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ARTICLES

Inflation and Relative Price Variability

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Abstract: *This paper explores the nature of relationship between inflation and relative price variability (RPV). It finds a U-shape relationship between the two that not only fits the overall data well but also different inflationary regimes as identified by Bai-Perron multiple structural break tests. It was also found that threshold level of inflation, in terms of RPV, varies with general inflationary phases, i.e., in period of low inflation, the threshold inflation is also low and vice versa. It suggests a cautious monetary policy during different phases of inflation.*

JEL classification**:** E30, E31, E52
Keywords: relative price variability, inflation, threshold inflation

1. Introduction

The literature explaining the welfare cost of inflation argues that inflation increases the relative price variability (RPV) which, in turn, distorts the decision making process of economic agents (Fielding and Mizen 2008). While menu cost theory of pricing predicts that it is the expected inflation that affects RPV, the signal extraction model puts emphasis on unexpected inflation as determinants of RPV. However, there is no consensus on the nature of the relationship between inflation and relative price variability. A number of papers like Parks (1978), Lach & Tsiddon (1992), and, Bryan & Cecchetti (1999) find a linear and positive relationship, while others find just the opposite, i.e., neither linear nor positive. The studies by Fielding and Mizen (2008) and Choi (2010) support the latter view. Such contradictory results make drawing policy implications very difficult.

In an environment when inflation also increases RPV – which in turn hampers business decisions through inefficient resource allocation – it is always desirable to chalk out a policy to reduce inflation. However, in circumstances where relationship between inflation and RPV is not positive – as found by some studies

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– the choice of appropriate policy becomes challenging. More seriously, if the relationship between the two variables is non-linear then some kind of predetermined policy rule may actually prove counterproductive.[1]

In the absence of any study on the nature of relationship between inflation and RPV in case of Pakistan, there is a risk that monetary policy moves to influence inflation may hurt growth through impact of changes in inflation on relative price variability. It is, therefore, important to understand how relative price changes behave with overall inflation in Pakistan.

This study is an attempt to investigate the nature of relationship between inflation and RPV which may provide a guideline for policy formulation. The study also estimates a threshold level of inflation in terms of relative price variability. In the next section, the data issues and some stylized facts shall be discussed; the section 3 will present the methodology and section 4 will discuss the results. The final section concludes the paper.

2. The data and stylized facts

Monthly data of consumer price indices (CPI) on commodity groups has been used in this study for the period from July, 1986 to June, 2011 published by Federal Bureau of Statistics, Pakistan.[2] The structure of these indices is given in Table 1. Inflation is defined as the monthly log difference of respective indices from seasonally adjusted data series using the census X-12 method. The relative price variability (RPV), on the other hand is computed as follows:

$$RPV_t = [\Sigma \omega_i (\Pi_{it} - \Pi_t)^2]^{1/2} \quad (1)$$

Where $\Pi_{it} = \ln(CPI_{it} / CPI_{i,t-1})$; $\Pi_t = \Sigma\omega_i \Pi_{it}$; and ω_i denotes the weight of i^{th} commodity group in CPI. This measure has been widely used in the literature since the influential paper by Parks (1978).

[1] A non-liner relationship between inflation and RPV implies that there exists some threshold level of inflation with respect to RPV.

[2] The scope of this study is confined to overall inflation and relative price variability of commodity groups. However, further research on this relationship within different commodity groups can be useful. Specifically in a developing country like Pakistan, food group has the dominant share in CPI basket and thus changes in the prices of food items could affect the welfare of the general public. Studies by Ukoha and Okpara (2007) on Nigerian agriculture sector and Loy and Weaver (1998) on Russian food market are examples of such investigation.

