

**CONVERGENCE OF IN-COUNTRY PRICES FOR THE  
TURKISH ECONOMY: A PANEL DATA SEARCH FOR THE  
PPP HYPOTHESIS USING SUB-REGIONAL  
DISAGGREGATED DATA**

**TÜRKİYE EKONOMİSİ İÇİN ÜLKE-İÇİ FİYATLARIN YAKINSAMASI: PPP  
VARSAYIMI İÇİN ALT-BÖLGESEL TOPLULAŞTIRILMAMIŞ VERİ  
KULLANAN BİR PANEL VERİ ARAŞTIRMASI**

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**ABSTRACT:** This paper tries to examine that in-country prices from the Turkish economy can be specified as a stationary relationship giving support to the long-run purchasing power parity in economics theory. For this purpose, a sub-regional categorization of the economy is considered over the investigation period of 2005-2012, and, following Esaka (2003), the study uses a panel estimation framework consisting of 12 disaggregated consumer price indices to search for whether the relative prices of goods between sub-regions of the Turkish economy can be represented by stationary time series properties.

**Keywords:** Purchasing Power Parity; Panel Data Econometrics; Disaggregated Price Data; Turkish Economy

**JEL Classifications:** C23; E30; E31

**ÖZET:** Bu çalışma Türkiye ekonomisinden ülke-içi fiyatların iktisat kuramındaki uzun-dönem satın alma gücü paritesine destek veren durağan bir ilişki olarak belirtilebilmesi durumunu incelemeye çalışmaktadır. Bu amaçla ekonominin alt-bölgesel bir sınıflandırması 2005-2012 araştırma dönemi için dikkate alınmakta, ve Esaka (2003) izlenerek, çalışma 12 toplulaştırılmamış tüketici fiyat endeksinden oluşan bir panel tahmin yapısını Türkiye ekonomisinin alt-bölgeleri arasında malların göreceli fiyatlarının durağan zaman serisi özellikleri ile temsil edilip edilemeyeceğini araştırmak için kullanmaktadır.

**Anahtar Kelimeler:** Satınalma Gücü Paritesi; Panel Veri Ekonometrisi; Toplulaştırılmamış Fiyat Verisi; Türkiye Ekonomisi

## **1. Introduction**

Advances in time series estimation techniques allow for researchers to investigate the theoretical backgrounds on which the science of economics is constructed so that the base of economic policies can be formed to fit well with the consequences in a more scrutinized way. A robust framework comes from the well-known Purchasing Power Parity theory (henceforth, PPP) that relates itself to the so-called *law of one price* which states that under the frictionless goods arbitrage the prices of individual traded goods should have been equalized when the prices are expressed in terms of the same currency of denomination. This approach leads to PPP in the sense that one could buy the same basket of goods in any country for the same value in terms of

prices denominated in a common currency. Froot and Rogoff (1995), Rogoff (1996) and Taylor (2006) are good papers that deal with PPP while Sarno and Taylor (2002) is a comprehensive resource for a wider range of issues in exchange rate economics.

Over the last two decades, tendency to search for PPP seems to be increasing and this is partly due to the new insights that contemporaneous econometrics give to the economists and other related researchers. For instance, panel unit root tests proposed by e.g. Maddala and Wu (MW) (1999), Choi (2001), Levin et al. (LLC) (2002) and Im et al. (IPS) (2003) have been demonstrated that they have more power than conventional univariate unit root tests. Recent estimations employing panel unit root tests yield findings significantly improving the results obtained by researchers in favour of the rejection of the non-stationarity of real exchange rates. Main inference in these studies is that PPP tends to hold by increasing the observations when compared to the earlier non-panel univariate time-series unit root tests, especially for the post-1980 periods of floating exchange rates and increasing openness to international trade all over the world. On these issues of interest, related readers can apply to a series of papers yielded by, e.g., Oh (1996), MacDonald (1996), Wu (1996), Lothian (1997), Papell (1997), Flôres et al. (1999), Heimonen (1999), Wu and Wu (2001), Chiu (2002), MacDonald et al. (2002), Alba and Park (2003) and Alba and Papell (2007) and examine various applications of panel unit root tests.

