

WEAK AND STRONG FORM TESTS FOR PURCHASING POWER PARITY: EVIDENCE FROM TURKEY

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Summary: This study investigates the presence of purchasing power parity hypothesis in weak and strong forms between Turkey and five major trading partners. The hypothesis is tested under fixed and flexible exchange rates, utilising monthly data for the post-1973 period. The 'weak form test' relies upon the existence of cointegration between bilateral exchange rate and price ratio of domestic to foreign country while the 'strong form test' is based upon the magnitudes of the parameters in the cointegrating vector. Kwiatkowski *et al.* (1992) KPSS and augmented Dickey-Fuller tests are used for the order of integration of the variables. The five Phillips-Ouliaris (1990) residual based cointegration tests are applied for cointegration, using Phillips-Hansen (1990) fully modified OLS residuals. The fully modified Wald test is employed in order to test the PPP restriction on the cointegrating parameters. The PPP hypothesis holds good in weak form for the exchange rates of the nations with which Turkey has close economic ties. Having considered the type of exchange rate system, the weak form of PPP is accepted for the fixed exchange rates during the 1970s while it is rejected for the flexible exchange rates during the post-1981 period. On the other hand, the strong form of PPP is entirely rejected for both systems and for all exchange rates considered.

I. Introduction

Purchasing power parity (PPP) is one of the most controversial hypotheses in the theory of exchange rate determination. The hypothesis in its absolute version states that the exchange rate equals the ratio of domestic to foreign prices. According to relative version of the hypothesis the change in the rate is equal to inflation differential. Although PPP is firmly embedded virtually in all discussions of exchange rate theory and policy, the presence of PPP remains open to question.

After Engle and Granger (1987), most of the tests with regard to the PPP rely on the cointegration between exchange rate and price ratio. In this context, PPP is taken as a long run equilibrium relationship and if the cointegration exists between the underlying variables the hypothesis holds. Dutt and Ghosh (1995) defines this as the necessary condition for PPP and call this type of test as the 'weak form test'. They also define the existence of a cointegration vector, which has some specified parameter magnitudes, as the necessary and sufficient condition for PPP. Such a testing procedure is, therefore, called the 'strong form test'.

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Though the presence of PPP is subject to controversy, it has been confirmed that PPP works better in countries with high inflation, which is usually dominated by monetary shocks¹. On the other hand, few studies have been undertaken on how PPP works under fixed and flexible exchange rates. Among these, Genberg (1978) has found that deviations from PPP are smaller under fixed exchange rates than flexible exchange rates in his study on some industrialised nations. Also, Henricsson and Lundbäck's (1995) augmented Dickey-Fuller (ADF) test results on real exchange rates confirm Genberg's (1978) finding, even though PPP is rejected.

The purpose of this study is to investigate the presence of PPP between Turkey and five major trading partners, the USA, the UK, Germany, France and Italy for the period of 1973 -1996. As a high inflationary developing country, Turkey pursued fixed exchange rates in the 1970s and turned to flexibility in the early 1980s². In this respect, the time period is split into two sub-periods depending on the kind of exchange rates followed: fixed exchange rates which was pursued from 1973.01 to 1981.04 and flexible exchange rates from 1981.05 to 1996.12. Consequently, PPP is tested in weak and strong forms under both fixed and flexible exchange rates in a country with high inflation rates, which provides a different case for the PPP literature. Some new popular econometric tools have been used, namely Phillips and Hansen (1990) (hereafter PH) fully modified ordinary least squares (FMOLS) procedure for cointegration, Kwiatkowski *et al.* (1992) KPSS test of the null of stationarity hypothesis and Phillips and Ouliaris (1990) (hereafter PO) cointegration tests.

The remainder of this research is arranged as follows: Section II outlines the model and explains the methodology. Empirical results are discussed in Section III and Section IV concludes the investigation.

