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PRICE LEVEL CONVERGENCE
Evidence from Pakistan Cities

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Abstract. We examine convergence of prices among 35 Pakistani cities and also explore how location of cities affects the convergence. We have found that there is bilateral price-level convergence for only food group and speed of convergence is around 3 months. On the other hand, prices of non-food commodities have very low speed of adjustment with 20 months. As a result, the overall CPI basket (food and non-food combined) has a moderate speed of convergence – 8 months. Moreover, relative prices have been found sensitive to locality as well as distance among them.

Keywords: Inflation, Price convergence, Law of one price, Relative price variability

JEL classification: E31, F49

I. INTRODUCTION

According to the law of one price (LOP), the efficient market arbitrage and trade will keep the prices of identical commodities same in two or more markets. However, the transport and transaction costs may prevent the LOP to hold. A number of studies have shown that the distance between the two markets has positive relationship with deviation from LOP (see for example Crucini and Shintani (2006)). Earlier, Engel and Rogers (1996) in their

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pioneer work on CPI data of US and Canadian cities, found both distance and borders matter for relative price variability and thus the law of one price. In case of Pakistan, however, the behaviour of relative prices across cities has not been studied yet except some similar work by two papers; one by Mohsin and Gilbert (2010) which estimates relative city price convergence in overall CPI during July 2001 to June 2008, and second by Akmal (2012) which explores the relationship between relative price variability and overall inflation in Pakistan using commodity groups. This study undertakes a comprehensive examination of city-wise and commodity-wise data of consumer prices in order to explore the price convergence in Pakistani cities.

Mohsin and Gilbert (2010) estimated relative price convergence using CPI data of 35 Pakistani cities from July 2001 to June 2008. They considered Lahore and Karachi as numeraire cities and found speed of convergence, as measured by half-life, less than 5 months but it varies from 1.3 to 68 months in the case of individual cities. They used two techniques for estimating half-life: spatial GLS and OLS, and found that spatial GLS estimates are lower than OLS which shows importance of spatial correlations for the estimation of half-life. Their result also showed that average half-life of price shock in Lahore is less than that of Karachi.

Akmal (2012) explored the nature of relationship between relative price variability and inflation using monthly data of CPI (seasonally adjusted) on commodity groups from July 1986 to June 2011. He found a U-shape relationship between the two. He also found that threshold level of inflation in terms of RPV varies with general inflationary phases, *i.e.*, in period of high inflation, the threshold inflation is also high and vice versa.

Parslay and Wei (1996), using quarterly price data of goods and services in 48 US cities, found much faster convergence of prices to purchasing power parity in case of US than typically found in cross-country data. They also found that tradable goods converge very fast to price parity with around 4 to 5 quarters half-life of the price gap compared with 15 quarters for services. Additionally, they also present evidence of non-linearities in the rate of convergence.

Cecchetti *et al.* (2002) studied the behaviour of price indices in major US cities by using panel econometric methods. They found relative price levels among cities mean revert at an exceptionally slow rate – with a half-life of convergence about 9 years. Transportation costs, varying speeds of adjustments to large and small shocks, and presence of non-traded goods prices in the overall price index are given as explanation of slow rate of convergence.

The behaviour of prices in a cross-country set up has also been studied by Crucini and Shintani (2006). They examine the dynamics of commodity-wise real exchange rates using a panel of 270 prices taken from major cities of 63 countries and 258 prices taken from 13 US cities. They found an average commodity had a similar pattern of convergence in OECD, LDC and within US with about 1 year of half-life of deviations from the law of one price. The average non-traded good has a half-life higher than traded goods for the OECD, with lesser differences elsewhere.

In these studies, price level convergence across regions is tested jointly by using panel unit root tests, and most of the studies use benchmark or numeraire for calculating relative prices. However, Crucini and Shintani (2006) and Pesaran (2007) used a different technique which does not use arbitrary benchmark. In this study, we use Pesaran (2007) methodology.

The rest of the paper is organized as follows. Section II describes the data and methodology; section III presents the empirical result; and section IV concludes the paper.

II. DATA AND METHODOLOGY

We use item-wise and city-wise data of consumer price index (CPI) collected and disseminated by Pakistan Bureau of Statistics (PBS). PBS publishes two series of CPI: item-wise and city-wise price data of 374 individual commodities; and 92 indices of composite items at base year of 2000-01.[1] The data set used in this study includes CPI indices of 92 composite commodities for 35 cities for period from July 2001 to June 2011. The list of cities is given in Table 1.

