive mean. This explains why the rejection rates are too high in the right tail and too low in the left tail.

One might expect that doubling the sample size in either the time or the cross-sectional dimensions would mitigate the difficulties encountered above. However, the results in Panel A for N=1,000 and T=128 are remarkably similar to the results in the smaller sample. By increasing the size of the sample, we do not correct the false rejections evidenced in the smaller sample.

We also investigate the implications of observation error on size by setting the parameter *k* equal to 0.5. The results reported in the last three rows of Table 3, Panel A are largely unchanged. Finally, in Panel B, we set the value of the parameter *s* at 5.94. The frequency of false rejections is even higher than in Panel A. Taken together, the results suggest that we over-reject the true null of incomplete consumption insurance against an unspecified alternative.

In Table 4, we present results on the size of tests of the Euler equation, applied to the risk-free rate when the null hypothesis is the incomplete consumption insurance economy. This table is organized as Table 3. We calculate the unexplained risk-free rate (*u¢)* under the null. Without observation error, the reported mean is approximately zero because the expected unexplained risk-free rate is zero by construction. With observation error, the reported mean is about 1100% per quarter, illustrating the huge positive bias introduced by the observation error. Because of this bias, the t-test rejects the true null with 100% frequency. Moreover, by doubling the size of the database, we do not mitigate the problem. This suggests that tests of the incomplete consumption insurance hypothesis by using the Euler equation of the risk-free rate are problematic.

In this section, we have identified major problems in the size of tests of the incomplete consumption insurance hypothesis. The simple t-test over-rejects the true null of incomplete consumption insurance against an unspecified alternative. The problem is much more severe in the Euler equation of the risk-free rate than in the Euler equation of the market premium.

### 3.6 Simulated Distribution of the Correlation between the Market Premium and the Cross-Sectional Variance of the Households' Consumption Growth

The incomplete consumption insurance model has the potential to explain the mean equity premium, if the idiosyncratic income shocks are persistent and heteroscedastic and *if the correlation of the market premium and the cross-sectional variance of the households' consumption growth ( $y_t^2$ ) is sufficiently large and negative.* Therefore, the estimation of this correlation is a direct way to gauge the potential of this model. In Table 5, we present results on the simulated distribution of the correlation between the market premium and $y_t^2$ , when the null hypothesis is the incomplete consumption insurance.

First, we set the value of the parameter *s* at 2.43. The implied theoretical correlation of the market premium and $y_t^2$ is about 50%. With sample size N = 500 and T = 64, and with zero observation error, Table 5 shows that the mean and median of the correlation are approximately equal and the tails of the distribution appear to be symmetric. According to this distribution, one would hardly ever fail to estimate a negative correlation, when incomplete consumption insurance is a major factor driving the mean equity premium. When the sample size doubles in both the cross-section and the time dimension, the distribution becomes slightly more concentrated and the conclusion remains unchanged.

The effect of observation error in the household consumption growth is to introduce error in the estimated cross-sectional variance $y_t^2$ and bias towards zero the estimated correlation of the market premium and $y_t^2$ . Indeed, this is what we observe in the last line of Panel A. Whereas the distribution remains symmetric, it is shifted drastically towards zero. The mean value of the correlation increases from -52.8% to -21.4%. The bias is so large that we estimate positive correlation with frequency 7.6% , even though the theoretical correlation is about –50% . Even if it were possible to double the sample size in both the cross-section and the time dimension, the bias would hardly be mitigated. When the sample size doubles, the mean value of the correlation decreases from –21.4% to –27.6% .

In Panel B of Table 5, we set the value of the parameter *s* at 5.94. The results are even stronger than in Panel A. With observation error, the mean value of the correlation becomes -0.006, even though the theoretical correlation is about -30% . The bias is so large that we estimate positive correlation with frequency 48.4%. Even if it were possible to double the sample size in both the cross-section and the time dimension, we would still be estimating positive correlation with frequency 46.2%.

In Panel C, we report the correlation between the market premium and $y_t^2$, estimated from quarterly data in the period 1980q2-1996q1. These results are discussed in Section 6.

## 4. Description of the Data

### 4.1 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 - 1996q1. Each quarter, roughly 5,000 U.S. households are surveyed, chosen randomly according to stratification criteria determined by the U.S. Census. A detailed weighting scheme, based on a number of demographic variables, allows extrapolation of the data to the general U.S. population.

Each household participates in the survey for five consecutive quarters, one training quarter and four regular ones, during which their 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. However, it is always possible to extrapolate to the general population by employing the stratification weights that also vary through time in accordance with changes in the sample.

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 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.

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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.

Starting in 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 perfectly across the 1985q4-1986q1 gap. However, each yearly release of the CEX contains households from the first quarter of the subsequent year's household data in a "pre-release" format. We bridge the gap between 1985q4 and 1986q1 by using these households. While this procedure allows us to establish a correspondence between these two quarters, we still lose information on the asset holdings of households whose fifth interview occurred either in 1986q2 or in 1986q3. In addition, we discard from our sample the first quarter of 1980 because the total number of households interviewed that quarter is 250 (versus 3,500 households in the second quarter of 1980). Finally, in a significant number of years, the BLS failed to survey households not located near an urban area. Therefore, we do not consider non-urban households appearing in the survey at any time.

### 4.2 Definition of the Consumption Variables

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.[18] 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.

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, with weights proportional to the CEX-reported weights. These weights are normalized in order to keep constant the size of the overall population implicit in the original weights.[19] The *per capita* consumption *growth* between quarters t and t+1 is defined as the *ratio* of the *per capita* consumption in quarters t+1 and t. The *per capita* consumption growth is seasonally adjusted by using *additive* adjustments obtained from regression on 16 quarterly consumption growths, eight on each side of the growth being adjusted.[20]

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

### 4.3 Household Selection Criteria

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[18] The Universal Classification Code scheme we employ is available upon request.
[19] Results with equal weights are reported also. The results remain unchanged.
[20] In adjusting growth rates either in the beginning or the end of the sample, we use less than 16 quarters. For example, our first growth rate occurs between 1980q2 and 1980q3. We seasonally adjust this growth rate using information only from the following eight growth rates.

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. Missing information on the above items is counted as zero consumption.

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*.[21] 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 $40,000 in 1996q1 dollars. We also present results for non-asset holders, defined as the households in the database that reported total assets *below* the threshold of $2,000. The number of households that are included as asset holders in our sample varies across quarters and across thresholds.

The households that pass the above selection criteria form the sample used in deriving the results presented in Tables 7 and 8. In calculating the *per capita* consumption, the normalized household consumption is averaged across the households, as explained in Section 4.2. This averaging mitigates the observation error in the individual households' consumption.

In deriving the results presented in Table 9, we calculate the individual households' marginal rate of substitution by raising the individual households' consumption growth to the power $-\alpha$. When the RRA coefficient is large, the results are sensitive to observation error in the individual households' consumption. We mitigate this problem by subjecting the households to a *consumption growth filter*. The filter consists of the following three selection criteria. First, we delete from the sample households with consumption reported in fewer than three consecutive quarters. Second, we delete from the sample the consumption growth $c_{i\,t} / c_{i\,,\,t-1}$ , if $c_{i\,t} / c_{i,\,t-1} > 2$ *and* $c_{i,\,t+1} / c_{i\,t} < ½$ . Third, we delete the consumption growth $c_{i\,t} / c_{i\,,\,t-1}$ , if $c_{i\,t} / c_{i,\,t-1} < ½$ *and* $c_{i,\,t+1} / c_{i\,t} > 2$. The surviving subsample of households is substantially smaller than the original one.

### 4.4 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 (CRSP) of the University of Chicago. We calculate the nominal *quarterly* market return as the compounded buy-and-hold, three-month investment. We also report results using the equally weighted (EW) market return. We calculate the *real,* quarterly market return as the nominal market return, divided by the 3-

[21] 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.

month (one-plus) inflation rate. Finally, we calculate the quarterly equity premium as the difference between the real, quarterly market return and the real, quarterly interest rate.

### 4.5 Summary Statistics and Preview of the Equity Premium Puzzle

In Panel A of Table 6,we present summary statistics on the quarterly, *per capita*, NDS consumption, for a variety of definitions of asset holders, for the period 1980q2 - 1996q1. In the first row, *per capita* consumption is obtained from NIPA.[22] In all other rows, *per capita* consumption is obtained from CEX, with asset holders defined as the households in the database that report total assets, in 1996-adjusted dollars, satisfying the criterion stated in the first column. In the last row, *per capita* consumption is obtained with *equal* weights on the households, rather than with weights proportional to the CEX-reported weights.

In the consumer expenditure survey, the total number of households with any amount of assets ranges between 3,999 and 5,986. The number of households that are classified as asset holders diminishes rapidly as the threshold value is raised. The number of households with assets exceeding $2,000 ranges between 153 and 709, with median 608, while the number of households with assets exceeding $40,000 ranges between 45 and 249, with median 158. 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.[23]

In Panel B of Table 6, we present summary statistics on the *per capita* consumption *growth rate.* The layout of the rows is as in Panel A. The standard deviation of the *per capita* consumption growth in the CEX database is double that from the NIPA *per capita* consumption growth. The standard deviation of the *per capita* consumption growth, based on the subset of households with assets $40,000 or higher, is five times that from the entire CEX database. To the extent that this standard deviation is evidence of increasing observation error in smaller databases, we anticipate increasing bias in the estimated unexplained risk-free rate.

The most interesting statistics are the reported correlation of the consumption growth with the market indices and the implied coefficients of RRA. The correlation of the CEX *per capita* consumption growth with the value-weighted index increases from 4.7% to 30.5%, as the definition of asset holders is tightened. We also calculate and report the RRA coefficient required to generate the sample mean of the equity premium. As in Grossman and Shiller (1982), we calculate the RRA coefficient as the ratio of the sample mean of the equity premium and the covariance of the consumption growth with the market index. For the VW market index,

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[22] Although NIPA *per capita* consumption is available for a longer period, we report results only for the sub-period 1980q2 - 1996q1, in order to make them comparable to the results on CEX *per capita* consumption.

[23] Recall that, in deriving the results presented in Tables 9 and 10, we subject the households to a *consumption growth filter*. The surviving subsample of households is substantially smaller than the original one. The number of households with assets exceeding $2,000 ranges between 125 and 339, with median 287. The number of households with assets exceeding $10,000 ranges between 68 and 221, with median 161. The number of households with assets exceeding $20,000 ranges between 45 and 176, with median 119. The number of households with assets exceeding $30,000 ranges between 34 and 152, with median 94. The number of households with assets exceeding $40,000 ranges between 26 and 122, with median 77.

the RRA coefficient decreases from 405 to 13, as the threshold in the definition of asset holders is raised from $0 to $40,000. These results confirm the earlier results by Mankiw and Zeldes (1991) and Brav and Geczy (1995), that participation by households in the capital markets is limited. The statistical investigation of these issues is presented in Section 5.

In the row before last of Panel B, we present summary statistics on the *per capita* consumption of the non-asset holders, defined as the households in the database that reported total assets below the threshold of $2,000. The reported correlation of the consumption growth with the value-weighted index is 2.8% and the implied coefficient of RRA is 592. This suggests that the households designated as non-asset holders are indeed infra marginal in the capital markets.