Further, another way of investigating PPP needs a search for cointegrating relationships to test whether the prices of individual traded goods can in fact be equalized when the prices are expressed in terms of the same currency of denomination. Considering the open economy characteristics of the theory in its original form, PPP can be indicated in a linear combination of the same order integrated variables as below:

$$p_{i,t}^d = e_t + p_{i,t}^f \quad (1)$$

where  $p_{i,t}^d$  is the domestic currency price of any good  $i$  at any time  $t$ ,  $e_t$  the domestic currency price of foreign exchange at time  $t$ , and  $p_{i,t}^f$  the relevant foreign currency price of good  $i$  at time  $t$ , all expressed in natural logarithms. Support for PPP in its absolute form requires a variable vector  $(p_i^d \ e_t \ p_i^f)'$  which satisfies the coefficient restrictions  $(1 \ -1 \ -1)'$  with a significant feedback process that reveals the endogeneity of the variables. Taylor (1988) and Kim (1990) testing the long-run PPP relationship for some major currencies against the US dollar can be considered among the pioneering studies that use cointegration and vector error correction techniques to reveal both the long-run stationary relationships leading to the PPP hypothesis and the deviations from the PPP relationship. Sarno and Taylor (1998) and Taylor and Sarno (1998) at this point are deserved to be examined in the economics literature. Similar to the advances in unit root estimation methodology, the panel frameworks pooling together the data that differ across individual cross sections, e.g. countries and cities/regions, gain the researchers new insights that help us arrive at more general conclusions with an increasing statistical power. Among many others, for instance, Azali et al. (2001), Basher and Mohsin (2004), Jenkins

and Snaith (2005), Alba and Papell (2007) and Cerrato and Sarantis (2008) are some empirical papers published in respectable scientific economics journals. To our knowledge, as for the PPP studies upon the Turkish economy, Metin (1994), Telatar and Kazdağlı (1998), Yazgan (2003), Erlat (2003), Yıldırım (2003) and Özdemir (2004) can be given as some examples of empirical papers.

However, in this paper, we aim to test whether long-run PPP holds in a sub-regional categorization using a panel of 12 disaggregated consumer price indices taken from the Turkish economy over the period 2005-2012. For analyses of PPP with disaggregated price data, the paper is benefited from Engel and Rogers (1996), Parsley and Wei (1996), Jenkins (1997), Takagi and Yoshida (1999), and mainly follows Esaka (2003) to test the hypothesis that the relative prices of goods between sub-regions of the Turkish economy can be represented by stationary time series properties. Following Esaka (2003), such a choice of research subject and the estimation methodology using sub-regional data in the same country will enable us to observe the relationship between the deviations from PPP and the type of goods. Indeed, the choice of aggregate price indices, existence of trade barriers and volatility in exchange rates that reflect border effects can affect the extent to which PPP holds, and the use of disaggregated price data between sub-regions in the same country can allow the researcher to exclude some of these effects. For this purpose, Esaka considers a panel of 13 disaggregated consumer price indices from seven cities in Japan. Another advantage of this choice is resulted from the use of panel data econometrics leading us to obtain more consistent results from a full dynamic panel of consumer prices in a country. Details for the estimation methodology are reported in the next section.

The organization of study can be summarized as follows. Section 2 outlines the methodology used for estimation purposes. Section 3 is attributed to the estimations of the paper. It includes both the data descriptions, and the results of the panel estimation methodology with panel unit root findings that examine the convergence of prices in a stationary process. The last section concludes the paper with a short policy discussion.

## 2. A Methodological Reminder

In this section, we try to summarize the knowledge of panel unit root testing methodology followed in this paper. Let us assume unit root tests on the basis of whether there are restrictions on the autoregressive process across cross-sections or series and consider an AR(1) process for panel data:

$$y_{it} = \gamma_i + \rho_i y_{it-1} + X_{it} \delta_i + \varepsilon_{it} \quad (2)$$

where  $i = 1, 2, \dots, N$  cross-section units or series, that are observed over periods  $t = 1, 2, \dots, T_i$ .

The  $X_{it}$  represent the exogenous variables in the model, including any fixed effects or individual trend,  $\rho_i$  are the autoregressive coefficients, and the errors  $\varepsilon_{it}$  are assumed to be mutually independent idiosyncratic disturbances. If  $|\rho_i| = 1$  then  $y_i$  contains a unit root.

