

# Stochastic properties of the consumption-income ratios in central and eastern European countries\*

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## Abstract

*This paper aims to investigate stochastic properties of the consumption-income ratios in eleven central and eastern European (CEE) countries: Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. The heterogeneous panel unit root tests are used to account for cross-sectional dependence and the Modified Augmented Dickey-Fuller unit root test over the period March 1997 – September 2012. The half-lives are also calculated as to find the strong mean-reversion in the consumption-income ratio for nine of eleven CEE economies; and the exceptions are Croatia and Slovenia. In other words, empirical findings provide significant support for the existence of hypothesis that the consumption-income ratio is a mean reversion. Accordingly, the policy implications have permanent effects on the consumption of households only in Croatia and Slovenia.*

**Key words:** *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) is a mean reversion 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 examine stochastic behavior of the consumption-income ratio in eleven central and eastern

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European (henceforth CEE) economies: Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia.

The stochastic properties of the consumption-income ratio are subject to different implications in macroeconomic modeling and economic policy for understanding consumption function, savings behavior, business cycles, and global imbalances. For instance, presence of a 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 of 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 cause higher domestic interest rate. These processes finally tend to an appreciation in real exchange rate and this likely has negative effect on exports. On the other hand, significant change in consumption or savings due to changes in income can display different features at different business cycles (Cerrato et al., 2013). These issues, which are particularly relevant in developing CEE economies, have been neglected in literature.

Our main hypothesis is that external shocks would permanently affect the consumption-income ratios in CEE countries, and we therefore expect unit root in the series. If our empirical findings provide significant support for the existence of hypothesis that the consumption-income ratio is a unit root, this means the policy implications have permanent effects on the consumption of households. The results in favor of unit root suggest that fiscal policy and monetary policy implications would have long-run effects on the consumption-income ratios. The main contribution of this paper is that to apply the second generation PUR test of Pesaran (2007) on the consumption-income ratio of CEE economies, and this is fairly important in overcoming the shortfall of first generation PUR tests that assume cross-sectional independence by default.

The remainder of the paper is organized as follows. Section 2 briefly reviews the related literature. Section 3 describes the econometric methodology. Section 4 reports the procedures of data collection and the empirical analysis. Section 5 discusses the empirical results, and Section 6 concludes.

## **2. Literature review**

On the theoretical background, there are two opponent remarks 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 is a mean-reverting process, particularly in the long-run. Hence, they expect stationary APC. Second, the absolute income hypothesis of Keynes (1936) and involuntary savings theory of Deaton (1977) propose that the consumption-income ratio would be a non-stationary process. We refer to the recent paper of Baykara and Telatar (2012), for descriptions of the theoretical background and explanations why the APC should or should not be stationary in these different theories.

Indeed, stochastic behavior of the consumption-income ratio has empirically been examined in numerous 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. For this purpose, individual unit root tests, Panel Unit Root (PUR) tests, and co-integration analysis have commonly been used in the literature. For instance, Drobny and Hall (1989), Molana (1991), Horioka (1997), Cook (2003), and Fallahi (2012) obtained the evidences in line with validity of the hypothesis of the non-stationary consumption-income ratios by using individual unit root tests and co-integration techniques.

In addition, Sarantis and Stewart (1999) used 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. Employing “first generation” PUR tests over the period 1960-2005, Romero-Avila (2008) confirmed the main finding of Sarantis and Stewart (1999) that there is a strong unit root in the APC for 23 OECD economics. Cerrato et al. (2013) applied heterogeneous non-linear and linear PUR tests which account for cross-sectional dependence in the APC of 24 OECD and 33 non-OECD countries for the period from 1951 to 2003. Their evidences favor the non-stationary consumption-income ratios for both the OECD countries and the non-OECD countries. However, they naturally ignored the cases of CEE economics in such a large time dimension.

On the contrary, studies have also concluded in favor of the stationary consumption-income ratio (King et al., 1991; Jin, 1995; Cook, 2005; Liao et al., 2011). Moreover, using cross-sectional dependence PUR test that allow for an unknown number of multiple breaks and considering the same data along with Romero-Avila (2008), Romero-Avila (2009) reached the contrary results to Romero-Avila (2008), namely the APCs are the regime stationarity. To the best of our knowledge, Baykara and Telatar (2012) only analyzed the stochastic properties of the consumption-income ratios in transition economies: Belarus, Bulgaria, the Czech Republic, Croatia, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Poland, Romania, Russia, Slovakia, and Slovenia. However, they took both nonlinearities and asymmetries into account and used the unit root tests which are based on the Threshold Autoregressive (TAR) models. They found empirical results in favor of the stationary consumption-income ratios for all transition countries.