In the last row of Panel B, the *per capita* consumption is obtained with *equal* weights on the households, rather than with weights proportional to the CEX-reported weights. In explaining the premium of the value-weighted index, the implied coefficient of RRA increases from 40 to 45, suggesting that the choice between the two weighting schemes may be unimportant.

## 5. The Test Results under Complete Consumption Insurance

In Tables 7 and 8, we present test results of the Euler equations of *per capita* consumption, for the period 1980q2 - 1996q1 (with 63 consumption growth rates). The RRA coefficient is set at values ranging from zero to 20. The subjective discount factor is set equal to one. For the equally weighted and the value-weighted market premia, the reported unexplained premium is the time-average of the product of the realized excess market return and the marginal rate of substitution, as in equation (9). For the risk-free rate, the reported unexplained rate is the time-average of the product of (one plus) the risk-free rate of interest and the marginal rate of substitution, minus one, as in equation (11). Both rates are expressed in percent. The reported "bootstrap p-value" is the frequency at which the unexplained premium is negative, in 500 bootstrapped samples, each having 63 consumption growth rates.

In Table 7, we do not distinguish between asset holders and non-asset holders. *Per capita* consumption is calculated from the pooled sample of asset holders and non-asset holders. In Panel A, *per capita* consumption is obtained from NIPA. Under the column corresponding to the RRA coefficient being equal to zero, the marginal rate of substitution is identically equal to one. The quarterly EW market premium is 2.26% and the quarterly VW market premium is 2.10%. Both are marginally significant. The quarterly risk-free rate is .74% and is significantly different from zero at the 5% level.

With RRA coefficient equal to one, the unexplained premium remains essentially unchanged but the unexplained risk-free rate vanishes. As the RRA coefficient increases, the unexplained premium decreases, but only marginally, thereby illustrating the puzzle that the mean equity premium is too large. The unexplained risk-free rate becomes very large *negative* and significant, thereby illustrating the puzzle that the risk-free rate is too small. If we were to set the quarterly subjective discount factor at the value of .995, instead of the value of one, the unexplained risk-free rate would decrease by 0.5%, thereby aggravating the risk-free rate puzzle.

These test results for the period 1980q2 - 1996q1 confirm well-known earlier results in the literature and serve as a benchmark for the results that rely on the CEX database.

In Panel B, *per capita* consumption is obtained from the CEX database, with weights proportional to the CEX-reported weights. The results on the unexplained premium are similar to those in Panel A. As the RRA coefficient increases, the unexplained premium decreases, but the rate of decrease is even slower than that in Panel A. The striking difference is on the unexplained risk-free rate. The unexplained risk-free rate is *increasing* in the RRA coefficient, but the t-statistic drops to values below 1.5 when the RRA coefficient is 4 or higher. If we were to set the quarterly subjective discount factor at the value of .995, instead of the value of one, the unexplained risk-free rate would decrease by 0.5%, thereby explaining away the risk-free rate puzzle.

The casual conclusion is that the risk-free rate is explained by the *per capita* consumption of the pooled sample of asset holders and non-asset holders, taken from the CEX database, while the equity premium is not explained. However, our discussion in Section 3 suggests that multiplicative observation error on the consumption growth biases positively the statistic for the unexplained risk-free rate. Thus, the CEX *per capita* consumption data may appear to resolve the risk-free-rate puzzle because the observation error on the consumption growth is higher than in the NIPA data.

In Table 8, we address the limited participation of households in the capital markets. In Panel A, asset holders are defined as the households in the CEX database that reported total assets exceeding the threshold of $2,000, in 1996-adjusted dollars in their first regular quarter. In Panels B, C and D, the threshold is $10,000, $20,000 and $40,000, respectively. The *per capita* consumption is obtained as the average consumption across the asset holders, with weights proportional to the CEX-reported weights.

For a given RRA coefficient, the unexplained premium and its t-statistic decrease as the threshold is raised. Furthermore, as the RRA coefficient increases, the unexplained premium decreases. With RRA coefficient equal to 6, the unexplained premium of the VW market index (and the t-statistic) are 2.09 (2.18), 1.76 (1.70), 1.43 (1.34), 1.20 (1.07) and 1.03 (.85), at threshold levels $0, $2,000, $10,000, $20,000 and $40,000, respectively. We conclude that limited participation by households goes a long way in explaining the mean equity premium with a moderate/high value of the RRA coefficient. Note that the increasing observation error of the *per capita* consumption growth does not bias the statistic for the unexplained premium, if the observation error is multiplicative. However, it inflates the standard errors and biases the t-statistics towards zero.

The corresponding values of the unexplained risk-free rate (and the t-statistic) are 1.24 (1.09), 1.46 (.50), 3.80 (.88), 5.42 (1.13) and 8.38 (1.35). The point estimates increase as the threshold is raised. One plausible explanation is that *per capita* consumption growth is measured with increasing error, as the threshold is raised and the number of asset holders decreases. Consistent with this explanation, the standard error of the unexplained risk-free rate is increasing in the threshold, thereby keeping the t-statistics insignificant. We conclude that limited participation by households leads to failure of the test to reject the Euler equation of the risk-free rate, but observation error may be the reason.

## 6. The Test Results under Incomplete Consumption Insurance

The incomplete consumption insurance model has the potential to explain the mean equity premium, if the idiosyncratic income shocks are persistent and heteroscedastic and *if the correlation of the market premium and the cross-sectional variance of the households' consumption growth ( $y_t^2$ ) is sufficiently large and negative*, as discussed in Section 2.3. In Table 5, Panel C, we report this correlation for both the equally weighted and the value-weighted market index and for different threshold values of asset holdings by the households. The point estimate of the correlation is negative in all but one of the cases. This evidence should be interpreted with caution because the simulation results, reported in Panels A and B, indicate that estimates of this correlation are noisy.

We test the Euler equations of consumption (4) and (5) in order to assess the *economic* contribution of this negative correlation towards explaining the asset returns. These equations are derived without the assumption of complete consumption insurance. The ultimate goal is to investigate the incremental explanatory power of the model when the assumption of complete consumption insurance is relaxed.

The test covers the period 1980q2 - 1996q1 with 63 consumption growth rates. The RRA coefficient is set at values ranging from zero to nine. The subjective discount factor is set equal to one. For the equally weighted and the value-weighted market, the reported unexplained premium is the time-average of the product of two terms: (1) the realized excess market return; and (2) the average, across households, of the marginal rate of substitution. For the risk-free rate, the reported unexplained rate is negative one, plus the time-average of the product of two terms: (1) (one plus) the risk-free rate of interest; and (2) the average, across households, of the marginal rate of substitution. Both rates are expressed in percent. The reported "bootstrap p-value" is the frequency at which the unexplained premium is negative, in 500 bootstrapped samples, each having 63 consumption growth rates.

First, we calculate the unexplained premium and the unexplained risk-free rate, *without* imposing the consumption growth filter, discussed in Section 4.3. The results are nonsensical and are not reported here. The explanation is that, in testing the Euler equations of consumption (4) and (5), the individual households' marginal rate of substitution is calculated by raising the individual households' consumption growth to the power $-a$. If the reported consumption growth of even *one* household is substantially smaller than one, the household's marginal rate of substitution is large and can dominate the weighted average of the marginal rates of substitution in equations (4) and (5). Thus, even one household's large observation error can drive the statistics. This motivates the application of the consumption growth filter.

In Table 9, we report results for households that pass the consumption growth filter. In Panel A, we report results for households with asset holdings exceeding $2,000. The unexplained premium on the equally weighted market *increases*, as the RRA coefficient increases from zero to three, but the t-statistic *decreases*. When the RRA coefficient is four, the unexplained premium becomes negative and insignificant. At higher values of the RRA coefficient, the unexplained premium becomes very negative but insignificant. The unexplained premium on the value-weighted market follows a similar pattern. The casual conclusion is that incomplete consumption insurance explains the market premium when the households' RRA coefficient lies at some value between three and four. This conclusion is reinforced by the similarity of the pattern of the unexplained premium and the t-statistic, observed in Panels B and C, and corresponding to threshold values $10,000 and $20,000, respectively.

A very different picture emerges in Panel D, corresponding to the threshold value $40,000. The unexplained premium on the equally weighted market becomes very large, but insignificant, as the RRA coefficient increases. The unexplained premium on the value-weighted market is insignificant and switches sign from positive to negative values as the RRA coefficient increases from six to seven.

The change of the results, as one proceeds from the $20,000 threshold to the $40,000 threshold, suggests that a few outliers may be driving the results in these small samples. Thus, a cautious interpretation of the low t-statistics is that the test has low power to reject the null, given the small number of households and the observation error in the households' consumption growth.

As explained earlier, multiplicative observation errors bias positively the statistic of the unexplained risk-free rate. Indeed, even with the RRA coefficient set at one, the point estimate of the unexplained risk-free rate is large and becomes huge at high values of the RRA coefficient. The t-statistics are small, suggesting that the observation errors are large and the test lacks the power to reject the null.

Recall that the Euler equations of consumption (7) and (8), under *complete* consumption insurance, are nested within the Euler equations of consumption (4) and (5), under *incomplete* consumption insurance. If Tables 8 and 9 were based on the same sample of households, then comparison of their results would illustrate the incremental explanatory power of the model when the assumption of complete consumption insurance is relaxed. However, the results under incomplete consumption insurance, presented in Table 9, are based on a *subsample* of the households used in deriving the results under complete consumption insurance, presented in Table 8.

In Table 10, we present results of the Euler equations of *per capita* consumption, based on the same subsample of households that was used in deriving the results under incomplete consumption insurance, presented in Table 9. In Table 10, Panels A-C, the unexplained premium either remains constant or increases, as the RRA coefficient increases, unlike the results in Table 8. The t-statistics decrease, as the RRA coefficient increases. This may be due to increasing bias in the standard error, as the RRA coefficient increases. In Panel D, the unexplained premium decreases, as the RRA coefficient increases, but the rate of decrease is slower than in Panel D of Table 8. The t-statistics decrease, as the RRA coefficient increases. In all panels of Table 10, the unexplained risk-free rate is increasing in the RRA coefficient and is higher than in Table 8. This also is probably due to increasing bias in the point estimate of the unexplained risk-free rate, as the RRA coefficient increases.

The comparison of the results in Tables 8 and 10 suggests that the subsample of households produces noisier estimates of the *per capita* consumption than the full sample does. On the one hand, the subsample is free from the most obvious cases of reported error in the consumption data. On the other hand, too many households are eliminated from the subsample because of the requirement that households must have consumption reported in at least three consecutive quarters. We conjecture that the small size of the subsample is the dominant factor in producing the noisy estimates.

In comparing the results in Tables 9 and 10, we find that the unexplained premium and its t-statistic are lower when the assumption of complete consumption insurance is relaxed. However, the unexplained risk-free rate and its t-statistic are *higher* when the assumption of complete consumption insurance is relaxed. The casual conclusion is that relaxation of the assumption of complete consumption insurance helps explain the mean equity premium. The cautious conclusion is that observation error makes it impossible to test complete consumption insurance against incomplete consumption insurance.