II. The Model And Methodology

The PPP hypothesis in its absolute version is written as

$$E = AP / P^* \quad (1)$$

where A is an arbitrary constant term, E and P are bilateral exchange rate (number of domestic currency per a unit foreign currency) and price level respectively, an asterisk denotes the foreign country. The relationship in (1) is generally written in logarithms of the variables. Let lower case letters present the logs of the variables defined above; then PPP implies

$$e = a + p - p^* \quad (2)$$

A natural test of PPP uses the following equation, which is used in this study:

$$e_t = a + b(p_t - p_t^*) + u_t \quad (3)$$

where u_t is error term and a and b are parameters, t is time subscript. According to Engle and Granger (1987) terminology if e_t and $(p_t - p_t^*)$ are non-stationary and integrated of order one, i.e. $I(1)$, the necessary condition for PPP is the existence of a stationary error process, i.e. u_t should be $I(0)$. The necessary and sufficient condition for PPP is the existence of a cointegrating vector such that $(a,b)=(0,1)$. Dutt and Ghosh (1995) call testing procedure for the necessary condition 'weak form test', and for the necessary and sufficient condition 'strong form test'. In this study, weak and strong form tests are applied for Equation (3). For this purpose, firstly, for the order of integration of the variables, the well known ADF t test is applied as well as Kwiatkowski *et al.* (1992) KPSS test which has been widely popular. The KPSS test is explained as follows:

The KPSS test arises from the criticism against the standard unit root tests. A major criticism about the standard unit root tests is that they fail to reject the null of a unit root for many economic time series. Kwiatkowski *et al.* (1992) propose an alternative test where the null is stationarity against the alternative of a unit root, starting with the data generation process

$$y_t = \delta t + r_t + \varepsilon_t \quad (4)$$

$$r_t = r_{t-1} + \mu_t \quad (5)$$

where ε_t and μ_t are uncorrelated white noise error terms. Stationarity hypothesis is simply that the variance of μ_t is zero, $\sigma_\mu^2 = 0$. Under the null hypothesis y_t is level-stationary when $\delta = 0$ or trend-stationary when $\delta \neq 0$.

In practice, one simply runs a regression of y_t on a constant (in the case of level-stationarity) or a constant plus trend (in the case of trend-stationarity). Using the residuals, ε_t , from this regression, one computes the *LM* statistics:

$$LM = \sum_{l=1}^T S_l^2 / s^2(l) \quad (6)$$

where

$$S_t = \sum_{i=1}^t e_i \quad t = 1, 2, \dots, T$$

$$s^2(l) = T^{-1} \sum_{i=1}^T e_i^2 + 2T^{-1} \sum_{s=1}^l w(s,l) \sum_{i=s+1}^T e_i e_{i-k}$$

where $w(s, l) = 1 - s / (l + 1)$, which guarantees the non-negativity of Newey and West (1987) long-run variance estimate, $s^2(l)$, and l is lag truncation parameter for the long run variance. There are some different ‘rule of thumb’ usages in setting l . However, l is set in this study according to Said and Dickey’s (1984) usage as $l = \text{int}[T^{1/3}]$, ‘int’ denotes integer part of the term in brackets.

Once obtained that all variables are $I(1)$, secondly the PPP relationship in (3) are estimated, and residuals from this regression are obtained to test whether they are stationary for all foreign countries separately. For this purpose FMOLS is applied for the estimation of the PPP relationship and PO residual based cointegration tests is used to test cointegration using the FMOLS residuals. If there is a cointegration between the variables, PPP holds in weak form, the restriction, $(a, b) = (0, 1)$ is tested then to see the presence of PPP in the strong form. In testing the restriction, the FMOLS wald test is applied. The FMOLS procedure is summarised in the following sub-section but PO cointegration test procedure is not given for reasons of space³.

A. Fully Modified OLS Estimation

The well known problem of the OLS estimation of cointegration is that simulation studies have shown that small sample distributions of these estimates have substantial bias, persisting even in sample sizes of 100 or over (see. Banerjee *et al.* (1986)). PH proposes a non-parametric correction in order to mitigate for both bias in coefficient estimates and endogeneity in the data. Their estimator is termed FMOLS estimation and obtained as follows. Let us assume that one has a dependent variable y_t and $(k \times 1)$ vector of explanatory variables \mathbf{x}_t , and that all of the series are $I(1)$. The cointegration relation to be considered is

