CONSUMPTION BEHAVIOR, ASSET RETURNS, AND RISK AVERSION: EVIDENCE FROM THE JAPANESE HOUSEHOLD SURVEY[*,†]

Keiichi Kubota, Musashi University
Toshifumi Tokunaga, Musashi University
Kenji Wada, Keio University
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Abstract

We estimate both a limited participation model by Mankiw and Zeldes (1991) and a persistent income shock model by Constantinides and Duffie (1996). This is the first paper to use the Japanese income-decile consumption survey data to test the equity premium puzzle. We find that the risk aversion coefficients for higher income level households who may own larger equity positions are substantially smaller than those for the representative consumer. We conclude that the equity premium puzzle is partly resolved for Japan by the limited participation model, but not by the persistent income shock model.

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[*] The corresponding address is Toshifumi Tokunaga, Faculty of Economics, Musashi University, 1 - 26 - 1, Toyotama-kami, Nerima, 176 - 8534, Tokyo, Japan, tel: 81 - 3 - 5984 - 4655, fax:81 - 3 - 3991 - 1198. E-mail address: t-tkng@cc.musashi.ac.jp
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1. Introduction

Mehra and Prescott (1985) pointed out that the historical risk premium in the U.S. between 1889 and 1978 was too high to be consistent with a standard equilibrium asset pricing model. Since then, many researchers have tried to solve the equity premium puzzle by the following approaches: 1) generalize the utility function, 2) introduce market frictions, 3) consider heterogeneity of agents and 4) investigate the effect of incomplete markets.

Eichenbaum et al. (1988), Constantinides (1990), Abel (1990) and Epstein and Zin (1991) are notable examples of the first approach. However, Eichenbaum et al. (1988) and Epstein and Zin (1991) type models could not explain the risk premium. Constantinides (1990) and Abel (1990), on the other hand, did not test the Euler equation directly and instead they resorted to a rather restrictive calibration model.

He and Modest (1995), Heaton and Lucas (1996) and Luttmer (1996) took the second approach. They could not explain the risk premium puzzle without introducing severe market restrictions, as consumers can easily smooth their consumption with a storage technology or with just one financial asset.

Mankiw and Zeldes (1991) is an example of the third approach. They investigated the different consumption behavior between stock-holders and non stock-holders using Panel Survey of Income Dynamics. In their paper, they did not introduce any complex utility function or stringent market frictions. By focusing on the fact that there are some consumers who simply do not own any financial assets (only 27.6% of households own any stocks), they showed that the risk aversion coefficient for asset holder is much smaller than that for the representative agent.

Constantinides and Duffie (1996) and Brav et al (2002) investigated the effect of the fourth approach. Constantinides and Duffie (1996) theoretically considered the effect of uninsurable, persistent and heteroscedastic labor income shocks on equilibrium asset returns. Like Mankiw and Zeldes (1991), they did not introduce any complex utility function or stringent market frictions. What they did was to model the permanent and idiosyncratic income shock and investigate its effect on equilibrium asset returns. Brav et al (2002) empirically considered the Euler equations using the model by Constantinides and Duffie (1996) and found that the risk aversion coefficient of consumers becomes much smaller.[1]

Based on the success of the third and the fourth approach, we empirically consider the limited participation model by Mankiw and Zeldes (1991) and the persistent income shock model by Constantinides and Duffie (1996). We employ monthly, income-decile consumption data from Family Income and Expenditure Survey in Japan between January 1986 and December 1998. Unlike the CEX survey data typically used in the U.S. studies, Japanese Family Income and Expenditure Survey is available on a monthly frequency so our sample horizon is longer. Instead of the calibration approach taken by Mehra and Prescott (1985), Abel (1990), Constantinides (1990) and Brav et al. (2002), we directly test the Euler equations both for a limited participation model and a persistent income shock model..

In order to investigate the former, we compare the risk aversion coefficient from the standard Euler equations using aggregate consumption with those using each income-decile consumption. In order to investigate the latter, we compare the risk aversion coefficient from the standard Euler equation using aggregate consumption with that from the particular Euler equation modeled by Constantinides and Duffie (1996).

Hamori (1992) is one of the first studies which tested Euler conditions for Japanese asset returns data. He claims that the equity premium puzzle does not exist in Japan and accepts the null hypothesis with standard Euler condition tests. On the contrary,

[1] For a thorough survey on the equity premium issue, see Kocherlakota (1996), for example. For a survey on Japanese empirical results Iwaisako (2001) is most extensive.

Roy (1995) rejects Euler equations using several different set of instruments, and Nakano and Saito (1998) also reject Euler equations with a different utility function. All of these three studies above, however, employ aggregate consumption data. As far as the authors know, this paper is the first extensive study that considers the heterogeneity of Japanese investors by utilizing income-decile consumption survey data.

The Japanese income-decile consumption data has never been used in any empirical research in finance. There are a few papers that used income-quintile consumption data. Ogawa (1987), for example, used older annual income-quintile consumption data between 1969 and 1984, which were surveyed during that time only every five years, and he tested the Consumption CAPM. Shintani (1996) employed only quarterly income-quintile consumption data to investigate the excess consumption smoothness puzzle in Japan. We use decile consumption data which were recently released and test Euler conditions with considerations discussed above, which has never been done in the literature.

Section two discusses our estimation and testing method. Section three explains basic sample statistics of our data. Section four reports our main empirical results and Section five concludes the paper.

2. Estimation and Test of Euler Equations

Our estimation and testing strategy is as follows. We estimate and test Euler equations by GMM for both monthly raw and excess asset returns. Our data is from Family Income and Expenditure Survey income-decile monthly consumption data, and the detail of our data is explained in Appendix A.

2.1. Limited Participation Model

We do not have individual level consumption data on stockholders and non-holders like the ones in Mankiw and Zeldes (1991), but the higher income groups tend to invest more into risky assets (see Fig. 1). So the higher income groups are more likely to be stock holders than lower income groups. Thus it makes sense to test the Euler equation for each decile cohort consumption in order to see if the estimation and testing results change depending on which income group we focus on.

