Convergence to Purchasing Power Parity in Turkey:

Evidence from City Level Data

by

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Abstract

This thesis examines the price dispersion in Turkey over the period of January 2003 – June 2011 by using consumer price indices for twenty-six Turkish city groups. Preliminary analysis of the time series properties of price levels and deviations from purchasing power parity (PPP) with base cities Ankara, Istanbul, and Diyarbakir shows that deviations can be considerably persistent. The thesis examines convergence to PPP more formally by using two unit root tests (i.e., tests where the null is that the PPP deviations have a unit root) and a stationarity test (i.e., test where the null is that the PPP deviations are stationary). Unit root and stationarity tests show that deviations from PPP have a unit root for many of the cities. Specifically, the stationarity test rejects the null of stationarity in deviations for all cities when Istanbul is the base city and rejects all but one when Ankara and Diyarbakir are the base cities. Although unit root tests provide relatively more promising results in favor of PPP in Turkey, overall findings are not supportive of a weak form of PPP. Moreover, unit root tests show some variation across different base cities. For example, the Augmented Dickey-Fuller test provides evidence in favor of PPP in three, eight, and twelve city groups with Ankara, Istanbul, and Diyarbakir, respectively, as the base cities. Given the rather bleak evidence against PPP within Turkey, the thesis attempts to quantify the degree of persistence in deviations by using half-life measures. Despite some shortcomings of the measure used, the thesis provides some preliminary results that show relatively short half-lives for PPP deviations. Findings reveal that deviations from PPP on average halves within less than one year and the speed of convergence to PPP changes with the base city used. Deviations from PPP with Ankara and Istanbul as base cities tend to converge slower than Diyarbakir as the base city. In order to provide some insights into the variations in the persistence of PPP deviations across cities, the thesis regresses half-life measures on a proxy of transportation cost and estimates linear and nonlinear probability models to check to what degree outcomes of unit root tests can be explained by the transportation costs. Results show that transportation costs can plausibly explain both the variability in the persistence of deviations and the likelihood of having a unit root in the deviations.

Keywords: Purchasing Power Parity, Unit Root, Stationarity, Convergence, Half-Life

Özet

Bu tez, Türkiye'nin 26 bölgesinin tüketici fiyat endekslerini kullanarak, Ocak 2003 – Haziran 2011 dönemi için Türkiye'deki fiyat farklılıklarını incelemektedir. Fiyat seviyelerinin ve Ankara, İstanbul ve Diyarbakır baz şehirleri ile gerçekleştirilen satın alma gücü paritesinden sapma değerlerinin, zaman serisi özelliklerini içeren ön analiz göstermektedir ki sapmalar oldukça kalıcıdır. Tez, iki birim kök testini (sıfır hipotezine göre satın alma gücü paritesinden sapmalar birim köke sahiptir) ve durağanlık testini (sıfır hipotezine göre satın alma gücü paritesinden sapmalar durağandır) kullanarak satın alma gücü paritesine yakınsamayı daha örgün bir biçimde incelemektedir. Birim kök ve durağanlık test sonuçlarına göre satın alma paritesinden sapmalar birçok şehir için birim köke sahiptir. Özellikle, durağanlık testi, sıfır hipotezini İstanbul baz şehir iken tüm şehirler için, Ankara ve Diyarbakır baz şehirler iken bir şehir hariç diğer tüm şehirler için reddetmektedir. Birim kök testleri Türkiye'deki satın alma gücü paritesinin lehine daha umut vadeden sonuçlar sağlamasına rağmen, genel sonuçlar zayıf formlu satın alma gücü paritesini desteklemektedir. Dahası birim kök testleri farklı baz şehirlerde bazı sapmalar göstermektedir. Baz şehirler Ankara, İstanbul ve Diyarbakır olmak üzere sırasıyla üç, sekiz ve on iki şehir grubu için Augmented Dickey-Fuller testi satın alma gücü paritesi lehine kanıt göstermektedir. Türkiye'deki satın alma gücü paritesine zıt kanıtlara rağmen tez, yarı ömür yöntemlerini kullanarak sapmalardaki durağanlık derecesini ölçmeye çalışmaktadır. Yöntemlerdeki bazı yetersizliklere rağmen tez, satın alma gücü paritesi için göreli olarak kısa yarı ömür gösteren bazı ön sonuçlar sağlamaktadır. Sonuçlara göre ortalama yarı ömürler bir yıldan azdır ve yakınsama hızı, baz şehre göre değişmektedir. Ankara ve İstanbul'un baz şehir olarak alındığı satın alma paritesinden sapmalar, Diyarbakır'ın baz şehir olarak alındığı duruma göre daha yavaş yakınsamaktadır. Satın alma paritesinden sapmaların kalıcılığı konusunda öngörü sağlamak amacıyla tez yarılanma ömrü ölçütlerini ulaşım maliyetleri ile karşılaştırmış ve birim kök testlerinin sonuçlarının ne ölçüde ulaşım maliyetleri ile açıklanabildiğini doğrusal olmayan olasılık modelleri ile değerlendirmiştir. Sonuçlar göstermektedir ki ulaşım maliyetleri makul ölçüde, sapmaların kalıcılığındaki değişkenlik ve sapmaların birim köke sahip olma olasılığı ile açıklanabilmektedir.

Anahtar Sözcükler: Satın Alma Gücü Paritesi, birim kök, durağanlık, yakınsama, yarı ömür

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1. Introduction

The goal of this thesis is to revisit one of the key propositions in international macroeconomics and finance- the Law-of-One-Price (LOP) and Purchasing Power Parity (PPP) in an emerging market economy, namely, in Turkey. The main novelty of this thesis is the use of data at the city level over the period between 2003 and 2011. This thesis aims to gain novel insights about the key properties of relative prices without trade barriers and currency fluctuations. The majority of the existing literature on relative prices focuses on relative PPP, the persistence and time series variability of CPI-based real exchange rates. The consensus finding is that the variance of real and nominal bilateral exchange rate are roughly equal and that deviations of real exchange rates from their unconditional sample means have half-lives of between three and five years (see, Rogoff 1996, Taylor and Taylor 2004, Obstfeld and Rogoff 2001, among others). A growing number of studies also investigate deviations from PPP and LOP by using micro-level data (i.e., good-level data on absolute prices of goods in different countries or locations within a country) and draw conclusions on the dynamics of deviations by using various econometric tools. The results of this line of literature range in terms of the rate of convergence to PPP and LOP. The results vary considerably over the sampling period, countries and prices of goods from fairly high speeds of convergence to positive but slow convergence rates (see, Rogers and Jenkins 1995, Parsley and Wei 1996, Engel and Rogers 1996, Crucini and Shintani 2008, Crucini, Shintani and Tsurga 2009).

This thesis contributes to the literature on PPP and LOP by investigating the dynamic of deviations from PPP by using city-level monthly price data between January 2003 and June 2011 in Turkey. The data contains price index series for the 26 city groups in Turkey. Although the price series are aggregated to the city/region level, the thesis provides useful insights into the dynamic of deviations from PPP within a country where barriers to trade does not exist and deviations are insulated from the effects of exchange rate fluctuations. The analysis in the thesis shows that even within the same country, deviations from PPP can be non-stationary and hence PPP may not hold as a long run condition. Examination of the speed of convergence in PPP deviations with three different base city groups, namely Ankara, Istanbul, and Diyarbakir reveal considerable variation across city groups. Point estimates of half-life of PPP deviations show that average half lives vary somewhat with the base city used with longer estimates for Ankara and shorter estimates for Diyarbakir as the base city. Investigating the factors to account for the half-life variations show that distance as a proxy for the transportation cost may account some of the variations in half-life estimates and hence the degree of persistence in PPP deviations. Findings in this thesis also shows that the likelihood of PPP holding for a given city might be also associated with the transportation cost as such the higher the transportation cost the lower the probability of rejecting a unit root in the PPP deviations.

2. Law of One Price and Purchasing Power Parity

This section provides a discussion of purchasing PPP proposition and the basic building block of PPP, namely the LOP. The discussion in this section relies on Feenstra and Taylor (2008). The LOP postulates that tradable goods that are similar, once their national prices are expressed in a common currency, should sell for the same price across different international locations. Aggregating over tradable goods and services within a sector and then over sectors, one can obtain that the resulting basket of tradable goods and services should trade at the same price. This gives a rise the notion of PPP in tradable goods. A further aggregation over non-tradable goods and services results in the conventional PPP hypothesis: national price levels should be equal when expressed in a common currency.

The idea that drives the LOP and eventually PPP is the arbitrage. Arbitrage is a trading strategy that exploits any profit opportunities arising from price differences and when such a profit opportunity exists, the market is considered as to be out of equilibrium. Arbitrage occurs especially for financial assets in the international financial markets of the contemporary world but it also takes place in international and intra-national goods markets. Because of the goods market arbitrage, the common currency prices of goods in different countries must be equalized. In the absence of trade frictions such as transportation costs and tariffs; and under the conditions of free competition where no individual sellers or buyers have enough power to manipulate prices; identical goods sold in different locations must have the same price when the prices are expressed in a common currency. By definition in market equilibrium, there are no arbitrage opportunities. In this situation, two different locations form an integrated market.

LOP theory has two versions as absolute and relative LOP. In absolute version of LOP, the nominal exchange rate between two currencies should be equal to the ratio of the prices of a good in two different region. Ignoring transactions costs for the time being or assuming that transaction costs are zero, the absolute version of the LOP can be written formally as: $P_{i,t} = S_t P^*_{i,t}$ where $i = 1,....., n$ and $P_{i,t}$ is the price of good *i* in terms of the domestic currency at time *t*, $P^*_{i,t}$ is the price of good *i* in foreign currency at time *t*, and S_t is the nominal exchange rate expressed at the price of foreign currency at time *t*. The relative version of LOP theory specify that the percentage change in the nominal exchange rate between two currencies for a period of time must be equal to the difference between the percentage change of prices in national currencies. Fundamentally, the relative version of the LOP proposes that when there is a price dispersion between two regions in a period of time, this deviation continues to exist in the next period. Particularly, using logarithm derivation can be more manageable to clarify the relative version of LOP. If it is defined as $p_{i,t} = \log P_{i,t}$, $p^*_{i,t} = \log P^*_{i,t}$ and $s_t = \log S_t$, the logarithmic equation of absolute version of LOP in logarithms becomes $p_{i,t} = s_t + p^*_{i,t}$. The relative version of LOP theory can be represented in logarithm with time differences $(p_{i,t+1} - p_{i,t}) = (s_{t+1} - s_t) + (p^*_{i,t+1} - p^*_{i,t})$. The relative version of LOP theory can also be represented simply in the form of percentage change as $\%\Delta p_{i,t} = \%\Delta s_t + \%\Delta p^*_{i,t}$ where $\Delta p_{i,t} = p_{i,t+1} - p_{i,t}$, $\Delta s_t = s_{t+1} - s_t$ and $\Delta p^*_{i,t} = p^*_{i,t+1} - p^*_{i,t}$. The absolute version of the LOP implies also the relative version which can be formally stated as the following weaker condition: $\frac{P^*_{i,t+1} S_{t+1}}{P_{i,t+1}} = \frac{P^*_{i,t} S_t}{P_{i,t}}$, $i = 1,....., n$.

Purchasing Power Parity principle is essentially the macroeconomic counterpart of the Law of One Price Theory. PPP applies the LOP to the price levels of whole economy therefore instead of prices of a good, price indices are used such as consumer price index (CPI). LOP always implies PPP if the two region have the same consumption basket. As in the LOP theory, there are two versions of PPP, the absolute and relative. According to absolute PPP, unit of currency should be able to buy the same basket of goods in one country as the equivalent amount of foreign currency. If the absolute version of LOP holds for individual goods, the absolute PPP should hold for the CPI so the absolute version of

PPP can be written as $Q_t = S_t Q_t^*$ where Q_t is the CPI in terms of the domestic currency at time *t*, Q_t^* is the CPI in foreign currency at time *t*, and S_t is the nominal exchange rate expressed at the price of foreign currency at time *t*. When the absolute PPP is defined with logarithmic terms, $q_t = \log Q_t$, $q_t^* = \log Q_t^*$ and $s_t = \log S_t$, the logarithmic equation of absolute PPP becomes $q_t = s_t + q_t^*$. The relative version of PPP can be written in logarithms by the same reasoning with relative version LOP as $(q_{t+1} - q_t) = (s_{t+1} - s_t) + (q_{t+1}^* - q_t^*)$.

The absolute version of LOP theory implies absolute PPP and the relative version of LOP on the other hand, the relative version of LOP and the absolute PPP implies the relative PPP individually. Therefore the absolute version of LOP is the strongest but relative PPP is the weakest of this conjecture. When there is a constant deviation from the LOP, the relative version of LOP might hold but absolute version does not hold and this is valid also for PPP. According to absolute LOP and PPP the real exchange rate is always 1, on the other hand in relative version of LOP and PPP, real exchange rate is constant and it does not have to be 1.

This study is an intra-national analysis, the price levels are received from city groups of the same country and within a country the nominal exchange rate is 1. Therefore there is no exchange rate variability for our analysis. The relative price levels of the regions are subject to same economic policies in intra-national analysis and there is no trade friction such as tariffs and quotas that affects price convergence negatively as in international analyses. So it is expected that convergence rates would be faster than an international analysis.

3. Literature Review

This section provides an overview of existing literature on the LOP and PPP. More specifically, this section of the thesis discusses the empirical evidence from the existing literature on LOP and PPP and elaborates on the persistence of deviations from LOP and PPP. According to Taylor and Taylor (2004) in a self-equilibrating international macroeconomic system, PPP should help balance the exchange rate levels in the long run. However, there may exist reasons why PPP may fail to help equating prices across countries. These factors include among others, presence of transaction and transportation costs impediments to free trade of goods, existence of non-traded goods and stickiness in prices. Some or all of these factors may explain why the tendency for PPP to hold is relatively weak in the short run. One of the most common assumptions of macroeconomics is that prices are sticky in short run. The prices do not or cannot adjust quickly and flexibly to changes in market conditions. PPP assumes that arbitrage can force prices to adjust, but the adjustment will be slowed by price stickiness. Nominal exchange rates move up and down on a very extraordinary path but price levels might be are much more sluggish in their movements.