For purposes of testing, there are two natural assumptions that we can make about the  $\rho_i$ . First, one can assume that the persistence parameters are common across cross-sections so that  $\rho_i = \rho$  for all  $i$ . The LLC test employs this assumption. Alternatively, one can allow  $\rho_i$  to vary freely across cross-sections, thus allowing for heterogeneity in the value of  $\rho_i$ . IPS and Fisher-ADF tests are of this form characterized by combining of individual unit root tests to derive a panel-specific result.

To briefly describe these tests, Im et al. (2003) begin by specifying a separate ADF regression for each cross-section:

$$\Delta y_{it} = \rho_i y_{it-1} + \sum_{j=1}^{p_i} \beta_{ij} \Delta y_{it-j} + X_{it}' \delta_i + \varepsilon_{it} \quad (3)$$

The null hypothesis may be written as:

$$H_0 : \rho_i = 0, \text{ for all } i \quad (4)$$

while the alternative hypothesis is given by :

$$\begin{aligned} \rho_i &= 0, \text{ for } i = 1, 2, \dots, N_1 \\ H_1 : \rho_i &< 0, \text{ for } i = N_1 + 1, N_1 + 2, \dots, N \end{aligned} \quad (5)$$

After estimating the separate ADF regressions, the average of the  $t$ -statistics for  $\alpha_i$  from the individual ADF regressions,  $t_{iT}$  :

$$\psi_{NT} = N^{-1} \sum_{i=1}^N t_{iT} \quad (6)$$

is then adjusted to arrive at the desired test statistics. IPS show that a properly standardized  $\psi_{NT}$  has an asymptotic standard normal distribution:

$$W_{NT} = N^{1/2} \frac{\left( \psi_{NT} - N^{-1} \sum_{i=1}^N E(t_{iT}) \right)}{N^{-1} \sum_{i=1}^N \text{Var}(t_{iT})} \quad (7)$$

The expressions for the expected mean and variance of the ADF regression  $t$ -statistics,  $E(t_{iT})$  and  $\text{Var}(t_{iT})$ , are provided by IPS.

An alternative approach to panel unit root tests uses Fisher's (1932) results to derive tests that combine the  $p$ -values from individual unit root tests. This idea has been proposed by Maddala and Wu (1999) and Choi (2001). If we define  $\pi_i$  as the  $p$ -value from any individual unit root test for cross-section  $i$ , then under the null of unit root for all  $N$  cross-sections, we obtain the asymptotic result that:

$$-2\sum_{i=1}^N \log(\pi_i) \rightarrow \chi^2_{2N} \quad (8)$$

where  $\pi_i$  is the  $p$ -value of the test statistic in unit  $i$ , and is distributed as a  $\chi^2(2N)$  under the assumption of cross-sectional independence. The null and alternative hypotheses are the same as the IPS.

### 3. Results

For empirical purposes, we use the consumer price data from the Turkish economy and consider the time span of 2005:01 – 2012:12 with monthly frequency data in a balanced panel of 2496 sample observations. The study covers these data because of the base 2003: 100 is actually relevant for both aggregated and disaggregated consumer prices. All the data are taken from the electronic data delivery system of the Turkish Statistical Institute, <http://www.turkstat.gov.tr/>, include 26 regions and 12 main expenditure groups, and are in their natural logarithms. However the price indices with no cross-sections are available as of the beginning of the year 2003, introduction of city and region categories as cross-sections restricts the availability of data as of 2005. Sub-regions for prices and main expenditure groups are reported in the Appendix. Following Esaka (2003), we classify the goods as tradables and non-tradables with a common sense. We must state that the paper has to follow the categorization made by the Turkish Statistical Institute, and thus, we are exposed to the limitations as for the variations in population sizes and different consumption preferences across regions that influence the performance of PPP due to the calculations of the officials of the Turkish Statistical Institute. We present in Table 1 below the results of testing stationarity of relative prices of goods based on city and region considered in this paper. The optimum lag length is decided on the basis of Schwarz information criterion, and the observation-based maximum lag length is chosen as 12 due to the use of monthly data. The relevant probability values are reported in parentheses beneath the panel unit root statistics.