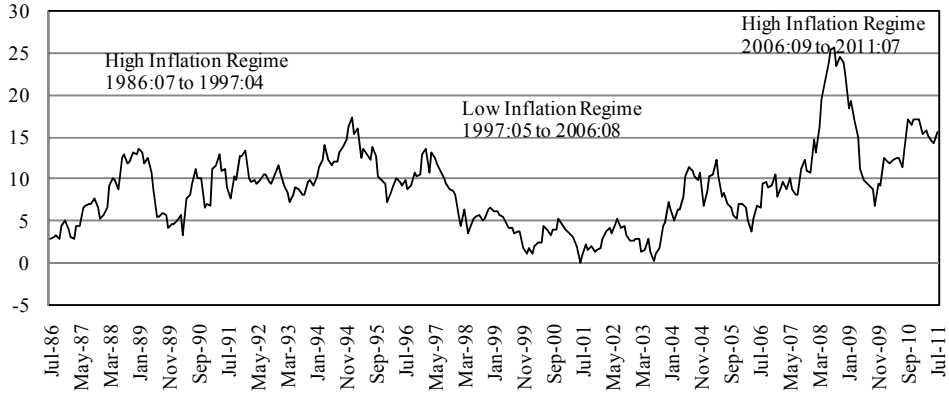
Stylized Facts

A visual examination of the data enables us to identify three regimes of inflation in Pakistan (Figure 1): (a) high inflation regime from July 1986 to April 1997 with average inflation of 9.4 percent; (b) low inflation regime from May 1997 to August 2006 with average inflation of 5.2 percent; and (c) another high inflation regime covering the period from September 2006 to June 2011 with average monthly inflation of 13.9 percent.

Table 1. Commodity Groups and their Composition in CPI Basket (2000-01 base)

	Groups	Weights (%)	No. of Individual Items in Group
1	Food & beverages	40.3418	124
2	Apparel, Tex. & footwear.	6.0977	42
3	House rent.	23.4298	1
4	Fuel and lighting.	7.2912	15
5	HH. furniture & equipment	3.2862	44
6	Transport & comm.	7.3222	43
7	Recreation & entertainment	0.8259	16
8	Education.	3.4548	24
9	Cleaning, laundry & p. appearance	5.8788	36
10	Medicare.	2.0728	29
	Total	**100**	**374**

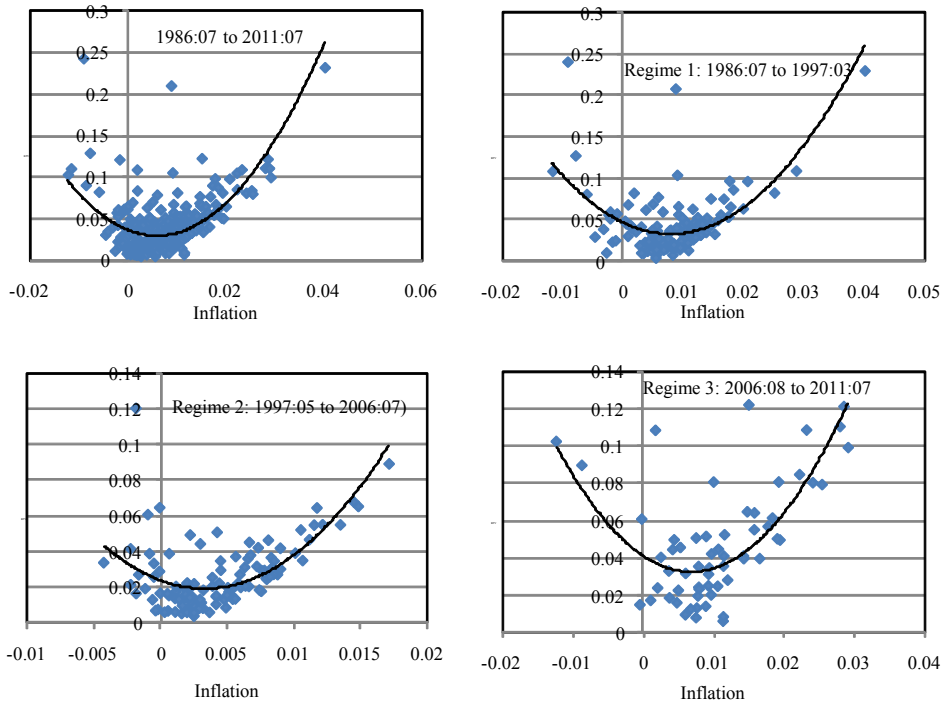
Figure 1. YoY inflation (%)



By plotting the inflation against the series of RPV in a scatter chart, it appears that the relationship between inflation and RPV is approximately U-shaped. This is true not only for whole sample but also for three inflationary regimes as identified above (Figure 2). The relationship persists even after adjusting the data for outliers.

Considering the bottom of U as a threshold, this relationship gives a clear policy implication: monetary tightening is advisable only when inflation is above the threshold; however, below threshold level of inflation the continued tightening of monetary policy could be harmful as its cost due to increased relative price volatility can be higher than benefit of reducing inflation. In order to validate the observed shape of the relationship, quantitative techniques as outlined in the next section have been used.

