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A Re-examination of the Consumption-based Capital Asset Pricing Model: The Case of US and Japan

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Abstract

This paper re-tests the classic consumption-based capital asset pricing model (CCAPM) by extending US quarterly samples and adding the Japanese case. Using the generalized method of moments (GMM) methodology developed by Hansen and Singleton (1982), we obtain the following findings. (1) First, in the case of the CCAPM with consumption for nondurable goods in the US, the discount rate parameters generally show plausible values; however, the risk aversion parameters show unstable values in general. Further, by the *J*-tests, the estimated CCAPMs with consumption for nondurable goods in the US are always supported. (2) Second, in the case of the CCAPM with consumption for nondurable goods and services in the US, although the parameters of discount rate generally show plausible values, the risk aversion parameters are unstable. In addition, judging the results of the *J*-tests, all estimated CCAPMs with consumption for nondurable goods and services in the US are supported. (3) Finally, as for the CCAPM with private final consumption expenditures in Japan, the parameters of discount rate take plausible values; on the other hand, the risk aversion parameter values are unstable in general. Regarding the model validity, our estimated CCAPMs for Japan are mostly supported by the *J*-tests.

Keywords: Asset pricing, CCAPM, GMM, Japanese stock market, US stock market

1. Introduction

Research of asset pricing by applying the methodology of the generalized method of moments (GMM) is important because by this approach, we can uniformly analyze different kinds of asset pricing models (see, for example, Jagannathan and Wang, 1996; Lettau and Ludvigson, 2001). Hence, re-examining important classic consumption-based capital asset pricing model (CCAPM) by employing this approach is meaningful. Based on this motivation, applying the methodology of Hansen and Singleton (1982), this paper re-tests the traditional CCAPM by updating US quarterly samples and adding the case of Japan.

Our investigations derive the following findings. (1) First, in the case of the CCAPM with consumption for nondurable goods in the US, the discount rate parameters generally show plausible values; however, the risk aversion parameters show unstable values in general. Further, by the *J*-tests, the estimated CCAPMs with consumption for nondurable goods in the US are always supported. (2) Second, in the case of the CCAPM with consumption for nondurable goods and services in the US, although the parameters of discount rate generally show plausible values, the risk aversion parameters are unstable. In addition, judging the results of the *J*-tests, all estimated CCAPMs with consumption for nondurable goods and services in the US are supported. (3) Finally, as for the CCAPM with private final consumption expenditures in Japan, the parameters of discount rate take plausible values; on the other hand, the risk aversion parameter values are unstable in general. Regarding the model validity, our estimated CCAPMs for Japan are mostly supported by the *J*-tests. The rest of this paper is as follows. Section 2 conducts a literature review; Section 3 explains our data and variables used for our analysis; and Section 4 documents our testing methodology. Section 5 describes our empirical results and Section 6 concludes the paper.

2. Literature Review

This section briefly conducts a literature review. There are many interesting theoretical and empirical studies of consumption-based asset pricing models, such as those by Constantinides and Duffie (1996), Jagannathan and Wang (1996), and Lettau and Ludvigson (2001); and Campbell (2003) is a seminal paper as to consumption-based asset pricing models.

An important paper by Weil (1989) suggested that the separation of the parameters of relative risk aversion and the elasticity of intertemporal substitution could be a solution of the so-called, 'risk-free rate puzzle.' Piazzesi et al. (2007) suggested a housing consumption-based model that considers non-housing and housing consumption. Lustig and Van Nieuwerburgh (2005) proposed other consumption-based asset pricing model that included the housing collateral ratio, which is a measure of housing wealth to total wealth.

As we already introduced, Hansen and Singleton (1982) developed and suggested the generalized instrumental variables estimation of asset pricing models; and many studies of asset pricing used this methodology. As to the issue of asset-pricing model evaluations, Hansen and Jagannathan (1997) proposed alternative methods for assessing specification errors in stochastic discount factor models. Further, considering the difficulty in actual noisy consumption data, Campbell (1993) suggested an intertemporal asset pricing model, from which consumption was removed.

