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The Relative City Price Convergence in Pakistan: Empirical Evidence from Spatial GLS

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I. INTRODUCTION

It is evident from general experience that price of same good may differ considerably among countries, regions, cities in same country and even adjacent shopping malls and outlets. It is also common knowledge that stronger competitive forces and information about market price tend to ensure convergence of prices. In the presence of these forces price differentials cannot be persistent and are hence short lived.

The recent literature on price convergence has focused on country studies using regional commodity prices and Consumer Price Index (CPI) data.[1] The analysis of relative prices or real exchange rates between regions or cities in a country has certain advantages in estimating Purchasing Power Parity (PPP) puzzle. There are no trade barriers and non tradable goods in a single country. Krugman and Obstfeld (2007) consider transportation costs, trade barriers and goods market segmentations as obstacles to hold international PPP. Furthermore they mention that countries have different endowments, baskets of goods and consumption weights in their inflation index. So PPP may not hold even if there are no non tradable goods and barriers. The PPP theory is related to the law of one price through arbitrage of international goods. The estimation of real exchange rates among countries shows that the convergence towards PPP is very slow.[2] This study attempts to use overall Consumer Price Index (CPI) data on 35 Pakistani cities from July 2001 to June 2008 to estimate relative city price convergence with Karachi and Lahore, two numeraire cities. The case of Pakistan is interesting primarily due to the following reasons.

First interesting aspect is the geographical location and diversified regions in Pakistan. Pakistan is in South Asian region consists of five provinces i.e. Punjab, Sindh, Balochistan, Khyber Pakhtunkhwa (KP) and Gilgit Baltistan (GB). Each province has its own regional language and ethnicity but they communicate in national language with each other. Furthermore, each province shares some international border e.g., Punjab and Sindh with India, KP with Afghanistan, Balochistan with Iran and Afghanistan and Gilgit-Baltistan with China.[3]

Second, there is also evidence of illegal trade on these borders.[4]

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[1]Cecchetti, *et al.* (2002), Morshed (2005), Chmelarova and Nath (2010), Lan and Sylwester (2010).

[2]"Consensus estimates suggest, however, that the speed of convergence to PPP is extremely slow" Rogoff (1996).

[3]The data on inflation in GB province is not reported in Inflation Monitor of SBP, so not included in my study.

[4]Sharif, *et al*. (2000) mentioned smuggled commodities and identified major routes of smuggling on Pakistan-Iran and Pakistan-Afghanistan borders.

Similarly there are also reports of illegal trade on the eastern borders with India with its worth ranging $0.5 to $3 billion.[5] There is a possibility that price levels in bordering cities do not converge with the two major cities in Pakistan in the presence of illegal trade in the presence of cheap smuggled goods.[6]

Third, there is evidence that some cities have persistently higher inflation than others. The State Bank of Pakistan's (SBP's) Inflation Monitor January 2010 states that 19 cities recorded higher than over all Year on Year (YOY) inflation in January 2010. The 16 cities recorded lower than average inflation.

The Table 1 ranks cities with higher or lower than average inflation based on Inflation Monitor of SBP various issues. Five cities in Punjab named Mianwali, Jhang,