$$y_t = \mathbf{b}\mathbf{x}_t + z_t \tag{7}$$

where z_t has to be stationary for the existence of cointegration and \mathbf{x}_t is generated according to $\Delta \mathbf{x}_t = \mathbf{h}_t$, \mathbf{h}_t which is a stationary vector process. Define $\mathbf{e}_t = [z_t, \mathbf{h}_t']$, which may be subject to autocorrelation. \mathbf{e}_t is weakly stationary with mean vector $[0, 0]'$ and long run covariance matrix Λ , where $\Lambda = \Lambda_y$. FMOLS estimator of \mathbf{b} is then

$$\hat{\mathbf{b}}_{FM} = \left(\sum_{t=1}^T \mathbf{x}_t \mathbf{x}_t' \right)^{-1} \left(T^{-1} \sum_{t=1}^T \mathbf{x}_t y_t^* - T \hat{\Gamma}_{FM} \right) \tag{8}$$

$$y_t^* = y_t - \hat{\Lambda}_{12} \hat{\Lambda}_{22}^{-1} \quad \hat{\Gamma} = \hat{\Psi} \begin{bmatrix} 1 \\ \hat{\Lambda}_{22}^{-1} \hat{\Lambda}_{21} \end{bmatrix} \quad \hat{\Psi} = \sum_{l=0}^{\infty} E[\mathbf{h}_t \mathbf{e}_{t-l}']$$

where $\hat{\Gamma}_{FM}$ is a bias correction term, $\hat{\Lambda}_{21}$ and $\hat{\Lambda}_{22}$ are consistent estimates of the corresponding elements of long run covariance matrix, and $\hat{\Psi}$ consistent estimate of Ψ . These estimates are obtained non-parametrically via kernel methods starting from the residuals of OLS estimate. Modifications in (8) are explained from two different points. First, $-\hat{T}\hat{\Gamma}_{FM}$ is a term to reduce the effect of second order bias, i.e. the bias induced by the autocorrelation properties in the error term e_t . Second, using \mathbf{x}_t^* instead of \mathbf{x}_t serves to reduce the effect of long run simultaneity, and this permits the use of conventional procedure for inference. Thus, fully modified standard errors (s^*) are obtained as follows:

$$s^* = \hat{\Lambda}_{11,2} \left(\sum_{t=1}^T \mathbf{x}_t \mathbf{x}_t' \right)^{-1} \quad (9)$$

where $\hat{\Lambda}_{11,2} = \hat{\Lambda}_{11} \hat{\Lambda} \hat{\Lambda}_{21}' \hat{\Lambda}_{22}^{-1} \hat{\Lambda}_{21}$. Then, it possible to test m restrictions on \mathbf{b} of the form $\mathbf{Rb} - \mathbf{r}$, using the following result⁴:

$$\left[\mathbf{R} \hat{\mathbf{b}}_{FM} - \mathbf{r} \right] \left[s^{*2} \mathbf{R} \left(\sum_{t=1}^T \mathbf{x}_t \mathbf{x}_t' \right)^{-1} \mathbf{R}' \right]^{-1} \left[\mathbf{R} \hat{\mathbf{b}}_{FM} - \mathbf{r} \right] \xrightarrow{L} \chi^2(m) \quad (10)$$

A test using (10) is called 'Wald test'. In this study, this kind of Wald tests are used to test the restriction, $(a,b)=(0,1)$ on the PPP hypothesis.

III. Empirical Results

Data for empirical analysis are the monthly figures of bilateral exchange rates in Turkey on the currencies of the USA, the UK, Germany, France and Italy, and price levels for all these countries for the period of 1973.01-1996.12. All exchange rates information has been obtained from various issues of *Quarterly Bulletin of The Central Bank of The Republic of Turkey*. Price level data, taken as CPI, is obtained from *International Financial Statistics*, published by the IMF. All price indices are converted to the 1973.01 base.

The ADF and the KPSS stationarity test results for the variables in both level and first differences are reported in Table 1. As clearly seen in the table, the ADF values can not reject the null of unit root and the KPSS values reject the null of stationarity for the variables in level whereas the ADF values reject unit roots and the KPSS values can not reject the null of stationarity for all variables in first differences⁵. Therefore, all variables are difference stationary i.e. all variables are I(1).