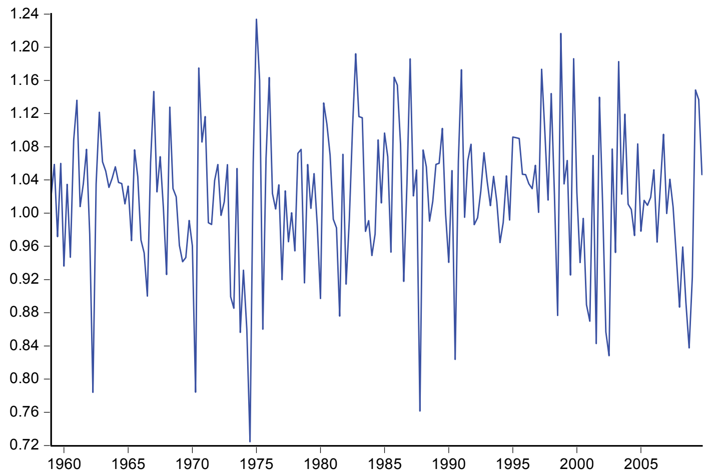
3. Data and Variables

In this section, we explain US and Japanese consumption and stock market return data used in this study. First, (1) ND means the seasonally-adjusted real per capita US personal consumption expenditures for nondurable goods, which is derived by using the seasonally-adjusted deflator of the US personal consumption expenditures for nondurable goods. Next, (2) NDS denotes the seasonally-adjusted real per capita US personal consumption expenditures for nondurable goods and services, which is derived by using the implicit deflator that we calculated by using the seasonally-adjusted deflator of the US personal consumption expenditures for nondurable goods and the seasonally-adjusted deflator of the US personal consumption expenditures for services. Third, (3) VWRND denotes the real value-weighted US stock market return, which is deflated by the seasonally-adjusted deflator of the US personal consumption expenditures for nondurable goods. Forth, (4) VWRNDS means the real value-weighted US stock market return, which is deflated by the above-mentioned implicit deflator of the US personal consumption expenditures for nondurable goods and services. Further, (5) PFCE denotes the seasonally-adjusted real private final consumption expenditures in Japan. PFCE is not per capita but the aggregate value data in billion yen. Finally, (6) TOPIXR means the real Tokyo stock price index (TOPIX) return derived by using the seasonally-adjusted total consumer price index (CPI) in Japan.

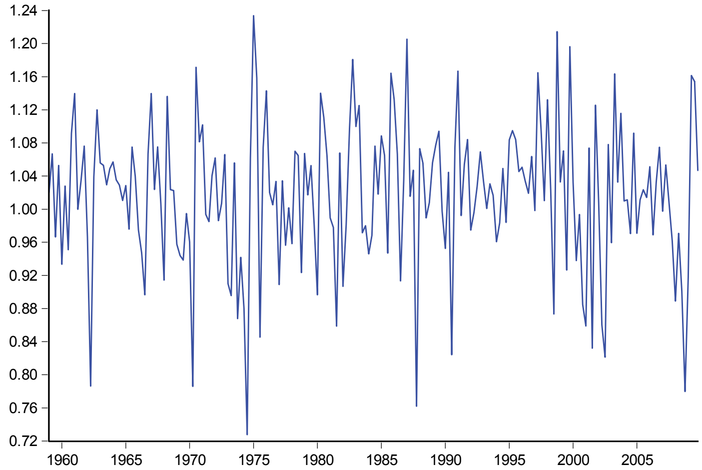
This study uses the US and Japanese quarterly data. For the US, the full sample period is from the first quarter of 1959 to the fourth quarter of 2009, the first sub-sample period is from the first quarter of 1959 to the fourth quarter of 1978, the second sub-sample period is from the first quarter of 1975 to the fourth quarter of 1994, and the third sub-sample period is from the first quarter of 1990 to the fourth quarter of 2009. As for Japan, the full sample period is from the first quarter of 1980 to the fourth quarter of 2014, the first sub-sample period is from the first quarter of 1980 to the fourth quarter of 1999, and the second sub-sample period is from the first quarter of 1995 to the fourth quarter of 2014.