The income-decile cohort is indexed by i for $i = 0, \ldots, 10$. The subscript 0 denotes the aggregate consumption, the subscript 1 denotes the consumption of the lowest income cohort (rank1), the subscript 2 denotes the consumption of the second lowest income cohort (rank2), and so forth. For each cohort i, $c_{i,t}$ is the real, per capita, seasonally adjusted consumption level (see Appendix B for consumption data construction). As for the financial assets, $R_{s,t}$ is the real stock index return, $R_{b,t}$ is the real bond index return, $R_{f,t}$ is the real risk free rate. Also, α_i is the coefficient of the relative risk aversion and, β_i is the coefficient of a time preference parameter for cohort i. Finally, Z_t is a set of instruments such as a constant, lagged stock and bond returns, lagged consumption series, and lagged labor income growth.[2]

Suppose each investor has a standard time-additive power utility function. In a complete market with a representative agent, we obtain the following Euler conditions for the representative agent (i=0) from the first order condition in each period t. We use Euler equations in an unconditional form. We use index k to denote s for stock, b for bonds, and f for risk free asset. Our Euler equation in a raw return form for a representative agent (i=0) is given by the following equation for each asset:

[2] The labor income variable is used because this variable is strongly related to the cross-sectional stock returns for Japan (Jagannathan et al., 1998). The theoretical justification that the labor income influences asset returns is given in Basak (1999) and Viceira (1999). Note a labor-income shock cannot be insured in the incomplete market models (Aiyagari and Gertler, 1991).

$$\mathrm{E}\left[\beta_0\left(\frac{c_{0,t+1}}{c_{0,t}}\right)^{-\alpha_0} R_{k,t+1}\middle| Z_t\right]=1, \quad \text{for } \forall t \text{ and } k=s,b,f, \tag{1}$$

and, in an excess return form, it is

$$\mathrm{E}\left[\left(\frac{c_{0,t+1}}{c_{0,t}}\right)^{-\alpha_0}\left(R_{k,t+1}-R_{f,t+1}\right)\middle| Z_t\right]=0, \quad \text{for } \forall t \text{ and } k=s,b. \tag{2}$$

In our paper, we also employ the following Euler equation (3) for each income-decile cohort, which holds under less stringent conditions than those for equation (1):

$$\mathrm{E}\left[\beta_i\left(\frac{c_{i,t+1}}{c_{i,t}}\right)^{-\alpha_i} R_{k,t+1}\middle| Z_t\right]=1, \quad \text{for } \forall t, i=1,\ldots,10, \text{ and } k=s,b,f. \tag{3}$$

Accordingly, we also employ the following Euler equation (4) for each cohort which once again holds under less stringent assumptions than those for equation (2):

$$\mathrm{E}\left[\left(\frac{c_{i,t+1}}{c_{i,t}}\right)^{-\alpha_i}\left(R_{k,t+1}-R_{f,t+1}\right)\middle| Z_t\right]=0, \quad \text{for } \forall t, i=1,\ldots,10, \text{ and } k=s,b. \tag{4}$$

2.2. Persistent Income Shock Model

Japan has experienced a rapidly rising unemployment rate in the 1990s and early 2000s. The average unemployment rate rose from 2.1% in 1990 to 5.4% in 2002. Also, the ratio of people unemployed for more than one year is 28% of total unemployed people in Japan in 2000.[3] This is much higher than 6% in the U.S. Thus, the persistent labor income shock is a crucial part of the shock in Japanese labor market. Jagannathan et al. (1998) also point out that the labor income growth rate comprises one of the risk factors that can

[3] The unemployment insurance is paid for maximum of 360 days in Japan

explain stock returns in Japan.

Thus, in this section, we consider a model suggested by Constantinides and Duffie (1996) where they investigate the effect of persistent, idiosyncratic labor income shock on equilibrium asset returns.[4] They derive the following Euler equation (5). They do not consider any complex utility function or severe restrictions in the financial market. All they do is to simply model a particular form of income shock to each consumer. In this equation (5), y_{t+1}^2 is the variance of a cross-section of log real, seasonally adjusted consumption growth rates for each individual investor at t+1.

$$\mathrm{E}\left[\beta\left(\frac{c_{0,t+1}}{c_{0,t}}\right)^{-\alpha} R_{k,t+1}\exp\left\{\frac{\alpha(\alpha+1)}{2}y_{t+1}^2\right\}\middle| Z_t\right]=1, \quad \text{for } \forall t \text{ and } k=s,b,f, \tag{5}$$

where

$$y_{t+1}^2=\mathrm{Var}\left(\ln\left\{\frac{\delta_{l,t+1}/c_{0,t+1}}{\delta_{l,t}/c_{0,t}}\right\}\right). \tag{6}$$

Similarly, the Euler equation in an excess return form is given as follows.

$$\mathrm{E}\left[\left(\frac{c_{0,t+1}}{c_{0,t}}\right)^{-\alpha}\left(R_{k,t+1}-R_{f,t+1}\right)\exp\left\{\frac{\alpha(\alpha+1)}{2}y_{t+1}^2\right\}\middle| Z_t\right]=0, \quad \text{for } \forall t \text{ and } k=s,b. \tag{7}$$

The symbol in equation (6), $\delta_{l,t}$, l=1, ..., L_t, denotes individual level consumption data in which L_t is the total number of all the individuals in the economy.

Because the consumption data $\delta_{l,t}$ for all the individuals in Japan is not available, we cannot estimate the equation (6) directly from our data. In the Family Income and Expenditure Survey on which our decile-cohort consumption data is based, there are approximately 5,000 household (the maximum is 5117 in 1989 and the minimum is 4874 in 1998) interviewed in each month during our sample period. Every month, one-sixth of

4 For the mechanism of how CD model works, see Cochrane (2005) for a very intuitive discussion.

existing households are replaced by new households.

Although the household level consumption data is available from CEX in the U.S., the household level consumption data is not available in Japan. Instead, we have access only to decile-cohort level consumption each of which is the average of consumption of 500 households.

Thus, we take two alternative approaches in this paper so that we can apply the above persistent income shock model to decile-cohort level consumption our data.[5]

The first approach, which we call CD, is to impose two additional assumptions on the cross-sectional properties of individual consumption data and estimate Euler equations similar to (5) that hold at a decile-cohort level. These necessary assumptions are as follows: 1) consumption growth rates for all different individuals within the same cohort are uncorrelated and 2) there are equal numbers of individuals within each cohort and these numbers are invariant over time.[6] In this case the same Euler equation (5) and (7) hold at the decile-cohort level. However, in these Euler equations, we need to estimate the correct variance by multiplying the variance estimated from decile data by the number of households in each decile and correct for the unobservable individual level data. Thus the correct variance is given by equation (8) where n_t is equal to 500 (total number of households in the survey divided by the number of cohorts in our data).[7]

$$y_{t+1}^2 = n_t \ \mathrm{Var}\left(\ln \left\{ \frac{c_{i,t+1} / c_{0,t+1}}{c_{i,t} / c_{0,t}} \right\} \right). \tag{8}$$

The second approach, which we call CD2, is to a priori impose the following functional form on the cross-sectional variance directly without imposing the above

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[5] The authors appreciate an anonymous referee for pointing out the necessity to make these corrections.