## 7. Extensions and Concluding Remarks

As a prelude to our empirical investigation, we examined the robustness of the statistical inferences on the Euler equations of consumption, given the finiteness of the sample size and given observation errors. We conducted a Monte Carlo simulation of two plausible versions of an economy with incomplete consumption insurance and with idiosyncratic income shocks, as in Constantinides and Duffie (1996). By construction, the simulated data supports the model of incomplete consumption insurance.

First, we tested the implications of the ubiquitous complete consumption insurance model when the alternative is the incomplete consumption insurance model. We found evidence in support of limited capital market participation. In addition, the data fail to reject the null of complete consumption insurance, but with limited capital market participation, against the alternative of incomplete consumption insurance. The latter result should be interpreted with caution because the non-rejection may be due to the lack of power. Indeed, we examined the power of simple statistical tests both for the equity premium and the risk-free rate under the complete consumption insurance null and concluded that the test has low power to reject the null.

Second, we tested the asset pricing implications of the incomplete consumption insurance model against an unspecified alternative. The data fail to reject the null of incomplete consumption insurance against an unspecified alternative, once the statistics are adjusted for size. The adjustment for size was made possible by our Monte Carlo investigation of the size characteristics for the test. The simple t-test over-rejects the true null of incomplete consumption insurance against an unspecified alternative. By doubling the sample size in either the time or the cross-sectional dimensions, we do not correct the false rejections evidenced in the smaller sample. The frequency of false rejections is even higher in the presence of observation error.

Third, we estimated the correlation of the market premium and the cross-sectional variance of the households' consumption growth. The estimated correlation is negative but low. Recall that the incomplete consumption insurance model has the potential to explain the mean equity premium, if the idiosyncratic income shocks are persistent and heteroscedastic and *if the above correlation is sufficiently large and negative.* Therefore, the estimation of this correlation appears to be a direct way of gauging the potential of this model. The low estimated value of the correlation may be explained by observation error. In our Monte Carlo investigation, we found that observation error strongly biases the correlation towards zero. Doubling either the number of households or the number of periods in the sample does not mitigate the problem.

In testing the asset pricing implications of the complete and the incomplete consumption insurance models, we considered the Euler equations on the risk-free rate and on the equity premium. Multiplicative observation error induces a strong positive bias in the mean unexplained risk-free rate and renders tests of the Euler equations of consumption practically worthless. By contrast, multiplicative observation error does not bias severely the mean unexplained equity premium or any other premium. (See the discussion in Section 3.1). This motivates the testing of the Euler equations on other premia also, such as the premium of low-capitalization stocks over high-capitalization stocks—the size premium—and the premium of value over growth stocks.[24] In our sample period 1980q2-1996q1, the mean quarterly premium of value stocks over growth stocks is merely 0.14% per quarter, with t-statistic 0.24. Thus, there is no value premium to be explained in this period.

By contrast, the size premium is 1.04% per quarter, with t-statistic 1.40. In Table 11, we present the unexplained size premium under the assumption of complete consumption insurance. The covariation of this premium with *per capita* consumption does not explain this premium. In Table 12, we present the unexplained size premium under the assumption of incomplete consumption insurance. The covariation of this premium with the conditional variance of the households' consumption growth does not explain this premium. Even worse, it suggests that the observed premium is too large. The main implication of Tables 11 and 12 is that consumption-type asset pricing models have nothing to say about a size premium in our sample period.

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[24] The monthly premium of low-capitalization stocks over high-capitalization stocks is defined as the difference between the monthly average return on the 50% of firms with the lowest capitalization and the monthly average return on the 50% of firms with the highest capitalization. The quarterly premium is calculated by compounding the monthly premium. The monthly premium of value stocks over growth stocks is defined as the difference between the monthly average return on the 30% of firms with the lowest book-to-market ratio and the monthly average return on the 30% of firms with the highest book-to-market ratio. The quarterly premium is calculated by compounding the monthly premium. Further information on these data is provided in Fama and French (1993). Fama kindly made the data available to us.

## Appendix: Description of the Monte Carlo

### A.1 The Simulated Model

We model the *per capita* consumption growth process as

$$\frac{c_t}{c_{t-1}} = \exp\{g + s_g e_t\}, \tag{A1}$$

where $\{e_t\}$ have the following properties: distinct subsets of $\{e_t\}$ are independent; and for all t, and $e_t$ is standard normal and independent of $F_{t-1}$. The parameters $g$ and $s_g$ are the mean and standard deviation of log ($c_t / c_{t-1}$), respectively.

We model the return on the market index as

$$R_{Mt} = \exp\{m + n\, s_M\, e_t + s_M Ö(1 - n^2)\, z_t\}\ , \tag{A2}$$

where $\{z_t\}$ have the following properties: distinct subsets of $\{z_t\}$ are independent; for all t; and $z_t$ is standard normal and independent of $F_{t-1}$ and $e_t$. The parameters $m$ and $s_M$ are the mean and standard deviation of log ($R_{Mt}$) , respectively. The parameter $n$ is the correlation between log ($R_M$) and log ($c_t / c_{t-1}$).

We model the households' consumption growth process as

$$\frac{c_{it}}{c_{i,t-1}} = \frac{c_t}{c_{t-1}} \exp\left\{ y_t h_{it} - \frac{y_t^2}{2} \right\}, \tag{A3}$$

where $\{h_{it}\}$ have the following properties: distinct subsets of $\{h_{it}\}$ are independent; and for all i and t, $h_{it}$ is standard normal and independent of $F_{t-1}$, $e_t$ and $z_t$. This leads to a representation of the pricing kernel as in equation (16). Recall that $y_t^2$ is the variance of the households' consumption growth, defined as the variance of log ($c_{it} / c_{i,t-1}$) – log ($c_t / c_{t-1}$).

The main result in CD (1996) is that there exists a process of idiosyncratic income shocks that induces the variance $y_t^2$ of the households' consumption growth and supports the given price processes in equilibrium. In our case, the two assets are the market index with return given by equation (A2), and the one-period bond with constant return $R_F$ . The process $y_t^2$ is not unique. We take advantage of this latitude and specify a process that is computationally convenient. First, we define the intermediate parameter $s$ as

$$s = \frac{1}{s_M \sqrt{1-n^2}} \log\left( \frac{R_F^{-1} \exp(r + ag - a^2 s_g^2 / 2) - 1}{\exp(r - m + ag - a^2 s_g^2 / 2 + ans_M s_g - s_M^2 / 2) - 1} \right), \tag{A4}$$

where $r$ = -log $b$ is the subjective discount rate. We impose the following two feasibility conditions on the parameters:

$$m < r + ag - a^2 s_g^2/2 + ans_M s_g - s_M^2/2 \qquad \text{(A5)}$$

and

$$\log(R_F) < m - a\,n\,s_M s_g + s_M^2/2\,. \qquad \text{(A6)}$$

These conditions guarantee that $s$ exists and is positive. Under complete consumption insurance, these conditions would hold as equalities. Condition (A5) states that the expected return on the market is *lower* than what is predicted under complete consumption insurance. Condition (A6) states that the expected premium on the market is *higher* than what is predicted under complete consumption insurance. Moreover, these conditions jointly state that the risk-free rate is *lower* than what is predicted under complete consumption insurance.

Finally, we set the variance of the households' consumption growth equal to

$$y_t^2 = \frac{2}{a^2 + a}\log\left\{1 + \left(R_F^{-1}\exp\left(r + ag - \frac{1}{2}a^2 s_g^2\right) - 1\right)\exp\left(-\frac{s^2}{2} - sz_t\right)\right\}. \qquad \text{(A7)}$$

The right-hand side of equation (A7) is positive and, therefore, the variance $y_t^2$ is well defined. With this particular choice of the variance process, the Euler equation (2) of each household's consumption holds for both the market return and the risk-free rate. The proof of this statement proceeds along the lines of the proofs in CD (1996) and is omitted.

### A.2 Calibration

We calibrate the model to match the sample moments of the *per capita* consumption growth process, the return on the market index, and the risk-free rate in our estimation period, 1980q2-1996q1. We also set the RRA coefficient and the subjective discount rate at such values that the model would explain only about 30% of the mean market premium and would overestimate the risk-free rate, *if there were complete consumption insurance*. Thus, the model is set up to reflect both the observed *equity premium puzzle* and the *risk-free-rate puzzle*, under complete consumption insurance. Note, however, that the assumption of incomplete consumption insurance, coupled with the choice of the variance of the idiosyncratic income shocks as in equation (A7), guarantees that the model explains both the observed mean equity premium and the risk-free rate *by construction.*

We calibrate the *per capita* consumption growth process by setting $s_g$ = 0.05/quarter. Whereas the standard deviation of the *per capita* consumption growth rate is too high by 50-year standards, it is representative of our sample period. We set the risk-free rate as $R_F$ = 1.007/quarter. We calibrate the market return process by setting $m$ = 0.015/quarter, $s_M$ = 0.10/quarter and $n$ = 0.26. These parameters imply that $E[R_{Mt}]$ = 1.02/quarter, the mean equity premium is 0.013/quarter, and the correlation of the market return with the *per capita* consumption growth rate is 0.26. We set the preference parameters as $a = 4$ and $r = 0.005$/quarter.

We consider two different values of the mean growth rate of the *per capita* consumption growth, $g = 0.015$/quarter and $g = 0.01$/quarter. Both rates are too high, both by 50-year standards and in our sample period. However, we choose these values in order to illustrate the implications of the *frequency of occurrence of periods when the variance of the households' consumption growth is high*, while satisfying the feasibility conditions (A5) and (A6).

It is important to understand the implications of this calibration regarding the frequency of occurrence of periods when the variance of the households' consumption growth is high. Equation (A7) states that the variance of the households' consumption growth is high when $-s^2/2-sz > 0$, that is, when $z < -s/2$, since $s > 0$.

Consider first the calibration $g = 0.015$/quarter. Equation (A7) implies that $s = 2.43$. The probability that $z < -2.43/2$ is about 11% per quarter. The probability that this event occurs at least once in any 5-year period is 90%. With this calibration, we model shocks to the economy that increase the variance of the households' consumption growth, where these shocks occur with frequency of the order of that of business cycles.

With the calibration $g = 0.01$/quarter, equation (A7) implies that $s = 5.94$. The probability that $z < -5.94/2$ is about 0.15% per quarter. The probability that this event occurs at least once in any 50-year period is 26%. With this calibration, we model shocks to the economy that occur with frequency substantially lower than that of business cycles—rare events.