Table 1. *Stationarity of the variables*

Foreign Country	ADF				KPSS			
	s_t	pr_t	Δs_t	Δpr_t	s_t	pr_t	Δs_t	Δpr_t
The USA	-2.11(0)	-1.15(6)	-16.71(0)	-7.27(4)	0.44	0.69	0.10	0.07
The UK	-2.04(3)	-1.19(2)	-16.21(1)	-9.88(1)	0.48	0.69	0.07	0.08
Germany	-1.63(0)	-1.08(4)	-16.23(0)	-5.06(6)	0.56	0.65	0.05	0.08
France	-1.45(0)	-0.70(1)	-17.49(0)	-9.37(2)	0.62	0.71	0.04	0.07
Italy	-2.00(0)	-0.68(1)	-15.74(0)	-13.70(0)	0.62	0.73	0.06	0.07

Notes: ADF is conventional t statistics on parameter α_1 from the regression $\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 t + \sum_{i=1}^p \gamma_i \Delta y_{t-i} + v_t$, to test null of stationary. KPSS is explained in the text. Critical values for ADF and KPSS are -3.78 and 0.216 at 1-% level, -3.42 and 0.146 at 5% level, and -3.11 and 0.119 at 10% level, respectively. Critical values are from Dickey and Fuller (1981) and Kwiatkowski *et al.* (1992) for ADF and KPSS, respectively. The lag length for the ADF test was selected as a minimum lag that there was not twelve-order autocorrelation according to lagrange multiplier test statistics.

Based on this finding, secondly, the PPP relationship in (3) are estimated, and residuals from this regression are obtained to test whether they are stationary for all foreign countries separately. PO cointegration test results for both fixed and flexible exchange rates and the entire period are presented in Table 2. It is seen that under the fixed exchange rates, except for P_2 all the test statistics support the PPP hypothesis rejecting the null of no cointegration for all foreign countries. Under the flexible exchange rates, there is less evidence for only the UK. On the other hand Germany and France give support for PPP for the entire sample period.

Table 3 reports the FMOLS estimation and the Wald test results for only the cointegrated relationships. The Wald statistics reject the restriction for all cointegrated relationships. This suggests that none of the relationships confirm the presence of PPP in strong form.

Table 2. *Phillips-Ouliaris cointegration test*

Foreign Country	t_{α}	Z_{α}	Z_t	P_u	P_z
<i>Fixed Exchange Rates (1973.01-1981.04)</i>					
The USA	-4.01(0) ^a	-27.91 ^b	-4.04 ^a	36.95 ^b	40.02
The UK	-4.42(0) ^a	-32.25 ^a	-4.48 ^a	40.04 ^b	47.27
Germany	-5.19(0) ^a	-42.19 ^a	-5.23 ^a	64.53 ^a	66.74 ^b
France	-4.70(0) ^a	-35.77 ^a	-4.74 ^a	52.14 ^a	56.21 ^b
Italy	-4.36(0) ^a	-30.24 ^a	-4.39 ^a	36.74 ^b	38.71
<i>Flexible Exchange Rates (1981.05-1996.12)</i>					
The USA	-2.82(0)	-10.88	-2.69	17.67	16.97
The UK	-2.85(0)	-15.44	-2.75	37.75 ^b	38.02
Germany	-2.42(0)	-9.93	-2.35	19.79	19.68
France	-2.80(0)	-14.09	-2.82	22.68	22.60
Italy	-2.41(0)	-8.42	-2.29	15.48	15.25
<i>The Entire Period (1973.01-1996.12)</i>					
The USA	-2.16(0)	-9.51	-2.27	12.31	12.37
The UK	-2.71(0)	-14.60	-2.81	20.95	21.14
Germany	-3.67(1) ^b	-31.56 ^a	-4.17 ^a	50.37 ^a	50.67 ^c
France	-3.12(1) ^c	-27.37 ^b	-3.88 ^b	40.38 ^b	40.38
Italy	-2.47(0)	-12.47	-2.56	18.36	18.47

Notes: Critical values for t_{α} , Z_{α} , Z_t , P_u and P_z are -3.96, -28.32, -3.96, 48.00 and 71.93 at 1% level, -3.36, -20.49, -3.36, 33.71 and 55.22 at 5% level, -3.06, -17.04, -3.06, 27.85 and 47.59 at 10% level, respectively. Critical values are from PO, pp.189-92.