Rogoff (1996) argues that, while some empirical studies take PPP as a short term proposition, most of them define PPP as a long run anchor for real exchange rates. Despite these problems; in a long run theory of exchange rates, PPP is still a useful approach and PPP may become even more relevant in the future as more goods are traded. The globalization trends may well continue by the evolution of information and transportation technology.

Debreu (1959) points out in the Theory of Value that a good can be a different economic object when it is produced and sold at different locations so the price of the same good might vary in different locations. International trade patterns can be explained by geographical considerations. According to Engel and Rogers (1996), physical distance and nominal price stickiness can explain the failure of the theory of the LOP, but in an international context, border effect should be considered to explain the failure of the LOP. The spread of the price of similar goods to the distance between markets varies by the effect of transportation cost. Their findings show that the volatility of similar goods between cities should be positively related to the distance between those cities. Physical distance plays a significant role in explaining the failure in the LOP between two locations in the same country. On the other hand they note that the physical distance alone does not explain the variability in prices of similar goods whether the two locations are in different countries. They conclude that two cities that are separated with the border beside a general physical distance will have larger failure of the LOP than two cities in the same country.

Parsley and Wei (1996) investigates a panel of prices from different cities in United States in order to provide an upper bound estimate of the rate of convergence to PPP. They find out that convergence is negatively related to the distance between city/country pairs. Nevertheless they note that distance is not enough to explain the convergence rates among the cities of the same country. Moreover, they indicate that convergence occurs faster for larger price differences. Like Engel and Rogers (1996), the study of Parsley and Wei (1996) claims that transportation costs allow the price differences between cities and the size of these differences is related with the arbitrage costs. Parsley and Wei (1996) indicates that there is a negative relationship between distance and convergence rate. On the other hand they point out that distance between cities cannot explain the convergence rates disparity itself although there is a higher variability for international prices than prices of cities in national borders. They compute approximately 4 quarters (12 months) half life for US and 4-7 quarters (12-28 months) for OECD countries.

Parsley and Wei (2001) surveys a panel data set of prices of traded goods, across the cities in the US and Japan. They examine several potential economic factors on the border effect like Engel and Rogers (1996). Their results show that price disparity increases with distance between the cities within a country. Also they add cross national political borders into the debate in the form of constant distance traveled. They find out that distance, unit shipping costs and exchange rate variability are the significant factors. In this study disaggregated U.S. prices seem more scattered than Japanese prices.

Haskel and Wolf (2001) criticizes that differences in local distribution costs, local taxes and tariffs do not explain the price pattern, leaving strategic pricing or other factors resulting in varying markups as alternative explanations. They examine a panel of local currency transaction prices of identical products sold by the same company in a large group of countries. They find significant common currency price divergences across countries. The distribution properties of the price divergences can not clarify the differences in local costs, tariffs or taxes, However they show that actual or potential arbitrage affects the size of violations of the LOP and may also lead to a gradual reduction of these differences over time. The findings demonstrate that considerable violations of the LOP are common features of individual goods prices.

Beck and Weber (2001) uses consumer price data of some European cities to study deviations from the law-of-one-price before and during the European Economic and

Monetary Union (EMU) by analyzing both aggregate and disaggregate CPI data for seven categories of goods. They conclude that, the distance between cities has positive correlation with the price disparities. Additionally, they find out that price disparity is higher for two cities located in different countries than for two equidistant cities in the same country. They also report in their paper that, the border effect is reduced after EMU eliminated the nominal exchange rate volatility but still distance plays an active role for intra-European relative price volatility.

In a Scandinavian LOP example, Asplund and Friberg (2001) uses duty free outlets whose price tags are exhibited in at least two currencies to provide options to customers therefore a helpful system for LOP theory. In this study, the price patterns of Scandinavian duty free outlets prove that large deviations from LOP are adjusted by firms but small deviations remain in long run because of the fixed costs of nominal price adjustments. As a result, Asplund and Freiberg (2001) concludes that national markets are not integrated enough to support LOP theory.

Ceglowski (2003) investigates the behavior of intra-national prices for specific consumer goods across Canadian cities to analyze intra-national deviations from the relative price parity and to study on the role of internal borders in intra national price movements. She finds out that distance and provincial borders play a positive role in intercity price disparities. She attains a median of 0.55 years (6 months) convergence rate for the disaggregated prices in Canada.

As in international context, the geographic distance between markets can play an important role in the failure of absolute price equalization. The greater distances between cities cause higher transportation or information costs and price variability can be larger for cities located further apart. International price studies like Engel and Rogers (1996) claims that border effect has more importance than distance in relative price differentials. The border can express wider range of factors such as exchange rate fluctuations, tax differences, national production networks, regulatory barriers and demand differences but all these factors are valid for intra-national context except exchange rate fluctuations. Geography can play an essential role for price variability especially for the cities that are far from the central location because of freight costs. Transportation costs are positively correlated with distance and therefore price level in peripheral cities is higher with respect to core locations.

Bils and Klenow (2004) examines the frequency of price changes for 350 categories of goods and services covering about 70 percent of consumer spending. This kind of selection might be a projection for CPI whose aim is to cover a significant amount of general spending basket of typical consumers. They notice considerably more frequent price changes than previous studies that were based on narrower sets of goods. The time between price changes is maximum 4.3 months for half of consumption.

Allington, Kattuman and Waldmann (2005) investigates the market integration and LOP in European Union (EU) that has a common currency regime. They conclude that euro has a positive effect on price convergence especially for tradable goods in euro zone with respect to non-EU members. EU is a common market with no exchange rate risk, no tariffs, no quotas and no other trade barriers and the only explanation for the failure of LOP seems transportation costs if national variations in consumer preferences are neglected. On the other hand, the high convergence rate has positive effect on trade and competition therefore common currency and trade union constitute a bilateral process. They claim that after the foundation of EU, single market and common currency, price dispersion decreases in Europe. They conclude that euro has a positive effect on the price convergence among EU members relative to the non-EU members.

In the study of Crucini, Shintani and Tsuruga (2010), Japanese micro data consisting of retail prices of more than 350 goods and services from 47 cities, is analyzed in order to find out how distance and the price stickiness effect the variability of LOP deviations. They ascertain that variability of LOP deviations are positively correlated with distance whereas negatively correlated with the degree of price stickiness by using regression equation like Engel and Rogers (1994) and also using a regression method as in Parsley and Wei (2001) for the border effect. Their theoretical model supports the interpretations of Engel and Rogers (1996) about the price stickiness and economic geography models of trade.

Sarno and Passari (2011) surveys the literature on LOP and PPP and argues that that the notion of PPP holds in the long run for a wide range of tradable goods and services and for many currencies. This paper focuses mainly on the international tradable goods and services rather than baskets of goods and services that also include non tradable components. Sarno and Passari (2011) notes that people in different countries have different consumer preferences and purchasing patterns even the same goods are available in two countries. Therefore comparing the price of the baskets of goods is complicated according to Sarno and Passari (2011). Sarno and Passari (2011) remarks that the deviations from the LOP are transitory and therefore the LOP holds in the long run among a broad range of tradable goods and currencies. Their survey of the literature on LOP for tradable goods and potential nonlinear dynamics in LOP deviations shows that the LOP holds over long periods of time for the tradable goods and services and that adjustment occurs in a nonlinear fashion in that large deviations generate faster adjustment than the smaller deviations.

Although arbitrage is a process which should equalize the prices in different places when the influence of factors such as border effect or distance, are removed; according to Schwarz (2011), arbitrage is an entrepreneurial activity and influenced by institutional quality. Low-quality institutions might constitute repressive costs on arbitrage activity as in the border effect of Engel and Rogers (1996) that borders with high tariffs generate large distances between cities. On the other hand the institutional quality can be upgraded by economic policy makers. This kind of technical regulation can be easier then to overcome the distance or language difference. Schwarz (2011) claims that the institutional quality significantly affects price dispersion intensity.

When a producer can provide a good or service at a lower cost because of a new production or transportation technology, the mechanism that spreads the new technology and decreases the price variability between the regions that have different production or transportation technique, is the entrepreneurial activity. Schwarz (2011) discusses that whether the arbitrage is accepted as a productive entrepreneurial activity, instead of primitive rent generating process, institutional quality can influence the price dispersion.

At the beginning of this study, in the literature review development there are some fundamental points of the researches and analyses that are examined. Independent from the region or country, in fact the summarized researches for developed economies such as US, EU, Japan, Canada, it is seen that the physical distance is the major determinant of price disparity. However the study of Crucini, Shintani and Tsuruga is seem to suggest other factors such as price stickiness. Except nominal price stickiness, the factor that causes price divergence in national economies is physical distance that can be also identified as geographical difficulties or transportation costs technically. An increase is physical distance causes price differences and prevents to hold the law of one price theory and the purchasing power partiy. When the studies on price disparities in international context are examined, again it can be seen that the importance of physical distance with the border effect that is the most common way of explaining the international price divergences in international horizon. In the sub-context of border effect, differences in tax regime, tariffs, quotas and exchange rate risk for trade are referred but the border effect is expressed in terms of distance.

4. Data and Preliminary Results

4.1. Data

This study employs the monthly regional CPI data for Turkey between 2003.01 and 2011.06. CPI data of Turkey is processed only by Turkish Statistical Institute (TURKSTAT) and results are announced every month with a bulletin. There is no seasonal adjustment for the price data. There is no significant difference between Turkish methodology and international standards that are defined by EUROSTAT. In the determination of weights and the calculation of index, the classification of individual consumption according to purpose (COICOP) is used and these consumptions are classified under 12 main groups and 44 sub groups. Totally 447 items are included in CPI. The weights in CPI are defined according to Household Budget Survey which includes about 25000 household from all socio economic groups, Tourism Survey to determine the consumption of foreign visitors in Turkey and Institutional Population Survey. The current weights are formed as 1/3 for 2003, 1/3 for 2004 and 1/3 for 2005 between January 2003 and December 2005 period.

In CPI with base year 2003, all monetary spending for domestic consumption of final goods and services are considered. The prices are gathered form all provinces and 72 town centers in Turkey. 330000 prices are collected from 23000 businesses and also the information of 3826 tenants is fallowed for the formation of the index monthly. The population scope of index is designated with no distinction according to income groups of population or geographical regions.

CPI measures the changes in prices of the goods and services that belong to household consumption in time. The aim of CPI with base year 2003 is to calculate the inflation rate by measuring the change in the prices of goods and services in the market. Accordingly, beside the household consumption, the domestic consumption of foreign visitors and institutional population are considered. In this context, the household production for their own consumption and the households' relative rents are excluded.

The price content of index is established as the retail purchasing prices including taxes are used in the price content of the index. Installments and contract prices are not included. Annual average retail prices of selected items that collected from 78 province centers are presented. The main subjects are food, beverage and tobacco, clothing and footwear, housing, furniture and furnishings, health, transportation, entertainment and culture, education, hotels, cafes and restaurants and miscellaneous goods and services expenditure. Non durables and oil prices are updated once in a week, other commodities are updated twice in a month and rents are updated once in a month.

The commodity baskets and weights are updated at the end of the each year and the series proceed with serial Laspeyres formulation. Every December new articles are included to the index or the articles that lose their significance are excluded form the list and weights are also modified according to new commodity list. The index is calculated as $I = w \times (P_i / P_0)$ and $I_t = w_i \times \left(P_{it} / P_{December(t-1)}\right) \times I_{December(t-1)}$ where I : index, P_i : current price, P_0 : base year price, w : weight, w_i : new weight and t: time. The current prices are divided by previous December prices and multiplied by their weights in index calculation then the sequence is formed by multiplying with previous December index.

The CPI data is gathered from TURKSTAT Databank. For the period in this study, TURKSTAT assigns the base year of 2003 and rearranges the regions in CPI data presentation. TURKSTAT provides price data for 26 regions of the country instead of individual 81 provinces. For example, TURKSTAT posts one data for Edirne, Tekirdag and Kirklareli provinces as a group. Therefore, there are 26 regions in the employed data. To make the labels clear in the study, all regions are demonstrated with the name of one city in the group. All groups with the name tags that we choose are listed in the Table 1. TURKSTAT collects the adequate sample of goods' prices and provides more general patterns for this study. By using aggregated price data, the representative nature of the price information can be increased and more general patterns can be found as opposed to studies focusing on a single commodity or small sample of commodities.

Table 1: Representation of City Groups

#	Name Tag	TURKSTAT Region
1	Adana	Adana, Mersin
2	Ankara	Ankara
3	Antalya	Antalya, Isparta, Burdur
4	Balikesir	Balikesir, Canakkale
5	Denizli	Aydin, Denizli, Mugla
6	Diyarbakir	Sanliurfa, Diyarbakir
7	Edirne	Tekirdag, Edirne, Kirklareli
8	Erzurum	Erzurum, Erzincan, Bayburt
9	Eskisehir	Bursa, Eskisehir, Bilecik
10	Gaziantep	Gaziantep, Adiyaman, Kilis
11	Hatay	Hatay, K.Maras, Osmaniye
12	Istanbul	Istanbul
13	Izmir	Izmir
14	Kars	Agri, Kars, Igdir, Ardahan
15	Kayseri	Kayseri, Sivas, Yozgat
16	Kirikkale	Kirikkale, Aksaray, Nigde, Nevsehir, Kirsehir
17	Kocaeli	Kocaeli, Sakarya, Duzce, Bolu, Yalova
18	Konya	Konya, Karaman
19	Malatya	Malatya, Elazig, Bingol, Tunceli
20	Manisa	Manisa, Afyonkarahisar, Kutahya, Usak
21	Mardin	Mardin, Batman, Sirnak, Siirt
22	Samsun	Samsun, Tokat, Corum, Amasya
23	Sinop	Kastamonu, Cankiri, Sinop
24	Trabzon	Trabzon, Ordu, Giresun, Rize, Artvin, Gumushane
25	Van	Van, Mus, Bitlis, Hakkari
26	Zonguldak	Zonguldak, Karabuk, Bartin

4.2. Preliminary Results

Table 2 reports the summary statistics of the percentage changes in PPP deviation with respect to base cities Ankara, Istanbul and Diyarbakir. The mean values show that, Mardin has the highest mean value of percentage change in PPP deviation, no matter which base city is chosen. In other words, Mardin has the highest mean absolute price differential variability with respect to 3 different base cities. On the other hand the lowest mean absolute price differential variability means in the mean value that is closest to zero. When the benchmark city is chosen as Ankara, the mean value of the PPP deviation of Istanbul has the closest value to zero with 0.098. Secondly when the base city is Istanbul, Ankara is the closest one to zero. (Naturally because of the definition of PPP deviation) Thirdly Manisa has the lowest absolute mean price differential when Diyarbakir is the reference city. For standard deviation values in Panel A and B, Mardin has the highest and Kocaeli has the lowest standard deviation for the percentage change in PPP deviation with the base cities Ankara and Istanbul but in Panel C, Gaziantep has the lowest and Izmir has the highest standard deviation value if the base city is Diyarbakir. The minimum and maximum values in Panel A, B and C show that there are different peak cities except Mardin that has highest min. value of percentage change of PPP deviation with three base cities. Kocaeli has the lowest min. value for PPP deviation with the base cities Ankara and Istanbul but Denizli has the lowest min. value when the base city is Diyarbakir. When Ankara is chosen as benchmark city, Denizli has the highest and Trabzon has the lowest maximum values. For analysis with the reference city Istanbul; Mardin has the highest and Eskisehir has the lowest maximum values and finally Ankara has the highest and Gaziantep has lowest maximum values in terms of percentage change in PPP deviation with benchmark city Diyarbakir, in Panel C.

