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Mean-reverting behavior of consumption-income ratio in OECD countries: evidence from SURADF panel unit root tests

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Abstract

This paper examines the existence of the mean-reverting behavior of the consumption-income ratio from a panel of 24 OECD countries through the application of the series-specific SURADF panel unit root test. The results show that the consumption-income ratios in 22 OECD countries exhibit mean-reverting behavior. Furthermore, the half-life of the consumption-income ratio for these 22 OECD countries is between 0.28 to 3.48 years. This implies that policy shocks in industrialized economies are not likely to have permanent effects on the consumption-income ratio.

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1. Introduction

The mean-reverting behavior of the consumption-income ratio, or the average propensity to consume (APC), has been a controversial issue in macroeconomics. On the theoretical side, there are two conflicting theoretical hypotheses about the mean-reverting behavior of the consumption-income ratio. The relative income hypothesis, the permanent income hypothesis, the life cycle hypothesis, and the habit persistent model all support that the consumption-income ratio will converge to a constant value in the long run. Unlike the above-mentioned point of view, the Keynesian absolute income hypothesis, the Marxian underconsumption theory, and Deaton's (1977) involuntary savings theory all consider that the consumption-income ratio does not come back to the equilibrium in the long run instead.

Whether the consumption-income ratio exhibits mean-reverting behavior or not has important implications to the modeling and understanding of consumption functions, savings behavior, business cycles, and economic policy. For example, a nonstationary consumption-income ratio implies that policy shocks will have permanent effects on individual's consumption and savings behavior. To investigate the integrated nature of consumption-income ratio, most previous studies, which utilized either single unit root tests or panel unit root tests, support the hypothesis of nonstationary consumption-income ratio (e.g., Drobny and Hall, 1989; Hall and Patterson, 1992; Horioka, 1997; Sarantis and Stewart, 1999; Tsionas and Christopoulos, 2002; Cook, 2002, 2003). Only a few studies provide the opposite results (e.g., King *et al*., 1991; Cook, 2005; Romero-Ávila, 2009).

The use of panel unit tests mentioned above is motivated by the advantage of increased statistical power over that of conventional single unit tests. However, the empirical testing results may differ due to the heterogeneity across the panel members. In addition, a common feature of the panel unit root tests is that the rejection of the null hypothesis of a unit root in all panel members only indicates at least one panel member is stationary. No information is provided about how many panel members are stationary. Furthermore, the presence of a unit root in all panel members is not likely in practice, the imposition of uniformity across the panel under the null hypothesis greatly lower the power of panel data analysis.

To allow for heterogeneous serial correlations across panel members and increase the power of panel data analysis, we adopted the series specific panel unit root test of Breuer *et al*. (SURADF test) to test for the mean-reverting behavior of the consumption-income ratio for the panel of 24 OECD countries. SURADF test is based on the estimation of the augmented Dickey-Fuller statistics using seeming unrelated regressions. SURADF is used to test individual unit root within the panel members. We also report the convergent speed (half-life) of the consumption-income ratios for stationary members of the panel in this paper. It is found that the consumption-income ratios in 22 OECD countries exhibit mean-reverting behavior. Furthermore, the half-life of the consumption-income ratio for these 22 OECD countries ranges from 0.28 to 3.48 years.

The remainder of this paper is organized as follows: SURADF unit root test and half-life estimation are briefly described in section 2. The empirical results are presented in section 3 while section 4 concludes the paper.

2. SURADF panel unit root test and half-life estimation

Following Breuer *et al*. (2002), the SURADF test is based on the system of ADF equations. The ADF regression for a sample of N (i = 1,2,…,N) countries observed over T time periods (t = 1,2,…,T) can be represented as:

$$
\begin{aligned}
&\Delta Y_{1,t} = \alpha_1 + \beta_1 Y_{1,t-1} + \gamma_1 t + \sum_{j=1}^{p} \delta_{1,j} \Delta Y_{1,t-j} + \varepsilon_{1,t} \\
&\Delta Y_{2,t} = \alpha_2 + \beta_2 Y_{2,t-1} + \gamma_2 t + \sum_{j=1}^{p} \delta_{2,j} \Delta Y_{2,t-j} + \varepsilon_{2,t} \\
&\vdots \\
&\Delta Y_{n,t} = \alpha_n + \beta_n Y_{n,t-1} + \gamma_n t + \sum_{j=1}^{p} \delta_{n,j} \Delta Y_{n,t-j} + \varepsilon_{n,t}
\end{aligned}
\tag{1}
$$

