Relative Price Convergence among Pakistani Cities: Does the Choice of Numeraire City Matter?

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ABSTRACT

This study examines the price dynamics across seventeen cities in Pakistan, considering monthly disaggregated goods prices, and the convergence behavior among tradables and non-tradables. The results show overwhelming evidence of mean reversion of relative prices among cities. Varying across items, the speed of convergence is only a few months or less. Nevertheless, the results challenge some of the previous findings as the services which are considered as non-tradable items also reject the null of unit root with half-lives of less than a year. The empirical results of this study support the conjecture that intra-national prices converge faster than international prices. Greater tendency of convergence towards the Law of One Price implies high integration of Pakistani markets or perhaps low degree of specialization and market differentiation.

***Keywords*:** Relative prices; Convergence; Law of one price, Tradables and Non-Tradables

1. INTRODUCTION

Price convergence studies are ostensibly an empirical exercise that tests for the economic theory of Law of One Price. Even after having controlled many factors as trade barriers, exchange rate volatility etc. which are present in international level, testing for price convergence on the international level (within the same country) failed to coincide with the Law of One Price (LOP). The price index at intra-national level is expected to be homogeneous because within a country the trade barriers and exchange rate volatility do not

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present. However, these two factors cannot capture price dispersion entirely (Engel and Rogers, 2001). On the other hand, since the Consumer Price Index (CPI) includes non-traded goods as well, the presence of these goods may also result in divergence from LOP. Balassa and Samuelson (1964) have used services as non-traded items they consider labor to be perfectly immovable. According to them, another factor that hampers prices to converge is the difference in productivity of growth among various sectors. Productivity growth is the rate at which goods and services is produced like output per unit of labor. The internal price structure of a country can be altered if there are differences in the growth of productivity of the two sectors i.e., tradable-goods sector and non-tradable goods sector. It implies that the differences of productivity growth of such sectors lead to inflation differentials within a country usually known as the "Harrod-Balassa-Samuelson effect". The productivity growth in tradable sector causes an increase in general wages. Due to slower productivity development in the non-tradable sector, the non-traded goods prices increase (Manuela-Nenna, 2001). Recently engaging the multivariate tests, researchers have found that relative prices within a country have a mean reverting-effect (Cecchetti, Sanora and Mark, 2000; Morshid, Ahn and Lee, 2005; Nath and Sarkar, 2009). The analysis by Ceglowski (2003) provides evidence that inter-city price differentials in Canada are significantly affected by provincial borders even though the effects of distance are controlled. However, the retail prices do converge to parity in the long run. The short run deviations were found to have half-lives of less than a year. They gave several reasons creating the provincial border effects including provincial tax differences, provincial trading networks and geography. Their analysis led to the conclusion that there is a positive link between distance and price disparity suggesting that price effects of distance cannot be entirely captured by intercity measures. Lee and Habibullah (2008) assessed the market integration in Malaysia using disaggregated monthly prices of various types of goods and services. They checked the stationarity of prices in three provinces/states: Peninsular Malaysia, Sabah, and Sarwak, after dividing the goods and services in nine different groups and tested for the existence of Harrod-Balassa-Samuelson effect. It was found that the convergence rate for the tradable category was much higher than the non-tradable category, having a half-life of 1-2 years. While in case of non-tradable goods the half-life was computed to be10 years. Iregui and Otero (2008) tested the LOP in food market

in Colombian cities using disaggregated data of food products. Little evidence of convergence was found using the univariate Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test. However, when the cross-sectional dependence was allowed in a panel context, using a large data set of thirteen cities and fifty-four food items, the test provided the evidence of market integration in food market. Lan and Sylwester (2010) used two estimation methods to examine the price divergences in China by using the fixed effect method for individual goods, and for all products they used mean group estimation specification. For the individual goods, the half-life was 2.95 months while the mean group estimator implied a half-life of 1.72 months. Wang (2012) found evidence of convergence for inter-regional prices with a slower speed of convergence. Guo and Shen (2016) got an evidence of a high speed of convergence among the product markets, and the level of market integration was found to be increasing since 2003. Later, the selection of numeraire (benchmark) city was also considered to get the effect of convergence rate (Chmelarova and Nath, 2010). Transportation costs also affects the rate of convergence by causing the relative prices between adjacent regions to converge quickly than far away regions, as the cost of moving goods among close areas is low. Krugman and Obstfeld (2009) consider transportation cost and market segmentation as sources of divergence from Purchasing Power Parity (PPP). Hegwood and Nath (2012) consider structural breaks as a source to slow the speed of convergence. They found that by accounting structural breaks, the convergence rate is much higher than previous estimation which did not account structural break.