Table 1

Persistence of Inflation in Pakistani Cities

Times> Average	Cities	2005	2006	2007	2008	2009	2010
5	Mianwali	Yes	Yes	Yes	Yes	No	Yes
4	Faisalabad	Yes	Yes	No	Yes	No	Yes
2	Sialkot	No	Yes	No	No	No	Yes
4	D.G.Khan	No	Yes	Yes	Yes	No	Yes
4	Bahawalpur	Yes	Yes	Yes	No	No	Yes
5	Vehari	Yes	Yes	Yes	Yes	No	Yes
5	Jhang	Yes	Yes	Yes	Yes	No	Yes
4	Sargodha	Yes	Yes	Yes	No	No	Yes
4	Loralai	Yes	Yes	No	Yes	Yes	No
5	Gujranwala	Yes	Yes	Yes	Yes	No	Yes
3	Attock	Yes	Yes	Yes	No	No	No
3	Peshawar	No	Yes	No	Yes	Yes	No
5	Okara	Yes	Yes	Yes	No	Yes	Yes
4	Bahawalnagar	No	Yes	Yes	Yes	No	Yes
4	Bannu	No	No	Yes	Yes	Yes	Yes
3	Rawalpindi	Yes	Yes	Yes	No	No	No
4	Nawab Shah	No	No	Yes	Yes	Yes	Yes
4	Mirpur Khas	No	No	Yes	Yes	Yes	Yes
4	Shahdadpur	No	No	Yes	Yes	Yes	Yes
3	Turbat	Yes	Yes	No	Yes	No	No
3	Lahore	Yes	Yes	No	No	No	No
3	Kunri	No	No	No	Yes	Yes	Yes
3	Larkana	No	No	Yes	Yes	Yes	No
2	Hyderabad	No	No	No	Yes	Yes	No
2	Sukkur	No	No	No	Yes	Yes	No
2	Quetta	No	No	No	Yes	Yes	No
2	Karachi	No	No	Yes	No	Yes	No
3	D.I.Khan	Yes	No	No	Yes	Yes	No
4	Khuzdar	Yes	No	Yes	Yes	Yes	No
3	Samundari	No	No	Yes	Yes	No	Yes
3	Abbottabad	No	No	No	Yes	Yes	Yes
3	Mardan	Yes	No	No	Yes	Yes	No
3	Multan	No	No	Yes	Yes	No	Yes
3	Jhelum	Yes	Yes	Yes	No	No	No
3	Islamabad	Yes	Yes	Yes	No	No	No

Note: Yes means inflation in current year is higher and no means lower than national average.

[5] For details see Khan (2005) Can Illegal Trade between Pakistan and India be Eliminated? SDPI.

[6] The estimation of border effects is not the scope of this study due to data limitations.

Okara, Vehari and Gujranwala showed more than average inflation in 5 years out of 6 years 2005-2010. There are 11 cities in which the inflation has recorded 4 out of 6 years higher than average inflation in Pakistan. These cities include Faisalabad, Sargodha, Dera Ghazi Khan, Loralai, Khuzdar, Bahawalpur, Bahawalnagar, Bannu, Nawabshah, Mirpurkhas and Shadadpur. The persistence of more than average inflation seems to higher in Punjab province since 7 out of 11 high inflation cities are located in Punjab province.

A high and persistent variability of regional inflation with in a country has adverse effects on the standard of living.[7] It can cause internal regional migration due to persistent lower real wage.

The study intends to find speed of convergence by estimating half life of price shock. Since the idea is to estimate relative price convergence, the numeraire cities are chosen to be Karachi and Lahore. They have highest population and they are urban commercial centers. Lahore is capital of province Punjab and can be considered as a central market for agricultural produce.[8] Karachi is capital of province Sindh and center of industrial and economic activity. The highest proportion of income tax is collected from Karachi.[9]

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II. LITERATURE REVIEW

The consensus estimates of Rogoff (1996) suggest 3–5 years duration of price convergence which is very slow. He considered difference of tastes and technology the main reason for slow prices adjustment. He did cross country analysis where the difference of tastes and technology may be wider. After Rogoff (1996), the literature emerged using country level regional data where the tastes, habits and technology may not differ considerably.

Parsely and Wei (1996) used panel of 51 prices from 45 USA cities and found higher convergence. They indicated a serious bias in estimates induced by i.i.d Measurement error in data and corrected for this bias in their study. They also found higher convergence if difference is higher but slower convergence for cities located farther apart.

Cecchetti, *et al*. (2002) found evidence of relative city price in USA but the convergence rate was found to be very sluggish, 9 years. The slow convergence for a single economy case is surprising. But the slow convergence as found by Cecchetti, *et al*. (2002) in the case of American cities is further puzzling since it is usually believed that trade barriers with in a country may be less than that of international borders.

Morshed, *et al*. (2005) found half of price shock in the case of 25 Indian cities as low as only three months and found strong evidence of relative price convergence for India.