[6] The sampling design adopted in the Family Income and Expenditure Survey indeed approximately satisfies this assumption 2.

[7] The derivations are available from the authors upon request.

mentioned two additional assumptions where γ and η are parameters:

$$y_{t+1}^2 = \gamma + \eta Var[\ln(\frac{c_{i,t+1}/c_{0,t+1}}{c_{i,t}/c_{0,t}})] \tag{9}$$

This is the same functional from as the one suggested in Constantinides and Duffie (1996). Then we can estimate the following Euler equation in a raw return form.

$$E[\beta^* (\frac{c_{0,t+1}}{c_{0,t}})^{-\alpha} R_{k,t+1} \exp\{\frac{\alpha(\alpha+1)\eta}{2} Var[\ln(\frac{c_{i,t+1}/c_{0,t+1}}{c_{i,t}/c_{0,t}})]\}] \tag{10}$$

where

$$\beta^* = \beta \exp\{\frac{\alpha(\alpha+1)\eta}{2}\}$$

However, the term η cannot be estimated in an excess return form, as it approaches to minus infinity in the GMM estimation and the local minimum value for it does not exist. Thus we can estimate only the raw return form for the second approach.

3. Data Descriptions

3.1. Consumption and Asset Return Data

Our sample period is from January 1986 to December 1998 and we have 167 monthly observations. As for consumption, we use eleven series: ten series for income-decile data and one series for the aggregate data. We construct seasonally-adjusted, real per-capita consumption growth rates. As for the asset returns, we use three series. The overnight call rate is taken as a proxy for the risk free rate. The bond index return is computed from the holding returns of long-term government bonds. The value-weighted total return is based on the index returns of all listed stocks in the first section of the Tokyo Stock Exchange adjusted for dividend yield and stock-splits. All three series are from Ibbotson Associates Japan, Inc. In order to deflate nominal asset return series, we use aggregate CPI index as reported by Ibbotson and Associates, because the equilibrium asset demand is an aggregated measure. The labor income data are from the monthly Japanese Ministry of Health, Labour, and Welfare survey and the particular series we have chosen is the "C" series in which the total payments per worker for regular wage and overtime wages are included.

3.2. Sample Statistics

We report the sample statistics for nominal consumption growth rates and asset returns in Table 1. From Panel A of Table 1 we find that the nominal aggregate consumption growth rate is 1.2 percent per month. The nominal consumption growth rate for the lowest income group is 1.0 percent, and that for the highest is 1.7 percent. The standard deviation is also higher for higher income groups. From Panel B of Table 1, we notice that the magnitude of autocorrelations is all negative for lag one and they are significant. Besides, the Box-Pierce Q statistics for lags 6 and 12 are significant. The ratios of the yen amount of the stock investment over the yen amount of net worth are depicted in Fig. 1 for years 1986, 1991, and 1996. It shows that the higher income groups own a much larger fraction of stock in their portfolio than lower income deciles.

The aggregate, seasonally unadjusted real consumption growth rate is 1.1% which is slightly lower than the aggregate, seasonally unadjusted nominal consumption in Table 1.[8] Although there was a moderate inflation in the late 1980s, there was a deflation in the 1990s so that the inflation during the sample period is quite low. The similar pattern holds for all income decile consumption growth rates.

Table 2 shows the summary statistics for the seasonally adjusted real series. In Table 2, we find that the real aggregate consumption growth rate is 0.11 percent per month.

8 The table related to this observation is available from the authors upon request.

The real consumption growth rate for the lowest income group is 0.19 percent, and for the highest 0.24 percent. The difference in the mean growth rate between Table 1 and Table 2 is due mainly to the seasonal adjustment than to inflation. We observe a big spike in December and a sharp decline in January for CPI indices in Japan, which is very different from the ones in the U.S. The standard deviation is only 1.7 percent for the aggregate consumption growth rate, but it is as high as 5.0 percent for the highest income quintile. This is almost three times as large as that from the aggregate consumption growth rate. One of the main reasons for the existence of the risk premium puzzle is a relatively stable consumption growth rate. As consumption is not that risky, we need to assume that consumers are quite risk averse in order to justify the relatively high risk premium. However, the disaggregated decile-level consumption growth rate is much more volatile than the aggregate consumption growth rate. Thus, it is natural to conjecture that the risk aversion coefficient estimated from Euler equations based on the decile consumption should be much smaller than that estimated from the one based on the aggregate consumption. Our empirical observations in the next section verify this conjecture.

The magnitude of autocorrelations becomes much smaller in this case even though they are still significant at lag one and the Box-Pierce statistics are still significant. Ferson and Harvey (1992) report a similar result for US data, but they employ quarterly consumption data at the aggregate level which are not seasonally adjusted. Accordingly, we cannot directly compare our result with theirs.

Table 3 presents similar sample statistics for real returns for stock, bonds, and risk-free assets. Note that our sample period is from January 1986 to December 1998. This period covers the pre-bubble era, the bubble-era and the post-bubble era in Japan. The real cumulative returns are depicted in Fig. 2 and we notice that stock returns are much lower than bond returns for the total period. The average real stock return is 0.19 percent per month and smaller than the bond return of 0.48 percent, and it is almost equal to the risk free rate of 0.18 percent. From Panel B of the same table we note that the magnitude of autocorrelations of all real return series is positive at lag one but they are not significantly different from zero for stock and bond returns. So are the Q statistics.

Table 4 shows correlation coefficients for real asset returns and real seasonally adjusted consumption growth rates. Remarkable is the fact that we find low correlations of consumption growth rates among different income decile groups. For instance, the correlation between the 10th income quintile and the 9th income quintile is only 2 percent and that between the 10th quintile and the 8th quintile is also only 2 percent. The largest correlation is only 27 percent and it is between the 10th quintile and the 7th quintile. As the magnitude of correlations among the income cohorts is quite small, it is not surprising that the aggregate consumption growth rate is much less volatile than that of each income quintile.

We find that the correlation between stock raw returns and consumption growth rates, the highest correlation is 13 percent and it is with the 10th income quintile. The highest correlation between stock excess return and consumption growth rates is 14 percent and it is also with the 10th income quintile. These results strongly suggest that the equity premium in Japan depends on the correlation between the stock excess returns and the wealthiest individuals who own major fraction of the stocks. This goes in line with the arguments and the empirical findings by Ait-Sahaila et al. (2004) who considered the relation between the equity premium and the luxury goods. Note that the luxury goods is mainly consumed by high-income or wealthy people, so there is an indirect link between the equity premium and the consumption of high-income or wealthy people.