### A.3 Observation Error

We explore the implications of a multiplicative unbiased observation error in the consumption growth. Specifically, we assume that the household consumption growth, $c_{it}/c_{i,t-1}$, is observed with multiplicative observation error $\exp(k e_{it} - k^2/2)$, where $\{e_{it}\}$ have the following properties: distinct subsets of $\{e_{it}\}$ are independent; and for all i and t, $e_{it}$ is standard normal and independent of $F_{t-1}$, $e_t$, $z_t$ and $h_{it}$. In the simulation, we consider the two cases, $k = 0$ (zero observation error) and $k = 0.5$ (realistic observation error).[25]

### A.4 Initial Values and Sample Paths

[25] The choice of the standard error of the observation is based on the following table that displays the conditional variance of the households' consumption growth:

| THRESHOLD | MEAN | 1% | 5% | 50% | 95% | 99% |
|---|---|---|---|---|---|---|
| \$2,000 | 0.13 | 0.09 | 0.10 | 0.13 | 0.17 | 0.18 |
| \$10,000 | 0.14 | 0.08 | 0.09 | 0.14 | 0.20 | 0.22 |
| \$20,000 | 0.15 | 0.08 | 0.09 | 0.15 | 0.23 | 0.24 |
| \$40,000 | 0.16 | 0.08 | 0.09 | 0.16 | 0.27 | 0.30 |

Each sample path generated begins at a random consumption level by allowing each household's consumption to grow from a common starting value for a burn-in period of 20 quarters. These 20 quarters are discarded as we concentrate on the ensuing 64 quarters worth of data.

We generate 10,000 sample paths of the market return and of the consumption of 500 households for 64 quarters. We initially choose the number of households to be 500 because this is a typical average number of households in our empirical investigation. We also initially choose the number of quarters to be 64 because this is the time-length of our sample. The 64 quarters generate a time series of 63 quarterly consumption growth rates. We also present results for the case in which the number of households and the length of the time series are doubled.

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## TABLE 1: Monte Carlo Simulation of Complete Consumption Insurance Economy
## Equity Premium Type II Error (Power) Results

We generate 10,000 sample paths of the market return and of the consumption of 500 households for 64 quarters. We calibrate the model to match the sample moments of the *per capita* consumption growth process, the return on the market index, and the risk-free rate in our estimation period, 1980q2-1996q1. Specifically, the risk-free rate is set at $R_F$ = 1.007/quarter, the market return process is calibrated by setting $m$ = 0.015/quarter, $s_M$ = 0.10/quarter and $n$ = 0.26. We set $s_g$ = 0.05/quarter and consider two different values of the mean growth rate $g$ of the *per capita* consumption growth. With $g$ = 0.015/quarter, equation (A4) implies that $s$ = 2.43 while with $g$ = 0.01/quarter, equation (A4) implies that $s$ = 5.94. These cases are presented in Panels A and B respectively. The preference parameters are $a$ = 4 and $r$ = 0.005/quarter. Within each panel we explore the implications of a multiplicative observation error in the consumption growth. We consider the two cases, $k$ = 0 (zero observation error) and $k$= 0.5 (moderate observation error). We also present results for the cases in which the number of households is increased to 1000, and the length of the time series is doubled to 128. *Unexplained premium (u)* is the statistic presented in equation (9) under the assumption of *complete* consumption insurance. *Theoretical t-stat* is the theoretical value of the t-statistic under the specified null of complete consumption insurance. We present the mean, 1st, 5th, 95th, and 99th percentiles for both the unexplained premium and the theoretical t-statistic. *Simulated rejection rates* is the empirical rejection rates of the complete consumption insurance specification when the alternative is, by construction, the incomplete consumption insurance economy.

**Panel A:** $s$ = 2.43

| Sample size specifications | N=500, T=64 | | | | | N=1,000, T=128 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | 1% | 5% | 95% | 99% | Mean | 1% | 5% | 95% | 99% |
| **Without Observation Error** | | | | | | | | | | |
| Unexplained Premium (*u*) | 0.01 | -0.021 | -0.013 | 0.028 | 0.037 | 0.01 | -0.013 | -0.007 | 0.022 | 0.028 |
| Theoretical t-stat | 0.0 | -2.39 | -1.67 | 1.67 | 2.39 | 0.0 | -2.36 | -1.66 | 1.66 | 2.36 |
| Simulated Rejection Rates (%) | | 0.13 | 1.02 | 15.13 | 4.24 | -- | -0.09 | 0.62 | 21.49 | 7.06 |
| **With Observation Error, *k* = 0.5** | | | | | | | | | | |
| Unexplained Premium (*u*) | 0.01 | -0.211 | -0.074 | 0.098 | 0.233 | 0.01 | -0.31 | -0.096 | 0.124 | 0.274 |
| Simulated Rejection Rates (%) | | 0.14 | 1.54 | 9.92 | 2.06 | -- | 0.08 | 1.29 | 11.19 | 2.12 |

**Panel B:** $s$ = 5.94

| Sample size specifications | N=500, T=64 | | | | | N=1,000, T=128 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | 1% | 5% | 95% | 99% | Mean | 1% | 5% | 95% | 99% |
| **Without Observation Error** | | | | | | | | | | |
| Unexplained Premium (*u*) | 0.007 | -0.022 | -0.013 | 0.029 | 0.038 | 0.008 | -0.013 | -0.007 | 0.023 | 0.029 |
| Theoretical t-stat | 0.0 | -2.39 | -1.67 | 1.67 | 2.39 | 0.0 | -2.36 | -1.66 | 1.66 | 2.36 |
| Simulated Rejection Rates (%) | | 0.14 | 1.18 | 15.76 | 4.89 | -- | 0.07 | 0.69 | 22.27 | 7.40 |
| **With Observation Error, *k* = 0.5** | | | | | | | | | | |
| Unexplained Premium (*u*) | 0.015 | -0.176 | -0.06 | 0.099 | 0.232 | 0.019 | -0.23 | -0.078 | 0.121 | 0.30 |
| Simulated Rejection Rates (%) | | 0.2 | 1.45 | 10.35 | 1.9 | -- | 0.09 | 1.11 | 11.61 | 2.18 |

## TABLE 2: Monte Carlo Simulation of Complete Consumption Insurance Economy
## Risk-Free Rate Type II Error (Power) Results

We generate 10,000 sample paths of the market return and of the consumption of 500 households for 64 quarters. We calibrate the model to match the sample moments of the *per capita* consumption growth process, the return on the market index, and the risk-free rate in our estimation period, 1980q2-1996q1. Specifically, the risk-free rate is set at $R_F$ = 1.007/quarter, the market return process is calibrated by setting $m$ = 0.015/quarter, $s_M$ = 0.10/quarter and $n$ = 0.26. We set $s_g$ = 0.05/quarter and and consider two different values of the mean growth rate $g$ of the *per capita* consumption growth. With $g$ = 0.015/quarter, equation (A4) implies that $s$ = 2.43 while with $g$ = 0.01/quarter, equation (A4) implies that $s$ = 5.94. These cases are presented in Panels A and B respectively. The preference parameters are $a$ = 4 and $r$ = 0.005/quarter. Within each panel we explore the implications of a multiplicative observation error in the consumption growth. We consider the two cases, $k$ = 0 (zero observation error) and $k$= 0.5 (moderate observation error). We also present results for the cases in which the number of households is increased to 1000, and the length of the time series is doubled to 128. Unexplained $R_F$ ($u$) is the statistic presented in equation (11) under the assumption of *complete* consumption insurance. *Theoretical t-stat* is the theoretical value of the t-statistic under the specified null of complete consumption insurance. We present the mean, 1st, 5th, 95th, and 99th percentiles for both the unexplained $R_F$ and the theoretical t-statistic. *Simulated rejection rates* is the empirical rejection rates of the complete consumption insurance specification when the alternative is, by construction, the incomplete consumption insurance economy.

**Panel A:** $s$ = 2.43

| Sample size specifications | N=500, T=64 | | | | | N=1,000, T=128 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | 1% | 5% | 95% | 99% | Mean | 1% | 5% | 95% | 99% |
| **Without Observation Error** | | | | | | | | | | |
| Unexplained $R_F$ ($u$) | -0.038 | -0.092 | -0.077 | 0.003 | 0.022 | -0.037 | -0.077 | -0.065 | -0.009 | 0.003 |
| Theoretical t-stat | 0.0 | -2.39 | -1.67 | 1.67 | 2.39 | 0.0 | -2.36 | -1.66 | 1.66 | 2.36 |
| Simulated Rejection Rates (%) | | 22.2 | 45.14 | 0.09 | 0.01 | -- | 42.95 | 68.66 | 0.01 | 0.0 |
| **With Observation Error, $k$ = 0.5** | | | | | | | | | | |
| Unexplained $R_F$ ($u$) | 0.95 | 0.240 | 0.327 | 2.344 | 4.758 | 1.49 | 0.455 | 0.568 | 3.432 | 6.446 |
| Simulated Rejection Rates (%) | | 0.0 | 0.0 | 93.32 | 64.63 | -- | 0 | 0 | 96.54 | 85.63 |

**Panel B:** $s$ = 5.94

| Sample size specifications | N=500, T=64 | | | | | N=1,000, T=128 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | 1% | 5% | 95% | 99% | Mean | 1% | 5% | 95% | 99% |
| **Without Observation Error** | | | | | | | | | | |
| Unexplained $R_F$ ($u$) | -0.018 | -0.075 | -0.058 | 0.023 | 0.043 | -0.018 | -0.059 | -0.046 | 0.011 | 0.023 |
| Theoretical t-stat | 0.0 | -2.39 | -1.67 | 1.67 | 2.39 | 0.0 | -2.36 | -1.66 | 1.66 | 2.36 |
| Simulated Rejection Rates (%) | | 6.9 | 19.19 | 0.79 | 0.09 | -- | 10.62 | 27.4 | 0.24 | 0.04 |
| **With Observation Error, $k$ = 0.5** | | | | | | | | | | |
| Unexplained $R_F$ ($u$) | 0.95 | 0.27 | 0.348 | 2.32 | 4.51 | 1.50 | 0.48 | 0.58 | 3.43 | 6.17 |
| Simulated Rejection Rates (%) | | 0.0 | 0.0 | 94.05 | 69.94 | -- | 0.0 | 0.0 | 97.17 | 86.74 |

# TABLE 3: Monte Carlo Simulation of Incomplete Consumption Insurance Economy
## Equity Premium Type I Error (Size) Results

The Monte Carlo setup is described in Section 3. Panels A and B provide results for *s* = 2.43 and *s* = 5.94, respectively. Within each panel we report results for the case where no observation error occurs (*k*=0) and with observation error (*k*=0.5). We also present results for the cases in which the number of households is increased to 1000, and the length of the time series is doubled to 128. *Unexplained premium (u')* is the statistic presented in equation (13) under the assumption of *incomplete* consumption insurance. *Theoretical t-stat* is the theoretical value of the t-statistic under the specified null of incomplete consumption insurance. We present the mean, 1st, 5th, 95th, and 99th percentiles for both the unexplained premium and the theoretical t-statistic. *Simulated rejection rates* is the empirical rejection rates of the incomplete consumption insurance economy. *Size-adjusted cut-off* is the corrected value for the t-statistic given the specified rejection rate.