We undertake the analysis not only for a full sample of 92 commodities but also for its two sub-groups, viz., food group (including 40 items and having weight of 40.34 percent) and non-food group (including the remaining 52 items and weight of 59.66 percent).

We have used pair-wise approach developed by Pesaran (2007) to study the convergence analysis of relative prices across cities. Convergence requires prices to be co-integrated with a vector of the form (1, –1), *i.e.* the difference between them, $r_t^{ij} = p_t^i - p_t^j$, with $i = 1, \ldots\ldots N-1$ and $j = i + 1, \ldots \ldots, N$, should be stationary for all $N(N-1)/2$ possible relative prices in 35 cities. We have applied this test on 595 relative price pairs.

[1]PBS has recently re-based CPI to year 2007-08; however, we use earlier data which is available for a longer period.

TABLE 1

List of Cities in CPI Basket (2000-01 Base)

01	Lahore	19	Karachi
02	Faisalabad	20	Hyderabad
03	Rawalpindi	21	Sukkur
04	Multan	22	Larkana
05	Gujranwala	23	Mirpur Khas
06	Islamabad	24	Nawab Shah
07	Sargodha	25	Shahdadpur
08	Sialkot	26	Kunri
09	Bahawalpur	27	Peshawar
10	Jhang	28	Mardan
11	Okara	29	Abbotabad
12	Dera Ghazi Khan	30	Dera Islamil Khan
13	Jhelum	31	Bannu
14	Bahawalnagar	32	Quetta
15	Vehari	33	Khuzdar
16	Mianwali	34	Turbat
17	Attock	35	Loralai and Cantt.
18	Samundari		

Formally we estimate the following ADF test:

$$\Delta r_t^{ij} = \alpha_0^{ij} + \gamma^{ij} r_{t-1}^{ij} + \sum_{k=1}^{p} \beta_k^{ij} \Delta r_{t-k}^{ij} + \varepsilon_t^{ij} \qquad (1)$$

where a_0^{ij} represents the intercept, p is the appropriate lag length, and ε_t^{ij} is the white noise error term. For the sake of consistency with the theory of purchasing power parity, we exclude the deterministic trend from the equation. With the null hypothesis of non-convergence, *i.e.* the existence of a unit root, the significance of the coefficient, γ^{ij} in the above equation for every pair of relative prices is tested.[2] Rejection of the null for a particular pair implies convergence of prices in the two cities. To analyze the speed of

[2]The lag length (p) is selected through general to specific approach beginning with the maximum lag of 11 and coming down to a suitable lag by using Schwartz Criterion (SIC).

convergence, the conventional half-life of a shock to r_t^{ij} is calculated as $\frac{-\ln(2)}{\ln(1+\gamma^{ij})}$ for each of the commodity group, *i.e.* overall, food and non-food groups using 595 possible relative pairs.

We also estimate the effect of provincial location of cities on the behaviour of relative prices by introducing province specific dummy variables. The province dummies are defined as follows:

REG = 1 when both cities of a relative price pair belong to the same province; 0 otherwise

REGP = 1 when both cities are located in the Punjab province; 0 otherwise

REGB = 1 when both cities are located in Balochistan; 0 otherwise

REGS = 1 when both cities are located in Sindh; 0 otherwise

REGKP = 1 when both cities are located in Khyber Pakthunkhwa; 0 otherwise

P = 1 when at least one of the cities in a relative price pair is located in the Punjab; 0 otherwise

B = 1 when at least one city is located in Balochistan; 0 otherwise

S = 1 when at least one city is located in Sindh; 0 otherwise

KP = 1 when at least one city is located in Khyber Pakthunkhwa; 0 otherwise

The basic model to estimate the province effect is as follows:

$$y_i = \beta_0 + \beta_1 RD_i + \varepsilon_i \qquad (2)$$

Where the dependent variable, y_i is standard deviation of relative prices (r_t^{ij}) for each of 595 pairs representing short-run relative price behaviour; β_0 is intercept; RD_i is a vector of provincial dummies in the set (*REG*, *REGP*, *REGB*, *REGS*, *REGKP*, *P*, *B*, *S*, *KP*); β_1 is the corresponding vector of coefficients and ε_i is the error term for i = 1, 2, 3, …… 595.

III. EMPIRICAL RESULTS

Summary statistics of relative price behaviour measure is presented in Table 2. In the 595 city pairs, 33 percent belong to the same province and the rest

are from different provinces. The mean standard deviation of relative prices is smaller if the corresponding city pairs belong to the same province compared to different provinces for all the commodity groups, i.e., overall, food and non-food groups.