TABLE 2: Summary Statistics of PPP Deviations												
	Panel A: Base City Ankara				Panel B: Base City Istanbul				Panel C: Base City Diyarbakir			
	Mean	**Std.**	**Min.**	**Max.**	**Mean**	**Std.**	**Min.**	**Max.**	**Mean**	**Std.**	**Min.**	**Max.**
Adana	-1.957	1.575	-5.775	1.624	-2.054	1.421	-4.812	1.613	1.526	1.412	-2.416	4.618
Ankara	.	.	.	.	-0.098**	1.182	-2.571	2.464	3.483	2.673	-2.465	9.035*
Antalya	-2.858	2.299	-6.549	1.294	-2.955	1.847	-6.829	1.646	0.625	2.505	-4.592	5.772
Balikesir	-0.210	1.272	-2.663	2.641	-0.307	1.012	-2.386	2.704	3.273	1.958	-1.724	6.956
Denizli	-0.599	1.816	-3.877	3.917*	-0.696	1.335	-4.169	1.729	2.884	2.388	-1.612**	8.000
Diyarbakir	-3.483	2.673	-9.035	2.465	-3.580	2.478	-8.028	2.022	.	.	.	.
Edirne	-1.332	2.122	-5.327	2.888	-1.430	1.673	-5.303	1.099	2.15	2.643	-2.355	7.619
Erzurum	-2.053	1.666	-5.688	2.047	-2.151	1.461	-4.803	1.729	1.429	1.764	-2.278	5.088
Eskisehir	-0.714	1.415	-3.174	2.066	-0.811	0.890	-2.522	0.800**	2.769	2.587	-1.704	8.413
Gaziantep	-4.426	2.910	-10.258	2.253	-4.523	2.640	-8.752	1.980	-0.943	0.798**	-2.493	1.021**
Hatay	-3.034	2.362	-7.699	2.506	-3.131	1.912	-6.353	2.271	0.449	1.345	-2.292	3.699
Istanbul	0.098**	1.182	-2.464	2.571	.	.	.	.	3.580	2.478	-2.022	8.028
Izmir	-0.811	2.089	-5.679	3.052	-0.909	1.718	-6.273	1.729	2.671	2.719*	-2.011	8.270
Kars	-1.544	1.939	-6.246	3.231	-1.642	1.802	-4.847	2.479	1.938	1.415	-2.090	4.740
Kayseri	-1.867	1.532	-5.509	1.734	-1.965	1.678	-5.049	2.655	1.615	1.510	-2.238	4.197
Kirikkale	-3.133	1.966	-6.449	1.530	-3.230	1.864	-5.900	1.342	0.350	1.064	-1.775	3.211
Kocaeli	0.202	1.165**	-2.140**	3.111	0.104	0.736**	-1.622**	2.250	3.684	2.476	-1.915	7.517
Konya	-1.502	1.609	-4.379	2.253	-1.599	1.297	-4.400	1.687	1.981	2.021	-1.687	7.040
Malatya	-4.350	2.558	-8.865	1.333	-4.448	2.354	-7.732	1.513	-0.868	1.030	-3.026	1.448
Manisa	-3.267	2.344	-6.462	2.197	-3.364	1.946	-6.825	2.084	0.216**	1.764	-3.557	3.853
Mardin	-7.376*	4.010*	-12.901*	2.873	-7.473*	3.626*	-12.050*	3.288*	-3.893*	2.195	-7.503*	1.696
Samsun	-2.409	1.650	-5.994	1.887	-2.506	1.262	-4.557	1.917	1.074	1.674	-2.210	4.334
Sinop	-3.707	2.610	-7.435	1.916	-3.804	2.114	-7.125	1.886	-0.224	1.720	-4.256	3.163
Trabzon	-2.969	1.769	-5.636	1.284**	-3.067	1.572	-5.500	1.384	0.513	1.493	-2.401	4.728
Van	-2.366	2.134	-7.571	1.621	-2.464	2.066	-6.068	1.896	1.116	1.362	-2.046	3.766
Zonguldak	-2.511	2.328	-6.731	1.523	-2.609	1.595	-5.600	2.063	0.971	2.459	-4.252	5.050

Table provides summary statistics for monthly PPP deviations with base city groups of Ankara, Istanbul and Diyarbakir. Mean is the sample average and std. is the standard deviation, Min and max show the minimum and the maximum PPP deviation of the city groups for the observed period. * indicates the highest and ** indicates the lowest value of each category.

A visual plot of the data is another step in the analysis of the time series. Graphs section provides the price index over time and PPP deviations over time graphs for each city group. First of all, when the graphs of the price index over time are examined and although there are significant fluctuations, the upward trending feature of price index data of the spoken period for 26 city groups can be observed.

Without any statistical analysis, it could seem that the time series figured in the graphs of price index data vs. time of all city groups, are non-stationary at least in mean values that is increasing in time. The graphs broadly show that there is a deterministic trend for price indices because the upward trending feature is completely predictable. For price index data, it could be said that the deviations from the trend line are random and disappear after a short period of time. On the other hand, when the graphs of PPP deviations of the price index over time are examined for each city group; the random walk around a stochastic trend can be observed. Deviations affect the evolution of the time series. As a result, the undulant nature of the PPP deviations affects the long run evolution of the time series data. Although the common properties of the graphs of PPP deviations of the price index can be noticed, these graphs exhibit different properties according to benchmark city selection. The values and the changes are naturally different but Ankara and Istanbul have generally similar patterns in terms of path and trajectory. At this point, the graphs of the third benchmark city, Diyarbakir, have visual differences. Although, the properties for the random walk is valid also for the graphs of PPP deviations of the price index with the benchmark city, Diyarbakir; they have stricter fluctuations of price deviations than the graphs of PPP deviations of Ankara and Istanbul.

5. Sample Autocorrelation Function Analysis

Sample Autocorrelations (AC) are examined for the data of log price index and the percentage change in PPP deviations with the base cities Ankara, Istanbul and Diyarbakir. The results of the autocorrelation analysis for log price index and PPP deviations with respect to three base cities can be observed in the Panel A, B, C, D of Table 3

TABLE 3: The Results of Autocorrelation Analysis												
	Panel A			Panel B			Panel C			Panel D		
	log(Price Index)			PPP Deviation			PPP Deviation			PPP Deviation		
				Base City: Ankara			Base City: Istanbul			Base City: Diyarbakir		
	Adana			**Adana**			**Adana**			**Adana**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.970	98.814	0.000	0.926	90.141	0.000	0.898	84.671	0.000	0.854	76.627	0.000
6	0.833	523.340	0.000	0.517	326.340	0.000	0.513	320.990	0.000	0.281	211.000	0.000
12	0.668	895.290	0.000	0.374	451.010	0.000	0.270	403.880	0.000	0.437	305.090	0.000
	Ankara			**Ankara**			**Ankara**			**Ankara**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.971	99.070	0.000	-0.074	0.572	0.449	0.904	85.882	0.000	0.939	92.511	0.000
6	0.835	525.990	0.000	-0.062	8.290	0.218	0.522	319.080	0.000	0.538	343.430	0.000
12	0.670	901.290	0.000	0.000	13.721	0.319	0.154	391.490	0.000	0.492	529.680	0.000
	Antalya			**Antalya**			**Antalya**			**Antalya**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.970	98.871	0.000	0.959	96.572	0.000	0.939	92.506	0.000	0.946	94.014	0.000
6	0.830	522.800	0.000	0.770	473.460	0.000	0.649	402.850	0.000	0.547	354.360	0.000
12	0.662	891.270	0.000	0.665	806.920	0.000	0.604	662.250	0.000	0.591	586.310	0.000
	Balikesir			**Balikesir**			**Balikesir**			**Balikesir**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.970	98.756	0.000	0.913	87.614	0.000	0.871	79.605	0.000	0.884	82.074	0.000
6	0.827	520.360	0.000	0.562	344.460	0.000	0.544	297.400	0.000	0.417	262.690	0.000
12	0.655	883.540	0.000	0.170	418.810	0.000	0.344	409.350	0.000	0.417	385.390	0.000
	Denizli			**Denizli**			**Denizli**			**Denizli**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.969	98.692	0.000	0.931	90.987	0.000	0.896	84.257	0.000	0.930	90.784	0.000
6	0.823	518.880	0.000	0.670	395.870	0.000	0.633	342.680	0.000	0.599	373.240	0.000
12	0.647	875.670	0.000	0.489	596.220	0.000	0.462	494.280	0.000	0.452	562.450	0.000
	Diyarbakir			**Diyarbakir**			**Diyarbakir**			**Diyarbakir**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.972	99.192	0.000	0.939	92.511	0.000	0.925	89.827	0.000	0.015	0.024	0.876
6	0.831	524.420	0.000	0.538	343.420	0.000	0.552	350.000	0.000	-0.063	1.249	0.974
12	0.667	893.920	0.000	0.492	529.670	0.000	0.463	524.120	0.000	-0.040	3.560	0.990
	Edirne			**Edirne**			**Edirne**			**Edirne**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.968	98.349	0.000	0.957	96.212	0.000	0.949	94.587	0.000	0.933	91.409	0.000
6	0.820	514.700	0.000	0.826	495.560	0.000	0.801	469.170	0.000	0.633	382.810	0.000
12	0.647	869.280	0.000	0.682	862.650	0.000	0.678	828.570	0.000	0.547	609.680	0.000

TABLE 3: The Results of Autocorrelation Analysis												
	Panel A			**Panel B**			**Panel C**			**Panel D**		
	log(Price Index)			**PPP Deviation**			**PPP Deviation**			**PPP Deviation**		
				Base City: Ankara			**Base City: Istanbul**			**Base City: Diyarbakir**		
	Erzurum			**Erzurum**			**Erzurum**			**Erzurum**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.971	99.093	0.0000	0.908	86.653	0.0000	0.849	75.649	0.000	0.878	80.983	0.000
6	0.834	525.850	0.0000	0.557	313.600	0.0000	0.338	204.450	0.000	0.238	189.080	0.000
12	0.667	899.140	0.0000	0.321	409.340	0.0000	0.234	235.760	0.000	0.377	258.060	0.000
	Eskisehir			**Eskisehir**			**Eskisehir**			**Eskisehir**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.970	98.848	0.000	0.928	90.459	0.000	0.902	85.358	0.000	0.938	92.309	0.000
6	0.830	522.240	0.000	0.743	435.690	0.000	0.677	384.850	0.000	0.601	376.040	0.000
12	0.660	889.630	0.000	0.564	712.180	0.000	0.527	616.640	0.000	0.515	587.900	0.000
	Gaziantep			**Gaziantep**			**Gaziantep**			**Gaziantep**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.972	99.249	0.000	0.947	94.280	0.000	0.931	91.003	0.000	0.697	51.024	0.000
6	0.834	526.930	0.000	0.676	413.660	0.000	0.669	408.620	0.000	0.018	92.177	0.000
12	0.671	901.020	0.000	0.529	661.360	0.000	0.500	634.430	0.000	0.249	105.810	0.000
	Hatay			**Hatay**			**Hatay**			**Hatay**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.970	98.908	0.000	0.949	94.630	0.000	0.919	88.721	0.000	0.883	81.833	0.000
6	0.831	524.180	0.000	0.673	409.050	0.000	0.608	365.200	0.000	0.435	262.680	0.000
12	0.661	890.950	0.000	0.530	653.780	0.000	0.506	572.370	0.000	0.469	391.740	0.000
	Istanbul			**Istanbul**			**Istanbul**			**Istanbul**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.971	98.953	0.000	0.904	85.882	0.000	0.070	0.512	0.475	0.925	89.827	0.000
6	0.831	523.720	0.000	0.522	319.080	0.000	0.059	7.536	0.274	0.552	350.000	0.000
12	0.666	894.390	0.000	0.154	391.480	0.000	-0.199	18.817	0.093	0.463	524.120	0.000
	Izmir			**Izmir**			**Izmir**			**Izmir**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.969	98.555	0.000	0.951	95.043	0.000	0.940	92.864	0.000	0.930	90.861	0.000
6	0.819	515.500	0.000	0.779	479.250	0.000	0.732	440.090	0.000	0.591	368.490	0.000
12	0.644	867.910	0.000	0.573	777.200	0.000	0.543	703.940	0.000	0.526	583.130	0.000
	Kars			**Kars**			**Kars**			**Kars**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.972	99.231	0.000	0.927	90.296	0.000	0.901	85.226	0.000	0.828	71.976	0.000
6	0.829	524.300	0.000	0.653	381.200	0.000	0.634	354.300	0.000	0.101	138.800	0.000
12	0.658	890.330	0.000	0.378	525.340	0.000	0.422	516.360	0.000	0.195	162.010	0.000