**Panel A:** *s* = 2.43

| Sample size specifications | N=500, T=64 | | | | | N=1,000, T=128 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | 1% | 5% | 95% | 99% | Mean | 1% | 5% | 95% | 99% |
| **Without Observation Error** | | | | | | | | | | |
| Unexplained Premium (*u*¢) | 0.0 | -0.064 | -0.029 | 0.025 | 0.034 | 0.0 | -0.051 | -0.022 | 0.186 | 0.026 |
| Theoretical t-stat | 0.0 | -2.39 | -1.67 | 1.67 | 2.39 | 0.0 | -2.36 | -1.66 | 1.66 | 2.36 |
| Simulated Rejection Rates (%) | | 0.19 | 2.21 | 9.38 | 2.54 | -- | 0.25 | 2.01 | 9.44 | 2.80 |
| Size-Adjusted Cut-off | | -1.92 | -1.37 | 2.03 | 2.81 | -- | -1.92 | -1.35 | 2.06 | 2.86 |
| **With Observation Error, *k* = 0.5** | | | | | | | | | | |
| Unexplained Premium (*u*¢) | 0.0 | -0.784 | -0.348 | 0.324 | 0.438 | 0.0 | -0.560 | -0.257 | 0.232 | 0.314 |
| Simulated Rejection Rates (%) | | 0.3 | 2.31 | 9.40 | 2.29 | -- | 0.17 | 2.12 | 9.75 | 2.90 |
| Size-Adjusted Cut-off | | -1.98 | -1.37 | 2.03 | 2.74 | -- | -1.88 | -1.34 | 2.06 | 2.82 |

**Panel B:** *s* = 5.94

| Sample size specifications | N=500, T=64 | | | | | N=1,000, T=128 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | 1% | 5% | 95% | 99% | Mean | 1% | 5% | 95% | 99% |
| **Without Observation Error** | | | | | | | | | | |
| Unexplained Premium (*u*¢ ) | 0.0 | -0.024 | -0.014 | 0.029 | 0.038 | 0.0 | -0.016 | -0.008 | 0.023 | 0.029 |
| Theoretical t-stat | 0.0 | -2.39 | -1.67 | 1.67 | 2.39 | 0.0 | -2.36 | -1.66 | 1.66 | 2.36 |
| Simulated Rejection Rates (%) | | 0.11 | 1.15 | 15.55 | 4.64 | -- | 0.07 | 0.69 | 21.82 | 7.26 |
| Size-Adjusted Cut-off | | -1.73 | -1.06 | 2.35 | 3.12 | -- | -1.53 | -0.83 | 2.56 | 3.28 |
| **With Observation Error, *k* = 0.5** | | | | | | | | | | |
| Unexplained Premium (*u*¢ ) | 0.08 | -0.30 | -0.18 | 0.358 | 0.478 | 0.0 | -0.201 | -0.102 | 0.276 | 0.346 |
| Simulated Rejection Rates (%) | | 0.22 | 1.30 | 14.23 | 4.11 | -- | 0.09 | 0.65 | 20.97 | 6.79 |
| Size-Adjusted Cut-off | | -1.75 | -1.09 | 2.27 | 2.97 | -- | -1.53 | -0.86 | 2.51 | 3.19 |

## TABLE 4: Monte Carlo Simulation of Incomplete Consumption Insurance Economy
## Risk-Free Rate Type I Error (Size) Results

The Monte Carlo setup is described in Section 3. Panels A and B provide results for *s* = 2.43 and *s* = 5.94 respectively. Within each panel we report results for the case where no observation error occurs (*k*=0) and with observation error (*k*=0.5). We also present results for the cases in which the number of households is increased to 1000, and the length of the time series is doubled to 128. *Unexplained* $R_F$ *(u¢)* is the statistic presented in equation (14) under the assumption of *incomplete* consumption insurance. *Theoretical t-stat* is the theoretical value of the t-statistic under the specified null of incomplete consumption insurance. We present the mean, 1st, 5th, 95th, and 99th percentiles for both the unexplained premium and the theoretical t-statistic. *Simulated rejection rates* is the empirical rejection rates of the incomplete consumption insurance economy. *Size-adjusted cut-off* is the corrected value for the t-statistic given the specified rejection rate.

**Panel A:** *s* = 2.43

| Sample size specifications | N=500, T=64 | | | | | N=1,000, T=128 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | 1% | 5% | 95% | 99% | Mean | 1% | 5% | 95% | 99% |
| **Without Observation Error** | | | | | | | | | | |
| Unexplained $R_F$ (*u¢*) | 0.0 | -0.073 | -0.055 | 0.071 | 0.199 | 0.0 | -0.056 | -0.042 | 0.058 | 0.148 |
| Theoretical t-stat | 0.0 | -2.39 | -1.67 | 1.67 | 2.39 | 0.0 | -2.36 | -1.66 | 1.66 | 2.36 |
| Simulated Rejection Rates (%) | | 4.18 | 12.75 | 1.06 | 0.08 | -- | 4.88 | 13.55 | 0.96 | 0.09 |
| Size-Adjusted Cut-off | | -3.09 | -2.27 | 1.20 | 1.69 | -- | -3.27 | -2.34 | 1.17 | 1.64 |
| **With Observation Error, *k* = 0.5** | | | | | | | | | | |
| Unexplained $R_F$ (*u¢*) | 11.17 | 9.84 | 10.15 | 12.43 | 13.91 | 11.17 | 10.28 | 10.51 | 11.97 | 13.10 |
| Simulated Rejection Rates (%) | | 0 | 0 | 100 | 100 | -- | 0 | 0 | 100 | 100 |
| Size-Adjusted Cut-off | | 5.10 | 10.26 | 25.91 | 28.54 | -- | 6.85 | 14.96 | 39.36 | 41.96 |

**Panel B:** *s* = 5.94

| Sample size specifications | N=500, T=64 | | | | | N=1,000, T=128 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | 1% | 5% | 95% | 99% | Mean | 1% | 5% | 95% | 99% |
| **Without Observation Error** | | | | | | | | | | |
| Unexplained $R_F$ (*u¢*) | 0.0 | -0.075 | -0.058 | 0.025 | 0.048 | -0.012 | -0.058 | -0.046 | 0.013 | 0.293 |
| Theoretical t-stat | 0.0 | -2.39 | -1.67 | 1.67 | 2.39 | 0.0 | -2.36 | -1.66 | 1.66 | 2.36 |
| Simulated Rejection Rates (%) | | 6.56 | 18.52 | 0.80 | 0.09 | -- | 10.16 | 26.62 | 0.25 | 0.04 |
| Size-Adjusted Cut-off | | -3.40 | -2.55 | 0.92 | 1.57 | -- | -3.60 | -2.75 | 0.68 | 1.27 |
| **With Observation Error, *k* = 0.5** | | | | | | | | | | |
| Unexplained $R_F$ (*u¢*) | 11.00 | 9.82 | 10.11 | 11.97 | 12.74 | 11.12 | 10.27 | 10.46 | 11.55 | 11.89 |
| Simulated Rejection Rates (%) | | 0 | 0 | 100 | 100 | -- | 0 | 0 | 100 | 100 |
| Size-Adjusted Cut-off | | 8.45 | 13.83 | 27.14 | 29.46 | -- | 16.47 | 25.97 | 41.55 | 43.96 |

## TABLE 5: Simulated Distribution of the Correlation between the Market Premium and $y_t^2$ (in %)

The Monte Carlo setup is described in Section 3 and Table 1. We present the mean, 1st, 5th, 95th, and 99th percentiles of the empirical distribution of the correlation coefficient between the market premium and the variance of the idiosyncratic income shocks $y_t^2$. Panels A and B provide results for $s$ = 2.43 and $s$ = 5.94, respectively. Within each panel we report results for the case where no observation error occurs ($k$=0) and with observation error ($k$=0.5). We also present results for the cases in which the number of households is increased to 1000, and the length of the time series is doubled to 128. In Panel C we report the empirical correlation between the estimates of the variance of the idiosyncratic income shocks $y_t^2$ and two measure of the market premium. We report these correlations for four levels of household asset holdings.

**Panel A:** $s$ = 2.43

| N=500, T=64 | | | | | | | N=1,000, T=128 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 1% | 5% | 50% | 95% | 99% | % > 0 | Mean | 1% | 5% | 50% | 95% | 99% | % > 0 |
| **Without Observation Error** | | | | | | | | | | | | | |
| -52.8 | -68.9 | -64.6 | -52.9 | -41.0 | -37.4 | 0.0 | -48.2 | -62.7 | -58.9 | -48.4 | -37.2 | -33.9 | 0.0 |
| **With Observation Error, *k* = 0.5** | | | | | | | | | | | | | |
| -21.4 | -51.5 | -44.4 | -21.9 | 3.1 | 13.9 | 7.6 | -27.6 | -47.1 | -42.9 | -28.5 | -9.7 | -1.2 | 0.80 |

**Panel B:** $s$ = 5.94

| N=500, T=64 | | | | | | | N=1,000, T=128 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 1% | 5% | 50% | 95% | 99% | % > 0 | Mean | 1% | 5% | 50% | 95% | 99% | % > 0 |
| **Without Observation Error** | | | | | | | | | | | | | |
| -34.3 | -50.3 | -45.2 | -33.6 | -25.7 | -23.3 | 0.0 | -27.4 | -40.9 | -36.9 | -26.5 | -20.5 | -18.6 | 0.0 |
| **With Observation Error, *k* = 0.5** | | | | | | | | | | | | | |
| -0.006 | -30.6 | -22.1 | -0.005 | 20.9 | 28.9 | 48.4 | -0.009 | -24.3 | -16.0 | -0.007 | 14.1 | 20.4 | 46.2 |

**Panel C:**

| Households with Assets Exceeding: | \$2,000 | \$10,000 | \$20,000 | \$40,000 |
|---|---|---|---|---|
| Correlation of $y_t^2$ with Equally Weighted Market (%) | -12.5 | -3.6 | -7.2 | 1.0 |
| Correlation of $y_t^2$ with Value-Weighted Market (%) | -8.9 | -2.4 | -5.4 | -1.9 |

## TABLE 6: Summary Statistics

We present summary statistics on the quarterly, *per capita*, NDS consumption, in the period 1980q2-1996q1, in 1996q1 dollars, for a variety of definitions of asset holders. Panel A provides summary statistics for the NDS *per capita* consumption *level*. In the first row, *per capita* consumption is obtained from NIPA. In all other rows, *per capita* consumption is obtained from CEX, with asset holders defined as the households in the database that report total assets, in 1996-adjusted dollars, satisfying the criterion stated in the first column. In the last row, *per capita* consumption is obtained with *equal* weights on the households, rather than with weights proportional to the CEX-reported weights. Panel B provides summary statistics for the NDS *per capita growth rates*, following the same row definitions as in Panel A.