where $\beta_i = (\rho_i - 1)$ and ρ_i is the autoregressive coefficient for country i. The system (1) is estimated by the SUR procedure. To test null and alternative hypotheses separately for each panel member within a SUR framework, N null and alternative hypotheses are tested individually:

$$
\begin{aligned}
&H_0^1 : \beta_1 = 0; \quad \mathrm{H}_\mathrm{A}^1 : \beta_1 < 0 \\
&H_0^2 : \beta_2 = 0; \quad \mathrm{H}_\mathrm{A}^2 : \beta_2 < 0 \\
&\vdots \\
&H_0^N : \beta_N = 0; \quad \mathrm{H}_\mathrm{A}^\mathrm{N} : \beta_N < 0
\end{aligned}
\tag{2}
$$

with test statistics computed from SUR estimates of the system (1). The critical values are generated through Monte Carlo simulations because the test statistics from the SUR model have nonstandard distributions. Therefore, the computed critical values will be specific to panel composition. In the Monte Carlo simulations, the lagged differences and the covariances matrix were obtained from the SUR estimation on the actual consumption-income ratio data. The SURADF test statistic for each of the 24 OECD countries was computed as the t-statistic calculated individually for the coefficient on the lagged level. To obtain critical values, the simulations were replicated 10,000 times and the critical values of 1%, 5%, and 10% are tailored to each of the 24 OECD countries.

The series-specific SURADF panel unit root test has several advantages. First, this test produces efficient estimators over the single-equation unit root tests by exploiting the information from cross-equation residual covariance and allowing for autoregressive process. Second, the estimation allows for heterogeneity in lag structure across the panel members. Third, the test allows identification of how many and which members of the panel contain a unit root. Forth, the test also allows us to calculate the convergent speed of the consumption-income ratios for stationary members of the panel[1].

3. Empirical results

Annual data of consumption and income over the period 1970-2006 for 24 OECD countries were obtained from OECD.Stat Extracts (Source OECD).[2] Before applying SURADF panel unit root test, we first used single-equation unit root tests to examine the null hypothesis of a unit root in each series. As shown in Table 1, the null hypothesis of non-stationary consumption-income ratio is rejected in only 6 countries – Finland, Italy, New Zealand, Portugal, Sweden, and United States. Then we applied Levin *et al*. (2002, LLC test) and Im *et al*. (2003, IPS test) panel unit root test methods to examine the null hypothesis that all series contain a unit root. As reported in Table 2, the null hypothesis of non-stationary are rejected at conventional significant levels for the full panel in both LLC and IPS tests. This finding implies that there maybe a mixture of stationary and nonstationary processes in the panel under the alternative hypothesis.

According to Sarno and Taylor (1998), panel unit root tests are meaningful when the single-equation unit root tests fail to reject the non-stationary null hypothesis. To resolve the ambiguous results described above, we applied SURADF panel unit root test to further exploit the information in the error covariances. With more powerful

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[1] According to Andrews (1993), half-life (HL) can be defined as: $HL = \left|\frac{ln(0.5)}{ln(\rho)}\right|$, where ρ is the autoregressive coefficient of series i in AR(1) model ($Y_t = \rho Y_{t-1} + \varepsilon_t$).

[2] Consumption is measured by private final consumption expenditure at current prices, annual levels, S.A, while income is measured by gross domestic product at current prices, annual levels, S.A. Panel members include 24 OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States.

test statistics over single-equation methods, SURADF test allows us to identify how many and which members of the panel contain a unit root.

Table 1. Single-equation unit root test results of consumption-income ratio

Country	Lag Length	ADF (with intercept and trend terms)
Australia	0	-2.1940
Austria	0	-1.9993
Belgium	0	-1.5861
Canada	1	-2.4011
Denmark	1	-3.0284
Finland	1	-3.5052*
France	0	-1.7757
Germany	0	-2.2191
Greece	0	-1.5141
Iceland	0	-2.7026
Italy	0	-3.2270*
Japan	0	-2.5147
Korea	0	-1.2790
Luxembourg	0	-2.5547
Mexico	0	-1.8017
Netherlands	0	-1.2246
New Zealand	2	-3.4846*
Norway	0	-1.5683
Portugal	1	-4.0177**
Spain	2	-2.9284
Sweden	1	-3.2978*
Switzerland	0	-1.7863
United Kingdom	0	-1.6443
United States	0	-3.3874*

Notes: (1) The null hypothesis of ADF is H_0 : Variable has a unit root.

(2) Asterisks (**,*) denote statistical significance at the 5%, 10% level, respectively.