Imbs, *et al*. (2005) in their seminal paper showed importance of dynamic aggregation bias in estimating PPP. They found higher rate of convergence among real exchange rates when heterogeneity is taken in to account. The main argument is that all

[7] Das and Bhattacharya (2008).
[8] Zahid, *et al*. (2007).
[9] Federal Bureau of Revenue (FBR) Year Book 2009.

the goods which are part of CPI do not converge at the same speed. They estimated half life to be less than a year, 11 months.

Das and Bhattacharya (2008) used monthly data on Indian regions from January 1995 to June 2004 and estimated price convergence across Indian regions using panel unit root tests robust to cross sectional dependence. They found that relative price levels are mean reverting in Indian regions. The estimated lowest half life is estimated to 6.7 months for Kerala and as highest as 25.80 months for Uttar Pradesh. The all states half life is 18.85 months and all centers is 19.83 months.

Sonara Robert (2009) addressed the issue of structural breaks using city price data from USA over the period 1918–1997. He used Zivot and Andrew (1992) and Perron-Vogesang (1992) unit roots tests with structural breaks and found relative prices to be stationary. The structural breaks are found significant and convergence rates found to be lower than panel unit root tests.

Chmelarova and Nath (2010) used annual CPI data of 17 USA cities from 1917-2007 and constructed relative city price panels with each city as numeraire. They used Cross Sectional Augmented Dickey Fuller Test [Pasaran (2007)] and found that choice of numeraire city matters for relative city price convergence analysis. They also adjusted the estimates for bias and found a smaller half life of a price shock. But the speed of convergence is estimated to be low. They decomposed the relative price series in to common factor and idiosyncratic factor. The lack of convergence in six cities is due to non stationarity of common factor.

Lan and Sylwester (2010) used commodity price data from 36 cities in China to examine rate of convergence following idiosyncratic shock. The study used fixed effect model for individual goods panels and mean group method for all goods. They found evidence of convergence at faster rates and estimated half life few months, smaller than other studies.

Fan and Wei (2006) used 7 years monthly CPI data of 36 Chinese cities and applied panel unit root tests to find price convergence. They found that price levels across Chinese cities are mean reverting and duration of half life of price shock is as low as 3-4 months. They consider the use of high frequency time series data in finding fast rate of convergence as suggested by Taylor (2001).

III. METHODOLOGY AND DATA

This study attempts to use monthly Consumer Price Index (CPI) data of 35 Pakistani cities from July 2001 to June 2008. The data has been compiled from Monthly Bulletin of Statistics various issues by Federal Bureau of Statistics. The study intends to use Ordinary Least Squares (OLS) city by city 34 equations. Furthermore in the presence of spatial dependence among cross section units it is also useful to use Spatial Generalised Least Square (GLS) method and compare the results with OLS. The significant difference in results may emphasise the importance of spatial correlations. The relative city prices or exchange rates have been calculated as following:

$$RP_{it} = \frac{P_{it}}{P_{bt}} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

i=1 …N cities and t=1 ….T time periods or months; b =1, 2 the base or numeraire cities

In log form Equation 1 can be written as

$$rp_{it} = p_{it} - p_{bt} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

The objective is to estimate model with varying intercept and cross section slope dummies as an AR (1) process to check the stationarity of relative price series:

$$rp_{it} = \alpha_i + \rho_i rp_{it-1} + \varepsilon_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

The relative price is converging if individual cross section $\hat{\rho} < 1$ where rho is autoregressive coefficient. The following hypothesis will be tested:

$$H_o : \hat{\rho}_i = 1$$
$$H_a : \hat{\rho}_i < 1$$

The OLS assumes that error term is homoskedastic and not serially correlated that is $E\left[\frac{\varepsilon}{X}\right] = 0$ and $E\left[\varepsilon\frac{\varepsilon'}{X} = \sigma^2 I\right]$. The OLS estimator is best linear unbiased, consistent and asymptotically normally distributed.[10] However if the variance covariance matrix from Equation 3 is not homoskedastic, the least squares estimator is still unbiased and consistent. But the sample variance is biased estimator of σ^2 when disturbances are hetroskedastic. "When the covariance matrix of the disturbance vector is not scalar, multiple of identity matrix, it is well known that GLS estimator provides best linear unbiased estimator in contrast to OLS. [11]

