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HOW RELATIVE PRICE VARIABILITY IS RELATED TO UNANTICIPATED INFLATION AND REAL INCOME?

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Abstract. The paper examines the behavior of price setting agents as reflected in relative price changes in response to demand and supply factors. We have followed Parks (1978) model on monthly data of consumer price index of Pakistan. Results show that relative price variability is determined mainly by supply factors, as reflected by unanticipated inflation. The demand factors (*i.e.*, changes in real income) are found insignificant in determining relative price variability.

Keywords: Anticipated inflation, Unanticipated inflation, Relative price variability, Macroeconomic framework

JEL classification: E10, E31, E64

I. INTRODUCTION

The relative price variability (RPV) and its relationship with inflation, income, monetary expansion, etc. have got considerable attention in economic research, both theoretical and empirical, as the subject has important lessons for welfare cost of inflation and neutrality of monetary

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policy. While theoretical models, like menu-cost and asymmetric information, predict a positive association between inflation and RPV, the empirical research has found a range of results, including insignificant, positive significant, linear and non-linear relationships between the two. Cukierman (1983) has presented a comprehensive analytical survey of the subject. A typical explanation to support the relationship between RPV and inflation is that industries and sectors may differ in their speed of adjustment to nominal shocks. As fixed costs are associated with changing prices, individual commodity prices change only at discrete intervals, which create divergence in relative prices. A second approach is based on differences in short-run supply elasticities across industries. If the short-run supply elasticity in one industry is smaller than that in another but the long-run elasticities are similar, then a demand shift between the industries may result in a change in both aggregate and relative prices even if the shift is ultimately neutral in its relative-price effect. Another possible explanation for the relationship is the hypothesis of imperfect information, according to which: as individual firms lack full information regarding general price level, they may confuse changes in the general price level with relative price changes.[1]

Apart from the nature of relationship between RPV and inflation, the empirical studies also explore which component of inflation is more relevant for explaining RPV, *i.e.* expected inflation, unexpected inflation, or inflation uncertainty. Parks (1978), for example, finds a positive relationship between RPV and unexpected inflation, while Lach and Tsiddon (1992) find that expected inflation has a stronger effect on price variability than unexpected inflation. Grier and Perry (1996), on the other hand, show that only *ex ante* inflation uncertainty increases relative price variability.

A preliminary examination of price data in Pakistan also shows a link between the inflation and RPV. As shown in Figure 1, overall CPI inflation in a given month and range of individual commodity price changes move together, in general, over time. For a formal enquiry of the subject on Pakistani data, we have followed Parks (1978) who has introduced a methodology to explore the impact of unexpected inflation and real income on relative price changes. As a first step, he proposed a measure of changes in relative prices which was found to move in line with the general inflationary trends. And then, he estimated a set of regression equations to

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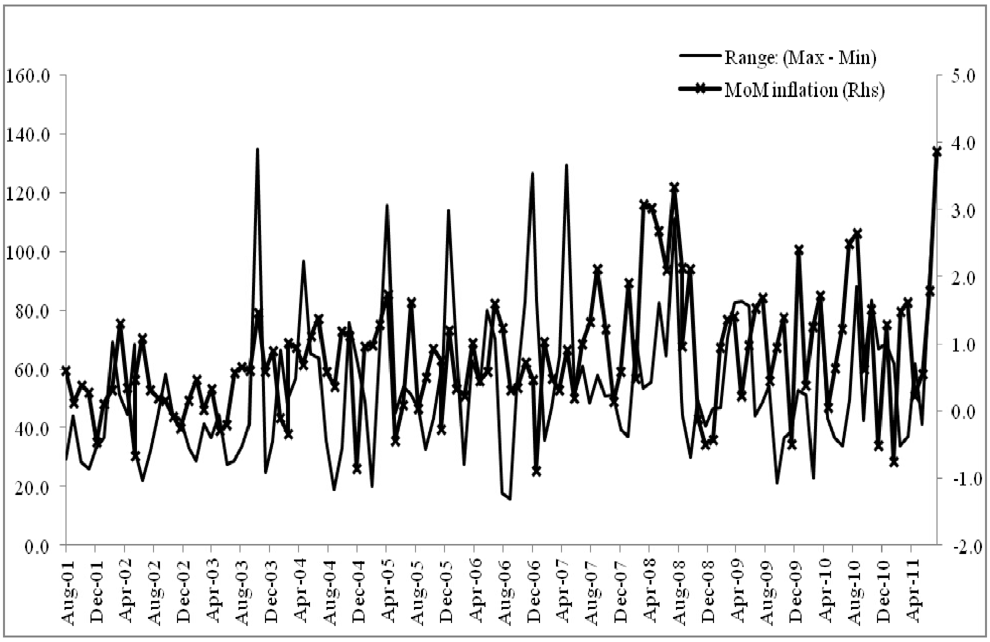
[1]*See* Caraballo and Dabus (2008) for an account of various theoretical explanations on the relationship and a review of empirical studies.