**Panel A**: Quarterly *Per Capita* Consumption Level

| Household Assets | Number of Households | | | Mean Cons' | Median Cons' | Std Cons' | Min. Cons' | Max. Cons' | One-lag auto-corr | Two-lag auto-corr | Three-lag auto-corr | Four-lag auto-corr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min. | Median | Max | | | | | | | | | |
| NIPA | NA | NA | NA | 11045 | 11304 | 1,430 | 8,697 | 13,251 | 1.00 | 1.00 | 1.00 | .99 |
| ≥ 0 | 3999 | 5097 | 5986 | 3,146 | 3,141 | 111 | 2,910 | 3,406 | .57 | .43 | .47 | .73 |
| ≥ 2,000 | 153 | 608 | 709 | 4,344 | 4,329 | 289 | 3,668 | 5,162 | .59 | .56 | .52 | .59 |
| ≥ 10,000 | 95 | 341 | 449 | 4,728 | 4,719 | 418 | 3,925 | 5,777 | .64 | .58 | .56 | .50 |
| ≥ 20,000 | 67 | 250 | 357 | 4,893 | 4,818 | 495 | 4,055 | 6,115 | .68 | .61 | .55 | .50 |
| ≥ 30,000 | 52 | 199 | 303 | 5,053 | 4,973 | 563 | 3,964 | 6,654 | .67 | .58 | .54 | .48 |
| ≥ 40,000 | 45 | 158 | 249 | 5,187 | 5,110 | 605 | 4,244 | 6,888 | .65 | .58 | .54 | .45 |
| < 2,000 | 3548 | 4500 | 5326 | 2,999 | 2,989 | 106 | 2,763 | 3,201 | .58 | .40 | .45 | .70 |
| ≥ 2,000 | 153 | 608 | 709 | 4,341 | 4,341 | 275 | 3,647 | 4,952 | .68 | .57 | .50 | .65 |

**Panel B**: Quarterly *Per Capita* Consumption Growth Rate

| Household Assets | Mean | Std | One-lag auto-corr | Two-lag auto-corr | Three-lag auto-corr | Four-lag auto-corr | Corr with EW market | RRA : EW market | Corr with VW market | RRA: VW market |
|---|---|---|---|---|---|---|---|---|---|---|
| NIPA | .007 | .007 | .074 | -.006 | .186 | .155 | .226 | 136 | .235 | 161 |
| ≥ 0 | .000 | .015 | -.232 | .122 | .134 | -.442 | .067 | 230 | .047 | 405 |
| ≥ 2,000 | .003 | .037 | -.364 | -.009 | .391 | -.561 | .200 | 31 | .192 | 40 |
| ≥ 10,000 | .005 | .054 | -.379 | -.056 | .512 | -.491 | .213 | 20 | .250 | 21 |
| ≥ 20,000 | .004 | .057 | -.351 | .104 | .322 | -.419 | .288 | 14 | .335 | 15 |
| ≥ 30,000 | .005 | .064 | -.349 | .078 | .369 | -.428 | .243 | 15 | .263 | 17 |
| ≥ 40,000 | .005 | .070 | -.375 | .069 | .409 | -.497 | .277 | 12 | .305 | 13 |
| < 2,000 | .000 | .017 | -.269 | .077 | .096 | -.336 | .022 | 626 | .028 | 592 |
| ≥ 2,000 | .003 | .027 | -.058 | .044 | .088 | -.299 | .283 | 30 | .234 | 45 |

## TABLE 7: Results under Complete Consumption Insurance

In Panels A and B, we report results based on the *per capita* consumption of all NIPA and CEX households, respectively, in the period 1980q2 - 1996q1.

**Panel A:** NIPA, all households

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 15 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.26 | 2.23 | 2.20 | 2.17 | 2.14 | 2.11 | 2.09 | 2.06 | 2.03 | 2.00 | 1.98 | 1.85 | 1.74 |
| | t-stat | 1.81 | 1.80 | 1.79 | 1.78 | 1.77 | 1.76 | 1.75 | 1.74 | 1.73 | 1.71 | 1.71 | 1.64 | 1.58 |
| | Bootstrap p-value | 0.04 | 0.04 | 0.03 | 0.04 | 0.04 | 0.04 | 0.03 | 0.04 | 0.04 | 0.05 | 0.04 | 0.05 | 0.06 |
| VW Market Premium | Unexplained Premium | 2.10 | 2.07 | 2.05 | 2.02 | 2.00 | 1.97 | 1.95 | 1.92 | 1.90 | 1.88 | 1.85 | 1.74 | 1.64 |
| | t-stat | 2.23 | 2.22 | 2.21 | 2.20 | 2.19 | 2.18 | 2.17 | 2.16 | 2.14 | 2.13 | 2.12 | 2.05 | 1.98 |
| | Bootstrap p-value | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.02 | 0.01 | 0.03 | 0.02 |
| Risk-free Rate | Unexplained Rate | 0.74 | 0.07 | -0.60 | -1.25 | -1.89 | -2.52 | -3.14 | -3.76 | -4.36 | -4.96 | -5.55 | -8.36 | -10.98 |
| | t-stat | 8.91 | 0.71 | -3.62 | -5.01 | -5.64 | -6.00 | -6.22 | -6.37 | -6.48 | -6.57 | -6.63 | -6.81 | -6.86 |
| | Bootstrap p-value | 0.00 | 0.22 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

**Panel B:** CEX, all households

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 15 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.26 | 2.26 | 2.25 | 2.42 | 2.24 | 2.23 | 2.23 | 2.23 | 2.23 | 2.23 | 2.23 | 2.26 | 2.31 |
| | t-stat | 1.81 | 1.80 | 1.79 | 1.79 | 1.78 | 1.77 | 1.76 | 1.75 | 1.74 | 1.73 | 1.72 | 1.68 | 1.64 |
| | Bootstrap p-value | 0.04 | 0.01 | 0.04 | 0.03 | 0.04 | 0.04 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 |
| VW Market Premium | Unexplained Premium | 2.10 | 2.10 | 2.09 | 2.09 | 2.09 | 2.09 | 2.09 | 2.09 | 2.09 | 2.09 | 2.10 | 2.12 | 2.17 |
| | t-stat | 2.23 | 2.22 | 2.21 | 2.21 | 2.20 | 2.19 | 2.18 | 2.18 | 2.17 | 2.16 | 2.15 | 2.12 | 2.08 |
| | Bootstrap p-value | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 |
| Risk-free Rate | Unexplained Rate | 0.74 | 0.77 | 0.82 | 0.89 | 0.99 | 1.10 | 1.24 | 1.41 | 1.59 | 1.80 | 2.02 | 3.51 | 5.57 |
| | t-stat | 8.91 | 3.76 | 2.13 | 1.56 | 1.30 | 1.17 | 1.09 | 1.06 | 1.04 | 1.05 | 1.06 | 1.20 | 1.4 |
| | Bootstrap p-value | 0.00 | 0.00 | 0.03 | 0.07 | 0.08 | 0.14 | 0.14 | 0.18 | 0.16 | 0.14 | 0.14 | 0.11 | 0.08 |

## TABLE 8: Results under Complete Consumption Insurance

Asset holders in a given quarter are defined as the households that report total assets exceeding a pre-specified threshold in 1996-adjusted dollars. The *per capita* consumption is obtained as the average consumption across the households, with weights proportional to the CEX-reported weights. Panels A through D contain results for households whose asset holdings exceeded \$2,000, \$10,000, \$20,000, and \$40,000, respectively. The results are for the period 1980q2-1996q1.

**Panel A:** Households with assets exceeding \$2,000

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 15 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.26 | 2.19 | 2.11 | 2.04 | 1.96 | 1.89 | 1.82 | 1.75 | 1.67 | 1.60 | 1.53 | 1.12 | 0.58 |
| | t-stat | 1.81 | 1.73 | 1.65 | 1.57 | 1.49 | 1.41 | 1.33 | 1.25 | 1.17 | 1.08 | 1.01 | 0.62 | 0.26 |
| | Bootstrap p-value | 0.03 | 0.03 | 0.04 | 0.05 | 0.06 | 0.09 | 0.10 | 0.08 | 0.14 | 0.17 | 0.14 | 0.22 | 0.39 |
| VW Market Premium | Unexplained Premium | 2.10 | 2.04 | 1.99 | 1.93 | 1.87 | 1.82 | 1.76 | 1.71 | 1.65 | 1.59 | 1.53 | 1.20 | 0.74 |
| | t-stat | 2.23 | 2.15 | 2.06 | 1.97 | 1.88 | 1.79 | 1.70 | 1.61 | 1.52 | 1.43 | 1.33 | 0.87 | 0.42 |
| | Bootstrap p-value | 0.02 | 0.02 | 0.01 | 0.03 | 0.03 | 0.05 | 0.05 | 0.04 | 0.07 | 0.09 | 0.08 | 0.19 | 0.34 |
| Risk-free Rate | Unexplained Rate | 0.74 | 0.52 | 0.44 | 0.50 | 0.68 | 1.00 | 1.46 | 2.06 | 2.81 | 3.70 | 4.76 | 12.73 | 26.48 |
| | t-stat | 8.91 | 1.12 | 0.48 | 0.35 | 0.36 | 0.42 | 0.50 | 0.60 | 0.69 | 0.79 | 0.89 | 1.30 | 1.53 |
| | Bootstrap p-value | 0.00 | 0.12 | 0.32 | 0.36 | 0.36 | 0.35 | 0.27 | 0.28 | 0.24 | 0.22 | 0.18 | 0.08 | 0.03 |

**Panel B:** Households with assets exceeding \$10,000

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 15 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.26 | 2.14 | 2.01 | 1.89 | 1.75 | 1.61 | 1.46 | 1.30 | 1.12 | 0.93 | 0.72 | -0.69 | -3.14 |
| | t-stat | 1.81 | 1.70 | 1.58 | 1.45 | 1.31 | 1.17 | 1.02 | 0.88 | 0.72 | 0.57 | 0.42 | -0.28 | -0.80 |
| | Bootstrap p-value | 0.03 | 0.04 | 0.04 | 0.06 | 0.08 | 0.11 | 0.17 | 0.18 | 0.24 | 0.31 | 0.31 | 0.56 | 0.77 |
| VW Market Premium | Unexplained Premium | 2.10 | 1.99 | 1.88 | 1.77 | 1.66 | 1.55 | 1.43 | 1.30 | 1.17 | 1.02 | 0.87 | -0.14 | -1.86 |
| | t-stat | 2.23 | 2.10 | 1.96 | 1.81 | 1.66 | 1.50 | 1.34 | 1.18 | 1.01 | 0.84 | 0.68 | -0.08 | -0.63 |
| | Bootstrap p-value | 0.02 | 0.02 | 0.01 | 0.04 | 0.05 | 0.08 | 0.11 | 0.12 | 0.17 | 0.23 | 0.23 | 0.53 | 0.74 |
| Risk-free Rate | Unexplained Rate | 0.74 | 0.54 | 0.62 | 0.98 | 1.63 | 2.56 | 3.80 | 5.35 | 7.22 | 9.45 | 12.04 | 31.73 | 67.14 |
| | t-stat | 8.91 | 0.79 | 0.46 | 0.48 | 0.59 | 0.73 | 0.88 | 1.03 | 1.18 | 1.32 | 1.45 | 1.95 | 2.20 |
| | Bootstrap p-value | 0.00 | 0.20 | 0.32 | 0.32 | 0.29 | 0.23 | 0.16 | 0.15 | 0.12 | 0.10 | 0.07 | 0.02 | 0.00 |