TABLE 3: The Results of Autocorrelation Analysis												
	Panel A			Panel B			Panel C			Panel D		
	log(Price Index)			PPP Deviation			PPP Deviation			PPP Deviation		
				Base City: Ankara			Base City: Istanbul			Base City: Diyarbakir		
	Kayseri			**Kayseri**			**Kayseri**			**Kayseri**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.973	99.444	0.000	0.890	83.230	0.000	0.879	81.184	0.000	0.896	84.291	0.000
6	0.839	529.940	0.000	0.577	300.700	0.000	0.627	342.730	0.000	0.450	278.140	0.000
12	0.673	909.660	0.000	0.374	437.410	0.000	0.342	477.750	0.000	0.481	442.110	0.000
	Kirikkale			**Kirikkale**			**Kirikkale**			**Kirikkale**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.972	99.156	0.000	0.936	92.055	0.000	0.906	86.280	0.000	0.784	64.520	0.000
6	0.835	526.980	0.000	0.724	414.040	0.000	0.690	387.460	0.000	-0.077	107.490	0.000
12	0.670	901.720	0.000	0.489	645.830	0.000	0.407	560.010	0.000	0.362	146.560	0.000
	Kocaeli			**Kocaeli**			**Kocaeli**			**Kocaeli**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.970	98.912	0.000	0.875	80.324	0.000	0.763	61.098	0.000	0.922	89.285	0.000
6	0.835	525.230	0.000	0.290	229.220	0.000	0.184	129.140	0.000	0.633	385.780	0.000
12	0.671	901.120	0.000	0.065	250.980	0.000	0.306	171.080	0.000	0.495	597.220	0.000
	Konya			**Konya**			**Konya**			**Konya**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.971	99.026	0.000	0.910	86.979	0.000	0.848	75.600	0.000	0.921	89.037	0.000
6	0.828	522.940	0.000	0.716	368.670	0.000	0.620	291.460	0.000	0.563	325.980	0.000
12	0.655	886.820	0.000	0.551	585.870	0.000	0.416	394.720	0.000	0.499	504.250	0.000
	Malatya			**Malatya**			**Malatya**			**Malatya**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.971	99.094	0.000	0.956	95.925	0.000	0.939	92.576	0.000	0.787	65.039	0.000
6	0.835	526.750	0.000	0.753	462.740	0.000	0.703	433.550	0.000	0.015	109.190	0.000
12	0.671	902.010	0.000	0.561	754.420	0.000	0.473	662.960	0.000	0.304	134.610	0.000
	Manisa			**Manisa**			**Manisa**			**Manisa**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.971	99.033	0.000	0.941	93.029	0.000	0.916	88.038	0.000	0.917	88.327	0.000
6	0.827	522.700	0.000	0.706	412.060	0.000	0.664	374.110	0.000	0.679	385.890	0.000
12	0.659	887.790	0.000	0.641	706.440	0.000	0.542	592.970	0.000	0.507	601.120	0.000
	Mardin			**Mardin**			**Mardin**			**Mardin**		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.973	99.346	0.000	0.947	94.086	0.000	0.934	91.667	0.000	0.940	92.790	0.000
6	0.839	528.740	0.000	0.634	394.350	0.000	0.596	375.390	0.000	0.636	403.440	0.000
12	0.683	911.980	0.000	0.552	641.950	0.000	0.479	568.500	0.000	0.404	567.070	0.000

TABLE 3: The Results of Autocorrelation Analysis												
	Panel A			Panel B			Panel C			Panel D		
	log(Price Index)			PPP Deviation			PPP Deviation			PPP Deviation		
				Base City: Ankara			Base City: Istanbul			Base City: Diyarbakir		
	Samsun			Samsun			Samsun			Samsun		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.971	99.101	0.000	0.914	87.719	0.000	0.842	74.524	0.000	0.925	89.856	0.000
6	0.837	526.560	0.000	0.568	345.720	0.000	0.433	267.600	0.000	0.558	349.620	0.000
12	0.670	901.980	0.000	0.500	553.940	0.000	0.323	354.820	0.000	0.454	510.240	0.000
	Sinop			Sinop			Sinop			Sinop		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.971	98.953	0.000	0.949	94.591	0.000	0.913	87.477	0.000	0.884	82.007	0.000
6	0.829	522.760	0.000	0.758	451.950	0.000	0.701	394.660	0.000	0.375	231.240	0.000
12	0.660	889.400	0.000	0.563	728.070	0.000	0.558	639.320	0.000	0.550	408.570	0.000
	Trabzon			Trabzon			Trabzon			Trabzon		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.971	99.115	0.000	0.943	93.423	0.000	0.907	86.382	0.000	0.859	77.566	0.000
6	0.837	527.340	0.000	0.694	424.410	0.000	0.566	348.190	0.000	0.038	152.110	0.000
12	0.672	904.130	0.000	0.451	630.850	0.000	0.351	475.260	0.000	0.482	234.350	0.000
	Van			Van			Van			Van		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.973	99.380	0.000	0.937	92.295	0.000	0.925	89.866	0.000	0.835	73.208	0.000
6	0.837	529.170	0.000	0.669	396.460	0.000	0.665	399.630	0.000	0.245	151.330	0.000
12	0.675	909.120	0.000	0.458	594.170	0.000	0.474	595.260	0.000	0.398	241.950	0.000
	Zonguldak			Zonguldak			Zonguldak			Zonguldak		
Lag	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.	AC	Q-Stat.	Prob.
1	0.971	99.097	0.000	0.945	93.712	0.000	0.899	84.922	0.000	0.935	91.755	0.000
6	0.833	525.420	0.000	0.723	436.410	0.000	0.637	364.270	0.000	0.547	356.940	0.000
12	0.664	896.340	0.000	0.469	663.050	0.000	0.477	546.060	0.000	0.426	511.570	0.000

Table 3 exhibits the sample autocorrelations (AC) , and Box-Pierce Q statistic and the associated p-values (Prob.) for testing the null of no autocorrelation up to a given lag for log(price index) in Panel A and PPP deviations with base cities, Ankara, Istanbul and Diyarbakir in Panel B,C and D, respectively. The details of sample autocorrelation coefficient and Box-Pierce Q statistics can be observed in Appendix section.

In Table 3, Panel A, there are the results of correlation analysis for log price index. AC, Q-Statistics and probability of Q statistics under the null hypothesis for each city group and the lags of 1, 6 and 12 are demonstrated. AC values decrease by the increase in the number of lags for each city group. Particularly it can be said that AC coefficients have a decreasing property. According the Panel A, the probability of Q-statistics under the null hypothesis that the estimated AC coefficient is zero is zero. As a result we can say that AC exist and the time series of data of log price indices for all cities is non stationary.

The results of the sample AC analysis of PPP deviations is pictured in Panel B, C and D in Table 3 for the benchmark cities Ankara, Istanbul and Diyarbakir respectively. AC coefficients of PPP deviations represent the same properties with the coefficients of log price indexes on Panel A, no matter which benchmark city is chosen. For each city, AC coefficients of PPP deviations decrease with the increase in lag numbers, as in the log price indices in Panel A. When the hypothesis that the AC coefficients, ρ_k of a city group is zero or not with Q statistics is tested, zero probability of Q statistics under the null hypothesis that the estimated AC coefficient is zero can be observed. Therefore the same results as in the correlation analysis of log price index are obtained. AC is detected for PPP deviations of price indices with the base cities Ankara, Istanbul and Diyarbakir. Therefore it can be concluded that there is a serial correlation up to 12 lags for log price index and PPP deviations of each city with respect to all benchmark cities. The time series of log price index and PPP deviations of the city groups are non-stationary.

6. Emprical Methods

In addition to standard autocorrelation analysis, unit root and stationarity tests are used to investigate the persistence and non-stationarity in deviations from the PPP across city groups in Turkey. Besides, the thesis utilizes half-life measures to quantify the persistence in the deviations. These econometric methods are well-known in the empirical economics literature and applied to study PPP and many other empirical issues in international finance, macroeconomics, and finance. Hamilton (1994) and Hayashi (2000) and Stock and Watson (2010) provide a user friendly discussion of these tools.

In addition to time series methods, this thesis also uses linear regression and linear and nonlinear probability models to explore the question of if transportation costs can explain the variation in the point estimates of half-lives in the variation of PPP deviations and the likelihood of rejecting null of a unit root in PPP deviations over the cross section of city groups.

6.1. Unit Root and Stationary Tests

The thesis uses two unit root statistics that test the null hypothesis of a unit root in a time series, namely the well-known Augmented Dickey-Fuller (ADF) test, developed by Dickey and Fuller (1984) and its generalized least squares version by Elliott, Rothenberg, Stock (1996). Preliminary data analysis revealed that deviations from PPP are persistence and hence a formal testing approach should provide information whether such persistence is associated with non-stationarity in the underlying time series data or not. Within the context of this thesis, stationarity refers to weak stationarity in that the mean and the variance of the time series process is time-invariant (i.e., covariance stationarity). Note that any strictly stationary process which has a finite mean and covariance is also weakly stationary. With this in mind, a time series is said to be of integrated of order one (i.e., I(1)) if the minimum number of differences required to obtain a stationary process is one. A time series is said to have a unit root if the process is I(1). The autoregressive representation (AR) of an I(1) time series process will have root that is on the unit circle and hence typically unit root tests exploits the AR(1) representations of time series. In this context, the well-known ADF test relies on the following AR regression,

$$\Delta q_{ij,t} = \alpha + (\rho - 1) q_{ij,t-1} + \sum_{l=1}^{m} \vartheta_l \Delta q_{ij,t-l} + \varepsilon_t \qquad (1)$$

where constant α is the drift parameter, ϑ is the coefficient of the sum of lagged variables and ε_t is assumed to be a white noise error process. The purpose of the augmentation terms (i.e., the lagged values of the dependent variable) in ADF regression equation (1) is to control serial correlation in the dependent variables by parametrically incorporating the information contained in the lagged dependent variable. Constant α is a unit specific constant to control the non-time depending variables. The coefficient of the first lag variable is defined as $\rho - 1$ instead of a single coefficient such as β to point out the unit root. The null hypothesis for ADF test is $H_0 : |\rho| = 1$, and under this null there is a unit root and the stochastic process is non-stationary (see also Hamilton 1994, Chapter 17). Dickey and Fuller (1979) shows that the t-statistic for testing the null hypothesis of a unit root in a regression equation without the augmentation terms has a non-standard distribution and hence critical values need to be simulated. Dickey and Fuller (1984) show that the t-statistic from the augmented regression equation as in Equation (1) above has the same asymptotic distribution and hence simulated critical values are the same from the regressions with and without augmentation terms.

The ADF test is known to lose power dramatically against stationary alternatives with a low order moving average process, a characterization that fits well into many macroeconomic time series. Along the lines of the ADF test, a more powerful variant is the modified version of Dickey-Fuller test, namely the Dickey Fuller Generalized Least Square statistic (DF-GLS) developed by Elliott, Rothenberg, and Stock (1996). The DF-GLS test is essentially similar to the ADF test and is shown to have better performance in terms of small sample size and power. Elliott, Rothenberg, and Stock (1996) have shown that the test is more efficient especially when there is an unknown mean or trend. DF-GLS test is based on the regression,

$$\Delta q_{ij,t}^{d} = \alpha + (\rho - 1) q_{ij,t-1}^{d} + \sum\nolimits_{l=1}^{m} \delta_i \Delta q_{ij,t-l}^{d} + \varepsilon_t \tag{2}$$

where constant α is the drift parameter, δ is the coefficient of the sum of lagged de-trended variables and ε_t is for white noise error terms. Note that $q_{ij,t}^{d} = q_{ij,t} - \widehat{\beta}' z_t$ where $z_t = (1,t)'$ and $\widehat{\beta}$ is calculated by the regression of $(q_{ij,1}, (1-\overline{\alpha}L) q_{ij,2}, \ldots, (1-\overline{\alpha}L) q_{ij,n})$, onto $(z_1, (1-\overline{\alpha}L) z_2, \ldots, (1-\overline{\alpha}L) z_n)$ where $\overline{\alpha} = 1 + \overline{c}/n$ and $\overline{c} = -13.5$, and L is the lag operator. When the demeaning is done for a constant only, then $\overline{c} = -7.0$ is used (see, Elliott, Rothenberg, and Stock 1996). According to Stock (1994), $\overline{c}$ values are determined to ensure that the test achieves the power envelope against stationary alternatives at 50% power. The null hypothesis for DF-GLS test is that the time series has a unit root, (i.e., $H_0 : |\rho| = 1$). This unit root null is tested against the alternative hypothesis is that the time series data is stationary around a constant drift.

Choosing the appropriate lag length is crucial for the reliability of unit root tests. If the decided lag length is not enough, the serial correlations of error term cannot be removed from the analysis. If the number of lags, m in Equations (1) and (2) above, is higher than the optimum level (i.e. the appropriate number of lags that render the residuals approximately white noise) then the tests can lose power. The thesis follows Ng and Perron (2001) and selects the number of lags by using Modified Akike Information

Criterion (MAIC). Ng and Perron (2001) shows that use of MAIC can improve the size of the unit root tests in finite samples. In the application of unit root tests, the maximum lag is chosen 12 by Schwert Criterion (Schwert 1989) which uses a sample size based formula given by $\overline{m}_{\max} = \text{int}\left[12(n/100)^{1/4}\right]$, where *int* is the integer part of the expression inside the squared brackets, *m* is the lag length, and *n* is the number of observations.

The stationarity test in this thesis is developed by Kwiatkowski, Phillips, Schmidt and Shin (KPSS, 1992). The KPSS test is a stationary test in that it tests the null hypothesis of stationarity against the alternative of non-stationarity. In other words, KPSS statistic tests the null hypothesis that the stochastic process is stationary $(H_0 : q_{ij,t} \approx I(0))$ where the null can be specified to be either trend stationarity or stationary around a drift. Use of the KPSS test in conjunction with unit root tests should provide useful information about the time series properties of the deviations from PPP. Given also that we have a relatively small sample size for each deviations, use of alternative tests can allow us to check the robustness of the findings from unit root tests that are typically used in applications. KPSS statistic is based on the same regression equation of DF-GLS, in that the time series data is de-trended by regressing $q_{ij,t}$ on $z_t = (1,t)'$, yielding residuals ε_t so the KPSS test statistic for stationarity (i.e., time series has zero order of integration) is

$$k_0 = n^{-2} \sum\nolimits_{t=1}^{n} s_t \,/\, n^{-1} \sum\nolimits_{t=1}^{n} \varepsilon_t^2 \,, \tag{3}$$

where s_t is the partial sum series of ε_t. The KPSS test requires estimation of the denominator of the statistic in Equation (3) and typically a nonparametric variance-covariance estimator, such as Newey-West estimate (Newey and West 1994), is used. The method of estimating the long run variance, that is the denominator of Equation (3), requires using an appropriate kernel estimator which in turn also requires selection of a bandwidth size. In this thesis, the Quadratic kernel with the automatic bandwidth selection method is used. Simulation evidence reported in Hobjin (1998) shows that the KPSS test performs better in small samples with Quadratic kernel and automatic bandwidth selection method.