TABLE 2

Selected Summary Statistics

	City Pairs	Mean Standard Deviation of Relative Prices			Number of Relative Price Series for which Unit Root Null is Rejected		
		Overall	Food Group	Non-Food Group	Overall	Food Group	Non-Food Group
Full sample of city pairs	595	0.0250	0.0322	0.0283	158 (26.6%)	441 (74.1%)	31 (5.2%)
City pairs in the same region	197 (33.1%)	0.0220	0.0260	0.0270	46 (23.4%)	144 (73.1%)	15 (7.6%)
City pairs in different regions	398 (66.9%)	0.0265	0.0353	0.0289	112 (28.1%)	297 (74.6%)	16 (4.0%)
Median speed of convergence in months (Half-life)					8	3	21

NOTE: Percentages are in brackets.

The results of unit root test for convergence, *i.e.*, the validity of the law of one price (LOP), show that only 27 percent of the total city pairs conform to the LOP. However, interestingly most of the city pairs that show convergence have cities of different provinces. There are total 197 city pairs that belong to the same province – of these only 46 showed convergences (*i.e.*, 23 percent). On the other hand, out of 398 pairs of cities which belong to different provinces, prices in 112 pairs converge (*i.e.*, 28 percent). Yet in both cases, the evidence of convergence is lower than expected. The median speed of convergence measured by half-life is around 8 months which is considered to be slow. From the above result we can say that LOP is not verified for overall commodity group of CPI basket. The reasons for this non-convergence may be the differences in development level, social behaviour, rural and urban divisions, cost of living and transportation among cities of Pakistan.

However, when we examine the sub-groups of food and non food, the results are revealing. In the food group, prices of 441 city pairs converge (which is 74 percent of total pairs). Of these, 144 are from the same province and 297 belong to different provinces. Median speed of price convergence for food group is around 3 months, which is faster than that in developed countries (Cecchetti *et al.*, 2002). Thus, it can be concluded that LOP holds for food group in Pakistan. Again, it is interesting to note that distance matters to a great extent for convergence. For example Attock and DG Khan are both from Punjab province, price convergence does not hold in this pair because of distance (they are 704 kilometer apart). Price convergence also does not hold in the pair of Gujranwala and Turbat — located in different provinces — as distance between them is 1693 kilometer. There are also some pairs in which distance matters less and the extent of convergence depends on other factors. For example, Islamabad and Rawalpindi: the distance between these two cities is only 17 kilometers but the pries are non-convergent. The reason may be the differences in living style, education level, consumption pattern, and structure of markets.

On the other hand, in case of non-food group, we could not find any significant level of convergence. Prices in only 31 city pairs (*i.e.*, only 5 percent) converge, of which 15 are from same province and 16 are from different provinces. Speed of convergence measured by half-life is 21 months which is very slow (*see* Table 2).

REGRESSIONS WITH PROVINCE DUMMIES ONLY

In order to explore the province-specific features of the behaviour of relative prices, we have estimated the following specific equations, results of which are reported in Table 3:

$$SD_i = \beta_0 + \beta_1 REG_i + \varepsilon_i \tag{3a}$$

$$SD_i = \beta_0 + \beta_1 REGP_i + \beta_2 REGB_i + \beta_3 REGS_i + \beta_4 REGKP_i + \varepsilon_i \tag{3b}$$

$$SD_i = \beta_0 + \beta_1 P_i + \beta_2 B_i + \beta_3 S_i + \beta_4 KP_i + \varepsilon_i \tag{3c}$$

Results of equation (3a) are reported in column 1, 4 and 7 of Table 3 for three commodity groups, *viz.* overall, food and non-food. Significantly smaller average relative price variability is observed if the city pairs belong to the same province. Moreover, among three groups, the coefficient of food group is smaller indicating that food prices converge relatively faster if the city pairs are from the same province.