When we examine the estimation results in Table 1, it can be observed that the null hypothesis of unit root cannot be rejected in 6 of the 12 goods at the 5 percent level for LLC test, in 4 of the 12 goods at the 5 percent level and in 1 of the 12 goods at the 10 percent level for IPS test, and in 2 of the 12 goods at the 5 percent level and 1 of the 12 goods at the 10 percent level for ADF-Fisher test. In respect of goods classification, these tests verify the non-unit root characteristics of first 3 goods which we accept in the branch of tradables, however they have different marginal significance levels. These main expenditure groups are Food and Non-Alcoholic Beverages, Alcoholic Beverages and Tobacco and Clothing and Footwear, but such a finding cannot be supported in all three tests for group 5 in tradables, that is, Furnishings, Household Equipment and Routine Maintenance of the House. On the other hand, for non-tradables, results are more contradictory in the sense that the expenditure groups 6, 8, 10, 11 and 12 cannot reject the panel non-stationary characteristics, but LLC and IPS for group 4 (Housing, water etc.), LLC for group 7 (Transport) and LLC and IPS for group 9 (Recreation and Culture) support panel stationarity for these non-tradable goods classifications. We can at least accept at this point that non-tradable goods and services, to a much greater extent than tradables, tend not to reject the non-stationary null hypothesis.

**Table 1. Panel Unit Root Tests on Main Expenditure Groups  
(Individual Effects)**

Balanced observations for each test				
Null Hypothesis: Unit root process				
Cross-sections: 26				
Main groups	Lag length	LLC	IPS <i>W</i> -stat	ADF- Fisher $\chi^2$
1	6	-1.74 (0.04)	-3.34 (0.00)	76.75 (0.01)
2	5	-3.38 (0.00)	-2.56 (0.00)	79.44 (0.00)
3	2	-2.74 (0.00)	-1.39 (0.09)	69.89 (0.08)
4	4	-3.19 (0.00)	-1.72 (0.04)	58.73 (0.24)
5	2	0.33 (0.63)	-1.05 (0.15)	47.24 (0.36)
6	1	0.82 (0.45)	-1.16 (0.11)	56.61 (0.31)
7	1	-3.44 (0.00)	0.10 (0.65)	55.73 (0.28)
8	4	-1.08 (0.16)	0.33 (0.63)	33.01 (0.86)
9	5	-2.94 (0.00)	-2.74 (0.00)	66.55 (0.17)
10	4	-0.53 (0.33)	-0.26 (0.40)	59.23 (0.23)
11	1	0.18 (0.76)	0.65 (0.74)	47.86 (0.64)
12	1	0.50 (0.70)	-0.89 (0.19)	52.02 (0.47)

To test for PPP hypothesis, what is more consistent with the theory is to estimate the model without a long-term trend component. See on this issue, for instance, Papell (1997) and Chiu (2002). However, to further control the results, we give in Table 2 the estimation findings also including a linear trend in the test specification such as Esaka (2003). When compared with the former results in Table 1, there is a consensus that the first three expenditure groups that are called tradables are panel-stationary. Also similar to the Table 1 is that for the expenditure groups 5, 8, 11 and 12 the null hypothesis of a panel unit root cannot be rejected. However, the group 4, that is, Housing, water etc., now turns out to be non-stationary. For groups 7 and 9, Transport and Recreation & Culture, results are in line with Table 1 if LLC test for the former and both LLC and IPS test for the latter are of a chosen type in testing procedure. Such a result is out of our expectation that non-tradables should not move in line with PPP. In our opinion, further examinations in future papers are required to see whether our estimations yield an anomaly to theory or behave as a stylized fact of the Turkish economy, if so, calling in mind a need to more micro-based investigation of the properties of these expenditure groups. For main expenditure groups 6 and 10, Health and Education, there exists a sharp distinction between Table 1 and Table 2 for which the former is in line with *a priori* expectation that these non-tradable expenditure groups do not fit well with PPP theory but the latter highly contradicts this result thus must be of a special issue of interest in future papers.

**Table 2. Panel Unit Root Tests on Main Expenditure Groups  
(Individual Effects & Individual Linear Trends)**

Balanced observations for each test				
Null Hypothesis: Unit root process				
Cross-sections: 26				
Main groups	Lag length	LLC	IPS <i>W</i> -stat	ADF-Fisher $\chi^2$
1	5	-4.36 (0.00)	-3.29 (0.00)	87.30 (0.00)
2	5	-4.85 (0.00)	-4.07 (0.00)	81.07 (0.01)
3	3	-1.68 (0.05)	-4.65 (0.00)	110.70 (0.00)
4	1	0.90 (0.82)	0.04 (0.51)	51.52 (0.49)
5	3	0.68 (0.75)	0.11 (0.54)	32.87 (0.88)
6	1	-2.67 (0.00)	-2.12 (0.01)	65.78 (0.09)
7	1	-2.59 (0.00)	-5.02 (0.00)	100.57 (0.00)
8	2	-1.08 (0.16)	0.56 (0.71)	32.66 (0.86)
9	3	-2.22 (0.01)	-5.54 (0.00)	122.75 (0.00)
10	5	-2.07 (0.02)	-2.80 (0.00)	86.95 (0.00)
11	1	-0.76 (0.22)	0.51 (0.70)	48.49 (0.61)
12	1	0.52 (0.70)	0.64 (0.66)	50.55 (0.59)