In this case $\varepsilon \sim N(0, V_\varepsilon)$; the estimation of GLS requires weighting of variables and the weights can be taken from the variance covariance matrix of estimated residuals from Equation 3.

$$V_\varepsilon^{-\frac{1}{2}} rp_{it} = V_\varepsilon^{-\frac{1}{2}} \alpha_i + \rho_i V_\varepsilon^{-\frac{1}{2}} rp_{it,-1} + \mu_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

After the transformation of Equation 4, it can be written as

$$rp_{it}^* = \alpha_i^* + \rho_i^* rp_{i,t-1}^* + \mu_{it}^* \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

Here $\mu_{it}^* \sim N(o, I)$

The autoregressive coefficient, *rho* in Equation 5 can be considered as the spatial autoregressive coefficient since the covariance matrix from OLS Equations contains spatial spatial correlations. The Equation 5 can be estimated by OLS.

The other objective is to estimate half life of a price shock. The convergence of price shock may be slow or fast depending upon the half life of a price shock. The study uses following formula to estimate half life of price shock;

$$H(\rho) = \frac{\log(0.5)}{\log(\hat{\rho})} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

[10] For details see Greene's text book.

[11] Gotu Butte (2001).

My study applies OLS and GLS both the techniques and provides estimates for comparison.

IV. DISCUSSION OF EMPIRICAL FINDINGS

The relative city prices convergence with numeraire city Karachi are reported in Table 2. The rho coefficient based on the average of 34 cities is 0.88 with OLS. The half life has been estimated to be 5.4 months which is less than 6 months. The individual cities results are different. The highest half life is estimated in the case of Islamabad, the capital territory at 34.3 months. It is almost 3 years. The city of Sialkot showed lowest half life of 1.4 months with Karachi. The other cities who remained below average half life are Faisalabad, Abbotabad, Okara, Lahore, Dera Ghazi Khan, Multan, Sukkur, Shadadpur, Larkana, Kunri and Dera Ismaeel Khan and Bannu. The other 19 cities are above average in terms of half life when the results are estimated with OLS.

Table 2

Relative City Price Convergence with Karachi

No.	Cities	ρi-OLS	Std. Error	H(ρ)-OLS	ρi-GLS	Std. Error	H(ρ)-GLS
1	Abottabad	0.75	0.07	2.41	0.75	0.07	2.41
2	Attock	0.928	0.04	9.28	0.956	0.03	15.40
3	Bahawalnagar	0.946	0.03	12.49	0.94	0.037	11.20
4	Bannu	0.88	0.056	5.42	0.817	0.07	3.43
5	Bahawalpur	0.91	0.04	7.35	0.72	0.07	2.11
6	DGKhan	0.88	0.05	5.42	0.76	0.067	2.53
7	DI khan	0.83	0.059	3.72	0.79	0.065	2.94
8	Faisalbad	0.75	0.07	2.41	0.929	0.04	9.41
9	Gujranwala	0.96	0.03	16.98	0.98	0.039	34.31
10	Hyderabad	0.93	0.04	9.55	0.967	0	20.66
11	Islamabad	0.98	0.02	34.31	0.978	0.02	31.16
12	Jhelum	0.91	0.045	7.35	0.75	0.07	2.41
13	Jhang	0.9	0.048	6.58	0.84	0.059	3.98
14	Mardan	0.97	0.035	22.76	1	0.03	NA
15	Multan	0.88	0.05	5.42	0.908	0.058	7.18
16	Khuzdar	0.92	0.045	8.31	0.827	0.06	3.65
17	kunri	0.87	0.05	4.98	0.87	0.05	4.98
18	Lahore	0.8	0.067	3.11	0.988	0.02	57.41
19	Larkana	0.81	0.058	3.29	0.89	0.038	5.95
20	Loralai	0.96	0.04	16.98	0.97	0.03	22.76
21	MP Khas	0.81	0.066	3.29	0.87	0.055	4.98
22	Mianwali	0.9	0.05	6.58	0.78	0.07	2.79
23	Nawabshah	0.93	0.048	9.55	0.99	0.03	68.97
24	Okara	0.88	0.049	5.42	0.806	0.06	3.21
25	Peshawar	0.9	0.047	6.58	0.74	0.07	2.30
26	Quetta	0.93	0.046	9.55	0.858	0.059	4.53
27	Rawalpindi	0.96	0.029	16.98	0.925	0.04	8.89
28	Shadadpur	0.85	0.066	4.27	0.8	0.068	3.11
29	Sargodha	0.92	0.04	8.31	0.836	0.055	3.87
30	Sukkur	0.82	0.07	3.49	0.82	0.065	3.49
31	Sialkot	0.61	0.086	1.40	0.78	0.07	2.79
32	Samundri	0.94	0.039	11.20	0.829	0.067	3.70
33	Turbat	0.89	0.05	5.95	0.887	0.05	5.78
34	Vehari	0.96	0.028	16.98	0.99	0.01	68.97
	Avg-Pakistan	0.88	0.05	5.42	0.87	0.05	4.98