TABLE 3

Regression Results with Region Dummies

Dependent variable / Independent variables	Standard Deviation of Relative Prices								
	Overall			Food Group			Non-Food Group		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	2.66* (0.00)	2.65* (0.00)	2.00* (0.00)	3.53* (0.00)	3.50* (0.00)	2.08* (0.00)	(2.89* (0.00)	2.91* (0.00)	2.72* (0.00)
REG	–0.50* (0.00)			–0.93* (0.00)			–0.19*** (0.07)		
REGP		–0.50* (0.00)			–1.04* (0.00)			–0.18 (0.15)	
REGB		–0.96* (0.00)			–0.29 (0.18)			–0.59 (0.16)	
REGS		–0.31*** (0.08)			–0.41** (0.03)			–0.68* (0.00)	
REGKP		–0.51* (0.02)			–1.01* (0.00)			–0.37 (0.22)	
P			0.23** (0.02)			0.56* (0.00)			0.09 (0.51)
B			0.13 (0.16)			0.81* (0.00)			0.11 (0.48)
S			0.67* (0.00)			1.07* (0.00)			0.14 (0.23)
KP			0.10 (0.23)			0.49* (0.00)			–0.14 (0.25)
R-squared	0.08	0.08	0.12	0.29	0.30	0.31	0.01	0.02	0.01

NOTE: Probabilities values are in brackets. *significant at 1% level, **significant at 5% level, ***significant at 10% level.

However, result of equation (3b) for overall group (column 2 of Table 3) reveals that relative prices behave differently in different provinces. For example, in case of Balochistan, the coefficient of province-specific dummy is the lowest, indicating higher speed of convergence compared with other provinces. The results of equation (3c) (column 3 of Table 3) show that standard deviation of relative prices of overall commodities group increase when one of the two cities is located in a specific province and other in a different province.

For food group, the result of equation (3b) (column 5 of Table 3) shows that the standard deviation of relative prices is lower if both cities of a pair are located in one province. Interestingly, variations in relative prices of food

group are lower than those of non-food group if the city pairs belong to Punjab and KPK. On the other hand, when city pairs belong to Sindh or Balochistan, non-food relative prices show lower variations.

REGRESSIONS WITH DUMMIES OF PROVINCE AND DISTANCE

While the location within an administrative unit (province in case of Pakistan) has bearing on the extent of convergence, the distance by itself can be an explanatory variable as two cities can be closer despite being in different provinces. For example, Attock is in the Punjab province while Mardan is in the Khyber Pakhtunhawa but they are only 65 kilometers apart. Turbat and Laoralai both belong to Balochistan but they are 1007 kilometers apart. The importance of distance (as a proxy for transportation cost) in variation in relative prices has also been documented by Engle and Rogers (1996) and Parsley and Wei (1996).

We have estimated the following specific equations to explore the role of distance in relative prices while controlling for location in an administrative unit.

$$SD_i = \beta_0 + \beta_1 LDIST_i + \beta_2 REG_i + \varepsilon_i \tag{4a}$$

$$SD_i = \beta_0 + \beta_1 LDIST_i + \beta_2 REGP_i + \beta_3 REGB_i + \beta_4 REGS_i + \beta_5 REGKP_i + \varepsilon_i \tag{4b}$$

$$SD_i = \beta_0 + \beta_1 LDIST_i + \beta_2 P_i + \beta_3 B_i + \beta_4 S_i + \beta_5 KP_i + \varepsilon_i \tag{4c}$$

$$SD_i = \beta_0 + \beta_1 LDIST_i + \beta_2 REG_i + \beta_3 (LDIST_i * REG_i) + \varepsilon_i \tag{4d}$$

$$SD_i = \beta_0 + \beta_1 LDIST_i + \beta_2 P_i + \beta_3 B_i + \beta_4 S_i + \beta_5 KP_i + \beta_6 (LDIST_i * P_i) + \beta_7 (LDIST_i * B_i) + \beta_8 (LDIST_i * S_i) + \beta_9 (LDIST_i * KP_i) + \varepsilon_i \tag{4e}$$

LDIST is log of distance between cities and other variables are same as defined earlier. Table 4 reports the results: a statistically significant and positive effect of distance on standard deviation of relative prices has been found. It is consistent with Engle and Rogers (1996). The results show that the distance continues to have a significant impact on variability of relative prices even after controlling for location of cities of a pair. However, some province-specific diversity is also found. For example, when one of the two cities belongs to Sindh, the standard deviation goes up in case of overall commodity group. Similar result is found in case of all provinces for food group. However, no particular pattern can be found in case of non-food group.