Table 3. *Fully modified OLS estimation and wald test results*

Foreign Country	Period	\hat{a}	\hat{b}	Wald
The USA	1973.01-1979.12	2.5096 (0.0281)	1.0223 (0.0327)	16526
The UK	1973.01-1979.12	3.4095 (0.0244)	1.3277 (0.0405)	31540
Germany	1973.01-1979.12	1.5278 (0.0209)	1.0616 (0.0204)	12293
France	1973.01-1979.12	1.0115 (0.0230)	1.1324 (0.0296)	4209
Italy	1973.01-1979.12	0.7187 (0.0243)	1.1469 (0.0432)	1515
Germany	1973.01-1996.12	1.5523 (0.0292)	1.0739 (0.0065)	11134
France	1973.01-1996.12	1.1042 (0.0328)	1.0776 (0.0083)	4386

Notes: The critical χ^2 values for Wald test at 1% and 5% levels are 9.21 and 5.99, respectively

IV. Conclusion

This study is intended to investigate the presence of PPP in weak and strong forms utilising monthly data on Turkey and its five major trading partners. The hypothesis is tested under both fixed and flexible exchange rates over the period of 1973-1996. PPP in weak form relies upon cointegration between bilateral exchange rate and price ratio of Turkey to that of a foreign country, while PPP in strong form based upon the magnitudes of the parameter in the cointegrating vector. Empirical results indicate that PPP in weak form holds under the fixed exchange rates but does not in the flexible exchange rates. This is verified for all five countries considered in this study. However, in the entire period only Germany and France give support for PPP in weak form. These two countries have the two biggest shares in Turkey's balance of payment among the European countries. On the other hand, there is not any sufficient evidence for PPP in strong form.

The concrete conclusion is that PPP holds in weak form under the fixed exchange rates but does not in the flexible exchange rates for Turkey. This is consistent with Genberg's (1978) result that deviations from PPP is smaller under fixed exchange rates than flexible exchange rates. Without taking into account the type of exchange rate system, PPP holds good in weak form for nations with which Turkey has close economic ties.

Notes

¹ See for example Frenkel (1978, 1981), McNown and Wallace (1989), Liu (1992) and Mahdavi and Zou (1994).

² After Bretton Woods System crash in the early 1973, Turkey continued crawling peg exchange rate system with mini devaluations in relatively short periods up to the early 1980. In January 24, 1980 Turkish government declared a stabilisation program with a big devaluation and followed a certain number of liberalisation policies. Government handed over its authority to Central Bank in order to set exchange rates in May 1, 1981. Since then Central Bank has announced exchange rates daily, and flexibility on exchange rates has increased gradually. This study assumes fixed exchange rates for before the 1981.05 period and flexible exchange rates, from this period onwards.

³ PO investigates asymptotic distributions of five test statistics, namely Dickey and Fuller's (1981) ADF statistics (t_a), Phillips' (1987) Z_a and Z_r statistics and two new test statistics proposed by them, P_n and P_z , and tabulates critical values for 500 observations. See PO pp. 171-3, for a full discussion.

⁴ See, Hamilton (1994), p. 618

⁵ In all tests conventional 5% significance level is considered.

Özet: Bu çalışmada 'satılmalma gücü paritesi' (PPP) hipotezinin geçerliliği Türkiye ve beş büyük ticaret ortağı arasında zayıf ve güçlü formlarda araştırılmaktadır. Hipotez, 1973 sonrası dönem için aylık veriler kullanılarak sabit ve esnek döviz kuru rejimleri altında sınanmaktadır. 'Zayıf form sınaması' döviz kuru ile yurtiçi-yurtdışı fiyat oranı