### 3. Methodology

#### 3.1. First generation and second generation panel unit root tests

PUR tests have begun to be widely used in literature. First generation PUR tests can commonly be arranged in groups by cross-section independence and heterogeneous or homogenous unit roots, such as those proposed by Harris and Tzavalis (1999), Breitung (2000), Hadri (2000), Levin et al. (2002), and Im et al. (2003). However, literature suggests that we 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 the mentioned first generation PUR tests and they combined the p-values from individual unit root tests. On the other hand, there are now several second-generation PUR tests available in literature (Bai and Ng, 2002 and 2004; Chang, 2002 and 2004; Choi, 2006; Moon and Perron, 2004; Pesaran, 2007; Phillips and Sul, 2003) but as giving relatively small dimension of the strongly balanced panel data in this paper, the PUR test of Pesaran (2007) would probably be a good choice (Breitung and Pesaran, 2008).

#### 3.2. Testing for cross-sectional dependence among panel units

Related to our purpose, firstly, we consider performing a formal test for cross-sectional dependence. For instance, Pesaran (2004) proposes the test statistic (CD) that is an alternative of the Lagrange Multiplier (LM) statistic of Breusch and Pagan (1980). Breusch and Pagan (1980) propose the LM statistic, which is valid for fixed  $N$  and  $T \rightarrow \infty$ , and it is given by:

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

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

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

$\hat{u}_{it}$  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) proposes the alternative test statistic, and it is defined for balanced panels as follows:

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

He shows 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.

### 3.3. Second generation panel unit root of Pesaran (2007)

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

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

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

$$u_{it} = \gamma_i f_t + e_{it} \quad (5)$$

In Equation (5),  $f_t$  is the unobserved common factor,  $\gamma_i$  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 heterogenous linear model as follows:

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

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

$$\Delta Y_{it} = \alpha_i + b_i Y_{it-1} + c_i \bar{Y}_{t-1} + d_i \Delta \bar{Y}_t + \varepsilon_{it} \quad (7)$$

In the CADF equation,  $\bar{Y}_{t-1} = \sum_{i=1}^N Y_{it-1}$  and  $\Delta \bar{Y}_t = \sum_{i=1}^N \Delta Y_{it}$ , and  $\varepsilon_{it}$  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,

$$\overline{CADF} = N^{-1} \sum_{i=1}^N CADF_i \quad (8)$$

#### **4. Data collection and empirical analysis**

In this paper we use data for the seasonally adjusted household consumption expenditures and the disposable income to calculate the consumption-income ratios in eleven CEE countries over the period March 1997-September 2012 within quarterly panel data set. We focus on Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. We totally use 693 samples for the analyses. We have obtained the data from the International Financial Statistics database of the International Money Fund (IMF). Various theories on consumers' behavior are based on concept of the disposable income of household. In this paper, therefore, we do not use Gross Domestic Product (GDP) as an indicator of overall income. Indeed, concept of disposable income of households incorporates distributional effects in the domestic economy and impact of property income and social and other transfers. It is important to note that in some countries, particularly some heavily indebted CEE countries, because of deterioration of balance of primary income position regarding transactions to and from abroad, disposable income is significantly lower in comparison to GDP. In addition, we report a summary of the descriptive statistics of the consumption-income ratios in eleven CEE countries in Table 1 as follows:

Table 1: Summary statistics of the consumption-income ratio

Statistics	Bulgaria	Croatia	The Czech Republic	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
Mean	0.68	0.54	0.50	0.55	0.66	0.63	0.64	0.68	0.63	0.69	0.55
Maximum	0.77	0.61	0.55	0.62	0.75	0.71	0.70	0.77	0.73	0.79	0.59
Minimum	0.54	0.48	0.46	0.48	0.59	0.59	0.57	0.54	0.53	0.57	0.51
Standard deviation	0.05	0.03	0.02	0.03	0.03	0.02	0.03	0.05	0.05	0.06	0.02
Skewness	-0.31	0.17	0.13	-0.14	0.54	0.87	-0.25	-0.51	-0.13	0.67	-0.32
Kurtosis	2.57	2.39	2.44	3.04	3.37	5.77	3.97	2.57	1.95	3.56	2.34
Jarque-Bera (JB)	1.41	1.93	0.77	0.21	3.32	26.87	3.00	3.16	2.94	5.37	2.07
JB (probability)	(0.49)	(0.38)	(0.68)	(0.89)	(0.19)	(0.00)	(0.22)	(0.20)	(0.22)	(0.11)	(0.35)
Observation	63	63	63	63	63	63	63	63	63	63	63

Source: International financial statistics database of the IMF and author's calculations

## 5. Results and discussion

We report the findings of the CD test procedure for the consumption-income ratios in eleven CEE countries in Table 2 as follows:

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 eleven CEE countries. The p-value is in parenthesis.

Source: Author's calculations

As seen in Table 2, the CD test of Pesaran (2004) strongly rejects the null hypothesis of no cross-sectional independence. Therefore, following the results of the CD test of Pesaran (2004), we apply the three PUR tests which are based on the cross-sectional dependence and report the findings of the MWC of Maddala and Wu (1999) and Choi (2001), and the CIPS of Pesaran (2007) in Table 3. In this paper we use the bootstrap versions for PUR tests of Maddala and Wu (1999) and Choi (2001) just because their bootstrap methods resulted in a decrease of the size distortions due to the cross-sectional correlations. In short, the bootstrap versions of these first generation PUR tests perform much better.