The investigation of convergence of relative prices provides an important insight of market integration, reflecting how changes in one market are transmitted to another (Fan and Wei, 2002; Na-li, 2006). Richardson (1978) argues that LOP is a test of market integration which is an indicator that explains how well different markets are related to each other. It occurs when prices of related goods among various markets follow similar patterns over a long period and provides important information about the efficiency of the markets. The government can use such information to decide the extent to which it should promote market development. Pakistan, being a developing country with a disease of high inflation (at least after 2005) is expected to provide the evidence of PPP hypothesis. According the State Bank of Pakistan

(2011), the overall Consumer Price Index (CPI) rose to 13.2% on Year-On-Year basis till March 2011. The city-wise inflation level at the major cities indicates that the inflation in Peshawar and Lahore is highly persistent (existing for a long or longer than usual time). Out of 35 cities in the CPI, 23 cities showed higher inflation than the overall inflation rate (State Bank of Pakistan, 2015). In Pakistan, efficient functioning of market is subject to several impediments such as difficulties in evaluating market information, government monopoly over marketing system, insufficiency of transportation infrastructure, restriction on movement of goods between regions, and price fixing etc. With the presence of such hurdles, markets cannot be well integrated, and that could distort the price signals leading to inefficient allocation of resources (Tahir and Riaz, 1997). The geographic location of Pakistan is also of great significance as all its provinces share an international border like Punjab and Sindh with India, Khyber Pakhtunkhwa with Afghanistan, and Baluchistan with Iran, Afghanistan, and China. Across these boarders there is some evidence of illegal trade which leads to inflation, and divergence of prices across cities within a country (Sharif, et al. 2000; Khan, 2005; Gilbert and Mohsin, 2010). Pakistan's economy is largely dependent upon agriculture (with a contribution of 21 percent to the GDP). The food consumer price index constitutes 40 percent of the overall CPI (Janjua, 2005). Market integration of agricultural products is of massive importance due to its potential application in policy making. The high degree of market integration means that the markets are competitive and there is no need of costly government intervention to enhance the market efficiency. Due to the transmission of incentives across the marketing chain, market integration leads to price stabilization. If the markets are highly integrated, government can maintain stable prices in all the markets by stabilizing them in the key markets. Arbitrage forces ensure stabilization of prices in other markets. Thus, market integration reduces the cost of stabilization immensely. Even though, the literature on market integration is limited in case of Pakistan, studies reveal that the markets are well integrated. Most studies are confined to food/ agricultural products. Food markets as Wheat, Maize, Apple, Mango and Gram were found to be integrated among Pakistani markets (Zahid, Qayyum and Malik, 2007; Mukhtar and Javed, 2007; Mushtaq and Dad, 2008; Ghafoor et al. 2009; Hussain et al. 2010). Apart from individual products, the overall CPI also provided evidence for spatial correlation. Recently, convergence of relative prices between cities has

been tested as a measure of market integration. Mohsin and Gilbert (2010) using CPI data of 35 cities over the period of 2001-2008, tested the relative price convergence by keeping Lahore and Karachi as the numeraire.

Looking at the previous findings, this study can hypothesize that food markets are well integrated in Pakistani cities but do all the components of the CPI behave in the same way? Is the market for services (non-traded items) also well integrated among the Pakistani cities as the market for consumer products? The purpose of this study is to assess the market integration among Pakistani cities. Previous studies have focused on the convergence behavior of aggregate prices across different cities in Pakistan. By checking the price convergence of homogeneous goods across different markets, the performance of the market system can be analyzed. Taylor (2001) has demonstrated that convergence can be underestimated if researchers use low frequency data. Moreover, using overall CPI data can result in longer half-life's due to aggregation bias. This study uses disaggregated monthly data, fixing for the aggregation bias caused using low frequency data (quarterly or annual). It also corrects the Nickell Bias which causes the serial correlation coefficient to bias downwards in small samples. In addition, this study examines the effect of non-tradable goods on price differentials. Although, the "Harrod-Balassa-Samuelson effect" has been tested for several developed countries such results cannot be generalized to draw conclusion in case of Pakistan due to country-specific economic differences. The rest of the study is organized as follows: section two discusses the methodology and data, section three delves into the results, and section four concludes the study.

2. DATA AND METHODOLOGY

To analyze the convergence of prices across cities, the relative prices are computed for each commodity across all cities of Pakistan. The relative price of a commodity/service is defined as the price of that commodity/service in terms of another i.e., the ratio of two prices. The methodology to calculate relative prices for each city is given as under:

