E C O N O M I C S B U L L E T I N

Non−Sationarity in the Consumption−Income Ratio: Further Evidence from Panel and Assymetric Unit Root Tests

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Abstract

In this paper we test the stationarity properties of the consumption−income ratio for a sample of 14 European Union countries over the period 1960−1999 utilizing recent advances in panel unit root and asymmetric unit root tests. We find that a failure to take account of asymmetries, would imply I(1) consumption income ratio although unit root tests based on TAR models indicate stationarity in at least one regime. This result provides more evidence in relation to Sarantis and Stewart (Economics Letters, 1999) who found that the consumption−income ratio is I(1).

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1. Introduction

The time series properties of the consumption-income ratio is a controversial issue in theoretical and empirical macroeconomics. The relative income hypothesis, the habit persistent model, the permanent income hypothesis and life cycle hypothesis all predict that a long run equilibrium relationship exists between consumption and income which in turns implies that the consumption-income ratio converges to a steady state. Within this framework, deviations in average propensity to consume from the steady state should be temporary. On the contrary, the Keynesian absolute income hypothesis, the Marxian underconsumption theory and Deaton's (1977) involuntary savings theory all imply that the average propensity to consume does not converge towards a constant in the long run. The theories can be tested by investigating the stationarity properties of the consumption-income ratio. The finding of a unit root in the consumption-income ratio would imply that this series does not fluctuate around a predictable level. Under this scenario, all shocks permanently alter the average propensity to consume with no tendency to return to a constant value. In this case, a structural relationship between consumption and income cannot be established, so the average propensity to consume cannot have a long run equilibrium.

This result has far reaching implications for modeling and forecasting the economy and for understanding savings behavior and the business cycle. On the empirical side, Drobny and Hall (1989), Hall and Patterson (1992), and Horioka (1997) produced evidence for a non-stationary average propensity to consume while Ungern-Stenberg (1986) and King *et al* (1991) reached the opposite conclusion. According to Sarantis and Stewart (1999) the lack of consensus can be attributed to the low power of unit root tests. To this end, they used the Im, Pesaran and Shin (1997) (hereafter IPS) and Taylor and Sarno (1998) panel unit root tests to draw sharp inferences. Their results led support to the contention that the average propensity to consume is generated by a non-stationary stochastic process.

In this paper using data for 14 European union countries over the period 1960-1999 we test for the existence of a unit root in the consumption-income ratio. More specifically:

1. We use the IPS panel unit root test along with Maddala and Wu (MW) (1999) and Harris-Tzavalis (1999) (hereafter HT) panel unit root tests that have considerable more power relative to the IPS test, see Breitung (1999).
2. We acknowledge that an asymmetric adjustment may have affected the properties of our time series. Enders and Granger (1998) reviewed many important examples of asymmetric adjustment of economic variables such as real GDP, unemployment, and industrial production. To that end, we consider the Caner and Hansen (2000) unit root

test in the context of threshold autoregressive models, and we provide an MW panel version of this test.

The layout of this paper is as follows: Panel unit root tests as well as the asymmetric unit root test are outlined in section 2. The empirical results are contained in section 3 while section 4 concludes the paper.

2. Methodology

To test for a unit root in panel data, Harris and Tzavalis (1999) consider the model

$$y_{it} = \rho_i y_{i,t-1} + z'_{it}\gamma + u_{it} \tag{1}$$

where z_{it} are deterministic variables, u_{it} is $iid(0,\sigma^2)$ and $\rho_i = \rho$. The test statistic is a $t-$statistic on ρ given by

$$t_\rho = \frac{(\hat{\rho}-1)\sqrt{\sum_{i=1}^{N}\sum_{t=1}^{T}\tilde{y}_{i,t-1}^2}}{s_e} \tag{2}$$

where $\tilde{y}_{it} = y_{it} - \sum_{s=1}^{T} h(t,s)y_{is}$, $\tilde{u}_{it} = u_{it} - \sum_{s=1}^{T} h(t,s)u_{is}$ $h(t,s) = z'_t(\sum_{t=1}^{T} z_t z'_t)z_s$,

$s_e^2 = (NT)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\tilde{u}_{it}^2$, and $\hat{\rho}$ is the OLS estimate of ρ. It can be shown that if there are fixed effects and a time trend in the model, then

$$\sqrt{N}(\hat{\rho} - 1 + \tfrac{3}{T+1}) \to N(0, \tfrac{3(17T^2-20T+17}{5(T-1)(T+1)^3}) \tag{3}$$

A more popular approach for testing for unit roots in a panel data setting is the IPS statistic. This is based on averaging individual Dickey-Fuller unit root tests. Instead of averaging individual Dickey-Fuller unit root tests, Maddala and Wu (MW) (1999) proposed a statistic that combines the *p*-values from individual ADF tests (p_i say for the ith cross-section, $i = 1,..,N$). The MW statistic is $P = -2\sum_{i=1}^{N} \ln p_i$, distributed as $\chi^2(2N)$.