This rationalizes the motivation of our study to distinguish the consumption and investment behavior of different income groups. Since previous studies on Japanese capital markets and consumers' asset choice behavior have used only this aggregate consumption series, we point out the possibility that there might have been a lot of important information lost in the empirical results of the previous studies.[9]

4. Empirical Result

4.1. Euler Equation Estimation from the Total Period

Table 5 reports estimation results of Euler equations (2), (4) and (7). Although we tested Euler equations with many different combinations of instruments, we only report results from a typical case.[10] The instruments are a constant, one-lagged excess bond return, one-lagged excess stock returns, one-lagged consumption and two-lagged labor income.

First, we discuss the results from the limited participation model. The risk aversion coefficient from the aggregate consumption series is quite high at 14, while those from the highest, second highest and third highest income groups are 0.88, 2.3 and 2.0, respectively. For income groups 3 and 4, they are very high at 19 and 7.5. Unfortunately, coefficients from the 5th and the 6th income groups are negative. Although the Euler equations in excess return form are rejected in most of the cases, we have resolved the equity premium, at least in part, when we focus on the fact that the majority of equity in the Japanese financial market is owned by higher income investors and the fact that the risk aversion coefficients for those income groups are much lower than that for the representative agent. So the limited participation model helps resolve the equity premium puzzle in Japan.

Second, we investigate the results from the persistent labor income shock model

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[9] In an earlier version of the paper we used quintile data and, although the results are not dramatically different, we notice some important information is lost by the aggregation only at the quintile level.

[10] The results based on other sets of instruments are available from the authors upon request.

by Constantinides and Duffie (1996). The coefficient is negative at -0.49.[11] The model is also rejected. Thus, the persistent income shock model of Constantinides and Duffie (1996) does not resolve the equity premium puzzle in Japan. The first term in equation (7) is the aggregate consumption and the correlation between that term and the equity premium is small. Thus, the cross sectional variance among the decile cohort level log consumption growth must be positive and strongly correlated with excess asset returns in order for model to be accepted and the risk aversion coefficient to become smaller. However, the cross sectional variance among the decile cohort level log consumption growth is only weakly correlated with excess asset returns. In fact, the correlation between the cross sectional variance of log consumption growth and the equity premium is -0.07, i.e., the correlation is small and negative.

Thus it is not surprising that the limited participation model by Mankiw and Zeldes fares well while the persistent income shock model by Constantinides and Duffie model doest not in Japan.

Our observation is consistent and robust among various excess return tests. The result for the aggregate data is in conformity with previous studies using US data which pointed out an unusually high level of risk aversion coefficients and model rejection. We have successfully demonstrated that the puzzle of unreasonable higher risk aversion coefficients is resolved by focusing on consumption behavior of higher income groups.

Table 6 reports results using equations (1), (3) and (5).[12] The instruments are a constant, one-lagged and two-lagged stock returns, one-lagged consumption, and two-lagged labor income. Standard errors are reported in parentheses.

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[11] Brav et al. (2002) find the estimated relative risk aversion coefficients are quite unstable over three different cohorts sampled over three consecutive starting months. We estimated the coefficients by allowing for cross-variations of the different cohorts. We thank an anonymous referee for clarifying this point.

[12] See footnote 8.

First, we discuss the results from the limited participation model. We find that time preference parameters are uniformly close to one and are highly significant. Risk aversion coefficients are uniformly smaller than one and they are not significant.[13]

Second, we investigate the results from the persistent labor income shock model. We have two alternative formulations. The coefficient of risk aversion from the first formulation, CD, is 0.007 and it is insignificant. The coefficient from the second formulation, CD2, is 0.062 and it is insignificant. Again, the result is not surprising, since the cross sectional variance among the decile cohort level log consumption growth is only weakly correlated with raw asset returns. The correlation between the cross sectional variance of log consumption growth and the stock return is -0.09, so the correlation is again small and negative.

Finally, all various specifications of Euler equations are rejected at the 10% significance level.[14]

We once again reconfirm the tendency that the risk aversion coefficient becomes smaller, if we focus on the consumption of higher income group by constructing partially aggregated data from higher income groups as shown in Table 7. This finding is important in view of the unreasonably large risk aversion coefficients that are typically found for the aggregated data in this kind of study both in the U.S. and Japan.

Specifically, we construct the following three set of aggregate groups: 1) group one formed from rank 7, 8, 9 and 10, 2) group two formed from rank 8, 9 and 10 and 3) group 3 formed from rank 9 and 10. For instance, for group one, we follow the following procedure. First, we add the nominal non-durables of rank 7 to 10 deciles. Second, we add

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[13] This seems to be a common observation obtained from estimating these types of nonlinear Euler equations. The authors thank George Constantinides for pointing this out.

[14] The observation period and the set of instruments in our paper are different from those in Hamori (1992), so we cannot simply compare our results on the rejection of Euler equations with his results on the acceptance of Euler equations.

the nominal services of rank 7 to 10 deciles. Third, we deflate non-durables by the non-durables deflator and services by the services deflator. Finally, we add these two real consumption series and apply the X-11 seasonal adjustment method.

Table 7 reports results for the excess return Euler conditions test. The model is rejected. We can see that the volatility of consumption growth rate decreases when we aggregate the income-decile consumption growth rate. This is because the decile-level consumption growth rate may tend to offset each other. This result is consistent with the low correlation among higher income deciles as previously shown in Table 2. Note the difference between this result and the result for the total aggregated group denoted as "aggregate." The radical differences of these risk aversion coefficients warn us not to use the aggregated data under the assumption of homogenous consumers in testing the equity premium puzzle, and the result strongly recommends that one should use the limited participation model. This result has never been found elsewhere and it justifies our use of disaggregated or partially aggregated consumption data.

4.2. Euler Equation Estimation from Sub-Periods

Since the return for risky asset was low during our sampling period, we have also split the sample period into two sub-periods in order to investigate the difference of the result between the first sub-period and the second sub-period. In the first sub-period, the stock market was booming and in the second, the tendency was the opposite. From an excess return Euler equation, the risk aversion coefficient from the aggregate consumption growth series estimated from the first period is high at 6.4, while that from the second period is also high at 14. The risk aversion coefficients from the consumption growth rate of rank 5 to rank 10 are much lower and they are between -4.3 and 5.4 from the first period. They are again lower and they are between -4.7 and 2.3 from the second period.

In the total sample period, we find that the risk aversion coefficient from the aggregate data is much higher than those from the higher income group. We also find a similar tendency in each sub-period. Thus, our results are robust to the choice of the sample period as well.

For the Euler equations in the raw return form, the time preference parameters from the first period are between 0.99 and 1 and are highly significant. Also, those from the second period are between 0.99 and 1 (except for CD2 where the time preference is equal to 1.07) which are also highly significant. Risk aversion coefficients from the first period are all less than 0.11 and all of them are not statistically different from zero. Those from the second period are again less than 0.1 except for the 0.359 for CD2. Once again, our results are robust with respect to the choice of a sample period.