6.2. Measuring the Persistence in PPP Deviations

Previously, we present the regression equation for the ADF test for unit root as $\Delta q_{ij,t} = \alpha + (\rho - 1)q_{ij,t-1} + \sum_{l=1}^{m} \vartheta_l \Delta q_{ij,t-l} + \varepsilon_t$. When we define the coefficient of the first lag as β where $\beta = \rho - 1$, we can express the coefficient of the first lag compactly in ADF equation as $\Delta q_{ij,t} = \alpha + \beta(q_{ij,t-1}) + \sum_{l=1}^{m} \vartheta_l \Delta q_{ij,t-l} + \varepsilon_t$. In this formation β is the center of the test of convergence. If $\beta \geq 0$, PPP deviations are non stationary and the time series data contains persistent price divergence. On the other hand, if $\beta < 0$, the time series data of PPP deviations will have a price convergence and Half-Life (HL) is a way of detecting the speed of convergence. Fanelli and Parulo (2007) defines that HL is one of the typical measures of the convergence speed in a univariate case. It is formulated as

$$\ln(0.5)/\ln(1+\beta) \text{ if } \beta < 0 \text{ but it goes to infinity if } \beta \geq 0. \quad (4)$$

We have monthly time series data, therefore the value of HL will show the time that the price divergences reduced by half, in terms of months. A low HL value for the data of the percentage change in LOP deviations implies that price divergences fade away and PPP/LOP is restored quickly as opposed to a high HL value.

In order to quantify the sampling uncertainty around the point estimates of half-lives, we used the conventional delta method approximation and constructed the 95% confidence intervals by using the formula,

$$HL \pm t_{0.05} \times SE_{\beta} \times \ln(0.5) \times (1+\beta)^{-1} \times (\ln(1+\beta))^{-2} \quad (5)$$

where $t_{0.05} = 1.96$ and SE_{β} is standard error of β. Note that the point estimate of the half-life given in Equation (4) ignores the presence of augmentation terms in the ADF regression. Although this might be a shortcoming of the approach, it is widely used in the empirical literature and hence the results in this thesis should be comparable to the available ones in terms of the method used. In a recent paper, Rossi (2005) extends the estimates in the presence of lagged terms. An additional weakness of the point estimates based on Equation (4) is that when the process is highly persistent therefore the estimates of the slope coefficient is in the vicinity of zero (i.e., $\beta \approx 0$), the point estimates and the associated confidence intervals may not be robust. Although these issues raise questions about the usefulness of the half-life estimates reported in this thesis, nevertheless they provide a preliminary analysis of the quantitative features of PPP deviations in Turkey.

6.3. Linear and Nonlinear Probability Models

Linear Probability Model (LPM) with k-explanatory variables is a typical regression model ,

$$Y_i = \beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + ... + \beta_{k,i} X_{k,i} + u_i , \qquad (6)$$

where the dependent variable is binary rather than continuous. Because the conditional expectation of Y_i is given as $E(Y_i | X_i) = \beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + ... + \beta_{k,i} X_{k,i}$ and since Y is Bernoulli distributed, the success probability, however it is defined, is given by $\Pr(Y_i = 1 | X_i) = \beta_0 + \beta_1 X_{1,i} + ... + \beta_k X_{k,i}$. Since the probability P_i must be between 0 and 1, the conditional expectation must be between 0 and 1 as $0 \leq E(Y_i | X_i) \leq 1$. Given that LPM is a linear regression model in essence, estimation and testing are performed as usual provided that the Least Squares assumptions are satisfied. The major change compared to the linear regression model is the interpretation of the coefficient estimates. For example, the coefficient for a given regressor now shows the estimated marginal effect of that variable on the probability Y taking on value 1 (generically defined as the success). Despite these advantages, LPM has several problems such as non-normality, possibility of predicted expected dependent variable becoming outside of 0-1 range and the lower R square values.

In order to accommodate some of the undesirable features of LPM, Probit and Logit Models are specifically designed for binary dependent variables. Probit Model can be expressed as

$$\Pr(Y_i = 1 | X_i) = \Phi(\beta_0 + \beta_1 X_{1,i} + ... + \beta_k X_{k,i}) \qquad (7)$$

where the dependent variable Y is binary, Φ is the cumulative standard normal distribution function and X_1, X_2 are regressors. The logit Model is similar to the Probit Model, except the cumulative standard normal distribution function Φ is replaced by *F,* the cumulative standard logistic distribution function. The Logit Model of the binary dependent variable *Y* can be written as,

$$\Pr(Y_i = 1 | X_i) = F(\beta_0 + \beta_1 X_{1,i} + ... + \beta_k X_{k,i}) = (1 + e^{-(\beta_0 + \beta_1 X_{1,i} + ... + \beta_k X_{k,i})})^{-1} \qquad (8)$$

A disturbance term is added to Equations (7) and (8) to obtain an econometric model. Since Cumulative Normal and Logistic Distribution functions are nonlinear functions of regressors, the estimation cannot be carried out by the Least Squares methods. Estimation under the assumption that the error process follows a normal distribution or the logistic distributions are carried out by the Maximum Likelihood Estimation (MLE) methods. If no such assumption is imposed, the nonlinear least squares (NLE) can be sued. It has been shown that if the errors follow a normal distribution, then MLE of probit and Logit models follows asymptotically normal distributions and hence standard inference procedures can be used. For detailed discussion of these models see Stock and Watson (2010) and Wooldridge (2002)

7. Empirical Results

7.1. Unit Root and Stationary Tests

Results of unit root and stationarity tests are reported in Table 4. The first, second, and third panels of the table provide the results of ADF, DF-GLS and the KPSS tests for base cities of Ankara, Istanbul, and Diyarbakir, respectively. In conducting the ADF test, using MAIC criterion selected lag one for all PPP deviations irrespective of the base city used. On the other hand, the same criterion shows slight variation in lags for the DF-GLS test. Overall, lag numbers varies between 1 and 12 depending on the PPP deviations for this statistic. Reported results in Panel A of the Table 4 shows that ADF test rejects the null of a unit root at 5 or 10 percent significance levels for three out of twenty five city-regions. The number of rejections slightly increases to four under DF-GLS test. Interestingly enough, cities for which ADF and DF-GLS rejects a unit root at 5 or 10 percent significance levels do not match. ADF rejects the unit root null for Erzurum, Kayseri, and Konya, while DF-GLS rejects the null of unit root for Adana, Balikesir, Denizli, and Kocaeli. Reported results for the KPSS test show that the null of stationarity is rejected for all but Kocaeli PPP deviations with Ankara as the base city.

With Istanbul as the base city, the number of rejections of the null of a unit root increases to eight cities, including Erzurum, Kocaeli, Konya, Manisa, Mardin, Samsun, Trabzon, and Zonguldak. The interesting finding from DF-GLS test is that the number of rejections becomes zero when Istanbul is the base city. In other words, we fail to reject the null of a unit root for any of the PPP deviations with Istanbul as the base city. The results of

KPSS test are consistent with the findings from DF-GLS in that it rejects the null of stationarity for all PPP deviations.

Using Diyarbakir as the base city provides the strongest evidence in favor of convergence to PPP as the number of rejections increases to twelve by the ADF test. In other words for 48 percent of the cities, ADF test rejects the null of a unit root in PPP deviations with Diyarbakir as the base city where three of these rejections are at the 1 percent significance level. A somewhat strange findings is that the DF-GLS test fails to reject a unit root in any of the PPP deviations with Diyarbakir as the base city. This result is similar to when Istanbul is used as the base city. KPSS test on the other hand rejects the null of a unit root for all LOP deviations except one city, namely Kirikkale which again differs from the city for which the test failed to reject the null of stationarity with Ankara as the base city.

ADF and DF-GLS tests provide considerably different results in terms of rejections and non-rejections for any given base city. Results from unit root tests also vary somewhat across different base cities. For example; the number of rejections of the null of unit root increases from three to eight and to twelve with Ankara, Istanbul, and Diyarbakir as the base cities, respectively. On the contrary, KPSS test provides considerably consistent results across different base cities.

One plausible factor that may account for the differences in the power of ADF and DF-GLS tests in distinguishing between the null hypothesis of a unit root from the alternative of a stationary process, especially given our sample size of 100 for all deviations. On the other hand the variations over different base cities especially in the case of ADF test might also be due to the variation in the persistence and time series dynamics of PPP deviations across base cities. Given the simulation results reported in Elliott, Rothenberg, and Stock (1996) that show that the DF-GLS test outperforms ADF test in small sample sizes, one may be inclined to attribute the differences in findings to the relative power loss of ADF test when especially the time series under consideration have a root that is local to unit root (i.e., the autoregressive root is near the neighborhood of one in ADF regressions). Indeed looking at the estimated parameter estimates for the lagged level of dependent variable in ADF regressions in Table 4 reveals that the estimates are typically very low, suggesting considerable persistence in the PPP deviations. The following section undertakes a formal analysis of PPP persistence and attempts to quantify the persistence.

Table 4: The Results of the Unit Root and Stationarity Tests.									
	Panel A: Base City Ankara			Panel B: Base City Istanbul			Panel C: Base City Diyarbakir		
	ADF	**DF-GLS**	**KPSS**	**ADF**	**DF-GLS**	**KPSS**	**ADF**	**DF-GLS**	**KPSS**
Adana	-2.457	-2.725***	0.837 ***	-1.852	-1.267	0.515 **	-3.297 **	-0.306	0.563 **
Ankara	.	.	.	-1.540	-1.499	0.797 ***	-2.506	-1.313	0.788 ***
Antalya	-1.635	-0.281	2.420 ***	-2.439	0.272	2.110 ***	-2.099	-0.731	1.030 ***
Balikesir	-2.325	-2.381**	0.655 **	-1.617	-1.390	0.490 **	-2.871 *	-0.639	0.617 **
Denizli	-1.855	-1.881*	1.700 ***	-2.493	-0.867	1.240 ***	-1.852	-0.985	0.602 **
Diyarbakir	-2.506	-1.313	0.788 ***	-2.050	-0.790	0.635 **	.	.	.
Edirne	-1.437	-0.870	2.220 ***	-1.890	-0.836	1.840 ***	-1.994	-0.983	0.817 ***
Erzurum	-2.995 **	-1.027	0.868 ***	-3.078 **	-0.842	0.471 **	-3.457 **	-1.171	0.400 *
Eskisehir	-1.316	-1.047	2.080 ***	-2.247	-0.978	1.560 ***	-1.906	-0.955	0.597 **
Gaziantep	-2.216	-1.258	0.965 ***	-2.203	-1.037	0.781 ***	-4.108 ***	-0.611	0.732 **
Hatay	-2.260	-0.485	1.520 ***	-2.438	-0.515	1.250 ***	-2.756 *	-0.834	1.020 ***
Istanbul	-1.540	-1.499	0.797 ***	.	.	.	-2.050	-0.790	0.635 **
Izmir	-1.298	-1.162	1.940 ***	-1.803	-1.360	1.400 ***	-1.908	-1.203	0.699 **
Kars	-2.275	-1.247	0.594 **	-1.877	-0.926	0.604 **	-3.476 **	-1.127	0.565 **
Kayseri	-2.839 *	-0.634	0.493 **	-1.895	-0.802	0.684 **	-2.603 *	-1.205	1.120 ***
Kirikkale	-2.402	-0.600	0.987 ***	-2.201	-0.742	0.666 **	-3.902 ***	-1.025	0.258
Kocaeli	-2.530	-2.335**	0.282	-3.262 **	-1.425	0.800 ***	-2.075	-0.759	0.785 ***
Konya	-2.695 *	-0.958	1.800 ***	-3.070 **	-0.858	1.060 ***	-2.484	-0.987	0.555 **
Malatya	-2.078	-0.531	1.280 ***	-2.180	-0.406	0.940 ***	-3.957 ***	-1.114	0.862 ***
Manisa	-2.384	-0.364	2.010 ***	-2.866 *	-0.643	1.640 ***	-1.969	-0.990	1.200 ***
Mardin	-2.362	0.146	1.670 ***	-2.748 *	-0.204	1.460 ***	-1.979	0.653	2.170 ***
Samsun	-2.174	-0.636	1.660 ***	-3.017 **	-0.374	1.090 ***	-1.933	-1.409	0.581 **
Sinop	-2.006	-0.371	1.790 ***	-2.578	-0.156	1.620 ***	-2.884 *	-0.334	1.330 ***
Trabzon	-2.314	-0.668	1.290 ***	-2.590 *	-0.888	0.758 ***	-3.327 **	-0.781	0.350 *
Van	-2.244	-1.098	0.539 **	-1.671	-0.857	0.665 **	-3.705 **	-1.167	0.970 ***
Zonguldak	-1.570	-0.049	1.910 ***	-2.935 **	-0.157	2.090 ***	-1.658	-1.448	0.830 ***

The table shows the results of the unit root (ADF and DF-GLS) and stationarity (KPSS) tests. 1%, 5%, and 10% critical values for ADF tests are (1%: -3.510), (5%: -2.890), (10%: -2.580). The critical values of 1, 5, 10% for DF-GLS are interpolated from Elliott, Rothenberg, and Stock (1996). ***, **, and * indicate rejection of the null of a unit root in ADF and DF-GLS tests and null of stationarity in the case of KPSS test at 1%, 5%, and 10% significance levels, respectively.