We must express that by computing the deviations from the cross-section means, demeaned data were also used in our estimation procedure, but it is observed that the results are not sensitive to using original or demeaned data and we obtain highly similar findings in both cases. These additional results not reported here are available from the authors upon request.

In light of this results, the readers take into account that sample period is highly short in time series annual basis, thus, the estimation results in this paper must be evaluated cautiously.

#### 4. Concluding Remarks

This study investigates whether in-country prices from the Turkish economy converge to a stationary relationship in a contemporaneous panel data framework, if so, this finding would give support to the long-run purchasing power parity in economics theory. Benefited from a related literature, the paper considers a sub-regional categorization of the economy over the period 2005-2012, consisting of 12 disaggregated consumer price indices. Our methodological approach also allows us to classify the goods and services as tradables and non-tradables in a common sense. The estimation results in general point out that the tests applied for empirical purposes tend to verify the non-unit root characteristics of goods which we accept in the branch of tradables and that non-tradable goods and services, to a much greater extent than tradables, tend not to reject the non-stationary null hypothesis. In this perspective, investigating the micro or sectoral based reasons of stickiness of prices

against convergence is highly crucial in an economics policy sense. Revealing such kind of inferences, if possible, will enable both policy makers and other researchers to infer at what degree these sectors are open to trade domestically. At the same time, these additional researches will be able to yield some other policy inferences as for the public interventions restricting free trade of goods and services.

We must also specify that future papers following such kind of studies require crucially to extend the sample period to further verify econometric findings in our empirical analysis. We think that the longer the sample period the more likely will be the convergence of prices between the sub-regions and sectors. The usual disclaimer applies.

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## Appendix

Based on the classification of the Turkish Statistical Institute,  
Cross-sections - city and region considered for prices

- 1 İstanbul
- 2 Tekirdağ, Edirne, Kırklareli
- 3 Balıkesir, Çanakkale
- 4 İzmir
- 5 Aydın, Denizli, Muğla
- 6 Manisa, Afyonkarahisar, Kütahya, Uşak
- 7 Bursa, Eskişehir, Bilecik
- 8 Kocaeli, Sakarya, Düzce, Bolu, Yalova
- 9 Ankara
- 10 Konya, Karaman
- 11 Antalya, Isparta, Burdur

- 12 Adana, Mersin
- 13 Hatay, Kahramanmaraş, Osmaniye
- 14 Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir
- 15 Kayseri, Sivas, Yozgat
- 16 Zonguldak, Karabük, Bartın
- 17 Kastamonu, Çankırı, Sinop
- 18 Samsun, Tokat, Çorum, Amasya
- 19 Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane
- 20 Erzurum, Erzincan, Bayburt
- 21 Ağrı, Kars, Iğdır, Ardahan
- 22 Malatya, Elazığ, Bingöl, Tunceli
- 23 Van, Muş, Bitlis, Hakkari
- 24 Gaziantep, Adıyaman, Kilis
- 25 Şanlıurfa, Diyarbakır
- 26 Mardin, Batman, Şırnak, Siirt

Main expenditure groups

General

- 1 Food and Non-Alcoholic Beverages (Tradable)
- 2 Alcoholic Beverages and Tobacco (Tradable)
- 3 Clothing and Footwear (Tradable)
- 4 Housing, Water, Electricity, Gas and Other Fuels (Non-Tradable)
- 5 Furnishings, Household Equipment, Routine Maintenance of the House (Tradable)
- 6 Health (Non-Tradable)
- 7 Transport (Non-Tradable)
- 8 Communications (Non-Tradable)
- 9 Recreation and Culture (Tradable for Goods, Non-Tradable for Services)
- 10 Education (Non-Tradable)
- 11 Hotels, Cafes and Restaurants (Non-Tradable)
- 12 Miscellaneous Goods and Services (Non-Tradable)