5. Conclusions

In this paper we investigated the consumption based asset pricing model using Japanese household income decile consumption data from February 1986 through December 1998. This decile survey data has never been used previously and we add new evidence to the literature. Only a small percentage of Japanese households own common stock, and lower-income decile households invest more in bank deposits, postal savings, Japanese government bonds, and long-term bank notes. Hence, we expect to find systematically different risk aversion coefficients for each income cohort. From Euler equations in the excess return form, we find that it is indeed the case and that the risk aversion coefficients for higher income decile households are much smaller than those estimated from aggregate consumption data. We conclude that we can resolve the equity premium puzzle in Japan, at least in part, if we focus on the higher income consumers in the limited participation model.

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Appendix A: Description of the Japanese Household Survey

Our consumption data is based on the Family Income and Expenditure Survey, which is administered by the Minister of the Management and Coordination Agency and conducted at each prefecture level by the board of governors. We collected data at the Statistical Bureau of the Minister of the Management and Coordination Agency, because these detailed items are not published in the monthly statistics book. The selected items are publicly reported both monthly and annually. It also forms the base for the Gross National Expenditure statistics and the Consumer Price Index. Workers' Households refer to households whose heads are employed as workers in enterprises or establishment, private or government, such as government offices, private companies, factories, schools, hospitals, shops, etc. The following households are, however, excluded as inappropriate households. (a) Households engaged in agriculture and cultivating 10 acres of land or more (in Hokkaido 30 acres or more), (b) Households engaged in forestry, (c) Households engaged in fishery, (d) One-person households, (e) Households which manage restaurants, hotels, boarding houses or dormitories, using their dwellings, (f) Households which serve meals to boarders even though not managing boarding houses as business, (g) Households with 4 or more living-in employees, (h) Households whose heads are absent for a long time, and (i) Foreigner households.

The survey uses a stratified random sampling. Approximately 8,000 households are selected. Each household is surveyed for six months and then is replaced by a new one. That is, every month one-sixth of the sample is replaced. However, this replacement is designed so that the continuity of the sample is kept. The replacement is conducted across unit areas defined within the same block area so that the continuity of the pseudo-panel type sampling will be kept. The older survey was based on quintile income groups and the survey with a new classification scheme composed of the decile income group was

Annual Income for Each Decile Group (unit: 10,000 yen)

	rank1	rank2	rank3	rank4	rank5	rank6	rank7	rank8	rank9	rank10
1987	244	337	397	448	503	561	630	720	842	1,163
1988	254	349	412	470	525	587	655	745	872	1,208
1989	264	366	431	491	548	610	680	768	905	1,239
1990	278	387	452	513	577	644	716	812	951	1,308
1991	288	404	475	541	605	679	758	850	1,003	1,402
1992	301	426	502	570	636	708	788	894	1,057	1,441
1993	314	442	518	586	656	727	812	913	1,071	1,477
1994	326	450	522	592	662	735	821	931	1,084	1,511
1995	316	444	518	591	665	741	828	939	1,094	1,524
1996	313	446	524	595	669	748	838	946	1,104	1,499
1997	313	450	532	603	678	756	844	954	1,113	1,552
1998	316	451	533	609	684	765	856	976	1,141	1,555

introduced in 1981. The monthly consumption data necessary for our analysis can go back only to January 1986, from which time our analysis starts. Average values within each income group in the data are the arithmetic averages, and so is the aggregate consumption. Classification of the sample into decile income groups is done every month based on the households' previous twelve-month income level and the equal number of sample points is allotted to each decile. Since only one-sixth of the sample changes every month after designating the sample points within the well-defined area, there exists time series continuity in this decile data survey to some extent, even though it is not a perfect panel data. The annual income for each decile group during the sample period is shown in the above table. There are more than 300 separate items to be recorded as consumption expense in the survey. These are decomposed into service consumption, non-durable, semi-durable, and durable. The semi-durable items include the consumption of sporting shoes, kettles, or TV games the data series. After carefully analyzing the time series of the above four series, we decided to use only the service consumption and the non-durable consumption in our monthly consumption series to match against monthly stock returns.

Appendix B: The Seasonal Adjustment of Consumption Data

The original household-level consumption data is a nominal number and is not seasonally adjusted. In order to generate the real per-capita, seasonally adjusted decile consumption series from the original data, we take the following steps for each decile. First, we deflate both the nominal non-durable consumption series and the nominal service consumption series by the non-durable consumption deflator and the service consumption deflator, respectively. Second, we add real non-durable consumption series and real service consumption series. Third, we divide the consumption series obtained above by the number of the people in each decile. Finally, we seasonally adjust these final real per capita decile consumption series by X-11 using RATS. In our first version of the paper we used the monthly dummy regression method to seasonally adjust the series. It can reduce the seasonal variations of the data better, but the results for Euler condition tests were not remarkably different. Hence, we use only the standard X-11 method. Bell and Hillmer (1984) discuss in detail how to seasonally adjust the mixed series. Based on what they advocate, we employ our method of seasonally adjusting our mixed series.

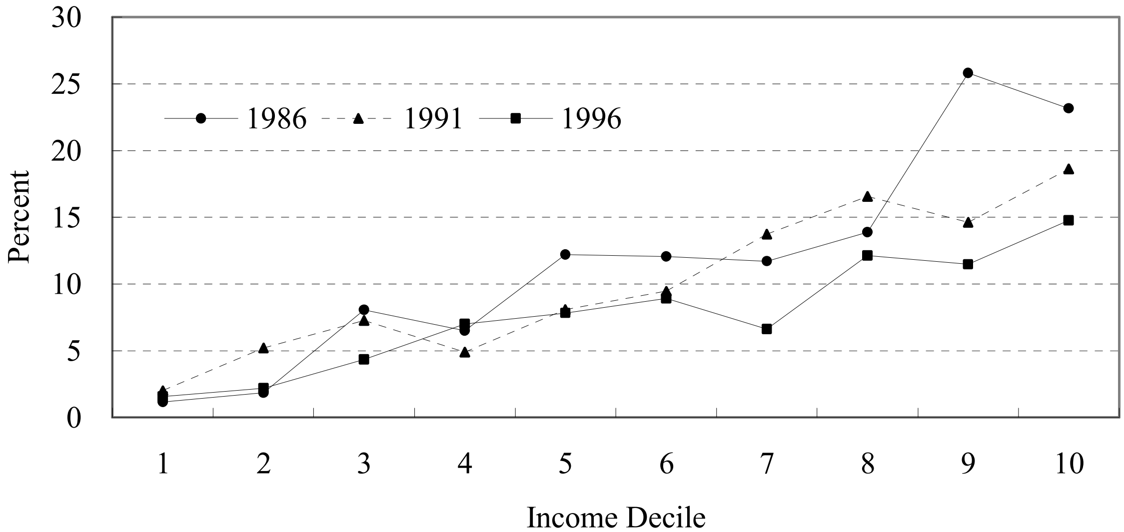

Fig. 1. The Ratios of The Yen Amount of The Stock Investment over The Yen Amount of Net Worth
The graph shows the ratio of household's stock holding to their net worth for each decile for year 1986, 1991 and 1996, in which years survey is conducted for the asset holdings. The decile 1 is the lowest income-decile and the decile 10 is the highest.

