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Stochastic Properties of the Consumption-Income Ratios in Central and Eastern European Countries

Abstract:

This paper aims to investigate stochastic properties of the consumption-income ratios in 11 Central and Eastern European (CEE) countries. We use the heterogeneous panel unit root tests those account for cross-sectional dependence and the Modified Augmented Dickey-Fuller unit root test over the period March 1997-September 2012 in quarterly data set. We find the strong mean-reversion in the consumption-income ratio for 9 of 11 CEE economies. Accordingly, the empirical findings provide significant support for existence of the hypothesis that the consumption-income ratio converges towards a constant value.

Keywords: The Consumption-Income Ratio, Central and Eastern European Economies, Panel Unit Root Tests, Cross-Sectional Dependence, Half-Life

JEL Classification: E21, C23, C22

1 Introduction

Whether the consumption-income ratio or the Average Propensity to Consume (APC) converges towards a constant value or not has been a debating issue in macroeconomics literature. Different theoretical frameworks indicate that the consumption-income ratio is a unit root process or a mean reversion. In this paper, we aim to investigate stochastic behavior of the consumption-income ratio in 11 Central and Eastern European (henceforth CEE) economies: Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.

From the theoretical background, actually, there are two opponent hypotheses about the stochastic properties of the APC. First, the Relative Income Hypothesis of Duesenberry (1949); the Life Cycle Hypothesis of Modigliani and Brumberg (1954) and Ando and Modigliani (1963); the Permanent Income Hypothesis of Friedman (1957); and the Habit Persistent Model of Gale (1973) all suggest that the consumption-income ratio would converge towards a constant value, particularly in the long-run. Hence, they expect the stationary APC. Second, the Absolute Income Hypothesis of Keynes (1936), and Involuntary Savings Theory of Deaton (1977) propose that the consumption-income ratio would not converges towards an equilibrium level even in the long-run. Hence they indicate that the APC should be non-stationary.

Indeed, stochastic behavior of the consumption-income ratio has empirically examined in many studies but the seminal work of Nelson and Plosser (1982) which investigated the stochastic behavior of many macroeconomic time series was the starting point of the literature. Single equation (classical) unit root tests, panel unit root (henceforth PUR) tests and cointegration analysis have commonly used in literature. For instance, Drobny and Hall (1989), Molana (1991), Horioka (1997), Cook (2003) and Fallahi (2012) supported the validity of hypothesis of the non-stationary consumption-income ratios by using the single unit root tests and the cointegration analysis.

In addition, Sarantis and Stewart (1999) used the linear PUR tests and found that the APC was non-stationary for 20 Organization for Economic Co-operation and Development (OECD) countries for the period from 1955 to 1994. Romero-Avila (2008) confirmed the findings of Sarantis and Stewart (1999) that existence of a clear unit root in the APC for 23 OECD economics by using the "first generation" PUR tests over the period 1960-2005. Cerrato et al. (2013) firstly applied the heterogeneous non-linear and linear PUR tests that account for cross-sectional dependence into the APC of 24 OECD and 33 non-OECD countries for the period from 1951 to 2003. They found the evidence in favor the non-stationary consumption-income ratios for both the OECD countries and the non-OECD countries. However, they naturally ignored the samples for CEE economics in such a large time dimension. On the contrary, only few numbers of studies have concluded in favor of the stationary consumption-income ratio (King et al., 1991; Jin, 1995; Cook, 2005; and Liao et al., 2011). Moreover, using the same data along with Romero-Avila (2008), Romero-Avila (2009) obtained the contrary evidence for the regime stationarity APC by using cross-sectional dependence PUR test allow for an unknown number of multiple breaks. To the best of our knowledge, Baykara and Telatar (2012) firstly and only analyzed the stationarity properties of the consumption-income ratios for 14 transition economies: Belarus, Bulgaria, the Czech Republic, Croatia, Estonia, Hungary**,** Kazakhstan, Latvia, Lithuania, Poland, Romania**,** Russia, Slovakia, and Slovenia. However, they together took nonlinearities and asymmetries into account and used the unit root tests based on the Threshold Autoregressive (TAR) models. They found evidence in favor of the stationary consumption-income ratios for all transition countries.