2.1. Relative Prices

The relative prices for each city are calculated as:

$$r_{ist} = p_{i,s,t} - \hat{p}_{i,s,t} \quad (1)$$

where, r_{ist} is the log relative price in city i, $p_{i,s,t}$ is the log-price of commodity s of city i and $\hat{p}_{i,s,t}$ is the logof the mean prices of commodity s over cities in period t. After calculating the relative prices for each city, the convergence of these relative prices has been analyzed. Price convergence is commonly examined by the application of a unit root test to check whether the series of relative prices are stationary. The time series of the relative prices is stationary if the unit root hypothesis is rejected. If the unit root hypothesis is not rejected it implies that the relative prices, follow a random path. The general structure used by most (though not all) panel unit root testing procedures is:

$$\Delta y_{i,t} = \rho_i y_{i,t-1} + \sum_{l=1}^{\rho_i} \emptyset_{i,l} \Delta y_{i,t-1} + \alpha_i d_{it} + \varepsilon_{i,t} \quad (2)$$

where, d_{it} are the deterministic components, $\rho_i = 0$ implies that the process has a unit root for individual i, while $\rho_i < 0$ implies that the process is stationary around the deterministic part. This study has made use of two-unit root tests to test the convergence of relative prices across Pakistani cities which are explained in the following subsections:

2.1.1. Levin-Lin-Chu test (LLC)

Levin, Lin, and Chu (2002) proposed a unit root test in which the alternative hypothesis states that the ρ_i are identical and negative.[3] To isolate only the ρ_i in equation (2), the residuals from regressions of $\Delta y_{i,t}$ and $y_{i,t-1}$ from all the "nuisance" variables (lags and deterministic) are obtained using single regressions. Generally, the data is scaled down by a feasible estimate of the standard deviation of the variance of ε_{it}. This produces two series $\tilde{e}_{i,t}$ (from $\Delta y_{i,t}$) and $\tilde{v}_{i,t-1}$ (from $y_{i,t-1}$). The test statistic used is the t statistic for the linear regression of $\tilde{e}_{i,t}$ on $\tilde{v}_{i,t-1}$. For a single individual, this would be identically the Dickey Fuller t-test statistic for the given set of augmenting lags and deterministic components. Instead of using the Dickey

[3] This circulated as a working paper with just Levin and Lin, so is more commonly known as the Levin-Lin test.

Fuller distribution, the constants are normalized such that, as $N \to \infty$[4] an adjusted t converges to a standard Normal. The long run variances of the $\tilde{v}_{i,t}$ processes across i are also corrected. The Levin-Lin-Chu (2002) test simultaneously analyzes the stationary of the relative prices across the cities by using the following equation:

$$\Delta r_{i,s,t} = \alpha_{i,s} + \theta_t + \beta_s r_{i,s,t-1} + \sum_{j=1}^{k} \gamma_{s,j} \Delta r_{i,s,t-j} + \varepsilon_{i,t} \qquad 3$$

where$\alpha_{i,s}$is the city-specific constant that controls for the non-time dependent heterogeneity across cities and θ_t is the common time effect,$\gamma_{ij}$are the lag coefficients in the process characterizing $r_{i,s,t}$, $\beta_i \equiv \rho_i - 1$ and $\rho_i \equiv \sum_{j=1}^{k} \gamma_{ij}$. Panel data analysis gives the advantage of accounting the two effects simultaneously,$\alpha_{i,s}$reflects the heterogeneity across cities that is due to the income level and sales tax differences, while macroeconomic shocks that determine cross-sectional dependence in relative prices are captured by the common time effect. The null hypothesis ($\beta i = \beta = 0$) that each series contains a unit root is tested against the alternative hypothesis ($\beta i = \beta < 0$) of mean convergence. Our analysis is based on the t-statistic provided by the LLC test.

2.1.2. Estimation of Half –life

The speed of convergence of the relative price behavior of the goods and services is estimated through half-life which gives the required time by a divergence to dispel by one half. If $\beta i \geq 0$, it means that that the deviations of the price differential r_{ist} of product 's' are persistent. The negative and significant value of βi implies prices converge. The value of βi defines the speed of convergence. The half-life of product s is measured by the following formula:

$$h(\rho) = {-\ln(2)}\Big/{\ln(1 + \beta_s)} \qquad 4$$

where, h (ρ) denotes half-life.

[4] With $N/T \to 0$.

2.1.3. IM-Pesaran-Shin Test (IPS)

IM, Pesaran, and Shin (2003) test has the same basic model (2), but, unlike Levin-Lin-Chu, the alternative hypothesis is more general such that the ρ_i can vary and, in fact, that some variables can be non-stationary. However, by allowing some degree of non-stationarity, the power of the test decreases severely. The ADF is computed separately for every individual and then combined by taking the average of the t statistics.The averaged test statistic is a normalized version called Z_t which has an asymptotic $N(0,1)$ distribution. This has large Nasymptotic.The IPS test is an extension of the LLC. The IPS test has more power than LLC as it allows heterogeneity in β for the alternative hypothesis (Bowman, 1998;Maddala and Wu, 1997). The test is based on the following equation:

$$\Delta r_{i,s,t} = \alpha_{i,s} + \theta_t + \beta_{i,s} r_{i,s,t-1} + \sum_{j=1}^{k} \gamma_{s,j} \Delta r_{i,s,t-j} + \varepsilon_{i,t} \qquad 5$$

As in the LLC test, the fixed effects specific for cities like the wage cost and transportation cost are captured by the constant terms. The IPS differs in the treatment of βi under the alternative hypothesis, with: $\beta i < 0$ for some i. The half-life is estimated by using the following formula:

$$h(\rho) = {-\ln(2)}\Big/{\ln(1+\beta_s)} \qquad 6$$

where, h (ρ) denotes half-life and β_s is the average of all the Beta's across cross sections i.e. $\beta s = \frac{1}{N}\sum_{i=1}^{N} \beta_{i,s}$.