7.2. Half-Life: Measuring the convergence to PPP across Turkish city groups

The results of the unit root and KPSS tests showed that the percentage deviations from PPP with three different base cities are considerably persistent. Despite some relatively minor evidence in favor of stationarity from ADF test, overall, test results suggest presence of non-stationarity for deviations. In order to provide some preliminary assessment of the persistence of PPP deviations, the results of point half-life estimates and the corresponding 95 percent confidence intervals are reported in Table 5. It should be noted that the method used in this thesis to estimate half-life of deviations and the associated confidence intervals are not robust to the presence of unit root or local-to-unit root in the underlying time series. Therefore, caution should be exercised in interpreting the findings in this section. Despite the shortcomings, half-life estimates and confidence intervals should provide some preliminary evidence on the speed of convergence to PPP and hence persistence in deviations.

The results of the half-life estimates are reported in panels A, B, and C of Table 5 with base cities Ankara, Istanbul, and Diyarbakir, respectively. In addition to half-lives, and the lower bounds (LB) and the upper bounds (UB) of 95 percent confidence intervals, Table 5 reports estimates of α and β in the ADF regressions. When the benchmark city is Ankara (in Panel A of the table), point estimates of half-life range between about 5 months (Kocaeli) to 20 months (Antalya) with an average of about 11 months across all cities in the sample. With an estimated half-life of 11 months, Istanbul has the average convergence rate. Note that since the unit of time is months, the value of 5.36 means that the price differential of Kocaeli with respect to Ankara could disappear in about 5 months. Looking at the 95% confidence intervals, the lower bounds range from 0 (for 8 city groups) to 2.01 months (Mardin) and the average lower bound is 0.82 closest to 0.87 (Kars). The upper bounds range between 9.79 months (Kocaeli) and 45.04 months (Izmir) with the average 22.52 months closest to 22.31 months (Gaziantep).

The point estimates of half-life vary between 2 months (Kocaeli) and 13 months (Van) with average 8.78 months closest to 8.87 months (Hatay) in Table 5, Panel B when the benchmark city is Istanbul. For 95% confidence interval, lower bounds range from 0 (for 8 city group) and 2.82 months (Mardin) with the average 0.93 month closest to 0.92 month

(Gaziantep) and upper bounds fluctuate between 4.43 months (Kocaeli) and 30.02 months (Van). The average upper bound for the point estimates of half-life is 17.15 months closest to 17.82 months (Adana).

In Table 5, Panel C, half-life analysis of the benchmark city Diyarbakir, the minimum and maximum values for the point estimates of half-life are 1.80 months (Gaziantep) and 13.90 months (Mardin) with the average 7.21 months (Konya). The lower bounds fluctuate between 0 (for 8 city group) and 1.74 months (Ankara) with the average 0.72 month closest to 0.71 months (Gaziantep). The upper bounds have a range from 2.84 months (Gaziantep) to 26.36 months (Zonguldak). The average upper bound of 95% confidence interval is 13.95 month closest to 13.19 months (Konya).

According to Rogoff (1996), convergence rate that is smaller than 15% per year for PPP/LOP deviations is glacial. 15 percent per year means that a half-life of 3.25 years or 40 months. Parsley and Wei (1996) predicted 4-15 quarters (12 - 45 months) for the half lives of the consumer prices of goods and services, on the other hand Cecchetti, Mark and Sanora (2002) reports longer half lives for US by using consumer price indexes. Crucini and Shintani (2008) employ the commodity prices of many cities of different countries and reports average estimate of 19 months for OECD and 12 months for non-OECD countries. Ceglowski (2003) finds 0.55 years or approximately 6 months for Canadian disaggregated retail prices. Fan and Wei (2006) utilize the prices of industrial and agricultural products and estimate half lives between 0.75 and 5.01 months for China. According to our results, PPP deviations die out faster than the commonly accepted 3-5 years. Our findings reveal that on average half-life of PPP deviations are 11, 9, and 7 months with Ankara, Istanbul, and Diyarbakir as the base cities, respectively.

Table 5: Half-Life Analysis

	Panel A: Base City Ankara					**Panel B: Base City Istanbul**					**Panel C: Base City Diyarbakir**				
	$\hat{\alpha}$	$\hat{\beta}$	**Half-life**	**LB**	**UB**	$\hat{\alpha}$	$\hat{\beta}$	**Half-life**	**LB**	**UB**	$\hat{\alpha}$	$\hat{\beta}$	**Half-life**	**LB**	**UB**
Adana	-0.186	-0.092	7.20	1.17	13.24	-0.154	-0.079	8.47	0.00	17.82	0.270	-0.154	4.14	1.46	6.82
Ankara	.	.	.	.	.	0.011	-0.060	11.26	0.00	26.05	0.279	-0.072	9.24	1.74	16.75
Antalya	-0.151	-0.035	19.41	0.00	43.11	-0.220	-0.061	11.04	1.88	20.20	0.025	-0.062	10.78	0.38	21.18
Balikesir	-0.024	-0.097	6.81	0.77	12.84	-0.008	-0.080	8.35	0.00	18.91	0.425	-0.118	5.51	1.50	9.52
Denizli	-0.064	-0.067	10.04	0.00	21.03	-0.087	-0.112	5.82	0.96	10.67	0.187	-0.060	11.26	0.00	23.54
Diyarbakir	-0.279	-0.072	9.24	1.74	16.75	-0.243	-0.062	10.81	0.14	21.48	.	.	.	.	.
Edirne	-0.081	-0.040	17.16	0.00	41.06	-0.095	-0.059	11.48	0.00	23.76	0.143	-0.063	10.64	0.00	21.45
Erzurum	-0.249	-0.113	5.78	1.76	9.80	-0.296	-0.135	4.78	1.50	8.05	0.243	-0.159	4.00	1.52	6.47
Eskisehir	-0.065	-0.047	14.52	0.00	36.68	-0.089	-0.093	7.11	0.60	13.63	0.170	-0.058	11.56	0.00	23.81
Gaziantep	-0.299	-0.058	11.67	1.03	22.31	-0.312	-0.060	11.23	0.92	21.53	-0.319	-0.320	1.80	0.75	2.84
Hatay	-0.217	-0.060	11.28	1.19	21.37	-0.268	-0.075	8.87	1.45	16.29	0.054	-0.131	4.92	1.16	8.68
Istanbul	-0.011	-0.060	11.26	0.00	26.05	.	.	.	.	.	0.243	-0.062	10.81	0.14	21.48
Izmir	-0.063	-0.038	17.73	0.00	45.04	-0.069	-0.061	11.00	0.00	23.35	0.180	-0.064	10.46	0.00	21.57
Kars	-0.137	-0.078	8.53	0.87	16.18	-0.105	-0.064	10.46	0.00	21.76	0.408	-0.200	3.11	1.15	5.07
Kayseri	-0.233	-0.114	5.75	1.53	9.96	-0.148	-0.072	9.32	0.00	19.33	0.208	-0.118	5.52	1.09	9.96
Kirikkale	-0.262	-0.074	9.07	1.38	16.77	-0.264	-0.075	8.89	0.66	17.12	0.094	-0.252	2.38	0.99	3.77
Kocaeli	0.013	-0.121	5.36	0.93	9.79	0.029	-0.232	2.63	0.82	4.43	0.278	-0.067	10.01	0.22	19.80
Konya	-0.180	-0.103	6.37	1.47	11.26	-0.260	-0.150	4.25	1.30	7.20	0.188	-0.092	7.21	1.24	13.19
Malatya	-0.252	-0.048	14.21	0.48	27.95	-0.256	-0.050	13.5	1.05	25.95	-0.231	-0.256	2.34	0.99	3.69
Manisa	-0.255	-0.064	10.44	1.57	19.31	-0.318	-0.084	7.86	2.24	13.48	-0.001	-0.080	8.36	0.00	17.03
Mardin	-0.449	-0.050	13.53	2.01	25.05	-0.555	-0.063	10.7	2.82	18.58	-0.262	-0.049	13.9	0.00	28.02
Samsun	-0.229	-0.078	8.55	0.52	16.57	-0.359	-0.130	4.99	1.51	8.47	0.081	-0.074	9.05	0.00	18.59
Sinop	0.240	-0.052	13.02	0.00	26.09	-0.353	-0.083	8.05	1.66	14.44	-0.042	-0.137	4.71	1.26	8.16
Trabzon	-0.230	-0.064	10.50	1.31	19.69	-0.273	-0.080	8.33	1.76	14.90	0.088	-0.171	3.70	1.30	6.10
Van	-0.185	-0.070	9.54	0.89	18.18	-0.128	-0.050	13.62	0.00	30.02	0.244	-0.205	3.01	1.22	4.81
Zonguldak	-0.170	-0.042	16.28	0.00	37.04	-0.320	-0.100	6.60	1.95	11.24	0.030	-0.057	11.89	0.00	26.36
Average			10.93	0.82	22.52			8.78	0.93	17.15			7.21	0.72	13.95

The table provides the point half-life estimates, lower bounds (LB) and upper bounds (UB) for each city. The lower and upper bounds are the 95% confidence intervals estimated by using a Delta method approximation. Alfa is the slope coefficient and beta is the coefficient for the lagged PPP deviations in ADF regression.

8. Can Transportation Costs Explain the PPP Deviations?

Given our findings from unit root and stationarity tests and the results of half-life estimates, we obtain considerable variation in terms of both unit root tests and half-life estimates across different city PPP deviations with various base cities. Since, our analysis is based on intra-country data, it is plausible to raise the question what factors can explain the variation in the variation in the half-life estimates. Given that we do not have the complications that arise in studies that use data over different countries, such as presence of trade barriers, differences in utility functions, or wealth one can plausible assume that the differences within a country might be due to the transportation costs or to the differences in the income distribution across cities. In this section, we explore the variation in transportation costs in explaining two results, namely the variation in convergence rates as measured by half-lives and the likelihood that the ADF test rejects the null of a unit root in PPP deviations. The second analysis aims to provide insights into the findings on non-stationarity of PPP deviations across cities and should be useful as a complementary approach for the first exercise. Due to unavailability of income series at the city level, we cannot explore the potential income effects in explaining the variability of PPP deviations in this thesis.

In order to study the effect of transportation costs, we use the distance in kilometers between a given city and the base city to proxy transportation costs. This measure has been used in the international trade literature to proxy transportation costs. To investigate the effect of transportation costs on the variability of half-lives across cities, we regress half-life estimates on a constant and the distance for each given base city and report results in Table 6.

Reported regression results in Table 6 show that the coefficient for the distance has a positive sign for all base city groups, indicating that as the transportation costs increases, the estimated half-lives increases as well. The slope coefficient is statistically significant for the base city groups of Istanbul and Diyarbakir at 5 percent significance level. This is a striking result given especially the very small sample size we have. Although the R-squared value for the base city group of Ankara is very low (only 0.2 percent), it is considerably high for the other base city groups. For example, the transportation cost as measured by distance explains about 20 and 30 percent of the variation in half-lives when Istanbul and Diyarbakir are the base city groups, respectively.

Table 6: Regression Results for Half-Life on Transportation Costs

Base City	n	Constant	Transportation Cost	R2
Ankara	25	10.8029	0.0002	0.0002
		(1.8929)	(0.003)	
Istanbul	25	6.3582	0.003*	0.1975
		(1.1415)	(0.0013)	
Diyarbakir	25	3.1903	0.0046*	0.2987
		(1.4317)	(0.0015)	

Table 6 reports the results of regressing estimated half-lives on a constant and the transportation costs. The transportation cost is proxied by the distance between a given city group and the base city in kilometers. n is the number of observations. The values in parenthesis show the standard deviations of the estimated coefficients.* indicates that estimated slope coefficient is statistically significant at 5% level. R2 is the R-squared value.

As a complementary approach, we evaluate the effect of transportation costs on the likelihood of PPP deviations being stationary by first creating a binary variable which indicates ADF test rejects the null of a unit root at 10 percent significance level or not. Specifically, the indicator variable is defined to be one if ADF statistic is less than its 10 percent significance level of -2.58 (i.e., a rejection) and zero otherwise. We estimate both linear and nonlinear probability models, namely probit and logit models. The results from LPM and probit model are reported in Table 7.

Since results from the logit model were very similar to probit model, Table 7 reports only the results from probit model. Findings from the LPM show that as distance increases, the likelihood of rejecting the null of a unit root in PPP deviations across city groups is decreases for all base city groups. Although the slope coefficients are not statistically significant for Ankara and Istanbul, it becomes significant at 1 percent level for Diyarbakir. Estimation of probit and logit (not reported) models provide similar results in that as the distance between a given city group and the base city increases, the probability of rejecting the null of a unit root in PPP deviations decreases. This suggests that as the transportation cost increases the likelihood that PPP would not hold as measured by the outcome of ADF test increases. With Diyarbakir as the base city group, the effect of distance on the likelihood of rejecting a unit root null is statistically significant at 1 percent significance level. Given the very small sample size, the findings in Table 7 provide considerable econometric evidence in favor of the effect of transportation costs on the cross-sectional variation of rejecting the null of a unit root in PPP deviations.

Table 7:				
Nonlinear Probability Models (Probit Model)				
Base City	**n**	**Constant**	**Transportation Cost**	**psedoR2**
Ankara	25	0.1844	-0.0014	0.0589
		(0.6443)	(0.0011)	
Istanbul	25	-0.288	-0.0002	0.004
		(0.5692)	(0.0006)	
Diyarbakir	25	1.6553	-0.002*	0.2742
		(0.6507)	(0.0007)	
Results for LPM				
Base City	**n**	**Constant**	**Transportation Cost**	**R2**
Ankara	25	0.5169	-0.0004	0.0626
		(0.2116)	(0.0003)	
Istanbul	25	0.385	-0.0001	0.0051
		(0.2134)	(0.0002)	
Diyarbakir	25	1.0812	-0.0007*	0.3494
		(0.1906)	(0.0002)	

Table 7 reports the results of estimating LPM and probit model where the dependent variable is a binary variable taking the value of 1 when the ADF test is less than the 10 significance level of -2.58 and 0 otherwise. The explanatory variable, transportation cost, is proxied by the distance between a given city group and the base city in kilometers. n is number of observations, and the values in parenthesis are the standard deviations of the estimated coefficients. Pseudo R2 is a version of R2 for binary regressand models. * indicates that estimated slope coefficient is statistically significant at 1% level. For 3 benchmark cities negative coefficients for distance are in favor rejecting null of unit root in PPP deviations

9. Conclusion

This thesis examined the time series dynamic of deviations from the PPP and price convergence without trade barriers and exchange rate fluctuations by using aggregate price series of 26 Turkish city groups between January 2003 and June 2011. Contemporary studies that have a majority of international analyses mostly focus on the persistence of relative exchange rates and presume the PPP hypothesis as a long term phenomenon. Preliminary examination and autocorrelation analysis revealed the persistence in time series dynamics of the deviations. Unit root and stationary tests results point out that price deviations may contain non-stationary components. Although there exist some variation depending on the benchmark city used, overall findings show that for many city groups, price deviations are highly persistence and possibly non-stationarity. As a result, there is strong evidence against PPP at the aggregate price level. On the other hand half-life measures suggest that deviations disappear usually within a year for most city groups, a result that is broadly consistent with models with price stickiness.