The stochastic properties of the consumption-income ratio have been pioneered to different implications in macroeconomic modeling and economic policy: particularly for understanding of consumption function, savings behavior, business cycles, and global imbalances. For instance, presence of significant unit root in the consumption-income ratio means that policy shocks will have permanent effects on consumption and savings behaviors of households. Indeed, one of the main reasons for large trade deficits is a sharp decline in domestic savings. Budget deficits may also contribute to large trade deficits in a developing or a developed country. Within this context, investments are likely to be substantiated by foreign portfolio investment, and this may causes higher domestic interest rate. These processes finally tend to the real exchange rate appreciation, and this likely has a negative impact on the exports. On the other hand, the significant change in consumption or savings due to changes in income can be different during different stages of the business cycle (Cerrato et al., 2013). These issues, which are particularly relevant in developing CEE economies, have neglected in the literature.

In this paper, we use heterogeneous PUR test that account for cross-sectional dependence, the Augmented Dickey-Fuller, and the Modified Augmented Dickey-Fuller (MADF) unit root tests. We find the mean reversion in 9 of 11 CEE economies, and the exceptions are Croatia and Slovenia. This study attempts to make three contributions into the existing literature. First, the impact of cross-sectional dependence is likely to be statistically significant on the consumption-income ratios in CEE countries. Hence this study considers performing a formal test of cross-sectional dependence, such as that proposed by Pesaran (2004). Our result supports the presence of cross-sectional dependence, and we replace "first-generation" PUR tests, which assume cross-sectional independence, in favor of "second-generation" PUR tests. Second, to the best of our knowledge, this paper is the first to apply the second generation PUR test, such as that proposed by Pesaran (2007) that accounting for cross-sectional dependence for the consumption-income ratio in CEE economies. The test offers the robust procedure in small samples, and the presence of structural-breaks (Pesaran, 2007). Third, related to our aim, the methodology used, and the period covered, this paper includes the homogenous observations for 11 CEE countries, including the period of the Russian crisis in 1998, and the great global recession of 2007-08. We consider that these shocks might have significantly affected on the consumption-income ratios in 11 CEE economies. In short, this paper uses the second generation PUR tests, and this is fairly important in overcoming the shortfall of first generation PUR tests that assume cross-sectional independence by default. We believe that such empirical evidences could be valuable for the policy-makers and both theoretical and empirical works that interest in related CEE economies.

The remainder of the paper is organized as follows. Section 2 describes the data and the methodology. Section 3 reports and discusses the empirical findings. Section 4 presents our concluding remarks.

2 Data and Methodology

2.1 Data

In this paper, we use the seasonally adjusted household consumption expenditures and the disposable income data and calculate the consumption-income ratios for 11 CEE countries over the period from March 1997 to September 2012 in quarterly data set. We totally use 693 samples for the analyses. Data in this study are obtained from the International Money Fund (IMF) Financial Statistics. We report the descriptive summary statistics of the consumption-income ratios in Table 1.

Table 1. Summary Statistics of the Consumption-income Ratios

Statistics	Bulgaria	Croatia	The Czech Republic	Estonia	Hungary
Mean	0.68	0.54	0.50	0.55	0.66
Maximum	0.77	0.61	0.55	0.62	0.75
Minimum	0.54	0.48	0.46	0.48	0.59
Standard deviation	0.05	0.03	0.02	0.03	0.03
Skewness	-0.31	0.17	0.13	-0.14	0.54
Kurtosis	2.57	2.39	2.44	3.04	3.37
Jarque-Bera (JB)	1.41	1.93	0.77	0.21	3.32
JB (probability)	(0.49)	(0.38)	(0.68)	(0.89)	(0.19)

Observation	63	63	63	63	63
Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
0.63	0.64	0.68	0.63	0.69	0.55
0.71	0.70	0.77	0.73	0.79	0.59
0.59	0.57	0.54	0.53	0.57	0.51
0.02	0.03	0.05	0.05	0.06	0.02
0.87	-0.25	-0.51	-0.13	0.67	-0.32
5.77	3.97	2.57	1.95	3.56	2.34
26.87	3.00	3.16	2.94	5.37	2.07
(0.00)	(0.22)	(0.20)	(0.22)	(0.11)	(0.35)
63	63	63	63	63	63