2.2. The Data

The data is taken from Monthly Bulletin of Statistics.[5] Monthly city wise data[6] on prices of individual commodities and services for the period 2000-2019 is used. The individual commodities are selected from the monthly Sensitive Price Index (SPI) through three criterian

[5] Government of Pakistan, Statistics division, Federal Bureau of Statistics
[6] Excluding the products and services prices whose prices completely converged among all the cities.

i.e. for each commodity, wide coverage in terms of availability across cities[7] and time, variation in the degree of tradability of the commodities and homogeneity of the commodities over time (Parsely and Wei, 1996). The services data is taken from the Consumer Price Index (CPI). For the analysis, monthly data is used as it is a high frequency data and results are to a great extent accurate in the context of objectives (Fan and Wei, 2006; Wimanda, 2009; Taylor, 2001). Present study has taken all those commodities which are highly used in the private consumption, representing higher weights in the consumer expenditure and their prices are sensitive to shocks. The commodities are categorized as tradable goods. Services are termed as non-traded items on the international level (Parsely and Wei, 1996). So, present study categorize them in the non-traded goods. Tradable goods are further categorized as perishable and non-perishable goods. This data covers information of the monthly prices of 23 products and 5 services of 17 cities for the period of July 2001 to June 2016. The list of products and services is given in the Appendix table A.1 and A.2. Over time, the definitions of the products used have remained stable. Briefly our sample contains prices of 12 perishable goods (chicken, beef, mutton, eggs, bread, milk, potatoes, onions, tomatoes, bananas, curd, and garlic), 11 storage goods (wheat, rice, masoor pulse, moong pulse, mash pulse, sugar, salt, red chilies, lawn, shirting and washing soap) and 5 services (doctor, carpenter, mason, labor, plumber). The commodities and services whose prices completely converged to the mean prices (relative prices turned out to be zero), are excluded from the sample as testing convergence for these items is meaningless. To investigate whether the distance which is a proxy for the transportation cost has any effect on the relative price convergence, this study follows Cecchetti et al. (2002), and Das and Bhattacharya (2004). The data for distance is taken from the site of Distance Calculator of Pakistan. The distance used is the air distance in kilometres of city i from the numeraire city. Lahore and Karachi are kept as the numeraire cities. Lahore is the capital of Punjab and is considered as the central market for agricultural products. On the other hand, Karachi is the capital of Sindh, and is considered as the center of

[7]Islamabad, Rawalpindi, Gujranwala, Sialkot, Lahore, Faisalabad, Sargodha, Multan, Bahawalpur, Karachi, Hyderabad, Sukkur, Larkana, Peshawar, Bannu, Quetta and Khuzdar

industrial and economic activity. Proportion of income tax collected from Karachi is the highest among all cities and are considered as the urban commercial centers with the highest populations. Keeping Lahore and Karachi as the numeraire and using distance as the independent variable, present study checks the impact of distance by running the following regressions:

$$s.d.\left(r_{i,s,t}\right) = \beta \ln(\text{distance}) + \text{dummies} \quad (7)$$

$$\bar{r}_{i,s,t} = \beta \ln(\text{distance}) + \text{dummies} \quad (8)$$

where $s.d.\left(r_{i,s,t}\right)$ is the price differential variability, measured by taking the standard deviation over time of the price differentials, $\bar{r}_{i,s,t}$ is the mean absolute price differential that is calculated by taking the mean of the absolute relative prices ($\left|\ln\left(p_{i,s,t} - p_{j,s,t}\right)\right|$) over time and natural log of distance and product dummies are used as the independent variables ("j" is the numeraire city). The product dummies are used to differentiate among the three groups of perishable, storage, and non-tradable goods.

3. EMPIRICAL RESULTS

Summary statistics of the price differentials for the individual commodities and services is given in Appendix table A.3. Our benchmark is the cross-sectional mean of prices over the cities. The natural benchmark for the relative prices ($ln(pi, s, t - \hat{p}i, s, t)$) is zero. However, the price differentials may differ from zero due to the obstacles in the arbitrage of goods and services. The impact of distance is analyzed through cross-sectional regressions of the $s.d.\left(r_{i,s,t}\right)$ and $\bar{r}_{i,s,t}$ on the log of distance and log of distance squared. Table 1 shows that the distance among the cities has a positive relation with the variability of price differentials for all the three categories of perishables, non-perishables, and services with Lahore as the numeraire city. The impact of distance is the greatest in case of the non-tradable services. The mean absolute price differentials also show a positive relation with the distance. It means there is a linear relation between the price differentials and the distance among the cities.

