CONVERGENCE ANALYSIS FOR ENERGY CONSUMPTION PER CAPITA AMONG HIGH-INCOME OECD COUNTRIES

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ABSTRACT

In this study we explored the convergence analysis for energy consumption per capita among high income OECD countries for the period 1960-2015 with annual data by using the panel unit root test developed by Carrion-i- Silvestre et al (2005) and Carrion-i- Silvestre (2005). In the study, we find evidence for the convergence of energy consumption per capita among high-income OECD countries in both individual country level and panel level.

Keywords: Convergence, OECD countries, Panel unit root test

JEL: O47, Q43, Q48

G-7 ÜLKELERİ İÇİN SATIN ALMA GÜCÜ PARİTESİNİN GEÇERLİLİĞİNİN TEST EDİLMESİ

ÖZET

Bu çalışmada, yüksek-gelirli OECD ülkelerinde kişi başına enerji tüketimi için yakınsama analizi, 1960-2015 dönemi yıllık verileri ve Carrion-i- Silvestre et al (2005) tarafından geliştirilen panel birim kök testi kullanılarak incelenmiştir. Çalışma sonucunda, yüksek-gelirli OECD ülkeleri için hem bireysel ülke hem de panel düzeyinde kişi başına enerji tüketimi için yakınsama hipotezinin geçerli olduğu bulunmuştur.

Anahtar Kelimeler: Yakınsama, OECD ülkeleri, Panel birim kök testi

1. Introduction

Energy is vital input for production function to achieve outputs needed the society. As the economies develop, energy intensities decline by improving energy efficiency because of the sophistication of the both energy consumption and energy supply patterns. Main driver of economic growth shifts from individual the production factors to total factor productivity (see Meng et al, 2013).

In this study, stochastic conditional convergence analysis is used for the convergence analysis of energy consumption per capita among high income OECD countries for the period 1960-2015 with annual data by using the panel unit root test developed by Carrion-i-Silvestre et al (2005) and Carrion-i- Silvestre (2005), allowing multiple structural breaks in the mean and/or the trend of the individual time series and the cross-section dependence as well.

The framework of the study is as follows. Section 2 analysis the literature. Section 3 provides the data and methodology. Section 4 covers empirical results and conclusion given in Section 5.

2. Literature Review

Table-1 shows the selected literature on the convergence analysis for energy consumption. The results in the literature mostly support convergence for energy consumption. (see Table-1.)

Table-1. Selected Literature on Convergence For Energy Consumption					
Author(s)	Year	Method	Period	Country(ies)	Findings
Mohammadi and Ram	2017	Regression and panel unit-root tests	1970 – 2013	the US states	Lack of convergence
Herrerias et al	2017	Panel Regression	1995-2011	Chinese regions	Convergence
Parker and Liddle	2017	Clustering algorithm	1971 - 2008	33 countries	Mixed Results
Mishra and Smyth	2017	Unit-root tests	1973 – 2014	Australia	Convergence
Payne et al	2017	LM and RALS-LM unit root tests	1970 – 2013	the US states	Convergence

Table-1. Selected Literature on Convergence For Energy Consumption					
Author(s)	Year	Method	Period	Country(ies)	Findings
Wan et al	2015	Regression	1995 – 2005	European Union	Convergence
Li and Lin	2015	Meta-frontier	1997 – 2011	Chinese regions	Negative effects
Fallahi and Voia	2015	Unit-root tests	1960 – 2012	OECD countries	Mixed Results
Mishra and Smyth	2014	Panel unit-root tests	1971 – 2011	ASEAN	Convergence
Herrerias	2013	Panel regressions	1980 – 2009	the US states	Mixed Results
Meng et al	2013	Panel unit-root tests	1960 – 2010	OECD	Convergence
Herrerias	2012	Dynamic of the distribution approach.	1971 – 2008	83 countries	Convergence
Jakob et al	2012	Panel regression	1971 – 2005	53 Countries	Convergence
Ma and Oxley	2012	Regression	1970 – 2013	China	Convergence
Mulder and Groot	2012	Regression	1970 – 2015	OECD	Mixed Results
Mohammadi and Ram	2012	Regression	1971 – 2007	World	Mixed Results
Le Pen and Sevi	2010	Panel unit-root tests	1971 – 2003	World	Mixed Results
Ma et al	2009	Panel unit-root tests	1995–2005	China	Convergence
Markandya	2006	Regression	1992–2002	EU, Eastern Europe	Convergence
Miketaa and Mulder	2005	Regression	1971 – 2005	56 countries	Local Convergence