The results of the MWC and the CIPS PUR tests in Table 3 indicate that the consumption-income ratios in eleven CEE countries are the non-stationary process. Furthermore, we run the single ADF test produce of Maddala and Wu (1999) to deeply analyze the stationary behavior of the consumption-income ratios for each CEE country. In addition, we calculate the Half-life time for the stationary findings.

At this point, Half-life (HL) can be calculated as  $HL = |\ln(0.5)| / |\ln(\rho)|$  where  $\rho$  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. We report all of these results in Table 4.



Table 3: Results of the PUR Tests for the consumption-income ratios

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 eleven CEE countries. The CIPS test assumes the 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.

Source: Author's calculations

As seen in Table 4, the results of the ADF test procedure of Maddala and Wu (1999) confirms the findings of the cross-sectional dependence PUR tests of the MWC of Maddala and Wu (1999) and Choi (2001), and the CIPS of Pesaran (2007). We also provide further evidences in favor of the stationary consumption-income ratios in nine of eleven CEE countries. The exception evidences of the non-stationary consumption-income ratios are obtained in Croatia and Slovenia over the related period.

Table 4: Results of the ADF Tests for the consumption-income ratio

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)

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 ADF test is defined under null hypothesis that the consumption-income ratio is a non-stationary process. The ADF test procedure includes both constant and trend terms.

Source: Author’s calculations

Furthermore, we calculate the half-life time for the stationary findings. The half-life times for the APCs in nine CEE economies are found as 1.08 to 3.30 years. The fastest converges to the equilibrium level is observed in Slovakia, the Czech Republic, and Poland, respectively. The panel average of 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. Finally, the slowest converge would occur in the Latvian economy.

## 6. Conclusion

The results of this paper show that external shocks permanently affect on the consumption-income ratios in Croatia and Slovenia, and the main hypothesis is proved only for these countries. It has been found that there is a mean reversion in nine of eleven CEE economies, and the exceptions are Croatia and Slovenia. Thus the empirical findings provide statistically significant support for the existence of

hypothesis that the consumption-income ratio is a mean-reversion in Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia. These results are in line with the theoretical frameworks 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. On the other hand, the exceptional results of Croatia and Slovenia are consistent with the absolute income hypothesis and the involuntary savings theory. Most of previous studies have also found the consumption-income ratios are non-stationary in literature. The results of this research are different from them, very likely, due to the sample countries, the period covered, and the method applied. These results are in line with the previous findings of Baykara and Telatar (2012) that find evidence in favor of stationarity in general. In addition, this paper includes the period of the great global recession of 2008-09. Our empirical results show that external shocks during the great global recession significantly affect on the consumption-income ratios in Croatia and Slovenia economies. However, observations have been limited to the post-recession period, and actually this is the main constraint of this empirical analysis. Future studies on this topic can build up a further empirical strategy, if they make the data broader over the period of the post-global recession.

The empirical evidences of this research could be valuable for policy-makers and both theoretical and empirical researchers that have interest in these CEE economies. From a policy implication perspective, the results indicate that fiscal policy and monetary policy implications in nine CEE countries will not have long-run effects on the consumption-income ratios. Such policy implications have permanent effects on the consumption of households only in the Croatian and the Slovenian economies. On the other hand, external factors, such as terms of trade shocks, government expenditures, and global interest rates could also affect temporary or permanent shifts in consumption-income ratios and influence the empirical results. In addition, income distribution and size of informal economy are important variables to determine consumption pattern in CEE economies. Policy implications presented in this study actually depends on these kinds of country-specific dynamics.

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## Stohastička svojstva omjera potrošnje i prihoda u zemljama srednje i istočne Europe

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### Sažetak

Cilj ovog rada je istražiti stohastička svojstva omjera potrošnje i prihoda u jedanaest zemalja srednje i istočne Europe (SIE): Bugarskoj, Hrvatskoj, Češkoj, Estoniji, Mađarskoj, Latviji, Litvi, Poljskoj, Rumunjskoj, Slovačkoj i Sloveniji. U radu se koriste heterogeni panel testovi jediničnih korijena za testiranje presjeka međuovisnosti i modificirani prošireni Dickey-Fuller test jediničnih korijena za razdoblje ožujak 1997. – rujan 2012. Također se izračunava polu-vijek i snažna prosječna recipročna vrijednost omjera između potrošnje i prihoda u devet od jedanaest gospodarstava SIE; izuzetak su Hrvatska i Slovenija. Drugim riječima, empirijski rezultati značajno podupiru hipotezu da je omjer potrošnje i prihoda u recipročnom odnosu. U skladu s tim, implikacije ekonomske politike imaju trajne učinke na potrošnju kućanstava samo u Hrvatskoj i Sloveniji.

**Ključne riječi:** Omjer potrošnje i prihoda, gospodarstva srednje i istočne Europe, Panel testovi jediničnih korijena, presjek međuovisnosti, polu-vijek

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