Figure 2. Inflation and RPV



3. Methodology

Although visual inspection of the data has provided very useful information about the inflation–RPV relationship, it is not an alternate to some appropriate quantitative tool for a reliable verdict. We considered the following quadratic functional form for the relationship:

$$RPV_t = \alpha_0 + \gamma_1 \Pi_t + \gamma_2 \Pi^2_t + \varepsilon_t \qquad (2)$$

The quadratic form is not only supported by the U-shaped pattern shown in scatter plot but also by a number of earlier studies like Parks (1978), Van Hoomissen (1988), and Fielding & Mizen (2008). Some important characteristics of quadratic

functional form are (a) γ_2 captures the direction of the relationship; (b) for U-shaped relationship to hold γ_2 should be significant and positive; and (c) the bottom of the curve pertains to the value of Π at which RPV is the lowest. By differentiating equation 2 an expression of the kind $\Pi^* = - \gamma_1 / 2\gamma_2$ is derived at which RPV is minimized. Where the Π^* is the threshold inflation.

In order to estimate the above relationship, the time series properties of the two variables were observed and found stationary on the basis of Augmented Dicky Fuller tests. A test of Granger causality on inflation and RPV shows that RPV is caused by inflation while inflation is not caused by RPV which suggests exogeneity (weak) of inflation in our model.[3]

The above model was estimated by ordinary least square (OLS) as first step and added lag dependent and some dummy variables subsequently to obtain a stable relationship. Although the relationship was found stable over the whole sample with the help of dummies, it is more appropriate to break the data into three sub sample as visible in Figure 1. However, for this purpose identification of precise break points was important. For this Bai and Perron (1998, 2003) methodology was used that endogenously locates multiple structural breaks in the data. This methodology does not require any prior knowledge about the potential break dates and number of breaks. Timing, the number of breaks, and the constant are estimated from sequential Wald tests. The algorithm suggested by Bai and Perron (2003) was implemented in RATS.[4]

4. Results

With a preliminary regression of the model given in (2), we obtained statistically significant parameters; however, residuals were serially correlated and a number of outliers were found. We, therefore, introduced ten dummies (in the sample of 301 observations) to capture these outliers and one period lag of dependent variable to correct for autocorrelation (a correlogram of the residuals of preliminary regression showed an AR(1) process).[5]

The results of the final regression are reported in Table 2. All the coefficients are statistically significant with expected signs. The coefficient on inflation is negative whereas the coefficient on inflation square is positive confirming the U-shaped

[3] The results of both Augmented Dickey Fuller and Granger causality are available with the author.
[4] For technical detail of this methodology see Bai and Perron (1998, 2003).
[5] The dummy variables (D) were selected by looking at the residual of regression (2). Each dummy takes the value 1 at an outlier pulse in the residual and zero otherwise. The first two digits of the subscripts in D are for year and the last two are for months, e.g. D8904 refers to April 1989.

relationship between inflation and RPV. The model explains more than 70 percent of the variations in RPV.

Table 2. Regression Results: Dependent = RPV; Sample = Jul86 to Jun11

Regressors	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Constant	0.02567	0.00203	12.63	0
Inflation	-1.43491	0.38224	-3.75	0.0002
Inflation Sqr.	184.15590	18.66207	9.87	0
RPV(-1)	0.11230	0.03096	3.65	0.0003
D8904	0.07405	0.01637	4.52	0
D9006	0.04416	0.01636	2.70	0.0074
D9011	0.11164	0.02280	4.90	0
D9102	-0.08802	0.02791	-3.15	0.0018
D9307	0.17580	0.01640	10.72	0
D9401	0.06951	0.01639	4.24	0
D9703	0.09021	0.01662	5.43	0
D0008	0.08475	0.01649	5.14	0
D0707	0.08291	0.01636	5.07	0
D1011	0.06821	0.01640	4.16	0
R-squared	0.74437	F-statistic	64.29	
Adjusted R-squared	0.73279			
S.E. of regression	0.01632	LM test statistic	1.35	

These results provide some very useful insights. The inflation threshold (annualized) with respect to RPV is 4.7 percent for the sample period. In this case the inflation threshold is lower than 6 to 9 percent found by Mubarak (2005) and Iqbal and Nawaz (2010) while studying relationship between inflation and growth.