3. Data and Methodology

In this study, we used the data for high income OECD countries for the period 1960-2015 with annual data from the OECD database by using the panel unit root test developed by Carrion-i- Silvestre et al (2005) and Carrion-i- Silvestre (2005). For each country i, the natural logarithm of the ratio of per capita energy use (PCEU) relative to the average of all OECD countries is used as follows:

$$y_{it} = ln(PCEU_{it}/\overline{PCEU_t}) \qquad (1)$$

The methodology used is the panel unit root test (PANKPSS) developed by Carrion-i-Silvestre et al (2005) and Carrion-i- Silvestre (2005), allowing multiple structural breaks in the mean and/or the trend of the individual time series and the cross-section dependence as well by following model, also for testing null hypothesis, modified and normalized the KPSS LM test statistics assuming homogeneity and heterogeneity of long-run variance (see also Güloğlu et al, 2011),

$$y_{it} = \alpha_{it} + \beta_i t + \varepsilon_{it}$$

$$\alpha_{it} = \sum_{k=1}^{m_i} \theta_{i,k} D\left(T_{b,k}^i\right)_t + \sum_{k=1}^{m_i} \gamma_{i,k} DU_{i,k,t} + \alpha_{i,t-1} + \upsilon_{i,t} \quad (2)$$

where $\upsilon_{i,t} \sim i.i.d. (0, \sigma_{u,i}^2)$ and αi, $\alpha_{i,0} = \alpha_{i,}$, a constant, with i= 1, ... , N individuals and t= 1, ... , T time periods. The dummy variables defined as $D\left(T_{b,k}^i\right)_t = 1$ for $t = T_{b,k}^i + 1$, 0 elsewhere and $DU_{i,k,t} = 1$ $t > T_{b,k}^i$, 0 elsewhere; $T_{b,k}^i$, is the date of the kth break for the ith individual, k= 1, ... , m_i, m_i≥ 1. The null hypothesis and one-sided alternative hypothesis:
$H_0 : \sigma_{u,i}^2 = 0$, $\forall i = 1,2,..., N$; $H_A : \sigma_{\varepsilon,i}^2 = 0$, i = 1,2,..., N

4. Empirical Results

In order to analyze stationarity of the y_{it}, first, we tested the significance of cross-sectional correlations by using CDLM tests developed by Pesaran (2004). Table-2 shows that the cross-sectional correlations are significant.

Table-2. Cross-section dependence tests results

Breusch-Pagan LM		Bias-corrected scaled LM	
Test statistic	Probability	Test statistic	Probability
3514.144	0.0000	179.5764	0.0000

For this reason, we use the PANKPSS test considering cross-section-dependence problem and multiple structural breaks. Table-3 shows that the individual KPSS statistics for the intercept-no trend. All of the test statistics both in Panel A: Panel individual KPSS test and Panel B: Panel KPSS tests for the whole of panel are less than the critical values, meaning

the null hypothesis of stationarity cannot be rejected. Based on the empirical results, we claimed that we find evidence for the convergence of energy consumption per capita among high-income OECD countries in both individual country level and panel level.

Table-3. Panel KPSS test: intercept-no trend

Panel A: Panel individual KPSS test and dates of structural breaks

Country	KPSS	m	$T_{b,1}$	$T_{b,2}$	$T_{b,3}$	$T_{b,4}$	Finite sample critical values		
							0.90	0.95	0.99
Australia	0.043	2	1967	2006			0.109	0.14	0.216
Canada	0.081	2	1968	1989			0.118	0.154	0.251
Italy	0.049	2	1967	1994			0.103	0.127	0.195
Norway	0.083	3	1975	1983	2007		0.104	0.117	0.172
Austria	0.058	2	1978	2002			0.113	0.148	0.235
Denmark	0.074	3	1972	1980	1998		0.116	0.152	0.232
Finland	0.092	3	1967	1979	2001		0.084	0.106	0.18
Germany	0.039	3	1969	1990	1998		0.118	0.152	0.243
Japan	0.109	2	1967	1989			0.118	0.149	0.235
N.Zealand	0.063	3	1967	1982	2007		0.089	0.113	0.185
Portugal	0.087	4	1970	1979	1988	1997	0.117	0.155	0.234
Belgium	0.126	3	1980	1993	2001		0.111	0.149	0.231
France	0.059	2	1969	1982			0.097	0.128	0.221
Netherlands	0.056	2	1968	1980			0.104	0.131	0.215
Switzerland	0.18	2	1979	1994			0.111	0.145	0.224
UK	0.102	4	1967	1975	1996	2006	0.123	0.161	0.243
US	0.068	4	1969	1979	1989	2000	0.109	0.149	0.233
Sweden	0.035	1	1996				0.093	0.122	0.199
Spain	0.048	4	1967	1975	1988	1997	0.118	0.156	0.252

Panel B: Panel KPSS tests for the whole of panel

Model	Test statistic	Asy Cv 0.90	Asy Cv 0.95	Asy Cv 0.99	Boot Cv 0.90	Boot Cv 0.95	Boot Cv 0.99
Breaks	1.159 (0.123)[hom]	1.389	1.705	2.510	1.39[hom]	1.71 [hom]	2.51 [hom]
Breaks	2.220 (0.013)[het]	2.600	3.155	4.364	2.60[het]	3.12 [het]	4.36 [het]

5. Conclusion

In this study we explored the convergence analysis for energy consumption per capita among high income OECD countries for the period 1960-2015 with annual data by using the panel unit root test developed by Carrion-i- Silvestre et al (2005) and Carrion-i- Silvestre (2005). In the study, we find evidence for the convergence of energy consumption per capita among high-income OECD countries in both individual country level and panel level.

As the economies develop, energy intensities decline by improving energy efficiency because of the sophistication of the both energy consumption and energy supply patterns. Main driver of economic growth shifts from individual the production factors to total factor productivity. In this context, energy policies should design such that maximizing energy efficiency in order to achieve sustainable economic growth and development.

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