estimate the quantitative relationship of relative price variability with demand and supply factors, which he proposed on the basis of a standard macroeconomic framework. He used his framework to analyze the movements in consumer prices in United States during 1929-75 and Netherlands during 1921-63.

FIGURE 1

Range of Price Changes of Individual Commodities and Overall Inflation



In the next section of the present study, a brief review of some studies having similarity with Parks' work for different countries and in different time periods is given. After that, the methodology used in this study is presented followed by the results. The last section concludes the paper.

II. LITERATURE REVIEW

Parks' study prompted the debate on relationship between relative price changes and inflation, though a number of authors addressed this issue even before Parks' study in 1978. For example, Glejser (1965) found inflation an important determinant of relative price changes (measured by weighted standard deviation) for 15 OECD countries during 1953-1959. A similar study was done by Okun (1971) that compared 17 OECD countries for the period 1951-68 and found a positive associatin between a country's average inflation and standard deviation of GDP deflator. Vining and Elwertoski

(1976) concluded that variance of relative price changes was associated with general inflation variability (during 1947-1974) in US. They found such association for both wholesale and consumer price indices and calculated variance of relative price changes by taking every sub-index of the main series and calculating a variance for each point in time. However, their study was criticized for weaknesses in measures of both general price inflation and relative price variability.

Motivated by Parks' study, Ashley (1981) used Granger causality tests to conclude that fluctuations in the inflation help cause fluctuations in relative prices, but not vice-versa. Cukierman and Wachtel (1982) used a framework that was also built on Parks' work except that they allowed inflation expectations to vary across markets. Since equilibrium prices (and their rates of change) in different markets may differ, inflation expectations across markets may also vary. They showed that there might be a positive relationship between relative price variability and the variance of inflation expectations. They also showed that changes in the variance of either aggregate demand or supply shocks would cause increased relative price variability.

Fischer (1982) studied the nature and direction of causality between relative price variability and inflation for Germany and US economies in order to understand the underlying process behind inflation and its social welfare cost. He found, while the link between unanticipated inflation and relative price variability was strong in both the economies, it was weak in case of aniticipated component of inflation and relative price variability. By estimating a small VAR model, he also concluded that the relationship between relative variability and inflation stemmed mainly from policy responses to supply shocks.

Blejer (1983) examined the experience of Argentina having high inflation coupled with trade liberalization policies; and studied the response of relative commodity prices to inflationary pressures. He undertook a detailed analysis of monthly prices of 61 componets of consumer price index between 1977 and 1981 and concluded that individual commodity prices had fluctuated over a much wider range than the overall CPI – possibley implying menu-cost of inflation. He also noted a clear upward trend in the relative price of services, with a consequent reduction in the relative price of goods and food products. Among the factors affecting relative price variability, his study found that only unxpected components of inflation and monetary growth had significant impacts, while the expected parts of these variables had insignificant coefficients.

Lach and Tsiddon (1992) analyzed the effects of inflation on the dispersion of food prices in Isreal by using disaggregated data of 1978-84. Contrary to other studies, they found that the effect of expected inflation on intramarket price variability was stronger than that of unexpected inflation. A similar result was obtained by Loy and Weaver (1998) in case of Russian food markets who showed that it was anticipated inflation which induced distortions in relative prices instead of unanticipated inflation or inflation uncertainty.

Chang and Cheng (2000) examined a disaggregated data set of US prices in post-war period to explore the link between inflation and relative price variability. As a first step, they used a model to estimate inflation variability conditional on past unexpected inflation and past inflation variability. Then they related it to relative price variability; and found a positive relationship of RPV with both the inflation rate and inflation variability. They also concluded that the relation remained robust to oil-price shocks.

Ukoha (2007) estimated this relationship in case of Nigeria with a focused study of relative price volatility of agriculture commodities during 1970 to 2003. He also found a positive significant impact of overall inflation on relative price variability of agricultural commodities – both in the short run and the long run. On the basis of his results, he also suggested policies to prevent agriculture sector from adverse implications of inflation.