The thesis also investigated the extent to which existence of transportation costs can explain the variation in the convergence rates of PPP deviations across city groups and the likelihood of rejecting the PPP. The distance between a given city group and the base city group in kilometers is used as a proxy for the transportation costs. Regression of the point estimates of half lives on the distance shows that the higher the distance between a given city group and the base city group is higher the half-life is. This finding suggests that in the cross section of city groups, part of the variability in the persistence of PPP deviations as measured by half-lives might be due to the variation in transportation costs. Estimated probability models show also that the likelihood of PPP to hold for a city group decreases with distance and hence with transportation cost.

The findings of the thesis relied on using unit root, stationarity tests, half-life estimation, and various regression models. Given the persistence and presence of a unit root component in PPP deviations for many of the city groups as indicated by the results of unit root and stationarity tests, one needs to exercise caution in interpreting the point estimates and the confidence intervals for these point estimates. The subsequent analysis to gain some insights in to the factors that can explain the variation in the persistence of PPP deviations and the likelihood of PPP holding in a given city group the thesis was forced to conduct the analysis for one plausible factor, namely the transportation cost as measured by the distance and therefore results should be evaluated with this in mind. Moreover, the thesis used the data at city group levels and not at the product level. In this sense the results should be interpreted as a preliminary step in the direction of a through analysis of LOP at a more disaggregated product level.

10. Appendix

10.1. Summary Statistics

Before the unit root and stationarity tests discussion, it is useful to look at the summary statistics on the price levels, logarithm and the PPP deviation of price levels. The mean, standard deviation, minimum and maximum values of 102 monthly data of 26 city groups are examined. $P_{j,t}$ is the price index of city *j* at time *t* and $P_{i,t}$ is the price index of the benchmark city *i* at time *t*. When $Q_{ij,t}$ is defined as the PPP deviation of the price level of city *j* with respect to the price level of the benchmark city *i* at time *t* as, it becomes $Q_{ij,t} = \log(P_{j,t} / P_{i,t})$ and by the properties of logarithm, $Q_{ij,t} = \log P_{j,t} - \log P_{i,t}$ or $Q_{ij,t} = p_{j,t} - p_{i,t}$ where $p_{j,t} = \log P_{j,t}$ and $p_{i,t} = \log P_{i,t}$ (and in LOP assumption $Q_{ij,t} = 0$). The percentage change in PPP deviation of price index is $q_{ij,t} = 100 \times Q_{ij,t}$. The arithmetic mean of the percentage change PPP deviation of price indices, $\overline{q}_{ij}$ is $\overline{q}_j = (1/n)\sum_{t=1}^{n} q_{j,t}$ and its standard deviation, s_{ij} is $s_{ij} = ((1/n)\sum_{t=1}^{n}(q_{j,t} - \overline{q}_j)^2)^{1/2}$.

10.2. Autocorrelation

According to Gujarati (2003), the presence of autocorrelation (AC) is a sign for non-stationarity in a time series data. To generate a simple test of stationarity, we employ auto correlation function (ACF), partial autocorrelation function (PACF) and correlograms for the time series data of the log price index of each city and their PPP deviations. The data obtained is a sample of stochastic process therefore the sample ACF is examined with sample variance and covariance. When the sample AC coefficient is defined as $\widehat{\rho}_k$ and

$\widehat{\rho}_k = \widehat{\gamma}_k / \widehat{\gamma}_0$ where $\widehat{\gamma}_k$ is the covariance at lag k and $\widehat{\gamma}_0$ is the sample variance respectively with their general formulas $\widehat{\gamma}_k = (1/n)\sum(q_{ij,t} - \overline{q}_{ij})(q_{ij,t+k} - \overline{q}_{ij})$ and $\widehat{\gamma}_0 = (1/n)\sum(q_{ij,t} - \overline{q}_{ij})^2$.

The choice of lag length is an empirical question. The rule of thumb is to compute ACF up to one third to one quarter according to the length of the time series. Gujarati (2003) advices that strong large lags and decreasing the number of lags by a statistical information criterion are useful to determine the number of lags. Finally, Box-Pierce Q-Statistics is used to test the statistical significance of individual AC coefficients. Q statistics that is developed by Box and Pierce (1970), $Q = n\sum_{k=1}^{m} \widehat{\rho}_k^{\,2}$ where n is the sample size and m is the lag length, controls the AC coefficients of all city groups up to the certain lags are simultaneously different than zero or not. Therefore the presence and the characteristics of the correlation in time series data can be determined.

10.3. Normal Distribution

D'Agustino, Stephans (1986) indicates that; Skewness-Kurtosis tests and chi-squared tests $\chi^2(2)$ such as Jarque-Bera, JB or D'Agustino-Pearson, $K^2(2)$ tests are powerful and informative tests for testing the large number of random variables are normally distributed. Skewness measures the degree of symmetry of the probability distribution and kurtosis measures the peakedness of the distribution in general. These central moments show how the distribution of a random variable deviates from a normal distribution. The JB test of normality is a large sample test that contains also skewness and kurtosis in the formula of JB test statistics therefore the JB test of normality is the joint hypothesis. As Jarque and Bera (1987) showed that in large samples, the JB statistic fallows the chi-square distribution with 2 degrees of freedom and under the null hypothesis the residuals are normally distributed. To check the time series data has a normal distribution or not, Skewness and Kurtosis tests are employed. The procedure is applied on the percentage change in PPP deviation for 3 reference cities and the results are exhibited in the Table A. According to results, the probability of skewness is close to zero for many city groups. The null hypothesis that the skewness for PPP deviations is equal to "0" can be rejected and it can not be said that the random variable for PPP deviations is normally distributed for each city group. Secondly, the probability of kurtosis is also nearly zero for the random variables of PPP deviations of some city groups so it is difficult to claim that the sample is normally distributed. Besides, the joint hypothesis of skewness and kurtosis in chi-squared distribution with degrees of freedom (2) is demonstrated in each Panel. It is seen that the probability of χ^2 test with d.f. 2, is close to zero for some city groups in Panel A, B and C. As a conclusion it can be claimed that the sample of the percentage change in PPP deviation data has mainly non-normal distribution without any benchmark city distinction.

TABLE: Skewness/Kurtosis Tests for PPP deviations

	Panel A: Base City Ankara			**Panel B: Base City Istanbul**			**Panel C: Base City Diyarbakir**		
	P(Skew)	**P(Kurt)**	**P>chi2**	**P(Skew)**	**P(Kurt)**	**P>chi2**	**P(Skew)**	**P(Kurt)**	**P>chi2**
Adana	0.747	0.936	0.946	0.213	0.306	0.264	0.116	0.954	0.282
Ankara	.	.	.	0.210	0.074	0.092	0.184	0.094	0.099
Antalya	0.441	0.000	0.000	0.662	0.197	0.386	0.963	0.133	0.313
Balikesir	0.023	0.903	0.078	0.217	0.730	0.432	0.028	0.966	0.088
Denizli	0.172	0.104	0.102	0.072	0.865	0.188	0.357	0.005	0.020
Diyarbakir	0.184	0.094	0.099	0.118	0.004	0.01	.	.	.
Edirne	0.304	0.000	0.001	0.142	0.000	0.000	0.345	0.001	0.008
Erzurum	0.267	0.489	0.416	0.047	0.237	0.073	0.455	0.039	0.090
Eskisehir	0.797	0.001	0.010	0.483	0.000	0.000	0.818	0.000	0.000
Gaziantep	0.034	0.205	0.054	0.017	0.162	0.030	0.354	0.366	0.424
Hatay	0.004	0.634	0.020	0.005	0.658	0.025	0.590	0.939	0.862
Istanbul	0.210	0.074	0.092	.	.	.	0.118	0.004	0.010
Izmir	0.784	0.010	0.043	0.001	0.269	0.004	0.167	0.000	0.002
Kars	0.736	0.877	0.934	0.157	0.013	0.025	0.403	0.892	0.694
Kayseri	0.392	0.739	0.651	0.012	0.045	0.011	0.027	0.198	0.045
Kirikkale	0.009	0.264	0.025	0.014	0.035	0.010	0.071	0.619	0.166
Kocaeli	0.230	0.289	0.268	0.805	0.295	0.553	0.206	0.000	0.000
Konya	0.167	0.051	0.063	0.842	0.444	0.728	0.168	0.01	0.022
Malatya	0.002	0.249	0.010	0.005	0.732	0.025	0.696	0.487	0.724
Manisa	0.007	0.052	0.008	0.014	0.922	0.055	0.695	0.075	0.182
Mardin	0.000	0.893	0.002	0.000	0.042	0.000	0.129	0.728	0.287
Samsun	0.007	0.625	0.032	0.000	0.002	0.000	0.989	0.000	0.000
Sinop	0.002	0.066	0.004	0.004	0.388	0.018	0.021	0.142	0.032
Trabzon	0.000	0.816	0.003	0.001	0.604	0.006	0.173	0.972	0.386
Van	0.142	0.056	0.060	0.514	0.000	0.000	0.802	0.490	0.760
Zonguldak	0.520	0.000	0.000	0.029	0.926	0.091	0.173	0.012	0.024

Table shows the p values for the normality tests of skewness, kurtosis and Jarque-Bera with P(Skew), P(Kurt) and P>chi2 columns respectively in each panel. It is seen that the p values are zero or close to zero for many different city groups in each panel.

11. Graphs

Adana | Ankara | Antalya | Balikesir

Price Index

PPP Base Ankara

PPP Base Istanbul

PPP Base Diyarbakir

Graphs II | **Denizli** | **Diyarbakir** | **Edirne** | **Erzurum**

Price Index

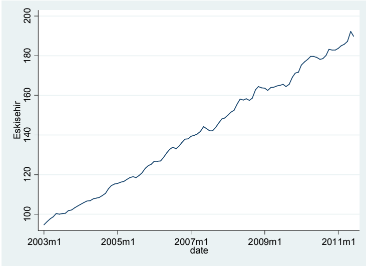
PPP Base Ankara

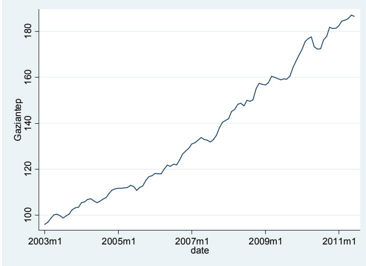
PPP Base Istanbul

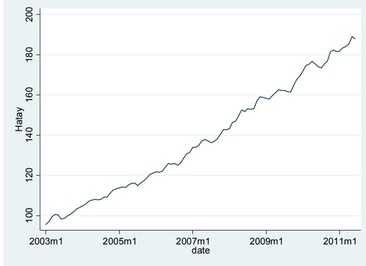
PPP Base Diyarbakir

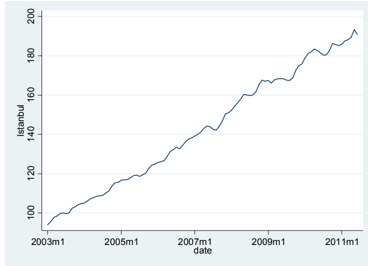
Graphs III

Eskisehir | **Gaziantep** | **Hatay** | **Istanbul**

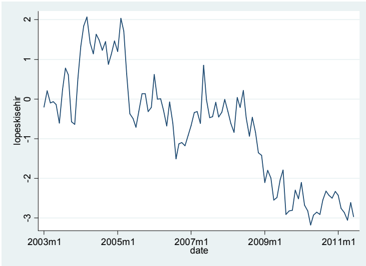


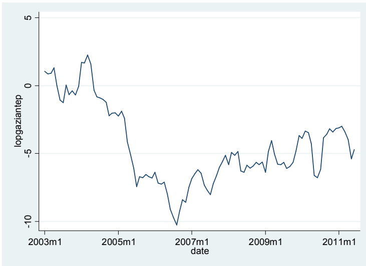


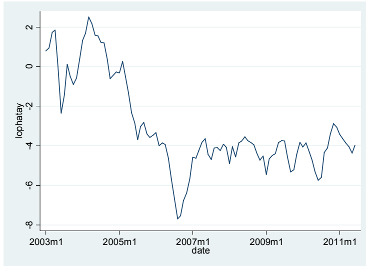


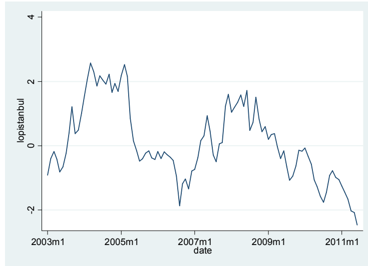


Price Index

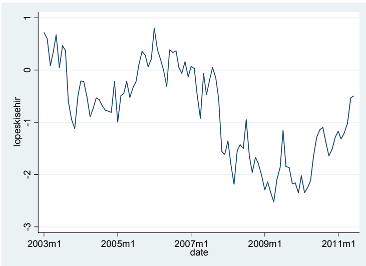


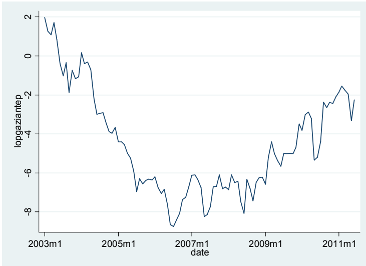


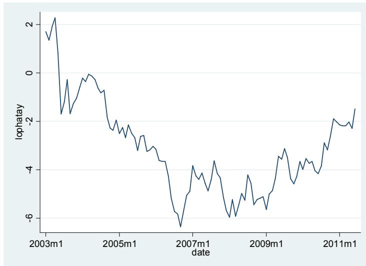




PPP Base Ankara







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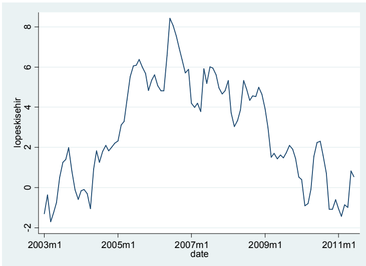
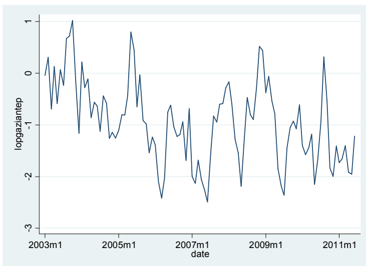
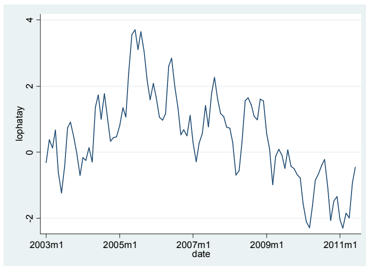
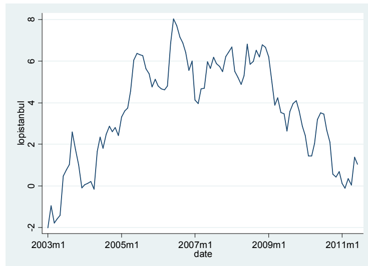