Now keeping Karachi as the numeraire Table 2 shows the distance has a positive relation with the mean absolute price differentials but the relation turned out to be insignificant in case of variability of price differentials. Therefore, present study conclude that the transport cost also plays a role in the divergence of prices.

Table 1. Impact of distance on price differentials keeping Lahore as the numeraire

Variability of Price Differentials			
	Perishables	**Non-Perishables**	**Services**
$ln(Distance)$	0.010	0.011	0.013
Std.Error	(0.002)	(0.002)	(0.002)
Product dummies	Yes	Yes	Yes
$\mathbf{R^2}$	0.66	0.64	0.65
Std. Error of regression	0.032	0.033	0.032
Number of observations	192	175	115
Mean Absolute Price Differentials			
	Perishables	**Non-Perishables**	**Services**
$ln(Distance)$	0.017	0.014	0.011
Std.Error	(0.003)	(0.002)	(0.001)
Product dummies	Yes	Yes	Yes
$\mathbf{R^2}$	0.53	0.52	0.54
Std. Error of regression	0.054	0.055	0.054
Number of observations	192	175	115

Table 2. Impact of distance on price differentials keeping Karachi as the numeraire

Variability of Price Differentials			
	Perishables	**Non-Perishables**	**Services**
$ln(Distance)$	-0.001	0.001	-0.001
Std.Error	(0.00426)	(0.00413)	(0.0043)
Product dummies	Yes	Yes	Yes
$\mathbf{R^2}$	0.55	0.55	0.55
Std. Error of regression	0.048	0.048	0.048
Number of observations	192	175	115
Mean Absolute Price Differentials			
	Perishables	Non-Perishables	Services
ln(Distance)	0.032	0.034	0.029
Std.Error	(0.032)	(0.0094)	(0.0037)
Product dummies	Yes	Yes	Yes
$\mathbf{R^2}$	0.44	0.45	0.44
Std. Error of regression	0.101	0.100	0.101
Number of observations	192	175	115

3.1. Panel Unit Root Tests

Instead of using any city or province as a benchmark, present study constructs it by using the cross-sectional averages, as per Cecchetti, Mark and Sanora (2002), the common time effect absorbs movements in the numeraire city, therefore, selecting a numeraire will be unnecessary in a panel analysis. Table A.6 in the Appendix presents the regression result on item-by-item base. The point estimate of beta was found to be negative in all cases. Results show that majority of the items (29 out of 30) reject the unit root null supporting the law of one price within Pakistan. The only item that shows nonstationary results is Shirting. Doctor, Carpenter, Mason, Labor and Plumber among the services turn out to be first difference stationary. Among the tradable goods 8 perishable goods (Chicken, Beef, Egg, Milk, Potatoes, Onions, Tomatoes, and Garlic) and 3 storage goods (Wheat, Red Chilies, Sugar) were found to be level stationary, while the rest were first difference stationary. Including trend along with intercept, all the services turned out to be first difference stationary. Among the tradable Rice, Masoor, Moong, Mash, Bread, Curd, Lawn and Washing Soap were first-difference stationary while the rest were level-stationary. Shirting remained to be non-stationary. Looking at table A.7, present study sees that the goods as well as the services and energy goods converge to the LOP. Shirting that possessed unit root for LLC also converged towards the mean using IPS. It is observed that all the items are level stationary. It means there is no evidence of a stochastic trend in the relative prices of the cities.

3.2. Speed of Convergence

After having evidence of convergence of the relative prices across cities, the speed of convergence is measured by using the persistence parameter (ρ_i). For the IPS ρ_i differs across cities so the average of all the ρ_i across cities is taken. This study has used Nickell's (1981) formula to adjust the estimated panel ρ to correct for the bias due to small samples. The Levin-Lin-Chu Test is a low power test which is biased towards the null of unit root. Most of the items were first difference stationary using the LLC test while for IPS test all turned out to be level stationary. Hence, this study used the results of the IPS to calculate the speed of convergence. Using the IPS test Shirting also converges with a half-life of 0.74 months. The

half-life's for services ranges from 1.1 months (Mason) to 6.6 months (Doctor Clinic fee). Excluding Doctor Clinic fee, the other services converge at a rate of less than 3 months. The half-life for the tradable goods ranges from 0.22 months (Eggs) to 2.8 months (Bread). The mean half-life of the services is 2.3 months. While the mean half-life of storable goods is 1.2 months and that of the perishable goods is 1 month. Present study analyzed the tradable goods have a faster speed of adjustment than the services. Our results coincide with the findings of Na-Li (2006) who found that services are also mean reverting with a high speed of convergence.