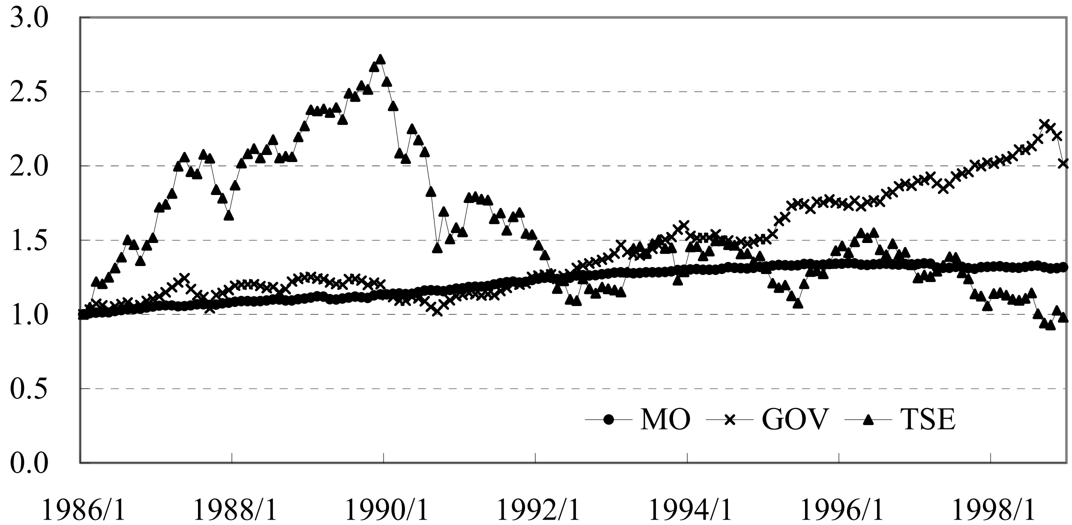

Fig. 2. Cumulative Real Rate of Returns for Stock, Bond and Risk Free Asset
Monthly returns are cumulated. Stock returns are the value weighted total return on all the stocks listed at the Tokyo Stock Exchange 1st section, the bond return is the long-term Japanese government bond return, and the risk free rate is overnight call rate. The initial value starts from one. "MO" is the rate of return on risk free asset, "GOV" is the rate of return on bond and "TSE" is the rate of return on stock.

Table 1
Summary Statistics for the Seaonally Unadjusted Nominal Consumption Growth Rate

Panel A

consumption growth	Mean (%)	Std Dev (%)	Skewness	Excess Kurtosis
aggregate	1.2	13	0.43	1.33
rank 1	1.0	12	0.10	1.18
rank 2	1.1	12	0.23	1.32
rank 3	1.1	12	0.02	1.03
rank 4	1.1	13	0.38	1.77
rank 5	1.1	13	0.38	1.48
rank 6	1.4	15	0.30	0.49
rank 7	1.5	15	0.54	1.24
rank 8	1.4	14	0.52	0.96
rank 9	1.5	15	0.59	0.90
rank 10	1.7	16	0.62	0.63

Panel B

consumption	autocorrelation						
growth	lag = 1	2	3	4	5	$Q(6)$	$Q(12)$
aggregate	-0.48 *	-0.16 *	0.07	0.15	0.19 *	85.0	279.2
rank 1	-0.52 *	0.00	-0.08	0.16 *	0.12	65.3	211.5
rank 2	-0.49 *	-0.11	0.01	0.12	0.21 *	83.6	246.6
rank 3	-0.45 *	-0.16 *	-0.02	0.16 *	0.25 *	90.1	240.5
rank 4	-0.49 *	-0.13	0.04	0.13	0.16 *	71.2	238.4
rank 5	-0.49 *	-0.11	0.07	0.04	0.25 *	84.8	253.2
rank 6	-0.49 *	-0.14	0.09	0.04	0.28 *	95.0	259.8
rank 7	-0.54 *	-0.04	0.06	0.05	0.16 *	68.0	215.7
rank 8	-0.48 *	-0.14	0.06	0.12	0.18 *	76.1	234.9
rank 9	-0.43 *	-0.25 *	0.11	0.21 *	0.01	58.6	206.5
rank 10	-0.42 *	-0.24 *	0.11	0.16 *	0.14	78.1	234.7

The nominal consumption data is composed of non-durable and services. The caption "aggregate" is aggregate consumption growth, "rank 1" is the consumption growth for the lowest income decile, and "rank 10" is that for the highest income decile. Q is Box-Pierce statistics. * indicates significance at the 5% level.

Table 2
Summary Statistics for the Seasonally Adjusted Real Consumption Growth Rate

Panel A

consumption growth	Mean (%)	Std Dev (%)	Skewness	Excess Kurtosis
aggregate	0.11	1.7	-0.07	0.71
rank 1	0.19	4.2	-0.19	0.63
rank 2	0.18	4.0	0.18	0.50
rank 3	0.19	4.3	0.31	1.82
rank 4	0.15	3.6	0.16	0.56
rank 5	0.09	3.7	0.23	0.72
rank 6	0.13	4.8	0.21	1.11
rank 7	0.26	5.2	-0.09	0.53
rank 8	0.21	4.8	0.50	0.68
rank 9	0.23	5.3	0.65	1.39
rank 10	0.24	5.0	0.07	0.04

Panel B

consumption	autocorrelation						
growth	lag = 1	2	3	4	5	$Q(6)$	$Q(12)$
aggregate	-0.50 *	0.07	-0.06	0.10	-0.03	41.7	79.6
rank 1	-0.55 *	0.19 *	-0.11	-0.02	0.08	55.2	62.8
rank 2	-0.54 *	0.19 *	-0.22 *	0.24 *	-0.28 *	82.5	93.6
rank 3	-0.51 *	0.08	-0.11	0.07	-0.05	46.3	65.5
rank 4	-0.46 *	0.02	0.02	0.05	-0.05	34.4	55.3
rank 5	-0.30 *	-0.11	0.05	-0.04	0.00	17.2	36.6
rank 6	-0.43 *	-0.06	0.05	-0.14	0.31 *	52.8	75.3
rank 7	-0.52 *	0.04	0.01	-0.07	0.13	47.1	69.2
rank 8	-0.38 *	-0.10	-0.01	-0.08	0.13	27.7	35.7
rank 9	-0.38 *	-0.18 *	0.06	0.05	0.04	30.6	63.3
rank 10	-0.39 *	-0.09	0.04	-0.05	0.01	26.1	38.3

The real consumption data is composed of non-durable and services in which the corresponding deflators are used to deflate the series. We used X-11 to seasonally adjust the real series. The caption "aggregate" is aggregate consumption growth, "rank 1" is the consumption growth for the lowest income decile, and "rank 10" is that for the highest income decile. Q is Box-Pierce statistics. * indicates significance at the 5% level.