2.2 Testing Unit Root Hypothesis within Panel Data

Classical unit root tests are subject to criticism that is occurred from the low-power of these tests, particularly in small samples. Consequently, PUR tests have begun to be widely used in the literature. First generation PUR tests can commonly be arranged in groups by cross-section independence and heterogeneous or homogenous unit roots, such as that proposed by Harris and Tzavalis (1999), Breitung (2000), Hadri (2000), Levin et al. (2002), and Im et al. (2003). However, literature suggests that one should reconsider whether it is worth to rely on the results from first generation PUR tests mentioned in above. Particularly, homogenous PUR tests report the evidence regarding the bias, and relative low-power of these tests may be fairly strong, so the evidence that homogenous PUR tests provide may not be relied upon (Breitung and Pesaran, 2008).

On the other hand, Maddala and Wu (1999) and Choi (2001) proposed an alternative approach to mentioned first generation PUR tests, and they combined the p-values from individual unit root tests. In this paper, we use the bootstrap versions for PUR tests of Maddala and Wu (1999) and Choi (2001). Because, their bootstrap methods resulted in a decrease of the size distortions due to the cross-sectional correlations; although they did not fully eliminate them. To sum up, the bootstrap versions of these first generation PUR tests perform much better. On the other hand, there are now several second-generation PUR tests available in the literature (Bai and Ng, 2002 and 2004; Chang, 2002 and 2004; Choi, 2006; Moon and Perron, 2004; Pesaran, 2007; Phillips and Sul, 2003**)**. But that given the relatively small dimension of the balanced panel data in this study, the PUR test proposed by Pesaran (2007) would probably a good choice (Breitung and Pesaran, 2008).

2.3 Testing Cross Sectional Dependence among Panel Units

Related to our purpose, firstly, we consider performing a formal test of cross-sectional dependence. For this purpose, Pesaran (2004) proposed the test statistic (CD) that it was an alternative of the Lagrange

Multiplier (LM) statistic of Breusch and Pagan (1980). Breusch and Pagan (1980) proposed the LM statistic, which was valid for fixed N and $T \rightarrow \infty$, and it was given by,

$$LM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^{2} \tag{1}$$

In this statistic, $\hat{\rho}_{ij}$ is the sample estimate of the pair-wise correlation of the residuals, and it can be calculated as follows:

$$\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{t=1}^{T}\hat{u}_{it}\hat{u}_{jt}}{\left(\sum_{t=1}^{T}\hat{u}_{it}^{2}\right)^{1/2}\left(\sum_{t=1}^{T}\hat{u}_{jt}^{2}\right)^{1/2}} \tag{2}$$

$\hat{u}_{it}$ is the estimate of u_{it}. *LM* is asymptotically distributed as chi-squared with $N(N-1)/2$ degrees of freedom. However, when *N* is large and *T* is finite, the LM statistic is likely to get biased. Pesaran (2004) proposed the alternative test statistic, and it was defined for balanced panels as follows:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right) \tag{3}$$

He showed that under null hypothesis of the no cross-sectional dependence, $CD \xrightarrow{d} N(0,1)$ for $N \rightarrow \infty$ and T is sufficiently large. The CD test statistic may also be used when both *T* and *N* are large. As we have already mentioned, this PUR test offered the robust procedure in the small samples, and the presence of structural-breaks (Pesaran, 2004).

2.4 Panel Unit Root Test Accounting Cross-sectional Dependence

Pesaran (2007) proposed the PUR test for balanced panel with N cross-section and T time series data. He defined a heterogonous linear model as follows:

$$Y_{it} = (1-\rho_i)u_i + \rho_i Y_{it-1} + u_{it} \tag{4}$$

In this model, u_{it} is an error term, and it has common factor structure. We separately write error term as follows:

$$u_{it} = \gamma_i f_t + e_{it} \tag{5}$$

In Equation (5), f_t is the unobserved common factor, γ_i is the loading of corresponding factor, e_{it} is an idiosyncratic error term independent across i, and it is independent from the unobserved common factor. We rewrite a simple heterogonous linear model as follows:

$$\Delta Y_{it} = \alpha_{0i} + \alpha_{1i}Y_{it-1} + \gamma_i f_t + e_{it} \tag{6}$$