The average rho coefficient is estimated at 0.87 with GLS less than 0.88 with OLS. The half life is estimated as 4.98 which are also less than 5.4 estimates with OLS. The highest half life is estimated for Nawab Shah and Vehari as 68.97 months. It means that half life is almost 6 years for these two cities. The lowest half life is estimated for city of Bahawalpur as 2.11 months. Some cities have more than average half life of 4.98 months e.g. Attock, Bahawalnagar, Gujranwala, Islamabad, Hyderabad, Multan, Lahore, Larkana, Loralai, Nawabshah, Rawalpindi, Turbat and Vehari. In the case of Mardan, the relative city price does not converge with Karachi. Its rho coefficient is estimated to be unit root and hence not stationary.[12] The distance of Mardan from Karachi is almost 730 miles. Some other cities like Abottabad, and Sialkot have more miles distance from Karachi but relative prices are converging there with Karachi. Similarly Islamabad and Rawalpindi are also more than 700 miles but maybe it's safer to travel there. The cities with equal to and less than 3 months of half life are Sialkot, Shadadpur, Peshawar, Mianlwali, Jhelum, Bahawalpur, Dera Ghazi Khan, Dera Ismaeel Khan, and Abbottabad.

The results on relative city price convergence with Lahore as numeraire or base are reported in Table 3. The average rho coefficient estimated with OLS is 0.89 (half life is 5.94) higher than the rho coefficient with Karachi as numeraire. The lowest half life is 1.8 for Sialkot and the highest is 68.97 for Gujranwala. Interestingly both the cities are close to Lahore relatively. Sialkot is 44.5 miles and Gujranwala is 68.8 miles from Lahore. The GLS results are same for Gujranwala. Other cities showing higher than average half life of shock (5.94 months) are Vehari, Samundri, Sargodha, Rawalpindi, Jhang, Gujranwala, Bahawalnagar, Attock (in Punjab), Sukkur, Nawabshah, Hyderabad, (in Sindh), Bannu, Mardan (in KP Province), Quetta, Loralai (in Balochistan) and Islamabad.

The estimates from GLS show a reduction in rho coefficient. It is estimated at 0.86 and the average half life is 4.8 months, lower than Karachi. The lowest half life is 1.3 months for Mir Pur Khas, almost 556 miles from Lahore. The highest half life is 68.97 months for Gujranwala (44.5 miles), Vehari (172 miles) and Islamabad (175 miles). The other cities where the half life of price shock is more than the average are Attock, Bahawalnagar, Faisalabad, Gujranwala, Hyderabad, Jhelum, Jhang, Larkana, Loralai, Mardan, Nawabshah, Okara, Rawalpindi, Sargodha,, Sukkur, Samundri and Vehari.

The Pakistani cities where half life of price shock in Lahore is almost 3 months or less, are Turbat, Sialkot, Shadadpur, Quetta, Peshawar, Mir pur Khas, Dera Ismaeel Khan, Dera Ghazi Khan, Bahawalpur and Abbotabad.