Finally, we allow the unit root hypothesis to be tested against an alternative of stationarity with *asymmetric adjustment*. Following Caner and Hansen (2000), The model is given by a TAR(k) of the form

$$\Delta y_t = \theta_1' x_{t-1} 1(z_{t-1} \le \lambda) + \theta_2' x_{t-1} 1(z_{t-1} \ge \lambda) + u_t \tag{4}$$

where y_t is the series we consider, λ is the threshold parameter, $x_{t-1} = (y_{t-1}, r'_{t-1}, \Delta y_{t-1}, .., \Delta y_{t-k})'$, $z_t \equiv y_t - y_{t-m}$ for some $m \ge 1$ ($m = 1$ in this application), and r_{t-1} is a vector of exogenous variables, a constant in our case. The

procedure can be used to test simultaneously for stationarity as well as threshold effects. First, model (4) is estimated by OLS for a fixed $\lambda \in [\underline{\lambda}, \overline{\lambda}]$, and the residual variance $s^2(\lambda) = T^{-1}\sum_{t=1}^{T} \hat{u}(\lambda)^2$ is computed. The threshold parameter is estimated by $\hat{\lambda} = \arg\min_{\lambda} : s^2(\lambda)$. For the estimate $\hat{\lambda}$, the residuals $\hat{u}_t$ and the residual variance s^2 are computed. To test for unit roots, we use the one-sided formulation of Caner and Hansen (2000), namely $H_0 : \rho_1 = \rho_2 = 0$ versus the alternative $H_1 : \rho_1 < 0$ or $\rho_2 < 0$ where ρ_i denotes the first element of θ_i. The test statistic is a two-sided Wald test of the form $R_{1T} = t_1^2 + t_2^2$ where t_i signifies the t-ratios for $\hat{\rho}_i$ from OLS regression in the TAR model. Exact p-values for this test can be computed using the bootstrap. Since exact p-values are available, a panel data version of the Caner and Hansen (2000) tests can be constructed by considering an MW formulation. This test combines the p-values from the individual asymmetric Dickey-Fuller equations according to the following formula $P = -2\sum_{i=1}^{N} \ln p_i$ and is distributed as $\chi^2(2N)$. This will be call the Maddala and Wu test under asymmetric adjustment (hereafter MWA).

3. Empirical Results

Time series ADF tests are reported in Table 1 for all fourteen countries[1]. It is evident that we cannot reject the presence of a unit root in the consumption-income ratio at conventional levels of statically significance. Panel unit roots tests (IPS, MW and HT), reported in Table 2, support the hypothesis of a unit root in the consumption-income[2] ratio across countries, as well as the hypothesis of $I(0)$ in first differences. However, the results are much different when we account for the presence of an asymmetric adjustment in the consumption-income ratio. $t-$tests for stationarity are reported in last column of Table 1. According to these findings, we find stationarity in at least one regime in eight cases (Belgium, Greece, France, Italy, Netherlands, Portugal, Norway, and Sweden). Save for Belgium, we have stationarity in the second regime.

[1] Annual consumption-income data over the period 1960-1999 are from the European Union's AMECO database (Annual Macro Economic Data Base DG2). Consumption is measured by total private consumers' expenditure, and income by GDP. Both variables are expressed in constant price euros.

[2] The results remained qualitatively the same when we considered a logistic transformation of the ratio.

Table 1. Unit Root Tests for the Consumption-Income Ratio

Country	ADF	*t test for stationarity*	
		t_1	t_2
Belgium	**-1.81**	2.83 (0.07)	**0.19** (0.78)
Denmark	**-1.89**	**-2.64** (0.99)	**2.33** (0.18)
Greece	**-2.31**	**1.53** (0.38)	2.78 (0.09)
Spain	**-2.62**	**-0.56** (0.85)	**1.46** (0.40)
France	**-2.19**	**-0.51** (0.86)	4.15 (0.009)
Ireland	**-3.08**	**0.36** (0.66)	**0.13** (0.78)
Italy	**-3.00**	**0.87** (0.54)	3.34 (0.04)
Netherlands	**-3.05**	**2.02** (0.27)	3.91 (0.01)
Portugal	**-2.93**	**2.07** (0.21)	4.63 (0.006)
UK	**-1.62**	**0.92** (0.53)	**0.72** (0.65)
Austria	**-2.77**	**-2.06** (0.98)	**2.65** (0.14)
Norway	**-2.72**	**0.61** (0.65)	3.43 (0.05)
Sweden	**-2.33**	**0.81** (0.54)	2.85 (0.09)
Finland	**-2.43**	**2.73** (0.11)	**1.15** (0.52)

Notes: ADF denotes the Augmented Dickey Fuller unit root test with drift and trend terms in the fitted equation. Boldface values denote sampling evidence in favour of unit roots. Numbers in parentheses are bootstrap p-values. For bootstrapping 10,000 replications have been used. Two-sided Wald tests are used for the asymmetric unit root test, and a significance level of 10% to decide whether there is a unit root in either regime.

A panel version of the asymmetric unit root test (MWA) provides additional evidence that stationarity prevails in at least one regime. This means that a failure to take account of asymmetries would imply a rejection of the hypothesis that the consumption income ratio is overall $I(0)$ although in eight out of fourteen countries this is clearly untrue in the second regime. In other words, the asymmetric unit root tests offer less evidence in favour of the unit root hypothesis.

Table 2. Panel Unit Root Tests for Consumption-Income Ratio

Levels					First differences		
IPS	*HT*	MW	MWA		IPS	HT	MW
			t_1	t_2			
-1.42	**-1.09**	**34.18**	**23.52**	63.31*	-6.88***	-15.46***	99.75***

Notes: IPS, HT and MW are respectively the Im, Pesaran and Shin, Harris and Tzavalis, and Maddala and Wu tests for a unit root in the model. Bold face values denote sampling evidence in favour of unit roots. The critical values for the MWA test are 48.28 and 41.336 at the 1% and 5% statistical level respectively. (***) signifies rejection of the unit root hypothesis at the 1% level.

4. Conclusions

This paper applies three panel unit root procedures, and an asymmetric unit root statistic to test the time series properties on the consumption-income ratio for a sample of 14 European union countries over the period 1960-1999. Although the IPS, Maddala and Wu (1999) and Harris and Tzavalis (1999) panel unit root procedures find the average propensity to consume to be stationary, the asymmetric unit root tests suggest that a stationary stochastic process is more plausible. Therefore, researchers that use standard unit root tests should be cautious about the presence of an asymmetric adjustment.

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