In this model, $\alpha_{0i} = (1-\rho_i)u_i$ and $\alpha_{1i} = (\rho_i - 1)$. At this point, Pesaran (2007) suggested that the Cross-sectionally Augmented Dickey Fuller (CADF) test equation as the cross-sectional averages of the first differences and the lagged levels of variable. Thus, he accounted for the cross-sectional dependence in the common factor. The CADF equation is given by,

$$\Delta Y_{it} = \alpha_i + b_i Y_{it-1} + c_i \overline{Y}_{t-1} + d_i \Delta \overline{Y}_t + \varepsilon_{it} \tag{7}$$

In the CADF equation, $\overline{Y}_{t-1} = \sum_{i=1}^{N} Y_{it-1}$ and $\Delta \overline{Y}_t = \sum_{i=1}^{N} \Delta Y_{it}$, and ε_{it} is the error term. Null hypothesis of the PUR test of Pesaran (2007) is, $\rho_i = 1$ for all *i* against and the heterogeneous alternative hypothesis is $\rho_i < 1$ for some *i* is given by the cross-sectional average of the $CADF_i$. Finally, this is calculated as such that,

$$\overline{CADF} = N^{-1} \sum_{i=1}^{N} CADF_i \tag{8}$$

3 Empirical Findings

3.1 Results of the Cross-sectional Dependence Test

In this section, firstly, we run the CD test procedure into the consumption-income ratios in 11 CEE countries, and report the findings in Table 2.

Table 2. Results of the CD Test for the Consumption-income Ratios

The CD-stat of Pesaran (2004)	8.395 (0.000)
Average absolute value of the off-diagonal elements	0.299

Notes: The CD test of Pesaran (2004) is defined under null hypothesis of the cross-sectional independence in the consumption-income ratios in 11 CEE countries. The p-value is in parenthesis.

As seen in Table 2, the CD test of Pesaran (2004) strongly rejects the null hypothesis of no cross-sectional independence. Thus, following the results of the CD test of Pesaran (2004), we apply the PUR tests that accounting for cross-sectional dependence.

3.2 Results of the Unit Root Hypothesis in Panel Data

At this point, we report the findings of the PUR tests of Maddala and Wu (1999), Choi (2001) and Pesaran (2007) in Table 3.

Table 3. Results of the PUR Tests that Accounting for Cross-sectional Dependence

Heterogeneous Unit Root (MWC) Maddala and Wu (1999) and Choi (2001)	Constant	Constant and Trend
ADF-Fisher (inverse chi-squared)	310.64 (0.000)	323.06 (0.000)

ADF-Fisher (inverse normal)	-15.47 (0.000)	-15.40 (0.000)
ADF-Fisher (inverse logit)	-27.33 (0.000)	-28.41 (0.000)
ADF-Fisher (modified inverse chi-squared)	45.95 (0.000)	47.91 (0.000)
PP-Fisher (inverse chi-squared)	302.74 (0.000)	326.98 (0.000)
PP-Fisher (inverse normal)	-14.59 (0.000)	-15.46 (0.000)
PP-Fisher (inverse logit)	-26.63 (0.000)	-28.74 (0.000)
PP-Fisher (modified inverse chi-squared)	44.70 (0.000)	48.53 (0.000)
Heterogeneous Unit Root (CIPS) Pesaran (2007)	Constant	Constant and Trend
Zt-bar Statistic	-9.664 (0.000)	-10.894 (0.000)

Notes: ADF: Augmented Dickey Fuller, PP: Phillips and Perron. The MWC and the CIPS tests are defined under null hypothesis of the non-stationary consumption-income ratios in 11 CEE countries. The CIPS test assumes that cross-sectional dependence in form of a single unobserved common factor. The optimal number of lag is selected by the Akaike Information Criteria (AIC). Probabilities for the Fisher tests are computed by related probability distributions. The p-values are in parentheses.