The next step was to identify structural breaks in the data with Bai-Perron test. A summary of the test results is reported in Table 3. The Bai-Perron test was implemented by setting minimum span of 36 months. In order to identify the best structural break points, 1 to 6 breaks were incorporated and the results for each of the break were obtained. On the basis of Bayesian Information Criteria (BIC) across all breaks, the optimal number of breaks was selected. The test also identifies the dates of breaks. The results show that there are two structural breaks and thus three regimes of inflation – RPV relationship in Pakistan.[6] These regimes approximately correspond to the judgment based in Figure 1.

[6] Bai-Parron assumes that the break does not occur in the initial 15 percent and final 15 percent of the sample. Our results show that the first break occurred at 20 percent and the second occurred before the last 20 percent of the sample period.

Table 3. Summary Bai-Perron Structural Break Test

Span	Regimes	BIC	Break Dates					
36	2	-7.437	1997:3					
36	3	-7.442	1997:4	2006:8	Optimal Break Points/Regimes			
36	4	-7.441	1990:9	1997:4	2006:8			
36	5	-7.411	1990:9	1994:2	1997:4	2006:8		
36	6	-7.364	1990:9	1994:2	1997:4	2000:8	2006:12	
36	7	-7.299	1990:9	1994:2	1997:4	2000:8	2004:6	2007:6

Interestingly, the relationship again turned out to be approximately U-shaped in scatter plots of inflation and RPV during each of the three regimes. Therefore, the same model was applied as in (2) along with dummies for each regime separately. The results of regime-wise regression are given in Table 4. All the coefficients are significant with expected signs, i.e., consistent with the U-shaped relationship. The existence of U-shaped relationship between inflation and RPV exists not only in low inflationary regime but also in high inflation scenario. This finding differs from the Choi (2010) who concludes for USA and Japan that "in a high inflationary environment, when the price setting becomes more flexible, the U-shaped profile vanishes".

Table 4. Regime Specific Regression Results – Dependent Variable: RPV

	Regime 1 (1986:7 to 1997:3)		**Regime 2** (1997:4 to 2006:7)		**Regime 3** (2006:8 to 2011:7)	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Constant	0.03	0	0.02	0	0.04	0
Inflation	-1.2	0.52	-1.77	0.54	-3.28	0.77
Inflation Sqr	137.38	16.25	328.75	37.24	230.81	30.91
RPV (-1)	0.1	0.04				
D8904	0.07	0.02				
D9011	0.13	0.03				
D9307	0.17	0.02				
D9401	0.07	0.02				
D9703	0.09	0.02				
D0008			0.1	0.01		
D0707					0.07	0.02
D1011					0.07	0.02
R-sqr	0.78		0.69		0.69	
Adj. R-sqr	0.77		0.68		0.67	
S.E. of Reg.	0.02		0.01		0.02	
F-statistic	54.38		80.03		31.23	
Pr (F-stat)	0		0		0	
DW Stat	1.71		1.69		1.8	

Now threshold level of inflation can be calculated across these regimes. It turns out that the threshold level is 5.2, 3.2 and 8.5 percent for regime 1, regime 2, and regime 3 respectively showing a time varying pattern of the relationship between inflation and RPV but with a consistent U-shape.

5. Conclusion

The issue of optimal level of inflation and the relationship between inflation and relative price variability (RPV) has been widely discussed in the economic literature. Following the work by Park (1978), it has long been believed that the relationship between inflation and RPV is linear and positive. It implies higher inflation is always associated with higher variation in relative prices. However, with the developments in techniques to know about the functional form more accurately, it is found that the relationship between inflation and RPV is neither linear nor stable over time. In this study, the relationship between inflation and RPV is nonlinear in Pakistan and approximately is U-shaped with the bottom lying in the positive coordinates. It implies that for maximization of social welfare for the society as a whole, some positive rate of inflation should be maintained.

It was found that threshold level of inflation, with respect to RPV, varies from 3.2 to 8.5 percent in Pakistan depending upon the general inflationary environment. Thus when the economy goes through a higher inflationary phase, the threshold inflation also inches up. This result has very interesting policy implication: a monetary authority with the objective of minimizing the gap between actual and threshold inflation should be careful as threshold inflation may shift in different inflationary phases.

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