## TABLE 8 (continued)

**Panel C:** Households with assets exceeding $20,000

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 15 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.26 | 2.10 | 1.92 | 1.75 | 1.57 | 1.38 | 1.18 | 0.97 | 0.74 | 0.50 | 0.23 | -1.50 | -4.37 |
| | t-stat | 1.81 | 1.66 | 1.49 | 1.32 | 1.15 | 0.97 | 0.79 | 0.62 | 0.45 | 0.28 | 0.13 | -0.54 | -0.99 |
| | Bootstrap p-value | 0.03 | 0.04 | 0.04 | 0.09 | 0.10 | 1.16 | 0.23 | 0.24 | 0.33 | 0.37 | 0.43 | 0.68 | 0.85 |
| VW Market Premium | Unexplained Premium | 2.10 | 1.95 | 1.81 | 1.66 | 1.51 | 1.36 | 1.20 | 1.03 | 0.86 | 0.68 | 0.48 | -0.75 | -2.69 |
| | t-stat | 2.23 | 2.05 | 1.87 | 1.67 | 1.47 | 1.27 | 1.07 | 0.88 | 0.69 | 0.51 | 0.34 | -0.36 | -0.80 |
| | Bootstrap p-value | 0.02 | 0.02 | 0.02 | 0.05 | 0.08 | 0.11 | 0.16 | 0.22 | 0.25 | 0.33 | 0.32 | 0.62 | 0.79 |
| Risk-free Rate | Unexplained Rate | 0.74 | 0.68 | 0.95 | 1.55 | 2.48 | 3.77 | 5.42 | 7.46 | 9.90 | 12.78 | 16.13 | 41.33 | 86.39 |
| | t-stat | 8.91 | 0.94 | 0.65 | 0.69 | 0.82 | 0.97 | 1.13 | 1.30 | 1.45 | 1.60 | 1.75 | 2.30 | 2.59 |
| | Bootstrap p-value | 0.00 | 0.18 | 0.25 | 0.26 | 0.21 | 0.17 | 0.11 | 0.09 | 0.07 | 0.04 | 0.04 | 0.00 | 0.00 |

**Panel D:** Households with assets exceeding $40,000

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 15 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.26 | 2.06 | 1.85 | 1.63 | 1.39 | 1.14 | 0.86 | 0.55 | 0.19 | -0.21 | -0.68 | -4.50 | -13.47 |
| | t-stat | 1.81 | 1.63 | 1.42 | 1.21 | 0.98 | 0.75 | 0.52 | 0.30 | 0.10 | -0.09 | -0.26 | -0.78 | -0.97 |
| | Bootstrap p-value | 0.03 | 0.05 | 0.05 | 0.12 | 0.13 | 0.23 | 0.29 | 0.34 | 0.47 | 0.50 | 0.59 | 0.74 | 0.83 |
| VW Market Premium | Unexplained Premium | 2.10 | 1.93 | 1.77 | 1.60 | 1.42 | 1.24 | 1.03 | 0.82 | 0.57 | 0.30 | -0.02 | -2.55 | -8.55 |
| | t-stat | 2.23 | 2.03 | 1.81 | 1.58 | 1.34 | 1.09 | 0.85 | 0.61 | 0.38 | 0.18 | -0.01 | -0.61 | -0.85 |
| | Bootstrap p-value | 0.02 | 0.02 | 0.03 | 0.07 | 0.10 | 0.16 | 0.20 | 0.29 | 0.35 | 0.47 | 0.45 | 0.68 | 0.75 |
| Risk-free Rate | Unexplained Rate | 0.74 | 0.72 | 1.19 | 2.17 | 3.68 | 5.73 | 8.38 | 11.67 | 15.65 | 20.41 | 26.02 | 71.32 | 164.9 |
| | t-stat | 8.91 | 0.80 | 0.66 | 0.78 | 0.96 | 1.16 | 1.35 | 1.53 | 1.70 | 1.85 | 1.97 | 2.32 | 2.29 |
| | Bootstrap p-value | 0.00 | 0.21 | 0.26 | 0.22 | 0.18 | 0.11 | 0.05 | 0.06 | 0.04 | 0.01 | 0.03 | 0.00 | 0.00 |

## TABLE 9: Results under Incomplete Consumption Insurance

Asset holders in a given quarter are defined as the households that report total assets exceeding a pre-specified threshold in 1996-adjusted dollars. Panels A through D contain results for households with asset holdings exceeding $2,000, $10,000, $20,000, and $40,000, respectively. The results are for the period 1980q2-1996q1 for nondurables and services using the CEX weights. We delete from the sample the observations that do not pass the consumption growth filter.

**Panel A:** Asset holdings exceeding $2,000

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.00 | 2.16 | 2.61 | 2.71 | -8.18 | -160.18 | -1935.97 | -21901.46 | -244034.21 | -2708315.43 |
| | t-stat | 1.57 | 1.58 | 1.49 | 0.85 | -0.51 | -1.04 | -1.18 | -1.23 | -1.26 | -1.28 |
| | Bootstrap p-value | 0.06 | 0.06 | 0.06 | 0.16 | 0.64 | 0.81 | 0.86 | 0.89 | 0.90 | 0.90 |
| VW Market Premium | Unexplained Premium | 1.89 | 2.06 | 2.55 | 3.02 | -4.04 | -114.38 | -1425.75 | -16170.96 | -179514.27 | -1981600.69 |
| | t-stat | 1.98 | 1.98 | 1.89 | 1.21 | -0.33 | -0.97 | -1.13 | -1.19 | -1.22 | -1.23 |
| | Bootstrap p-value | 0.02 | 0.02 | 0.02 | 0.12 | 0.56 | 0.76 | 0.84 | 0.86 | 0.90 | 0.91 |
| Risk-free Rate | Unexplained Rate | 0.73 | 8.09 | 35.43 | 118.93 | 499.39 | 3315.28 | 30573.62 | 322814.30 | 3577012.01 | 40401282.22 |
| | t-stat | 9.04 | 13.88 | 16.16 | 8.25 | 3.32 | 1.95 | 1.56 | 1.42 | 1.36 | 1.32 |
| | Bootstrap p-value | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Panel B:** Asset holdings exceeding $10,000

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.00 | 2.20 | 2.77 | 3.50 | -1.88 | -89.16 | -1086.96 | -12021.48 | -133044.64 | -1497607.24 |
| | t-stat | 1.57 | 1.59 | 1.55 | 1.08 | -0.14 | -0.83 | -1.02 | -1.04 | -1.03 | -1.01 |
| | Bootstrap p-value | 0.06 | 0.05 | 0.06 | 0.12 | 0.52 | 0.78 | 0.85 | 0.86 | 0.87 | 0.87 |
| VW Market Premium | Unexplained Premium | 1.89 | 2.07 | 2.61 | 3.38 | -0.91 | -74.26 | -896.13 | -9570.43 | -101435.24 | -1092396.71 |
| | t-stat | 1.98 | 1.98 | 1.91 | 1.36 | -0.10 | -1.06 | -1.36 | -1.39 | -1.33 | -1.25 |
| | Bootstrap p-value | 0.02 | 0.02 | 0.02 | 0.09 | 0.48 | 0.82 | 0.89 | 0.93 | 0.96 | 0.96 |
| Risk-free Rate | Unexplained Rate | 0.73 | 8.76 | 40.33 | 148.20 | 710.37 | 5152.90 | 48583.92 | 512138.72 | 5657357.63 | 63940833.14 |
| | t-stat | 9.04 | 10.99 | 11.85 | 5.72 | 2.59 | 1.65 | 1.34 | 1.21 | 1.14 | 1.10 |
| | Bootstrap p-value | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

## TABLE 9 (continued)

**Panel C:** Asset holdings exceeding $20,000

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.00 | 2.14 | 2.46 | 1.45 | -18.99 | -254.12 | -2828.11 | -31617.01 | -364181.47 | -4317718.15 |
| | t-stat | 1.57 | 1.53 | 1.32 | 0.35 | -0.73 | -1.05 | -1.13 | -1.13 | -1.10 | -1.07 |
| | Bootstrap p-value | 0.06 | 0.07 | 0.09 | 0.33 | 0.74 | 0.86 | 0.88 | 0.89 | 0.88 | 0.87 |
| VW Market Premium | Unexplained Premium | 1.89 | 2.04 | 2.43 | 1.90 | -14.78 | -212.27 | -2334.37 | -25179.15 | -277212.39 | -3137656.13 |
| | t-stat | 1.98 | 1.92 | 1.68 | 0.58 | -0.78 | -1.29 | -1.44 | -1.45 | -1.39 | -1.31 |
| | Bootstrap p-value | 0.02 | 0.02 | 0.04 | 0.27 | 0.71 | 0.88 | 0.91 | 0.95 | 0.96 | 0.97 |
| Risk-free Rate | Unexplained Rate | 0.73 | 9.27 | 43.91 | 179.93 | 1055.42 | 9268.76 | 99668.96 | 1158718.72 | 13930132.75 | 170448480.30 |
| | t-stat | 9.04 | 12.36 | 9.83 | 4.13 | 2.08 | 1.49 | 1.28 | 1.18 | 1.13 | 1.09 |
| | Bootstrap p-value | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Panel D:** Asset holdings exceeding $40,000

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.00 | 2.14 | 2.78 | 5.05 | 16.41 | 96.35 | 759.70 | 6597.88 | 58994.03 | 532553.04 |
| | t-stat | 1.57 | 1.54 | 1.52 | 1.57 | 1.42 | 1.17 | 1.07 | 1.04 | 1.03 | 1.02 |
| | Bootstrap p-value | 0.06 | 0.06 | 0.05 | 0.05 | 0.04 | 0.07 | 0.11 | 0.13 | 0.13 | 0.13 |
| VW Market Premium | Unexplained Premium | 1.89 | 2.03 | 2.63 | 4.30 | 8.81 | 18.67 | 1.79 | -596.85 | -8288.76 | -91212.19 |
| | t-stat | 1.98 | 1.91 | 1.80 | 1.59 | 1.08 | 0.46 | 0.01 | -0.31 | -0.54 | -0.69 |
| | Bootstrap p-value | 0.02 | 0.02 | 0.03 | 0.06 | 0.13 | 0.32 | 0.46 | 0.59 | 0.66 | 0.69 |
| Risk-free Rate | Unexplained Rate | 0.73 | 8.68 | 40.53 | 136.85 | 506.97 | 2486.66 | 16033.11 | 122210.66 | 1013155.88 | 8755783.03 |
| | t-stat | 9.04 | 8.82 | 9.26 | 5.94 | 3.22 | 1.97 | 1.47 | 1.25 | 1.15 | 1.09 |
| | Bootstrap p-value | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

## TABLE 10: Results under Complete Consumption Insurance as a Special Case of Incomplete Insurance

Asset holders in a given quarter are defined as the households that report total assets exceeding a pre-specified threshold in 1996-adjusted dollars. Panels A through D contain results for households with asset holdings exceeding $2,000, $10,000, $20,000, and $40,000, respectively. The results are for the period 1980q2-1996q1 for nondurables and services using the CEX weights. We delete from the sample the observations that do not pass the consumption growth filter.