Time-series evolution of two kinds of US real value-weighted stock market returns for the above US full sample period is exhibited in Panels A and B of Figure 1. Time-series of the real TOPIX return in Japan for the above Japanese full sample period is also shown in Panel C of Figure 1. In addition, Table 1 shows the descriptive statistics of the above US and Japanese stock return and consumption variables. Some data characteristics are as follows. First, excess kurtosis values of the above two kinds of US stock market returns are higher in our first sub-sample period for the US. Second, skewness values of the US and Japanese stock market returns are always negative except for TOPIXR in our Japanese second sub-sample period.

Panel A. VWRND



Panel B. VWRNDS



Panel C. TOPIXR

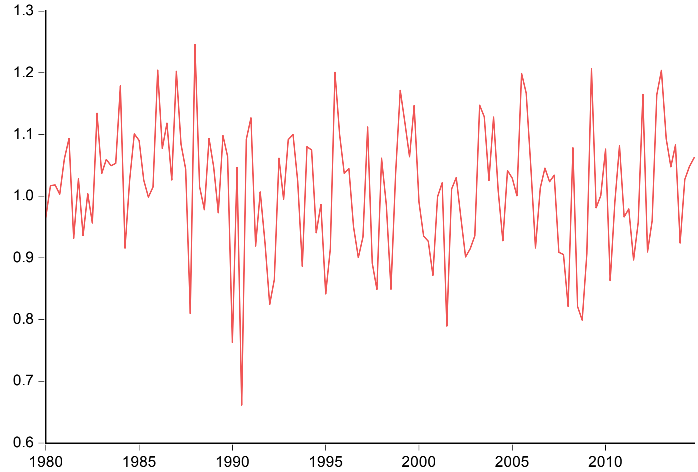


Figure 1. Two US real value-weighted stock market returns and the real TOPIX return in Japan: From the 1st quarter of 1959 to the 4th quarter of 2009 for the US and from the 1st quarter of 1980 to the 4th quarter of 2014 for Japan

Table 1. Descriptive statistics for the US and Japanese stock return and consumption variables

Panel A. USA				
Statistics for the full sample period from the first quarter of 1959 to the fourth quarter of 2009				
	VWRND	VWRNDS	ND	NDS
Mean	1.0187	1.0174	5303.2433	19305.5037
Standard deviation	0.0872	0.0876	1108.8731	5938.6217
Skewness	−0.4475	−0.4876	0.3071	0.1801
Excess kurtosis	0.6885	0.7451	−0.9048	−1.1767
Statistics for the first sub-sample period from the first quarter of 1959 to the fourth quarter of 1978				
	VWRND	VWRNDS	ND	NDS
Mean	1.0102	1.0098	4221.7095	13273.7937
Standard deviation	0.0889	0.0877	421.5923	2083.4330
Skewness	−0.5786	−0.5758	−0.2479	0.0439
Excess kurtosis	1.2384	1.2337	−1.3693	−1.2758
Statistics for the second sub-sample period from the first quarter of 1975 to the fourth quarter of 1994				
	VWRND	VWRNDS	ND	NDS