Table 3. Estimates of convergence rates by IPS

Category	IM-Pesaran-Shin						
	Item	**β**	**t-stat**	**ρ**	**Half life**	**Adjusted ρ**	**Adjusted Half-life**
Services and Other non-tradable items	**Doctor clinic fee**	-0.024	-12.4***	0.975	28.018	0.899	6.576
	Carpenter	-0.257	-13.6***	0.742	2.325	0.732	2.231
	Mason	-0.460	-13.7***	0.539	1.122	0.525	1.075
	Labor	-0.265	-15.8***	0.734	2.242	0.642	1.564
	Plumber	-0.213	-13***	0.786	2.893	0.780	2.801
Storable Goods	**Wheat**	-0.578	-7.5***	0.421	0.802	0.162	0.381
	Rice	-0.330	-3.7***	0.669	1.730	0.583	1.287
	Masoor	-0.250	-14.3***	0.749	2.400	0.692	1.888
	Moong	-0.211	-4.28***	0.788	2.924	0.737	2.277
	Mash	-0.320	-9.5***	0.679	1.794	0.614	1.421
	Sugar	-0.543	-4.2***	0.389	0.883	0.207	0.440
	Salt powdered	-0.701	-8.9***	0.745	0.573	0.297	0.571
	Red Chilies	-0.215	-4.7***	0.657	2.848	0.729	2.201
	Lawn	-0.336	-12.4***	0.332	1.688	0.563	1.210
	Shirting	-0.435	-12.3***	0.819	1.211	0.391	0.739
	Washing soap	-0.503	-14.4***	0.456	0.989	0.435	0.834

Meat, fresh produces, dairy products, and other perishable food items	**Chicken**	-0.610	-8.2***	0.577	0.735	0.231	0.473
	Beef	-0.254	-11***	0.586	2.361	0.685	1.838
	Mutton	-0.342	-3.8***	0.588	1.655	0.579	1.268
	Egg	-0.667	-11***	0.491	0.628	0.040	0.216
	Bread	-0.180	-13.2***	0.561	3.489	0.779	2.77
	Milk fresh	-0.422	-4.7***	0.281	1.261	0.414	0.785
	Curd	-0.413	-12.4***	0.298	1.299	0.498	0.994
	Potatoes	-0.411	-5.1***	0.784	1.308	0.421	0.801
	Onions	-0.508	-5.7***	0.727	0.977	0.243	0.490
	Tomatoes	-0.573	-8.6***	0.663	1.200	0.215	0.451
	Bananas	-0.718	-6.2***	0.564	0.547	0.265	0.522
	Garlic	-0.272	-2.9***	0.496	2.177	0.639	1.548

Our estimate of the mean half-life of the services is 2.3 months which is lesser than estimated by Parsley and Wei (1996). They found that the deviation converges within the U.S. with a half-life of 5 years. Ceglowski (2003) also got a similar result of convergence rate while testing for retail prices in Canada. Moreover, our results confirm the findings of Cheung and Lai (2000) and Crucini and Shintani (2008). They suggested that the speed of convergence is higher in case of developing countries than the developed countries. Looking at the convergence behavior of the twenty-eight items by using both tests, present study analyzed that although the convergence rates are different for various items, none of the items take a year or more to revert to their mean prices. It means the deviations from the LOP are very minor and short lived.

4. CONCLUSIONS AND POLICY IMPLICATIONS

Based on our empirical results, the evidence of convergence for all products is found but the convergence rate of this study is much higher than the findings of the earlier studies. First part of the study focuses on the disaggregated prices to check the deviations from the Law of One

Price. Not only do the results of this study supplement the previous findings but also gave new conclusions. Analyzing the relative prices on product basis, the LOP proved to be authentic in both cases of tradable and non-tradable goods. Only one item out of twenty-eight shows non-convergence using LLC test while the IPS gave evidence of convergence for all the 28 items. Moreover, testing price convergence with high frequency data supports the LOP with higher speed of convergence. Our results seem to be consistent with Taylor (2001) who claimed in his theoretical study that non- convergence could be the consequence of using low frequency data while testing price convergence. Second part of the study focuses on the rate of convergence of the individual items. The results suggest a remarkably fast convergence towards the Law of One Price. 15 items out of 28 converged with the speed of less than a month. Only 1 item (Doctor) has a speed of convergence of about half a year while, the half-life of the rest of the items is observed to be less than 3 months. It implies that price differentials for items that are termed as "non-tradable" in the international context do not deviate from zero indefinitely. The results confirm the findings of Cheung and Lai (2000) and Crucini and Shintani (2008) who suggested that the speed of convergence is higher in case of developing countries than the developed countries. This difference can be attributed to the low level of specialization, market concentration and market differentiation in the developing countries which could also be a potential for mean reversion. Considering these possibilities, the examination of the effect of market structure on price convergence could be an avenue for future research within Pakistan. Furthermore, LOP is known to hold quite well in case of high inflation countries (Ball and Mankiw, 1994). Government spending and inflation play a vital role in the convergence to LOP (Cheung and Lai, 2000). If monetary shocks dominate the price dynamics, Parity reversion is expected to prevail. During the period of 2016-17, Pakistan's average annual rate of inflation was 7.44% (State Bank of Pakistan, 2016). Thus, high inflation in Pakistan could also be explained for such short half-lives. In this study it is also observed that items taken from the sensitive price index (tradable goods) have a faster speed of convergence as compared to those (services) that are taken from the CPI as the sensitive price index is more responsive to shocks.