**Panel A:** Asset holdings exceeding $2,000

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 15 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.00 | 2.05 | 2.12 | 2.19 | 2.27 | 2.37 | 2.48 | 2.61 | 2.75 | 2.90 | 3.08 | 4.30 | 6.37 |
| | t-stat | 1.57 | 1.59 | 1.61 | 1.63 | 1.65 | 1.67 | 1.68 | 1.70 | 1.71 | 1.72 | 1.73 | 1.74 | 1.70 |
| | Bootstrap p-value | 0.06 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| VW Market Premium | Unexplained Premium | 1.89 | 1.95 | 2.01 | 2.08 | 2.16 | 2.26 | 2.37 | 2.49 | 2.63 | 2.78 | 2.95 | 4.19 | 6.37 |
| | t-stat | 1.98 | 1.99 | 2.00 | 2.01 | 2.02 | 2.02 | 2.02 | 2.02 | 2.01 | 2.00 | 1.99 | 1.89 | 1.78 |
| | Bootstrap p-value | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Risk-free Rate | Unexplained Rate | 0.73 | 1.83 | 3.10 | 4.57 | 6.23 | 8.10 | 10.2 | 12.5 | 15.1 | 17.9 | 21.1 | 42.1 | 75.2 |
| | t-stat | 9.04 | 3.38 | 2.85 | 2.74 | 2.73 | 2.76 | 2.81 | 2.86 | 2.90 | 2.95 | 2.99 | 3.09 | 3.04 |
| | Bootstrap p-value | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Panel B:** Asset holdings exceeding $10,000

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 15 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.00 | 2.02 | 2.04 | 2.07 | 2.11 | 2.16 | 2.21 | 2.28 | 2.35 | 2.43 | 2.51 | 3.14 | 4.22 |
| | t-stat | 1.57 | 1.57 | 1.57 | 1.56 | 1.56 | 1.55 | 1.54 | 1.52 | 1.51 | 1.49 | 1.47 | 1.34 | 1.19 |
| | Bootstrap p-value | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.09 | 0.12 |
| VW Market Premium | Unexplained Premium | 1.89 | 1.91 | 1.93 | 1.96 | 2.00 | 2.05 | 2.10 | 2.17 | 2.24 | 2.33 | 2.43 | 3.18 | 4.60 |
| | t-stat | 1.98 | 1.96 | 1.94 | 1.92 | 1.89 | 1.86 | 1.82 | 1.78 | 1.74 | 1.69 | 1.65 | 1.41 | 1.21 |
| | Bootstrap p-value | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 | 0.09 |
| Risk-free Rate | Unexplained Rate | 0.73 | 1.84 | 3.23 | 4.91 | 6.91 | 9.22 | 11.9 | 14.9 | 18.2 | 22.0 | 26.3 | 55.1 | 101.8 |
| | t-stat | 9.04 | 2.70 | 2.35 | 2.35 | 2.43 | 2.53 | 2.65 | 2.76 | 2.87 | 2.97 | 3.06 | 3.38 | 3.45 |
| | Bootstrap p-value | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

## TABLE 10 (continued)

**Panel C:** Asset holdings exceeding $20,000

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 15 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.00 | 1.97 | 1.96 | 1.95 | 1.94 | 1.94 | 1.94 | 1.96 | 1.97 | 2.00 | 2.02 | 2.28 | 2.80 |
| | t-stat | 1.57 | 1.52 | 1.48 | 1.44 | 1.39 | 1.35 | 1.31 | 1.26 | 1.22 | 1.18 | 1.14 | 0.96 | 0.82 |
| | Bootstrap p-value | 0.06 | 0.06 | 0.07 | 0.07 | 0.08 | 0.08 | 0.09 | 0.10 | 0.11 | 0.12 | 0.13 | 0.17 | 0.21 |
| VW Market Premium | Unexplained Premium | 1.89 | 1.88 | 1.88 | 1.88 | 1.89 | 1.90 | 1.91 | 1.93 | 1.96 | 1.99 | 2.03 | 2.35 | 2.97 |
| | t-stat | 1.98 | 1.92 | 1.86 | 1.80 | 1.74 | 1.68 | 1.62 | 1.55 | 1.49 | 1.43 | 1.37 | 1.09 | 0.87 |
| | Bootstrap p-value | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.14 | 0.20 |
| Risk-free Rate | Unexplained Rate | 0.73 | 2.21 | 4.00 | 6.11 | 8.55 | 11.4 | 14.5 | 18.1 | 22.2 | 26.7 | 31.7 | 66.2 | 122.9 |
| | t-stat | 9.04 | 3.15 | 2.82 | 2.82 | 2.89 | 2.98 | 3.08 | 3.18 | 3.27 | 3.35 | 3.43 | 3.67 | 3.73 |
| | Bootstrap p-value | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Panel D:** Asset holdings exceeding $40,000

| | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 15 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW Market Premium | Unexplained Premium | 2.00 | 1.94 | 1.89 | 1.86 | 1.83 | 1.81 | 1.80 | 1.79 | 1.79 | 1.79 | 1.80 | 1.91 | 2.12 |
| | t-stat | 1.57 | 1.53 | 1.48 | 1.43 | 1.38 | 1.33 | 1.27 | 1.22 | 1.16 | 1.10 | 1.04 | 0.73 | 0.46 |
| | Bootstrap p-value | 0.06 | 0.06 | 0.07 | 0.07 | 0.08 | 0.09 | 0.10 | 0.11 | 0.11 | 0.13 | 0.14 | 0.21 | 0.30 |
| VW Market Premium | Unexplained Premium | 1.89 | 1.85 | 1.82 | 1.79 | 1.77 | 1.75 | 1.73 | 1.71 | 1.69 | 1.67 | 1.65 | 1.47 | 1.02 |
| | t-stat | 1.98 | 1.91 | 1.83 | 1.74 | 1.65 | 1.56 | 1.46 | 1.36 | 1.25 | 1.15 | 1.05 | 0.58 | 0.23 |
| | Bootstrap p-value | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.07 | 0.09 | 0.10 | 0.12 | 0.15 | 0.31 | 0.44 |
| Risk-free Rate | Unexplained Rate | 0.73 | 1.29 | 2.30 | 3.78 | 5.76 | 8.27 | 11.4 | 15.1 | 19.5 | 24.6 | 30.5 | 76.4 | 163.7 |
| | t-stat | 9.04 | 1.46 | 1.29 | 1.38 | 1.53 | 1.69 | 1.85 | 2.01 | 2.16 | 2.29 | 2.42 | 2.84 | 3.00 |
| | Bootstrap p-value | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

## TABLE 11: The Size Premium under Complete Consumption Insurance

Asset holders in a given quarter are defined as the households that report total assets exceeding a pre-specified threshold in 1996-adjusted dollars. The results are for the period 1980q2-1996q1 for nondurables and services using the CEX weights. We delete from the sample the observations that do not pass the consumption growth filter.

| Asset Holdings Exceeding | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $2,000 | Unexplained Premium | 1.04 | 1.06 | 1.08 | 1.09 | 1.11 | 1.12 | 1.13 | 1.14 | 1.14 | 1.14 |
| | t-stat | 1.40 | 1.38 | 1.37 | 1.34 | 1.31 | 1.28 | 1.24 | 1.20 | 1.15 | 1.10 |
| | Bootstrap p-value | 0.09 | 0.09 | 0.09 | 0.10 | 0.10 | 0.10 | 0.11 | 0.11 | 0.12 | 0.13 |
| $10,000 | Unexplained Premium | 1.04 | 1.08 | 1.11 | 1.16 | 1.21 | 1.26 | 1.32 | 1.39 | 1.46 | 1.54 |
| | t-stat | 1.40 | 1.40 | 1.40 | 1.41 | 1.41 | 1.41 | 1.41 | 1.41 | 1.41 | 1.41 |
| | Bootstrap p-value | 0.09 | 0.09 | 0.09 | 0.08 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| $20,000 | Unexplained Premium | 1.04 | 1.09 | 1.15 | 1.21 | 1.29 | 1.37 | 1.46 | 1.57 | 1.68 | 1.81 |
| | t-stat | 1.40 | 1.43 | 1.47 | 1.51 | 1.55 | 1.58 | 1.61 | 1.65 | 1.68 | 1.71 |
| | Bootstrap p-value | 0.09 | 0.08 | 0.08 | 0.07 | 0.06 | 0.05 | 0.04 | 0.04 | 0.04 | 0.03 |
| $40,000 | Unexplained Premium | 1.04 | 1.13 | 1.23 | 1.34 | 1.48 | 1.62 | 1.79 | 1.99 | 2.21 | 2.46 |
| | t-stat | 1.40 | 1.49 | 1.57 | 1.65 | 1.72 | 1.78 | 1.83 | 1.86 | 1.89 | 1.91 |
| | Bootstrap p-value | 0.09 | 0.08 | 0.06 | 0.05 | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 |

## TABLE 12: The Size Premium under Incomplete Consumption Insurance

Asset holders in a given quarter are defined as the households that report total assets exceeding a pre-specified threshold in 1996-adjusted dollars. The results are for the period 1980q2-1996q1 for nondurables and services using the CEX weights. We delete from the sample the observations that do not pass the consumption growth filter.

| Asset Holdings Exceeding | RRA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $2,000 | Unexplained Premium | 1.04 | 1.11 | 1.47 | 3.33 | 17.72 | 156.04 | 1594.29 | 17066.91 | 186621.57 | 2066219.89 |
| | t-stat | 1.40 | 1.38 | 1.41 | 1.73 | 1.87 | 1.70 | 1.60 | 1.54 | 1.50 | 1.47 |
| | Bootstrap p-value | 0.10 | 0.10 | 0.10 | 0.05 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| $10,000 | Unexplained Premium | 1.04 | 1.11 | 1.56 | 4.21 | 25.29 | 220.17 | 2151.42 | 22114.82 | 235000.67 | 2560586.29 |
| | t-stat | 1.40 | 1.35 | 1.39 | 1.75 | 1.90 | 1.75 | 1.58 | 1.44 | 1.32 | 1.24 |
| | Bootstrap p-value | 0.10 | 0.11 | 0.10 | 0.05 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| $20,000 | Unexplained Premium | 1.04 | 1.13 | 1.76 | 6.12 | 44.42 | 426.28 | 4501.31 | 49980.72 | 574295.18 | 6766909.73 |
| | t-stat | 1.40 | 1.39 | 1.59 | 2.03 | 1.93 | 1.72 | 1.55 | 1.41 | 1.30 | 1.22 |
| | Bootstrap p-value | 0.10 | 0.10 | 0.06 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| $40,000 | Unexplained Premium | 1.04 | 1.16 | 1.67 | 3.92 | 17.85 | 125.01 | 1032.31 | 9041.43 | 81084.73 | 734772.23 |
| | t-stat | 1.40 | 1.42 | 1.47 | 1.47 | 1.24 | 1.09 | 1.04 | 1.01 | 1.00 | 1.00 |
| | Bootstrap p-value | 0.10 | 0.09 | 0.08 | 0.07 | 0.10 | 0.13 | 0.16 | 0.16 | 0.19 | 0.21 |