Mean	1.0293	1.0265	5201.1166	19069.2398
Standard deviation	0.0838	0.0844	387.1281	2346.0188
Skewness	−0.3089	−0.3177	−0.0963	0.0925
Excess kurtosis	0.9071	0.8866	−1.3751	−1.4131
Statistics for the third sub-sample period from the first quarter of 1990 to the fourth quarter of 2009				
	VWRND	VWRNDS	ND	NDS
Mean	1.0187	1.0173	6451.2774	25625.8723
Standard deviation	0.0863	0.0879	641.3071	2752.2968
Skewness	−0.2072	−0.3614	0.0240	−0.0746
Excess kurtosis	0.0831	0.3772	−1.4454	−1.4728
Panel B. Japan				
Statistics for the full sample period from the first quarter of 1980 to the fourth quarter of 2014				
	TOPIXR		PFCE	
Mean	1.0111		257655.7901	
Standard deviation	0.1034		38640.8379	
Skewness	−0.3426		−1.0432	
Excess kurtosis	0.3012		−0.4045	
Statistics for the first sub-sample period from the first quarter of 1980 to the fourth quarter of 1999				
	TOPIXR		PFCE	
Mean	1.0182		235668.9394	
Standard deviation	0.1055		38354.9160	
Skewness	−0.6475		−0.3082	
Excess kurtosis	0.9590		−1.4375	
Statistics for the second sub-sample period from the first quarter of 1995 to the fourth quarter of 2014				
	TOPIXR		PFCE	
Mean	1.0039		284902.2566	
Standard deviation	0.1034		5471.1778	
Skewness	0.0590		−0.0302	
Excess kurtosis	−0.6193		−0.3276	

Notes: This table shows the descriptive statistics for the quarterly data for the US full and sub-sample periods and for the Japanese full and sub-sample periods.

4. Testing Methodology

Using the above data and applying Hansen and Singleton's (1982) methodology as below, we re-examine the traditional CCAPM in the US and Japan by extending the US data and adding the Japanese case.

$$E_t f(\mathbf{z_{t+1}}, \mathbf{p_0}) = E_t\left[\beta(z_{2t+1})^{\alpha} z_{1t+1} - 1\right] = 0 \cdot \quad (1)$$

In the above equation (1), the function f includes the vector of parameters $\mathbf{p_0}$ and the vector of variables $\mathbf{z}_{t+1}$. Further, α is the risk aversion parameter and β is the discount rate. In addition, z_{1t+1} means the real market return and z_{2t+1} means the growth of consumption. Applying GMM, we estimate CCAPMs by using VWRND and ND or VWRNDS and NDS for the US; and for Japan, we estimate CCAPMs by using PFCE and TOPIXR. In our estimations, following Hansen and Singleton (1982), lag variables of the stock market returns and consumption growth are used as instrumental variables; and we use the lag of instrumental variables is 1, 2, 4, or 6 as Hansen and Singleton (1982) employed.

5. Empirical Results

First, we document the estimation results of the CCAPM with consumption for nondurable goods in the US. Table 2 presents the results and this table shows that (1) the discount rate parameters of the model always take similar values that are slightly less than one except for the three cases shown in Panel B of Table 2. Next, Table 2 also shows that (2) the risk aversion parameters generally take small minus values stably except for the four cases in Panel C and the two cases in Panel D of Table 2. Further, all estimated CCAPMs with consumption for nondurable goods in the US are always supported by the *J*-tests.

Table 2. Results of the GMM estimations of the CCAPM with consumption expenditures for nondurable goods: The case of USA