The policy implication that stems out of this study is that as the consumer products and services are highly sensitive towards the monetary shocks, small changes in the money supply can bring large effects on inflation. Therefore, the policy makers can take advantage by using micro data to calibrate monetary policy based on micro foundations. The policy makers usually overestimate the persistence of deviations from the law of one price by using aggregate CPI approach, in which all goods are treated identically. Our results prove that convergence can be underestimated if researchers use low frequency data. Moreover, using overall CPI data can result in longer half-life's due to aggregation bias. Based on the results it can be suggested that the market is closely integrated in Pakistan with small regional differences.

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Appendix

Table A.1. and A.2. List of Products and Services

Category	Description	Unit
Storable Goods	WHEAT	Kg
	RICE BASMATI	Kg
	MASOOR PULSE WASHED	Kg
	MOONG PULSE WASHED	Kg
	MASH PULSE WASHED	Kg
	SUGAR	Kg
	SALT POWDERED	Kg
	RED CHILLIES	Kg
	LAWN	Meter
	SHIRTING	Meter
	WASHING SOAP NYLON	Cake
Meat, freshproduces, dairyproducts, andother perishablefood items	CHICKEN (FARM)	Kg
	BEEF	Kg
	MUTTON	Kg
	EGG HEN (FARM)	Dozen
	BREAD PLAIN MID.SIZE	Each
	MILK FRESH	Liter
	POTATOES	Kg
	ONIONS	Kg
	TOMATOES	Kg
	BANANAS	Dozen
	CURD	Kg
	GARLIC	Kg
Services andother non-tradableitems	Doctor clinic fee	Each
	Carpenter	Per day
	Mason	Per day
	Labor	Per day
	Plumber	Per day

Table A.3. Summary Statistics of Relative Prices

PRODUCT	Mean	Median	Max	Min	Std.Dev.	Skewness	Kurtosis	Obs.
Wheat	0.00	0.00	0.82	-0.21	0.04	4.50	130.55	2448
Rice	0.00	0.00	0.32	-0.14	0.04	0.06	4.29	2448
Masoor pulse	0.00	0.00	0.10	-0.21	0.03	-0.43	5.04	2448
Moong pulse	0.00	0.00	0.15	-0.13	0.03	0.17	3.57	2448
Mash pulse	0.00	0.00	0.19	-0.15	0.04	-0.20	3.35	2448
Chicken	0.00	-0.01	0.21	-0.19	0.04	0.66	4.62	2448
Beef	0.00	0.00	0.26	-0.14	0.03	0.61	5.56	2448
Mutton	0.00	0.00	0.10	-0.83	0.05	-3.69	57.49	2448
Egg hen	0.00	0.00	0.24	-0.34	0.03	-0.36	17.51	2448
Bread	0.00	0.00	0.31	-0.16	0.04	-0.48	5.36	2448
Sugar	0.00	0.00	0.10	-0.19	0.01	-0.48	26.02	2448
Milk fresh	0.00	0.00	0.85	-0.27	0.05	1.05	27.99	2448
Curd	0.00	-0.02	0.19	-0.14	0.06	0.55	3.14	2448
Potatoes	-0.01	-0.02	0.28	-0.29	0.09	0.31	2.81	2448
Onions	-0.01	-0.01	0.27	-0.31	0.08	0.38	3.85	2448
Tomatoes	-0.01	0.00	0.28	-0.38	0.10	-0.59	3.56	2448
Bananas	-0.01	-0.01	0.28	-0.89	0.11	-0.12	4.85	2448
Salt Powder	-0.01	0.00	1.07	-0.64	0.10	-0.76	10.68	2448
Red chilies	0.00	0.00	0.19	-0.61	0.06	-2.84	20.73	2448
Garlic	-0.01	-0.01	0.30	-0.32	0.07	0.28	4.40	2448
Lawn	-0.01	0.02	0.20	-0.36	0.10	-0.84	3.10	2448
Shirting	-0.01	-0.01	0.70	-0.29	0.08	-0.20	5.64	2448
Washing Soap	-0.01	-0.03	0.34	-0.24	0.11	0.13	2.34	2448
Doctor fee	-0.02	-0.03	0.59	-0.36	0.13	0.73	4.50	2427
Carpenter	-0.01	0.00	0.17	-0.35	0.08	-0.40	2.91	2427
Mason	0.00	0.00	0.14	-0.29	0.06	-0.46	3.82	2427
Labor	-0.01	0.00	0.31	-0.25	0.09	-0.19	2.75	2427
Plumber	-0.01	0.00	0.16	-0.57	0.07	-0.39	4.37	2218

Table A.4 Summary Statistics keeping Lahore as the numeraire.