arasında eşbütünlüğün varlığına dayanmaktayken, güçlü form sınaması eşbütünlükteki parametrelerin alacağı değerlere bağlıdır. Değişkenlerin bütünlük dereceleri için Kwiatkowski v.d. (1992) KPSS ve genişletilmiş Diekey-Fuller (ADF) sınamaları kullanılmıştır. Eşbütünlük için, Phillips-Hansen (1990) 'tamamen değiştirilmiş en küçük kareler' (FMOLS) kalıntılarına, kalıntıya dayalı beş Phillips-Ouliaris (1990) sınaması uygulanmıştır. Eşbütünlük parametreleri üzerindeki PPP sınırlamalarını sınamak için 'tamamen değiştirilmiş Wald sınaması' düzenlenmiştir. PPP hipotezi, Türkiye'nin yakın ekonomik ilişki içinde olduğu ülkelerin döviz kurları için zayıf formda geçerlidir. Döviz kuru sisteminin türü dikkate alındığında, zayıf formdaki PPP 1970'li yıllardaki sabit döviz kuru için kabul edilmekteyken, 1981 sonrası dönemdeki esnek döviz kuru için reddedilmiştir. Diğer yandan güçlü formdaki PPP tüm döviz kurları için her iki sistemde de reddedilmiştir.

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BİLGİSAYAR DESTEKLİ OTOMASYON SİSTEMLERİ VE BİR UYGULAMA: ÖZEL YETENEK SINAVLARINDA BİLGİSAYAR KULLANIMI

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Özet: İnsan gücünün yoğun olarak kullanıldığı sektörlerde, kişilerin performansına bağlı olarak, verimlilik ve kalite faktörleri değişkenlik göstermektedir. İş akışı içerisinde insan gücünün katkısını azaltarak daha verimli ve kaliteli bir çalışma ortamı oluşturmak amacıyla bilgisayar destekli sistemlerin kullanımı yaygınlaşmaktadır. Bilgisayar destekli sistemlerin önem kazandığı diğer bir konu da ölçme ve değerlendirmedir. Özellikle bireylerin özel yeteneklerinin ölçülmesi ve değerlendirilmesinde bilgisayar kullanımı insan hatasını en aza indirmekte ve sınav sonuçlarına yapılan itirazların da azalmasını sağlamaktadır. Bu çalışmada üniversitelerin Beden Eğitimi ve Spor Bölümü Özel Yetenek sınavlarına yönelik bir otomasyon sistemi geliştirilmiş ve sistemin işleyişi hakkında bilgi verilmiştir.

I. Giriş

Bilgisayar kullanımı üretim alanında önemli değişmelere neden olmuş, güçler dengesinde de bazı değişmelere yol açmıştır. Druker'in belirttiği gibi 1920'lerin kilit üretimi olan otomobilde, hammadde ve enerji payı %60 iken, günümüzde bilgi toplumunun kilit üretimi olan mikro chip üretiminde, hammadde ve enerjinin payı %2'nin altına düşmüştür. Bu gelişme, sanayi ve bilgi toplumunda üretimi gerçekleştirilen mallarda, girdi ağırlığının ne denli bir kayma gösterdiğini sergilemektedir. Kısacası 21. yüzyıl "en çok petrol rezervi olan, en çok otomobili üreten, altın fiyatlarına hükmeden, tahıl ambarı olmakla övünen değil, en hızlı ve en güçlü yongayı en ucuz fiyata üreten ülkelerin yüzyılı olacaktır." (Akt., Gürses. 1992,21 Aralık: s.7).

Gelişen teknolojilerin getirdiği bu imkanlar sayesinde uygulaması yapılan birçok işte insan katkısının azaltılması yönündeki bu yaklaşım, birçok alanda uygulanabildiği gibi, eğitim alanında, bireylerin özel yeteneklerinin ölçülmesi ve değerlendirilmesi konusunda da uygulanabilecek ve birçok fayda sağlayacaktır. Bu yolla çok zahmetli, düzensiz ve her zaman objektif olamayan, aşırı zaman gerektiren, bir dizi zor işlemi; çok daha az sürede ve objektif kriterler uygulayarak yapmak mümkün olabilecektir.

Günümüzde, ilkokullardan üniversiteye kadar her aşamadaki okullarda hatta okul öncesi programlarda bile bilgisayar kullanımı yaygınlaşmıştır. Bilgisayar destekli öğretimde bilgisayarlar ya öğrenciye veri sağlamakta; ya da

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