The overall results show that GLS estimates of average rho and half life estimated to be lower than OLS results. The overall results show that overall prices in individual Pakistani cities converge to the numeraire cities of Lahore and Karachi. The overall half life based on the average of city estimates is less than 6 months with OLS and 5 months with GLS. The individual cities show different results and there is evidence of some heterogeneous behaviour in terms of city price convergence and half life of price shock. The price shock in Lahore dies out more quickly than a shock in Karachi. These estimates are higher than Morshed (2005) in the case of India (3 months) and Lan and Sylwester (2010) China (3 months). But the estimates of present study are less than Imbs et al (2005) and Das and Bhatacharia (2008 who estimated half life at 11 months and 18 months respectively.

[12]Mardan is in KP province and distance wise close to Swat and tribal areas where war against extremists is being fought.

Table 3

Relative City Price Convergence with Lahore

No.	Cities	ρi-OLS	Std. Error	H(ρ)-OLS	ρi-GLS	Std. Error	H(ρ)-GLS
1	Abottababd	0.79	0.067	2.94	0.79	0.067	2.94
2	Attock	0.92	0.04	8.31	0.95	0.03	13.51
3	Bahawalnagar	0.94	0.038	11.20	0.95	0.03	13.51
4	Bannu	0.909	0.05	7.26	0.82	0.07	3.49
5	Bahawalpur	0.89	0.04	5.95	0.76	0.07	2.53
6	DGKhan	0.88	0.05	5.42	0.69	0.08	1.87
7	DI khan	0.82	0.06	3.49	0.78	0.068	2.79
8	Faisalbad	0.86	0.05	4.60	0.89	0.049	5.95
9	Gujranwala	0.99	0.03	68.97	0.99	0.03	68.97
10	Hyderabad	0.94	0.038	11.20	0.96	0.021	16.98
11	Islamabad	0.98	0.02	34.31	0.99	0.016	68.97
12	Jhelum	0.88	0.05	5.42	0.908	0.043	7.18
13	Jhang	0.95	0.04	13.51	0.94	0.045	11.20
14	Karachi	0.8	0.067	3.11	0.84	0.06	3.98
15	Khuzdar	0.88	0.057	5.42	0.82	0.067	3.49
16	kunri	0.85	0.058	4.27	0.85	0.058	4.27
17	Larkana	0.85	0.05	4.27	0.878	0.04	5.33
18	Loralai	0.94	0.05	11.20	0.97	0.036	22.76
19	Mardan	0.96	0.04	16.98	0.96	0.04	16.98
20	Multan	0.84	0.058	3.98	0.87	0.057	4.98
21	MP Khas	0.84	0.06	3.98	0.59	0.09	1.31
22	Mianwali	0.87	0.06	4.98	0.82	0.06	3.49
23	Nawabshah	0.93	0.048	9.55	0.96	0.045	16.98
24	Okara	0.87	0.05	4.98	0.92	0.04	8.31
25	Peshawar	0.87	0.06	4.98	0.74	0.07	2.30
26	Quetta	0.92	0.056	8.31	0.77	0.07	2.65
27	Rawalpindi	0.94	0.04	11.20	0.89	0.05	5.95
28	Shadadpur	0.87	0.065	4.98	0.77	0.07	2.65
29	Sargodha	0.93	0.04	9.55	0.88	0.047	5.42
30	Sukkur	0.91	0.05	7.35	0.87	0.06	4.98
31	Sialkot	0.68	0.08	1.80	0.8	0.06	3.11
32	Samundri	0.97	0.03	22.76	0.92	0.05	8.31
33	Turbat	0.82	0.07	3.49	0.79	0.06	2.94
34	Vehari	0.98	0.025	34.31	0.99	0.017	68.97
	Avg-Pakistan	0.89	0.05	5.94	0.86	0.05	4.82

V. CONCLUSION

This study provides empirical evidence in favour of relative city price convergence in 35 Pakistani cities with two numeraire cities Lahore and Karachi using monthly CPI data from July 2001-June 2008. The empirical evidence supports that Purchasing Power

parity holds in Pakistan with both the techniques OLS and GLS. However the average half life of a price shock is estimated to be less than 5 months with GLS and 6 months with OLS. There is a significant evidence of differences in city behaviours in terms of the duration of half life shock. The individual cities' half life of shock varies from almost 1.3 months to 68 months which is huge. The half life of relative price shock with Lahore is smaller than Karachi implying the fact that cities are spatially more associated with Lahore than Karachi.

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