Recently, Choi (2010) presented new theoretical and empirical insights relating to the relationship between inflation and RPV on the basis of disaggregated CPI data for US and Japan. He found a non-linear and U-shape relationship between inflation and RPV. However, the relationship was not stable over time; instead it varied quite significantly with the changes in inflationary episodes or monetary policy regimes. Thus his findings are against the popular theoretical models of price setting like menu cost or imperfect information models which typically predict a positive association between inflation and RPV. Nonetheless, his result can be in line with an alternative theoretical explanation, *i.e.* Calvo sticky price model that incorporates sectoral heterogeneity in price rigidity.

A similar U-shape relationship between RPV and inflation was also found by Akmal (2011) in case of Pakistan. He also found that threshold level of inflation in terms of RPV varied with general inflationary phases, *i.e.*, in period of high inflation, the threshold inflation is also high and vice versa. There is hardly any other study on this subject in case of Pakistan. We have re-examined this relationship; however, this study is different from

Akmal (2011) in three aspects: (*a*) we have used more detailed data, *i.e.*, 92 composite items of monthly consumer price index compared with 12 broad groups used in Akmal (2011); (*b*) we have examined the impact of unanticipated inflation as well as overall inflation on RPV; and (*c*) we have also studied the impact of real income, as a demand factor, under macroeconomic framework as suggested by Parks (1978).

III. DATA AND METHODOLOGY

The price data have been obtained from Pakistan Bureau of Statistics (PBS), which releases two sets of price data, *i.e.* (*a*) prices of 374 commodities in consumer basket (2000-01 base); and (*b*) 92 composite indices whereby similar commodities are grouped together. PBS has published prices of 374 commodities by city level, but weights of these commodities are not in public domain, whereas weights of 92 composite commodities are published. Since for our work, we need both price indices as well as their weights, so we have used 92 composite indices for overall, food and non-food groups. The data used in this study is for the period from July 2001 to June 2011. We have used LSM index as a proxy of real income.[2]

By defining relative price as a ratio of individual price indices of 92 composite commodities to the overall price index (*i.e.* p_{it} / P_t), the rate of change in i^{th} commodity's relative price is worked out as: $Dp_{it} - DP_t$; where p_{it} is the index of the i^{th} commodity in time period t, P_t is overall consumer price index, which is a weighted average of individual indices (*i.e.*, $P_t = \sum_{i=1}^{92} w_i p_{it}$), w_i is weights of individual commodities in the CPI basket which sum to one, and D represents the first difference of natural logarithm of the indices.

While the average of rates of change in relative prices is zero by definition, we take the variance of these changes as a measure of the degree of relative price variability, following Parks (1978). It is calculated as a weighted sum of the squared deviations of the individual rates of price change around the average, that is:

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[2]GDP or other components of GDP are not available in monthly frequency in Pakistan. However, LSM has close proximity as it has strong backward linkages with agriculture sector and forward linkages with services sector – including trade, transport and financial services.

$$V_t = \sum_{i=1}^{92} w_i \left(Dp_{it} - DP_t\right)^2 \tag{1}$$

As argued by Parks, V_t (*i.e.*, variance of relative price changes) is also a measure of non-proportionality of the price movements as: (*a*) if all prices change by the same rate then the variance of relative price changes will be zero; and (*b*) it will be higher the more non-proportional the price changes are across commodities. We calculate both the DP_t (overall inflation) and V_t from the data set of monthly indices of 92 composite commodities. As the data set covers a ten-year period (with 120 observations), the relationship between the relative price variability and overall inflation accounts for episodes of both inflation and deflation. Parks suggests two types of specifications to capture this relationship, as given below:

$$V_t = a + b\left(DP_t\right)^2 + u_t \tag{2}$$

$$V_t = a + b_+\left(DP_t^+\right)^2 + b_-\left(DP_t^-\right)^2 + u_t \tag{3}$$

Where DP_t^+ (or DP_t^-) represents positive (or negative) price change. The second specification allows us to differentiate the degrees of response to inflation (positive price changes) and deflation (negative price changes).

The above models present preliminary evidence of the existence of certain kind of association between relative price variability and inflation. Parks (1978) developed a rigorous model to understand the nature of this relationship, particularly in the context of un-anticipated inflation and income. For the convenience of readers, key features of his framework which we used to derive final equation for the determinants of relative price variability, estimated for Pakistan, are presented here.