TABLE 4

Regression Results with Distance, Regional Dummies and Interactions

Dependent Variable / Independent Variables	Standard Deviation of Relative Prices (Overall)					Standard Deviation of Relative Prices (Food Group)					Standard Deviation of Relative Prices (Non-Food Group)				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Intercept	1.76* (0.00)	1.57* (0.00)	1.24* (0.00)	1.30* (0.00)	0.84 (0.45)	2.36* (0.00)	2.03* (0.00)	1.25* (0.00)	2.94* (0.00)	–2.79* 90.01)	1.45* (0.00)	1.94* (0.00)	1.44* (0.00)	1.22*** (0.06)	3.14* (0.03)
LDIST	0.14* (0.01)	0.16* (0.00)	0.16* (0.00)	0.21* (0.00)	0.23 (0.21)	0.18* (0.00)	0.22* (0.00)	0.17* (0.00)	0.09 (0.15)	0.83* (0.00)	0.22* (0.01)	0.15** (0.04)	0.26* (0.00)	0.25* (0.01)	0.00 (0.99)
REG	–0.36* (0.00)			0.85 (0.18)		–0.73* (0.00)			–1.96* (0.00)		0.05 (0.69)			0.54 (0.57)	
REGP		–0.33* (0.00)					–0.80* (0.00)					–0.03 (0.85)			
REGB		–0.91* (0.00)					–0.22 (0.31)					–0.54 (0.21)			
REGS		–0.09 (0.62)					–0.13 (0.54)					–0.48** (0.02)			
REGKP		–0.32 (0.16)					–0.75* (0.00)					–0.19 (0.54)			
P			0.12 (0.26)		0.32 (0.73)			0.44* (0.00)		2.83* (0.00)			–0.09 (0.53)		–1.15 (0.33)
B			–0.05 (0.65)		–0.04 (0.97)			0.62* (0.00)		3.97* (0.00)			–0.19 (0.25)		–3.12*** (0.10)
S			0.49* (0.00)		0.24 (0.81)			0.88* (0.00)		5.42* (0.00)			–0.16 (0.25)		–3.46* (0.01)
KP			0.01 (0.87)		1.50** (0.04)			0.39* (0.00)		3.07* (0.00)			–0.29* (0.02)		1.29 (0.19)
REG × LDIST				–0.20** (0.05)					0.21** (0.03)					–0.08 (0.61)	
P × LDIST					–0.04 (0.77)					–0.38* (0.01)					0.14 (0.45)
B × LDIST					0.00 (0.98)					–0.53* (0.00)					0.45 (0.12)
S × LDIST					0.04 (0.82)					–0.71* (0.00)					0.51* (0.01)
KP × LDIST					–0.24** (0.05)					–0.43* (0.00)					–0.26 (0.11)
R-squared	0.09	0.09	0.13	0.09	0.14	0.30	0.32	0.32	0.31	0.37	0.02	0.03	0.03	0.02	0.05

NOTE: Probabilities values are in brackets. *significant at 1% level, **significant at 5% level, ***significant at 10% level.

TABLE 5
F-Test Results for Joint Significance

Variables of which joint significance is tested	Standard Deviation of Relative Prices		
	Overall	Food Group	Non-Food Group
	(1)	(2)	(3)
REG, REG*LDIST	25.11 (0.00)	130.86 (0.00)	2.68 (0.07)
P, P*LDIST	19.95 (0.00)	115.95 (0.00)	3.75 (0.02)
B, B*LDIST	0.68 (0.51)	10.11 (0.00)	2.15 (0.12)
S, S*LDIST	41.52 (0.00)	61.47 (0.00)	7.40 (0.00)
KP, KP*LDIST	2.21 (0.11)	3.73 (0.02)	2.01 (0.13)

NOTE: *p*-values are in brackets. An intercept term is included in the regressions.

Table 5 reports the *F*-test results for joint significance of distance and its interactions with province dummies. The results show a significant effect of distance on standard deviation of relative prices in case of overall commodities group when one of the cities of a pair belongs to the Punjab and Sindh province. The same result is found in case of non-food group. In case of food group, the result shows significant effect on the standard deviation of relative prices for all provinces dummies and their interaction with distance.

IV. CONCLUSIONS

In this paper, we try to examine two aspects of the behaviour of relative prices (overall consumer prices, food prices and non-food prices) across 35 Pakistani cities. We have found that there is bilateral price-level convergence for only food group and speed of convergence measured by half-life is around 3 months. On the other hand, prices of non-food commodities have very low speed of adjustment with 20 month half-life. Consequently, relative prices of overall commodities group have half-life of 8 month – a moderate speed of convergence.

We have also identified differences in the behaviour of relative prices within and across provinces of Pakistan. The relative prices between two cities located in the same province show lower variability compared with cites pair located in different provinces. However, if at least one of city associated with a relative price series is located in one province, standard deviation of relative prices rises in case of overall and food group. While exploring the impact of distance between cities of a pair, we have found that the standard deviation of relative prices increase significantly with the distance. This result accords well with the findings of some previous studies, *e.g.* Engle and Rogers (1996).

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