Panel A. Results for the full sample period from the first quarter of 1959 to the fourth quarter of 2009					
NLAG	Return	Beta	*p*-value	Alpha	*p*-value
1	VWRND	0.9903**	0.0000	−2.0840	0.4417
2	VWRND	0.9905**	0.0000	−2.1719	0.4047
4	VWRND	0.9881**	0.0000	−1.7361	0.4313
6	VWRND	0.9852**	0.0000	−1.2527	0.5058
		Chi-squared statistic	Degree of freedom	*p*-value	
1	VWRND	1.7748	1	0.1828	
2	VWRND	1.7880	3	0.6175	
4	VWRND	2.8939	7	0.8946	
6	VWRND	4.3380	11	0.9590	
Panel B. Results for the first sub-sample period from the first quarter of 1959 to the fourth quarter of 1978					
NLAG	Return	Beta	*p*-value	Alpha	*p*-value
1	VWRND	1.0034**	0.0000	−1.9906	0.5163
2	VWRND	1.0003**	0.0000	−1.8981	0.5059
4	VWRND	1.0045**	0.0000	−2.9419	0.1928
6	VWRND	0.9917**	0.0000	−0.4387	0.7993
		Chi-squared statistic	Degree of freedom	*p*-value	
1	VWRND	2.4734	1	0.1158	
2	VWRND	3.5432	3	0.3152	
4	VWRND	5.6194	7	0.5848	
6	VWRND	10.9925	11	0.4439	
Panel C. Results for the second sub-sample period from the first quarter of 1975 to the fourth quarter of 1994					
NLAG	Return	Beta	*p*-value	Alpha	*p*-value
1	VWRND	0.9650**	0.0000	4.5146	0.3362
2	VWRND	0.9675**	0.0000	3.1257	0.4033
4	VWRND	0.9635**	0.0000	3.2063	0.2534
6	VWRND	0.9617**	0.0000	4.3811	0.1011
		Chi-squared statistic	Degree of freedom	*p*-value	
1	VWRND	2.0277	1	0.1545	
2	VWRND	1.9158	3	0.5901	
4	VWRND	6.3769	7	0.4965	
6	VWRND	11.2239	11	0.4247	
Panel D. Results for the third sub-sample period from the first quarter of 1990 to the fourth quarter of 2009					
NLAG	Return	Beta	*p*-value	Alpha	*p*-value
1	VWRND	0.9902**	0.0000	−3.3970	0.5757
2	VWRND	0.9849**	0.0000	−2.5501	0.5536
4	VWRND	0.9723**	0.0000	1.4125	0.6487
6	VWRND	0.9750**	0.0000	0.2106	0.9483
		Chi-squared statistic	Degree of freedom	*p*-value	
1	VWRND	0.2094	1	0.6472	
2	VWRND	0.1886	3	0.9794	
4	VWRND	2.5758	7	0.9213	
6	VWRND	9.0522	11	0.6171	

Notes: This table presents the results of GMM estimations of the CCAPM with the seasonally-adjusted real consumption expenditures for nondurable goods in the US. In this table, ** and * mean the statistical significance of the parameters or statistic at the 1% and 5% levels, respectively. Further, NLAG means the lag of the instrument variables in the GMM estimations, Alpha means the risk aversion parameter, and Beta means the discount rate.

Table 3. Results of the GMM estimations of the CCAPM with consumption expenditures for nondurable goods and services: The case of USA

Panel A. Results for the full sample period from the first quarter of 1959 to the fourth quarter of 2009					
NLAG	Return	Beta	*p*-value	Alpha	*p*-value
1	VWRNDS	0.9796**	0.0000	0.5582	0.8505
2	VWRNDS	0.9848**	0.0000	−0.3649	0.8951
4	VWRNDS	0.9906**	0.0000	−1.4866	0.5372
6	VWRNDS	0.9897**	0.0000	−1.4797	0.5077
		Chi-squared statistic	Degree of freedom	*p*-value	
1	VWRNDS	1.6379	1	0.2006	
2	VWRNDS	2.2700	3	0.5183	
4	VWRNDS	6.2787	7	0.5076	
6	VWRNDS	7.2785	11	0.7761	
Panel B. Results for the first sub-sample period from the first quarter of 1959 to the fourth quarter of 1978					
NLAG	Return	Beta	*p*-value	Alpha	*p*-value
1	VWRNDS	0.9795**	0.0000	1.9231	0.7649
2	VWRNDS	1.0009**	0.0000	−1.1641	0.8308
4	VWRNDS	1.0242**	0.0000	−4.7494	0.2286
6	VWRNDS	0.9930**	0.0000	−1.1907	0.6934
		Chi-squared statistic	Degree of freedom	*p*-value	
1	VWRNDS	1.5028	1	0.2202	
2	VWRNDS	2.6285	3	0.4525	
4	VWRNDS	6.4470	7	0.4886	
6	VWRNDS	11.8038	11	0.3786	
Panel C. Results for the second sub-sample period from the first quarter of 1975 to the fourth quarter of 1994					
NLAG	Return	Beta	*p*-value	Alpha	*p*-value
1	VWRNDS	0.9543**	0.0000	4.7888	0.3148
2	VWRNDS	0.9679**	0.0000	2.1108	0.5723
4	VWRNDS	0.9659**	0.0000	1.7402	0.4783
6	VWRNDS	0.9688**	0.0000	1.5030	0.4996
		Chi-squared statistic	Degree of freedom	*p*-value	
1	VWRNDS	0.0128	1	0.9098	
2	VWRNDS	1.5941	3	0.6607	
4	VWRNDS	4.2820	7	0.7468	
6	VWRNDS	8.9786	11	0.6239	
Panel D. Results for the third sub-sample period from the first quarter of 1990 to the fourth quarter of 2009					
NLAG	Return	Beta	*p*-value	Alpha	*p*-value
1	VWRNDS	0.9850**	0.0000	−0.8565	0.8584
2	VWRNDS	0.9884**	0.0000	−2.1400	0.6173
4	VWRNDS	0.9767**	0.0000	0.7257	0.8351
6	VWRNDS	0.9737**	0.0000	1.3074	0.7136
		Chi-squared statistic	Degree of freedom	*p*-value	
1	VWRNDS	0.1254	1	0.7232	
2	VWRNDS	0.3724	3	0.9459	
4	VWRNDS	2.4620	7	0.9299	
6	VWRNDS	6.8721	11	0.8093	