Parks' framework is built upon a supply-demand apparatus with focus on the effects of price expectations. Let q_{it} is the quantity of the i^{th} commodity supplied in period *t*, the supply function is as follows:

$$\ln q_{it} = a_i + b_i \ln\left(p_{it} \big/ P_t^* \right) + c_i T \tag{4}$$

Where P_t^* is anticipated level of overall consumer price index, and *T* represents trend variable. The supply function parameters are represented by a_i, b_i and c_i. For a positively sloped supply function, $b_i > 0$.

The demand function is specified as below:

$$\ln q_{it} = d_i + e_{ii} \ln[(p)_{it}] + f_{io} \ln(m_t) \tag{5}$$

Where m_t is nominal income, e_{ii} is the own-price elasticity, and f_{io} the income elasticity of demand. For simplicity, we ignore cross-price elasticities and assume the sum of income elasticity and own price elasticity is zero to maintain homogeneity. For negatively sloped demand function, $e_{ii} < 0$.

By taking the first differences of the logarithmic forms of the above supply and demand functions and solving for reduced form equations under market clearing assumption, we obtain the following:

$$Dp_{it} = k_i\left(-e_{ii}Dm_t + b_i DP_t^* - c_i\right) \tag{6}$$

$$Dq_{it} = e_{ii}k_i\left(-b_i Dm_t + b_i DP_t^* - c_t\right) \tag{7}$$

Where $k_i = \dfrac{1}{(b_i - e_{ii})}$. The above model predicts that anticipated overall inflation affects price changes of individual commodities positively and quantities negatively, while income has positive effect on both price and quantity. However, the extent of effects depends on the size of supply and demand elasticities.

From equation (6), we can obtain the relative price changes for individual commodities by subtracting DP_t (overall inflation) from both sides of the equation; *i.e.*

$$Dp_{it} - DP_t = k_i\left(-e_{ii}Dm_t + b_i DP_t^* - c_i\right) - DP_t \tag{8}$$

With a little manipulation, it becomes:

$$Dp_{it} - DP_t = k_i\left(-e_{ii}g_t - b_i n_t - c_i\right) \tag{8a}$$

Where $g_t = (Dm_t - DP_t)$ is real income growth and $n_t = \left[(DP_t - DP)_t^*\right]$ is unanticipated inflation.

By combining equations (1) and (8a), we can decompose the determinants of relative price variance into supply and demand parameters involving real growth and unanticipated inflation, as given below:

$$V_t = \sum w_i\left(Dp_{it} - DP_t\right)^2 = \sum w_i k_i^2\left(-e_{ii}g_t - b_i n_t - c_i\right)^2 \tag{9}$$

The equation (9) gives us the following quadratic equation (linear in parameters) which can be estimated through ordinary least square method:

$$V_t = a_0 + a_1 g_t^2 + a_2 n_t^2 + a_3 g_t n_t + a_4 g_t + a_5 n_t \tag{10}$$

The coefficients of the above equation (*i.e.*, a_0, a_1, …, a_2, a_3, a_4, a_5) are different combinations of weights of individual commodities (w_1i) and parameters of the model (e_{ii} and b_i).

While we have detailed price data for computing variance of relative prices (V_t) and real income as discussed above, we need some operational definition of unanticipated inflation (n_t) in order to estimate the above equation. Parks uses a simple time series model of the form $DP_t = DP_{t-1} + \mu + \varepsilon_t$ to get a measure of unanticipated inflation. We have developed a univariate ARIMA model on actual price level and used its fitted values as a measure of anticipated inflation.[3] Difference between the actual and the fitted values is unanticipated inflation.

We have taken care of time series properties of the variables included in the model and found them appropriate to be used in ordinary least square regressions.

IV. RESULTS

Our preliminary tests for a relationship between relative price variability and inflation – based on models (2) and (3) show that there exists such association as given in Table 1. What surprised Parks for Netherlands (Parks, 1978, p. 84) is also true in case of Pakistan, *i.e.*, the association between the two variables is stronger in the case deflation (price declines) than for inflation (price increases). It is interesting to note that price decreases are less common in our sample – only 17 instances of negative price changes out of 119 observations – which indicates downward price rigidity. However, their impact on relative price variance is high. Possible explanation of this result is: as most price decreases are related to food items which have strong seasonality in prices, they are unable to bring proportional price declines in other items; as a result, relative price variance becomes higher.[4] This explanation is substantiated by estimating the same equations (2 and 3) for food and non-food groups separately. The impact of price deflation on the variance reduces sharply (the coefficient reduces from 110.49 for overall basket to 30.16 for food group), which indicates seasonal price declines in food items bring proportional change in prices of the whole food group and thus have lesser impact on the group's relative price variance. In a sharp

[3]We have selected the parsimonious models (on the basis of AIC) as ARIMA (3,1,3) for overall price index; (3,1,2) for food price index; and (4,1,4) for non-food price index.