Table 2. LLC and IPS panel unit root tests results for consumption-income ratio

LLC (with intercept and trend terms)	IPS (with intercept and trend terms)
-2.6221***	-1.9907**
Stationary	Stationary

Notes: (1) The null hypothesis of LLC, IPS are H_0 : Variable has a unit root.

(2) Asterisks (***,**) denote statistical significance at the 1%,5% level, respectively.

As shown in Table 3, the null hypothesis of non-stationary consumption-income ratio is not rejected in only 2 countries — Greece and Netherlands. This finding is in contrast with the results of single-equation unit root tests (see Table 1) that most consumption-income ratios are non-stationary. This is not surprising because the SURADF test produces more efficient estimators and more powerful test statistics than single-equation methods when the data to be analyzed are based on a limit time series dimension. In effect, Breuer *et al*. (2002) have shown that the SURADF test is 28 to 65 percent more powerful than single-equation ADF test.

On the other hand, the result of SURADF test is somewhat similar to the findings in Table 2 that not all countries of the panel contain a unit root. However, rejection of the null hypothesis in Table 2 does not provide us with the information about the exact mix of stationary and nonstationary series in the panel. With null and alternative hypotheses testing separately for each panel member in SURADF tests, we further identified that only 2 OECD countries (Greece and Netherlands) have nonstationary consumption–income ratios. The remaining 22 OECD countries all have stationary consumption–income ratios. As shown in the second column of Table 3, the half-life estimates of the consumption–income ratios for these 22 OECD countries range from 0.28 to 3.48 years. The results imply that policy shocks in these OECD economies are not likely to have permanent effects on the consumption-income ratio.

4. Conclusions

The inference drawn from the single-equation unit root test suggests that most series in the panel are nonstationary while the SURADF panel unit root test indicates 22 out of 24 series are stationary. The findings from LLC, IPS, and SURADF panel unit tests reveal that single-equation unit root tests may lead to misleading inferences when the data to be analyzed are based on a limit time series dimension. Using SURADF panel unit tests, we further identified that the rejection of the null hypothesis of non-stationary consumption-income ratio in LLC and IPS tests is driven by most of the OECD countries within the panel. From a policy perspective, our half-life estimates suggest that policy shocks in most of the 24 OECD countries are not likely to have long-run effects on the consumption-income ratio.

Table 3. SURADF panel unit root test results for consumption-income ratio

Country	Half-Life (Year)	SURADF	Critical Value		
			1%	5%	10%
Australia	1.45	-4.7807**	-5.0546	-4.3580	-4.0174
Austria	1.66	-5.4727***	-5.2588	-4.5951	-4.2067
Belgium	3.15	-4.3847**	-4.8318	-4.1573	-3.7898
Canada	1.39	-7.5496***	-5.7171	-4.9826	-4.5884
Denmark	1.25	-10.2166***	-5.6557	-4.9254	-4.5280
Finland	0.88	-9.8866***	-5.2553	-4.5486	-4.1490
France	2.45	-6.4194***	-5.9396	5.2133	-4.8075
Germany	2.00	-7.9785***	-6.6481	5.9306	-5.5182
Greece	--	-3.0887	-5.0993	-4.3727	-3.9906
Iceland	1.99	-4.2093*	-5.0100	-4.2697	-3.8966
Italy	1.02	-6.0381***	-4.9619	-4.2203	-3.8400
Japan	2.16	-5.5016**	-5.5484	-4.7604	-4.3693
Korea	3.48	-3.8434*	-4.7515	-4.0828	-3.7172
Luxembourg	1.79	-5.8628**	-5.8932	-5.1826	-4.7798
Mexico	2.10	-4.6754***	-4.6660	-3.9771	-3.6226
Netherlands	--	-3.2962	-5.1922	-4.4811	-4.0873
New Zealand	0.28	-10.2501***	-6.0928	-5.3160	-4.9273
Norway	1.97	-5.2241**	-5.9171	-5.1593	-4.7381
Portugal	0.58	-16.8303***	-5.2095	-4.4843	-4.0959
Spain	1.54	-5.5831***	-5.1529	-4.4194	-4.0315
Sweden	0.82	-5.4460***	-4.9081	-4.1930	-3.8290
Switzerland	1.95	-7.7264***	-5.9445	-5.2092	-4.8178
United Kingdom	2.34	-4.7566**	-4.9878	-4.3070	-3.9569
United States	0.86	-7.4469***	-4.8640	-4.2111	-3.8454

Notes: (1) Critical values are calculated using Monte Carol simulations based on 37 observations for each series and 10,000 replications.
(2) Asterisks (***, **,*) denote statistical significance at the 1%, 5%, 10% level, respectively.

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