Notes: This table presents the results of GMM estimations of the CCAPM with the seasonally-adjusted real consumption expenditures for nondurable goods and services in the US. In this table, ** and * mean the statistical significance of the parameters or statistic at the 1% and 5% levels, respectively. Further, NLAG means the lag of the instrument variables in the GMM estimations, Alpha means the risk aversion parameter, and Beta means the discount rate.

Table 4. Results of the GMM estimations of the CCAPM with private final consumption expenditures: The case of Japan

Panel A. Results for the full sample period from the first quarter of 1980 to the fourth quarter of 2014					
NLAG	Return	Beta	*p*-value	Alpha	*p*-value
1	TOPIXR	0.9993**	0.0000	−2.8524	0.3609
2	TOPIXR	0.9958**	0.0000	−1.9797	0.5156
4	TOPIXR	0.9864**	0.0000	−0.1687	0.9157
6	TOPIXR	0.9890**	0.0000	−1.3137	0.3778
		Chi-squared statistic	Degree of freedom	*p*-value	
1	TOPIXR	0.6007	1	0.4383	
2	TOPIXR	3.7511	3	0.2896	
4	TOPIXR	7.9134	7	0.3403	
6	TOPIXR	11.7798	11	0.3804	
Panel B. Results for the first sub-sample period from the first quarter of 1980 to the fourth quarter of 1999					
NLAG	Return	Beta	*p*-value	Alpha	*p*-value
1	TOPIXR	0.9982**	0.0000	−2.7682	0.5097
2	TOPIXR	0.9712**	0.0000	1.0162	0.7982
4	TOPIXR	0.9730**	0.0000	0.3251	0.8474
6	TOPIXR	0.9730**	0.0000	−0.3558	0.8159
		Chi-squared statistic	Degree of freedom	*p*-value	
1	TOPIXR	0.0698	1	0.7916	
2	TOPIXR	3.4806	3	0.3233	
4	TOPIXR	4.3686	7	0.7365	
6	TOPIXR	7.3201	11	0.7726	
Panel C. Results for the second sub-sample period from the first quarter of 1995 to the fourth quarter of 2014					
NLAG	Return	Beta	*p*-value	Alpha	*p*-value
1	TOPIXR	0.9876**	0.0000	0.3672	0.8942
2	TOPIXR	0.9972**	0.0000	1.6126	0.4436
4	TOPIXR	0.9960**	0.0000	−1.5302	0.4938
6	TOPIXR	0.9983**	0.0000	0.3848	0.8293
		Chi-squared statistic	Degree of freedom	*p*-value	
1	TOPIXR	6.5576*	1	0.0104	
2	TOPIXR	9.5455*	3	0.0229	
4	TOPIXR	17.1323*	7	0.0166	
6	TOPIXR	18.4675	11	0.0713	