Variability of Price Differentials	Mean	Standard Deviation	Observations
Perishables	0.044	0.029	192
Non-Perishables	0.047	0.032	175
Services	0.109	0.083	115
Mean Absolute Price Differentials	**Mean**	**Standard Deviation**	**Observations**
Perishables	0.060	0.039	192
Non-Perishables	0.059	0.051	175
Services	0.154	0.114	115

The price differential variability is the standard deviation of the relative prices ($s.d.(r_{i,s,t})$) over time and mean absolute price differential is the mean of the absolute relative prices ($\left|\ln(p_{i,s,t} - p_{j,s,t})\right|$) over time.

Table A.5 Summary Statistics keeping Karachi as the numeraire.

Variability of Price Differentials	Mean	Standard Deviation	Observations
Perishables	0.12	0.071	192
Non-Perishables	0.12	0.072	175
Services	0.11	0.074	115
Mean Absolute Price Differentials	**Mean**	**Standard Deviation**	**Observations**
Perishables	0.18	0.117	192
Non-Perishables	0.16	0.138	175
Services	0.19	0.153	115

Table A.6 Results of Levin-Lin-Chu (LLC) Test

	Individual intercept	Individual intercept	Intercept and trend	Intercept and trend
	(Level)	(First Difference)	(Level)	(First Difference)
Item	**LLC**	**LLC**	**LLC**	**LLC**
	t-stat	**t-stat**	**t-stat**	**t-stat**
Doctor	4.14	-13.42	4.37	-14.22
Carpenter	-0.04	-9.12	-0.78	-8.38
Mason	-1.12	-5.60	-1.06	-3.84
Labor	0.66	-11.55	1.10	-11.56
Plumber	-0.25	-14.18	0.62	-14.64
Wheat	-5.10		-4.91	
Rice	-0.97	-7.89	-0.78	-7.05
Masoor	-1.51	-10.25	-1.10	-9.55
Moong	-0.93	-6.51	-0.37	-5.39
Mash	-0.32	-9.10	0.80	-8.44
Chicken	-5.12	-11.62	-7.58	
Beef	-2.36	-8.87	-2.41	
Mutton	-1.61	-10.81	-1.65	
Egg	-8.96	-0.92	-11.02	
Bread	0.01	-11.65	1.09	-11.59
Sugar	-9.81	-9.60	-11.66	
Milk	-4.70	-8.11	-6.44	
Curd	0.00	-5.45	0.94	-4.25
Potatoes	-8.63	-6.10	-8.29	
Onions	-10.47	-5.70	-11.54	
Tomatoes	-9.98	18.58	-10.92	
Bananas	-10.10	-9.35	-12.15	
Salt	-3.41	-17.78	-5.30	
Red chilies	-13.62	-17.84	-19.69	
Garlic	-5.15	-6.79	-5.05	
Lawn	2.34	-7.93	0.66	-7.17
Shirting	1.35	14.93	2.68	18.92
Washing soap	2.69	-1.68	2.91	-0.07

Table A.7 Results of IM-Pesaran-Shin (IPS) Test

Item	Individual intercept (Level)	intercept (Level)
Item	**IPS w-stat**	**IPS w-stat**
Doctor	0.43	0.71
Carpenter	-1.61	-2.40
Mason	-3.93	-2.97
Labor	-2.46	-2.20
Plumber	-2.92	-2.50
Wheat	-10.51	-8.756
Rice	-5.44	-5.054
Masoor	-6.61	-6.940
Moong	-7.09	-6.22
Mash	-4.93	-3.847
Chicken	-9.176	-9.28
Beef	-5.94	-5.79
Mutton	-7.11	-6.39
Egg	-16.41	-16.77
Bread	-4.41	-3.99
Sugar	-12.45	-12.30
Milk	-6.047	-5.751
Curd	-3.295	-2.548
Potatoes	-21.80	-22.72
Onions	-16.57	-16.23
Tomatoes	-19.37	-20.16
Bananas	-12.30	-12.59
Salt	-5.735	-6.514
Red chilies	-19.65	-21.46
Garlic	-9.109	-7.833
Lawn	-0.556	-1.415
Shirting	-0.434	0.617
Washing soap	1.277	1.279