[4]There were 30 instances of negative price changes in food index while only 5 in non-food index.

contrast to it, the coefficient of price deflation in case of non-food group increases sharply (from 110.49 to 337.51), which indicates lackluster proportional declines in prices of such items.

TABLE 1

Regression Results: Dependant Variable = VP_t
(Equations 2 and 3)

	For Overall		For Food Group		For Non-food Group	
Constant	0.002 (11.181)	0.002 (10.020)	0.002 (10.026)	0.001 (9.362)	0.00002 (0.633)	0.00001 (0.395)
(DP)^2	2.702 (3.235)		7.489 (3.945)		6.612 (9.259)	
(DP+)^2		3.330 (4.333)		7.084 (3.929)		6.692 (9.346)
(DP–)^2		110.492 (5.211)		30.164 (4.794)		337.511 (1.216)
DW	1.789	1.636	1.663	1.516	1.821	1.822
R^2	0.082	0.250	0.117	0.213	0.423	0.430

Note: Student t-values are in parentheses.

On the other hand, price increases (as well as overall inflation) have more profound impact on relative price variance in case of food group compared with non-food. It implies increase in certain food prices cause relatively less proportional changes in prices of other items while increases in non-food prices drive other prices upward with a higher proportion.

However, as mentioned above, these results do not help us figuring out the effects of unanticipated inflation and real variables in a standard demand-supply framework. However, estimation results of equation (10) give important insights in this regard, as reported in Table 2. Interestingly, the coefficients of real income are statistically insignificant for all the three equations, *i.e.*, for variance of relative prices of overall CPI basket, food group and non-food group. Nonetheless, the unanticipated inflation strongly affects relative price variations. Incidentally, the nature of relationship between RPV and unexpected inflation is the same U-shape as found by Akmal (2011) in case of actual inflation and RPV. In case of overall CPI, unanticipated inflation, lower than 0.6 percent affects RPV negatively while that higher than it affects RPV positively. Such turning points for food and non-food groups are –0.3 percent and –0.7 percent respectively.

TABLE 2

Regression Results; Dependant Variable = VP_t
(Equation 10)

	Overall	Food Group	Non-food Group
Constant	0.0019 (10.996)	0.0016 (9.731)	0.0004 (7.031)
g_t^2	–0.0013 (–0.076)	0.0031 (0.205)	–0.0026 (–0.678)
n_t^2	6.6931 (3.744)	14.3839 (5.161)	7.7038 (4.230)
$g_t n_t$	–0.2099 (–0.865)	–0.1030 (–0.373)	0.0844 (0.582)
g_t	0.0008 (0.319)	–0.0020 (–0.908)	0.0007 (1.031)
n_t	–0.0779 (–2.519)	0.0962 (3.230)	0.1010 (8.818)
DW	1.598	1.477	1.859
R^2	0.169	0.242	0.430

Note: Student t-values are in parentheses.

Moreover, the supply side factors, represented by the intercept, also have significant positive effect on relative price variability, though the impact is not very strong.

V. CONCLUSION

The study of relative price variability has been the subject of considerable interest for past several decades as it not only gives insights to price setting mechanism in an economy but also is considered an indicator of supply shocks. Moreover, the nature of relationship between inflation and relative price variability has useful policy implications. In case of Pakistan, a significant association between overall inflation and RPV is already documented by Akmal (2011); however, we have extended the work to examine the impact of unanticipated inflation and real income on RPV on the basis of a larger set of disaggregated price data. In this paper, we have followed Parks (1978) methodology which has been developed over a macroeconomic framework.

We have found that changes in real income have insignificant impact on relative price variability.

The results make sense as changes in income (with given preferences) almost evenly affect demand for all consumer items, which may lead to relatively proportional changes in their prices. It can be a case particularly in a developing economy like Pakistan, having a large informal sector, where response of firms is less constrained by wage contracts; and where capacity issues are less heterogeneous. On the other hand, unanticipated inflation, which usually comes from item-specific supply factors, may affect prices of different items unevenly before it is fully transmitted to general inflation.

The results suggest a careful macroeconomic policy for price stability, as the impact of demand management on relative price variability is not found significant. However, the results do not exclude the possible influence of demand factors on rate of inflation as such. This research can be extended further to estimate the impact of specific supply factors, like administered prices and exchange rate movements, along with demand factors on relative price variability.

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