Notes: This table presents the results of GMM estimations of the CCAPM with the seasonally-adjusted real private final consumption expenditures in Japan. In this table, ** and * mean the statistical significance of the parameters or statistic at the 1% and 5% levels, respectively. Further, NLAG means the lag of the instrument variables in the GMM estimations, Alpha means the risk aversion parameter, and Beta means the discount rate.

Second are the estimation results of the CCAPM with consumption for nondurable goods and services in the US. Table 3 exhibits the results and this table shows that (1) the parameters of discount rate always take similar values that are slightly less than one except for the two cases shown in Panel B of Table 3. Next, Table 3 also shows that (2) the risk aversion parameter values are unstable because they often take positive value; while all estimated CCAPMs with consumption for nondurable goods and services in the US are always supported by the *J*-tests.

Finally, we explain the estimation results of the CCAPM with private final consumption expenditures in Japan. Table 4 displays the results for Japan and this table shows that (1) the parameters of discount rate always take similar values that are slightly less than one with no exception. Table 4 also shows that (2) the risk aversion parameter values are again unstable for our Japanese CCAPMs in general. As for the model validity, our estimated CCAPMs for Japan are mostly supported by the *J*-tests except for the three cases in Panel C of Table 4.

6. Conclusions

This paper empirically re-tested the classic CCAPM by extending US quarterly samples and adding the Japanese case. Following the GMM methodology developed by Hansen and Singleton (1982), we demonstrated the following findings. First, (1) in the case of the CCAPM with consumption for nondurable goods in the US, although the discount rate parameters generally showed plausible values, the risk aversion parameters showed unstable values in general. Further, by the *J*-tests, the estimated CCAPMs with consumption for nondurable goods in the US were always supported.

Second, (2) in the case of the CCAPM with consumption for nondurable goods and services in the US, the parameters of discount rate generally showed plausible values; on the other hand, the risk aversion parameters were unstable as they often took positive values. In addition, by the *J*-tests, all our CCAPMs with consumption for nondurable goods and services in the US were supported.

Finally, (3) as for the CCAPM with private final consumption expenditures in Japan, the parameters of discount rate took plausible values; however, the risk aversion parameters were unstable for our Japanese CCAPMs in general. Regarding the model validity, our CCAPMs for Japan were mostly supported by the *J*-tests.

As above, the estimation results for the CCAPM with consumption for nondurable goods in the US were slightly better than those for the CCAPM with consumption for nondurable goods and services in the US. We consider that one of the reasons might be the use of deflators. The corresponding exact deflator of consumption of nondurable goods and services in the US was not available. Hence, as explained before, we calculated and used the implied deflator of the US consumption of nondurable goods and services to estimate the US CCAPM with consumption for nondurable goods and services in the US. Further, the results of our *J*-tests in this study were well both for the US CCAPMs and for the Japanese CCAPMs. It is therefore considered that the selection of instrumental variables in this study was generally appropriate.

The methodology of Hansen and Singleton (1982) is considered to be important in the research of asset pricing; while many other consumption-based models have been developed and recently, some new related papers have also emerged (e.g., Goswami and Tan, 2012; Adrian et al., 2015; Berk and van Binsbergen, 2016; Hahn and Yoon, 2016). We consider our careful re-examinations of the traditional CCAPM not only by updating US samples but also by adding the case of Japan are interesting and important for future research. In fact, several papers such as Lewellen et al. (2010) documented that many tests of asset pricing models with macroeconomic factors would overvalued the statistical significance in the tests. Further careful investigations with paying attention to meaningful economic notion, psychological aspects, goodness of fit of methodology, and appropriateness of data shall be important in future research in this field.

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