PPP Base Diyarbakir

Graphs IV **Izmir** **Kars** **Kayseri** **Kirikkale**

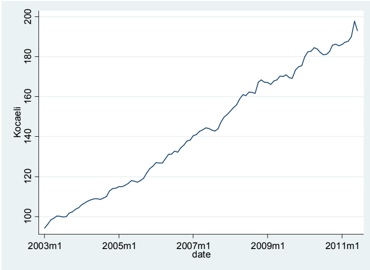
Price Index

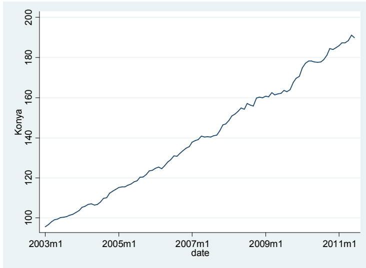
PPP Base Ankara

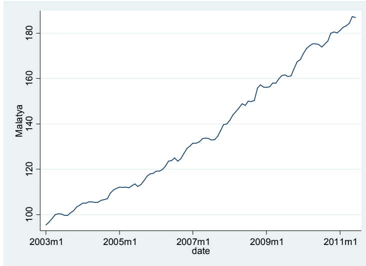
PPP Base Istanbul

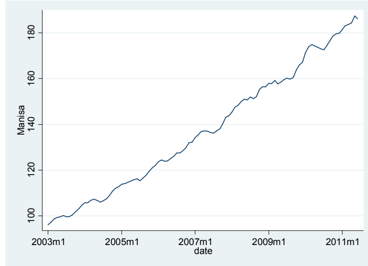
PPP Base Diyarbakir

Graphs V | **Kocaeli** | **Konya** | **Malatya** | **Manisa**

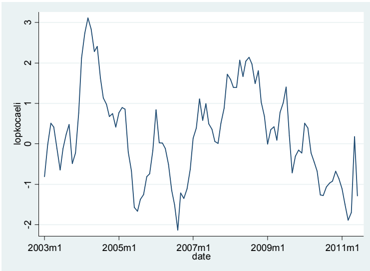


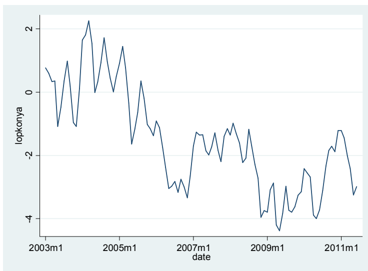


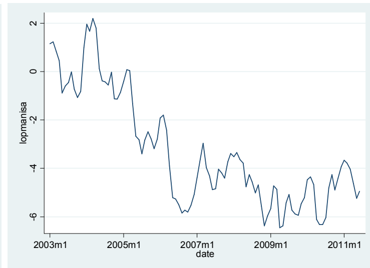




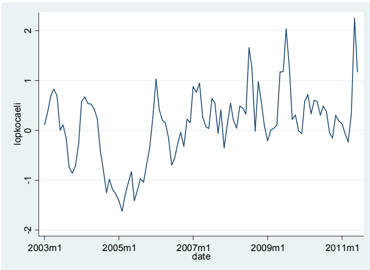
Price Index

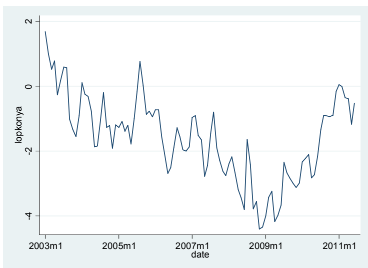


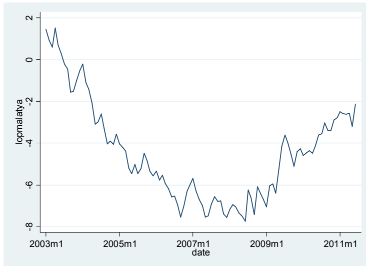


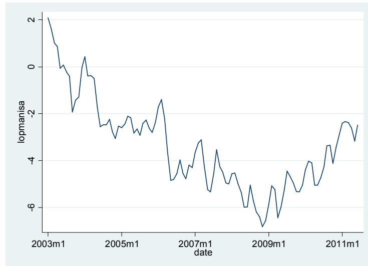


PPP Base Ankara

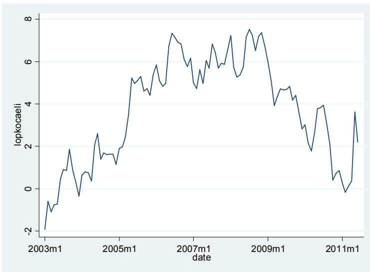


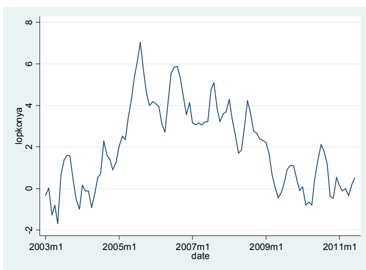


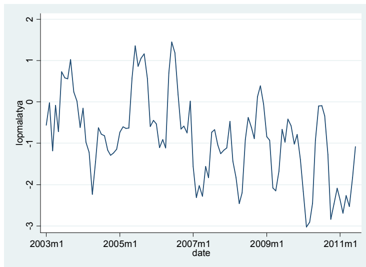


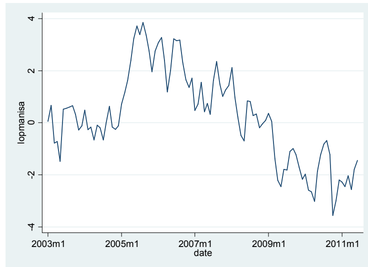


PPP Base Istanbul



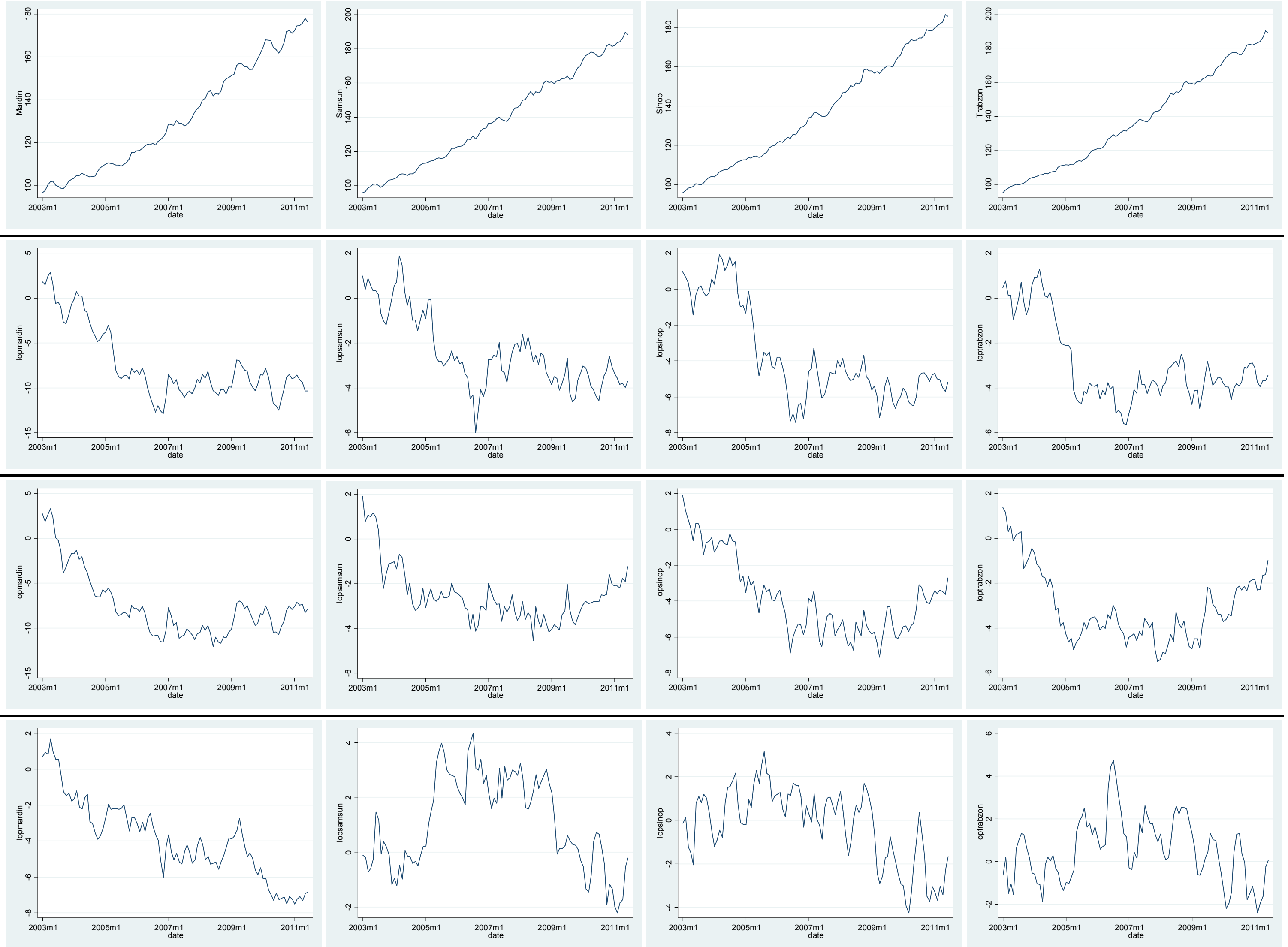






PPP Base Diyarbakir

Graphs VI **Mardin** **Samsun** **Sinop** **Trabzon**



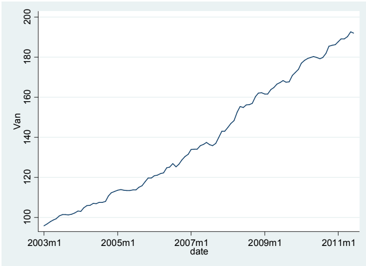
Price Index

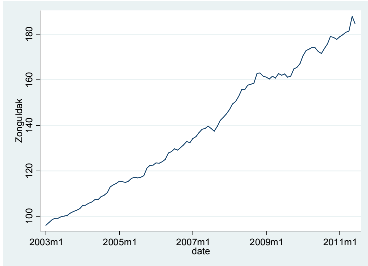
PPP Base Ankara

PPP Base Istanbul

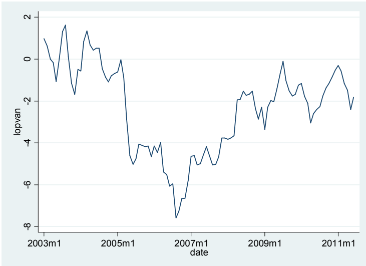
PPP Base Diyarbakir

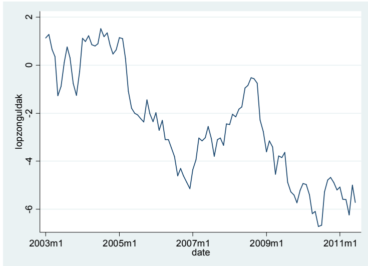
Graphs VII **Van** **Zonguldak**





Price Index





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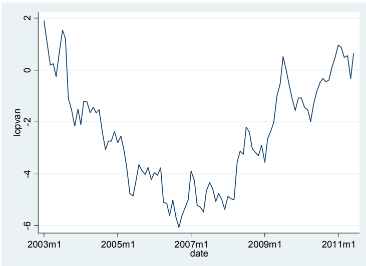
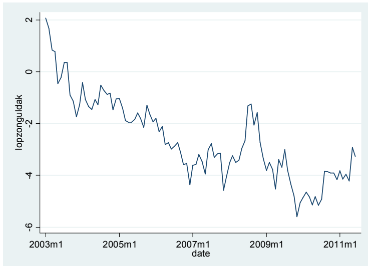
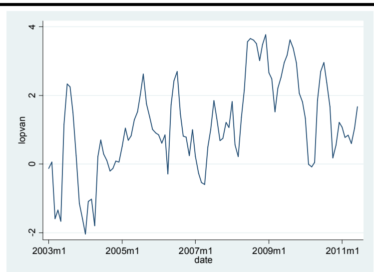
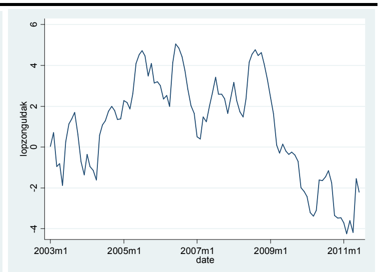




PPP Base Istanbul





PPP Base Diyarbakir

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