Table 3
Summary Statistics for Real Asset Returns

Panel A

	Mean (%)	Std (%)	Skewness	Excess Kurtosis
MO	0.18	0.46	-0.74	2.70
GOV	0.48	2.31	-0.57	2.25
TSE	0.19	6.30	0.06	0.65
GOV - MO	0.30	2.27	-0.52	2.59
TSE - MO	0.01	6.30	0.04	0.65

Panel B

	autocorrelation						
	lag = 1	2	3	4	5	$Q(6)$	$Q(12)$
MO	0.286 *	-0.259 *	-0.253 *	-0.022	0.257 *	62.6	145.9
GOV	0.142	0.040	-0.108	-0.187 *	-0.021	10.9	14.9
TSE	0.038	-0.016	-0.025	0.047	0.124	4.4	8.3
GOV - MO	0.151	0.045	-0.123	-0.209 *	0.005	13.1	16.5
TSE - MO	0.036	-0.018	-0.021	0.048	0.118	4.5	8.6

The caption "MO" is the overnight call rate, "GOV" is the long-term government bond return, and "TSE" is the value weighted total return on all the stocks listed at the Tokyo Stock Exchange 1st section. All the asset returns are deflated by CPI. Q is Box-Pierce statistics. * indicates significance at the 5% level.

Table 4
Correlations between Real Consumption Growth and Real Asset Returns

	aggregate	rank 1	rank 2	rank 3	rank 4	rank 5	rank 6	rank 7	rank 8	rank 9	rank 10	MO	GOV	TSE	GOV-MO
rank 1	0.31														
rank 2	0.40	0.12													
rank 3	0.30	0.22	0.19												
rank 4	0.37	0.11	0.10	0.18											
rank 5	0.26	0.20	0.18	0.08	0.17										
rank 6	0.30	0.00	-0.04	-0.01	0.04	0.02									
rank 7	0.42	0.01	0.09	-0.01	0.07	-0.06	0.19								
rank 8	0.29	0.11	0.00	0.14	0.08	-0.08	-0.10	-0.05							
rank 9	0.33	-0.04	0.15	-0.01	0.03	-0.03	-0.12	-0.11	0.01						
rank 10	0.59	0.07	0.15	0.00	0.07	0.06	0.07	0.27	0.02	0.02					
MO	0.09	0.11	0.11	0.13	0.17	0.10	-0.06	0.04	0.01	0.00	-0.01				
GOV	0.17	0.02	0.03	0.05	0.15	0.05	-0.04	0.13	0.19	0.07	0.01	0.17			
TSE	0.10	-0.04	-0.01	0.00	0.12	0.11	0.00	0.06	0.02	-0.07	0.13	0.04	0.08		
GOV-MO	0.15	0.00	0.00	0.03	0.12	0.03	-0.03	0.13	0.19	0.07	0.02	-0.03	0.98	0.07	
TSE-MO	0.09	-0.05	-0.02	-0.01	0.11	0.10	0.00	0.06	0.02	-0.07	0.14	-0.03	0.06	1.00	0.07

Consumption series are deflated by corresponding deflators and then seasonally adjusted by X-11. All asset returns are deflated by CPI. The caption "aggregate" is aggregate consumption growth and "rank1" is the consumption growth for the lowest income decile. The caption MO is the overnight call rate, GOV is the government bond return, and TSE is the value weighted total return on all the stocks listed at the Tokyo Stock Exchange 1st section.

Table 5
Results of Excess Return Euler Equation Tests with Aggregate Data, Decile Data and Heterogeneous Data

label	i	α		χ^2	p-value
aggregate	0	14	(17.4)	18.9	0.026
rank1	1	2.8	(7.72)	22.2	0.008
rank2	2	7.5	(7.07)	18.8	0.027
rank3	3	19	(6.51) *	11.0	0.277
rank4	4	7.5	(8.71)	20.6	0.014
rank5	5	-4.7	(10.5)	23.2	0.006
rank6	6	-3.3	(7.42)	22.0	0.009
rank7	7	1.9	(5.14)	22.4	0.008
rank8	8	2.0	(7.66)	21.9	0.009
rank9	9	2.3	(7.79)	22.1	0.009
rank10	10	0.88	(5.79)	22.7	0.007
CD		-0.49	(16.0)	22.8	0.007

The Euler equation test for excess returns: stock returns over risk-free assets and bond returns over risk-free assets. The rows from "aggregate" to "rank 10" are results from the standard Euler equation test and "CD" is the result from the Constantinides and Duffie type Euler equation test. The coefficient "α" is the risk aversion coefficient and chi-squares statistics are as in Hansen (1982). The instruments are a constant, one-lagged excess bond return, one-lagged excess stock return, one lagged consumption and two-lagged labor income. Standard errors of alpha coefficients are reported in parenthesis. * indicates significance at the 5% level.

Table 6
Results of Raw Return Euler Equation Tests with Aggregate Data, Decile Data and Heterogeneous Data

label	i	β			α		χ^2	p-value
aggregate	0	1.00	(0.00)	*	0.069	(0.05)	20.8	0.077
rank 1	1	1.00	(0.00)	*	0.024	(0.04)	21.1	0.071
rank 2	2	1.00	(0.00)	*	0.064	(0.05)	20.6	0.081
rank 3	3	1.00	(0.00)	*	0.043	(0.06)	21.3	0.066
rank 4	4	1.00	(0.00)	*	0.037	(0.03)	20.5	0.083
rank 5	5	1.00	(0.00)	*	0.075	(0.06)	20.5	0.082
rank 6	6	1.00	(0.00)	*	0.016	(0.03)	21.4	0.065
rank 7	7	1.00	(0.00)	*	0.024	(0.03)	21.4	0.065
rank 8	8	1.00	(0.00)	*	-0.040	(0.07)	21.2	0.070
rank 9	9	1.00	(0.00)	*	0.057	(0.04)	21.0	0.073
rank 10	10	1.00	(0.00)	*	0.035	(0.03)	21.1	0.072
CD		0.99	(0.00)	*	0.007	(0.01)	21.4	0.065
CD2		1.00	(0.00)	*	0.062	(0.06)	20.8	0.054
					η			
					10	(73.5)		

Euler equation tests for raw returns: stock, bond, and risk-free returns. The rows from "aggregate" to "rank 10" are results from standard Euler equation tests and "CD" is the result from the Constantinides and Duffie type Euler equation test. The coefficient "α" is the risk aversion coefficient, "β" is the discount factor, and chi-square statistics are as in Hansen (1982). The instruments are a constant, one-lagged and two-lagged stock returns, one-lagged consumption, and two-lagged labor income. Standard errors of alpha and beta coefficients are reported in parentheses. * indicates significance at the 5% level.