3.3 Results of the Unit Root Hypothesis for Each Country

Furthermore, we compute the single ADF test produce in Maddala and Wu (1999) and the MADF PUR test of Taylor and Sarno (1998) to analyze stationary behavior of the consumption-income ratios for each CEE country. Also, we calculate the half-life time for the stationary findings. Half-life (HL) can be calculated as $HL = |\ln(0.5)| / |\ln(\rho)|$ where ρ is the Autoregressive coefficient of $Y_t = \rho Y_{t-1} + \varepsilon_t$ equation as series *i* in AR (1) process. See Andrews (1993) for the formula in the higher order AR (p) process in details. We report all related results in Table 4.

Table 4. Results of the ADF and the MADF Test for the Consumption-income Ratios

Country	Half-life (Year)	ADF	10% CV	5% CV	1% CV	Probability
Bulgaria	1.92	-11.104	-3.259	-3.541	-4.342	(0.000)
Croatia	-	-2.303	-3.175	-3.501	-4.202	(0.481)
The Czech Republic	1.10	-4.043	-3.172	-3.487	-4.121	(0.012)
Estonia	2.39	-6.831	-3.211	-3.518	-4.278	(0.000)
Hungary	1.82	-3.932	-3.173	-3.489	-4.124	(0.016)

Latvia	3.30	-9.657	-3.309	-3.581	-4.389	(0.000)
Lithuania	1.61	-5.467	-3.192	-3.502	-4.219	(0.000)
Poland	1.17	-9.808	-3.169	-3.513	-4.261	(0.000)
Romania	3.01	-10.173	-3.286	-3.552	-4.359	(0.000)
Slovakia	1.08	-5.564	-3.302	-3.537	-4.112	(0.000)
Slovenia	-	-1.901	-3.173	-3.489	-4.124	(0.641)
Country	Half-life (Year)	MADF	10% CV	5% CV	1% CV	Probability
Panel	1.93	406.441	18.362	20.044	25.291	(0.000)

Notes: CV: Critical value. Critical values are calculated using Monte Carlo simulations for 63 observations in each country with 20000 replications. The optimal number of lag is selected by the AIC. The MADF test is defined under null hypothesis of that all 11 consumption-income ratios in panels are non-stationary processes. The ADF and the MADF procedures include both the constant and the trend terms.

Results from the ADF test procedure of Maddala and Wu (1999), and the MADF-PUR test of Taylor and Sarno (1998) confirm the findings from the cross-sectional dependence PUR tests. We also provide further evidences in favor of the stationary consumption-income ratios for 9 of 11 CEE countries. The only exception evidence of the non-stationary consumption-income ratios are found in Croatia and Slovenia over the related period. Furthermore, we calculate the half-life time for non-stationary findings. The-half-life of the APC for nine CEE economies is obtained from 1.08 to 3.30 years. The fastest converges into the equilibrium level is observed in Slovakia, the Czech Republic and Poland, respectively. The panel average 1.93 (almost two years) for the decay of the shocks upon the APC does not seem to be too long to consider that policy shocks have permanent effects on the consumption-income ratio in CEE economies.

4 Concluding Remarks

This paper investigates stochastic properties of the consumption-income ratios in 11 CEE economies from March 1997 to September 2012 in quarterly data set. We apply the heterogeneous PUR tests of Maddala and Wu (1999), Choi (2001) and Pesaran (2007) that accounting for cross-sectional dependence. We also use the single ADF test procedure of Maddala and Wu (1999) and the MADF-PUR test of Taylor and Sarno (1998) to analyze stochastic behavior of the consumption-income ratios for each CEE country. The empirical results show that there is a strong mean-reversion in the consumption-income ratios for 9 of 11 CEE countries, and the only exception evidences are obtained in Croatia and Slovenia. Thus the empirical findings provide significant support for the existence of hypothesis of the consumption-income ratio converges towards a constant value in Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia. Our robust results are in the line with the recent work of Baykara and Telatar (2012).

The results obtained in this paper are consistent with the theoretical framework of the Relative Income Hypothesis, the Life Cycle Hypothesis, the Permanent Income Hypothesis, and the Habit Persistent

Model which all assume a forward-looking consumer. From a policy implication perspective, the findings suggest that fiscal policy and monetary policy frameworks in related nine CEE countries will have not long-run effects on the consumption-income ratios. Policy implications have permanents effects on consumption of households only in Croatia and Slovenia.

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