Table 7
Results of Excess Return Euler Equation Tests with Aggregated Decile Data

label	i	α		χ^2	p-value
aggregate	0	14	(17.4)	18.9	0.026
rank 7:10	7:10	6.3	(9.16)	20.2	0.017
rank 8:10	8:10	2.6	(10.6)	21.8	0.009
rank 9:10	9:10	2.2	(8.47)	22.0	0.009
rank 10	10	0.88	(5.79)	22.7	0.007

The Euler equation tests for excess returns: stock returns over risk-free rate and bond returns over risk-free rate. We have aggregated decile data for higher income decile. The coefficient "α" is the risk aversion coefficient and chi-square statistics are as in Hansen (1982). The instruments are a constant, one-lagged excess bond return, one-lagged excess stork return, one lagged consumption and two-lagged labor income. Standard errors of alpha coefficients are reported in parentheses.

Table 8

Results of Excess Return Euler Equation Tests with Aggregate Data, Decile Data and Heterogeneous Data

		1986.2 - 1992.6				1992.7 - 1998.12			
label	i	α		χ^2	p-value	α		χ^2	p-value
aggregate	0	6.4	(18.0)	15.4	0.080	14	(17.4)	18.9	0.026
rank1	1	1.5	(21.0)	15.9	0.069	2.8	(7.72)	22.2	0.008
rank2	2	3.8	(8.11)	15.7	0.073	7.5	(7.07)	18.8	0.027
rank3	3	6.7	(12.1)	14.6	0.104	19	(6.51) *	11.0	0.277
rank4	4	0.37	(6.90)	15.9	0.070	10	(8.21)	21.3	0.011
rank5	5	-3.5	(12.8)	16.2	0.062	-4.7	(10.5)	23.2	0.006
rank6	6	-1.1	(12.5)	15.7	0.073	-3.3	(7.42)	22.0	0.009
rank7	7	1.4	(6.28)	16.0	0.067	1.9	(5.14)	22.4	0.008
rank8	8	-4.3	(6.14)	16.1	0.064	2.0	(7.66)	21.9	0.009
rank9	9	5.4	(9.82)	14.2	0.114	2.3	(7.79)	22.1	0.009
rank10	10	1.9	(4.83)	15.4	0.081	0.88	(5.79)	22.7	0.007
CD		-0.50	(19.1)	13.9	0.125	-0.49	(16.0)	18.3	0.032

The Euler equation test for excess returns: stock returns over risk-free assets and bond returns over risk-free assets. The rows from "aggregate" to "rank 10" are results from the standard Euler equation test and "CD" is the result from the Constantinides and Duffie type Euler equation test. The coefficient "α" is the risk aversion coefficient and chi-squares statistics are as in Hansen (1982). The instruments are a constant, one-lagged excess bond return, one-lagged excess stock return, one lagged consumption and two-lagged labor income. Standard errors of alpha coefficients are reported in parenthesis. * indicates significance at the 5% level.

Table 9

Results of Raw Return Euler Equation Tests with Aggregate Data, Decile Data and Heterogeneous Data

label	i	β		α		χ^2	p-value	β		α		χ^2	p-value
aggregate	0	1.00	(0.00) *	0.090	(0.08)	18.4	0.141	1.00	(0.00) *	0.069	(0.05)	20.8	0.077
rank 1	1	1.00	(0.00) *	0.006	(0.07)	18.8	0.129	1.00	(0.00) *	0.024	(0.04)	21.1	0.071
rank 2	2	1.00	(0.00) *	0.061	(0.08)	18.1	0.156	1.00	(0.00) *	0.064	(0.05)	20.6	0.081
rank 3	3	1.00	(0.00) *	0.048	(0.05)	18.9	0.127	1.00	(0.00) *	0.043	(0.06)	21.3	0.066
rank 4	4	1.00	(0.00) *	0.021	(0.03)	18.6	0.137	1.00	(0.00) *	0.037	(0.03)	20.5	0.083
rank 5	5	1.00	(0.00) *	0.11	(0.10)	18.0	0.156	1.00	(0.00) *	0.075	(0.06)	20.5	0.082
rank 6	6	1.00	(0.00) *	0.007	(0.04)	18.8	0.129	1.00	(0.00) *	0.016	(0.03)	21.4	0.065
rank 7	7	1.00	(0.00) *	0.007	(0.03)	18.9	0.128	1.00	(0.00) *	0.024	(0.03)	21.4	0.065
rank 8	8	1.00	(0.00) *	0.015	(0.06)	18.7	0.134	1.00	(0.00) *	-0.040	(0.07)	21.2	0.070
rank 9	9	1.00	(0.00) *	-0.018	(0.05)	18.7	0.133	1.00	(0.00) *	0.057	(0.04)	21.0	0.073
rank 10	10	1.00	(0.00) *	0.018	(0.06)	19.0	0.122	1.00	(0.00) *	0.035	(0.03)	21.1	0.072
CD		0.99	(0.00) *	0.010	(0.01)	18.7	0.132	0.99	(0.00) *	0.007	(0.01)	21.4	0.065
CD2		0.99	(0.00) *	0.081	(0.06)	18.0	0.115	1.07	(0.13) *	0.359	(1.51)	21.8	0.040
				η						η			
				38	(57.5)					-137	(496)		

Euler equation tests for raw returns: stock, bond, and risk-free returns. The rows from "aggregate" to "rank 10" are results from standard Euler equation tests and "CD" is the result from the Constantinides and Duffie type Euler equation test. The coefficient "α" is the risk aversion coefficient, "β" is the discount factor, and chi-square statistics are as in Hansen (1982). The instruments are a constant, one-lagged and two-lagged stock returns, one-lagged consumption, and two-lagged labor income. Standard errors of alpha and beta coefficients are reported in parentheses. * indicates significance at the 5% level.