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The Relationship between Inflation and Relative Price Variability in Pakistan

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Abstract

This paper explores the relationship between inflation and relative price variability (RPV) by using disaggregated CPI data for Pakistan. I have used three methods to assess the functional form and stability of the relationship between inflation and RPV; (a) visual assessment through scatter plots; (b) rolling regression analysis, and (c) Bai-Perron multiple structural break tests. Scatter plots and Bai-Perron methods confirm that the relationship between inflation and RPV is approximately U-shaped and it is unstable over time. Whereas the rolling regression approach shows that the relationship is not significant across all rolling samples, however, coefficients signs are in right direction. The findings also suggest that the optimal inflation level for RPV is positive in Pakistan. Moreover it may not always be good to follow anti inflationary policy if the relationship between inflation and RPV is non-linear as at below the threshold level of inflation such policy may actually increase volatility in relative prices and carry more social cost than benefit.

***JEL Classification*:** E30, E31, E52

Key words: inflation, monetary policy, relative price variability, welfare cost of inflation

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The Relationship between Inflation and Relative Price Variability in Pakistan

The literature explaining the welfare cost of inflation strongly argues that expected and unexpected inflation increases the relative price variability (RPV[1]) which in turn distorts the decision making process of the producers and consumers through volatility of nominal prices (Fielding and Mizen 2008). Another way to explain this behavior of relative prices is that as the prices of individual commodities take time to adjust in accordance with the overall inflation, the process of adjustment leads to increased volatility in relative prices. Parks (1978) considers that demand side factors such as changes in real income, family composition etc. as well as supply side factors such as changes in technology, resource availability etc. bring changes in the relative prices. Moreover, two types of theories explain the impact of inflation on RPV namely menu cost and signal extraction models of welfare cost of inflation. Both models differ in feedback effects of inflation as menu cost model predicts that it is the expected inflation that affects RPV whereas the signal extraction models emphasize on unexpected inflation impact on RPV.

However, the empirical literature does not provide conclusive argument about the positive and linear relationship between inflation and RPV across different countries and across various inflation regimes. The studies that found evidence of linear and positive relationship include Parks (1978), Hercowitz (1981), Domberger (1987), Van Hoomissen (1988), Lach and Tsiddon (1992), Parsley (1996), Bryan and Cecchetti (1999). There are number of studies that support the other side of the view which conclude the relationship between inflation and RPV is neither positive nor linear. The studies by Blejer and Leiderman (1980), Fischer (1981), van Hoomissen (1988), Tommasi (1991), Grier and Perry (1996), Aarstol (1999), Caglayan and Alpay (2003), Fielding and Mizen (2008), Chi-Young Choi (2010) and Choi and Kim (2010) support the latter. Thus it becomes difficult to draw policy implications on this kind of inconclusive relationship.

In an environment when inflation also increases RPV that in turn hampers business decisions through inefficient resource allocation, it is always desirable to chalk out a policy to reduce inflation. However, such kind of predetermined policy intervention would be harmful if the relationship between inflation and RPV is neither positive nor linear. It means there must be some threshold level of inflation with respect to RPV[2] around which one has to decide about the kind of policy intervention whether inflationary or disinflationary. For instance if the relationship between inflation and RPV is U-shaped, it might not be advisable to introduce a policy to contain inflation as the gains from lowering inflation could be offset by the losses due to increased volatility in relative prices without considering at which side of threshold level of inflation the economy stands at that particular point of time. In this background the decision about the relationship between inflation and RPV becomes of utmost importance.

With all theoretical explanations and empirical proofs in favor of linear and positive relationship between inflation and RPV, the relationship is not decisive because of two reasons: (a) the controversy about the functional form of the relationship; and (b) the knowledge about the stability of the relationship. The first point is important with monetary

[1] RPV was calculated by the weighted average of the sub aggregate inflation series by using: $RPV_t = [\ \Sigma\ \omega_i\ (\Pi_{it} - \Pi_t)^2]^{1/2}$ Where $\Pi t = \ln CPI_{it} - \ln CPI_{i,\,t-1}$, $\Pi t = \Sigma\ \omega i\ \Pi it$, ωi denotes the fixed expenditure weight of i^{th} group.

[2] The threshold level of inflation described here is in the context of relative price variability not with respect to growth.

policy perspective as monetary authority can reduce RPV unless the relationship is positive. However, in case of non-monotonic relationship, such policy would not work always. Whereas later observation about the stable relationship is also inconclusive on grounds that many studies reveal that relationship changes across regimes of inflation.

Even in case where inflation has positive and linear relationship with RPV, policy makers need to know how much the inflation has cost to welfare. According to Dostey and Peter (1996), "the traditional approach, developed by Bailey (1956) and Friedman (1969), treats real money balances as a consumption good and inflation as a tax on real balances. This approach measures the welfare cost by computing the appropriate area under the money demand curve. Fischer (1981) and Lucas (1981), find the cost of inflation to be low. Fischer computes the deadweight loss generated by an increase in inflation from zero to 10 percent as just 0.3 percent of GNP using the monetary base as the definition of money. Moreover Lucas places the cost of a10 percent inflation at 0.45 percent of GDP using M1 as the measure of money. Lucas (2000) revised his estimate upward, to slightly less than 1 percent of GNP."

Table 1: Commodity Groups and their Composition in CPI Basket

	Groups	Weights	Composite Commodities Sub-indices	No. of Individual Items in Group
1.	Food & Beverages	40.3418	40	124
2.	Apparel, Textile & Footwear.	6.0977	7	42
3.	House Rent.	23.4298	1	1
4.	Fuel and Lighting.	7.2912	6	15
5.	H.Hold.Furniture & Equipment Etc.	3.2862	11	44
6.	Transport & Communication.	7.3222	10	43
7.	Recreation & Entertainment.	0.8259	2	16
8.	Education.	3.4548	4	24
9.	Cleaning Laundry & Per.Appearance.	5.8788	9	36
10.	Medicare.	2.0728	2	29
	Total	**100**	**92**	**374**

In Pakistan the objective of the monetary policy is the stability of prices without hampering the economic growth. In order to achieve the policy objective, State Bank of Pakistan followed a tight monetary policy from 2005 to March 2009 then the policy rate came down from 15 percent to 12.5 up to July 2010 before rising again to 14 percent in November 2011 in an effort to contain inflationary pressures in the economy. There was lot of debate about the policy stance that SBP adopted, in particular after the sluggish economic growth and reduction in aggregate demand in the economy while the policy rate continued to rise. This study is important in Pakistan's context as it will help in deciding that it may not always be good to introduce anti inflationary policy when there is also a focus to maximize social welfare particularly in the presence of non-linear relationship between inflation and RPV.

In this paper I have investigated the relationship between inflation and RPV in Pakistan's context. Besides knowing the relationship, the paper will try to explore whether the threshold level for inflation exists or not? Implications for monetary policy will be discussed in the conclusion.

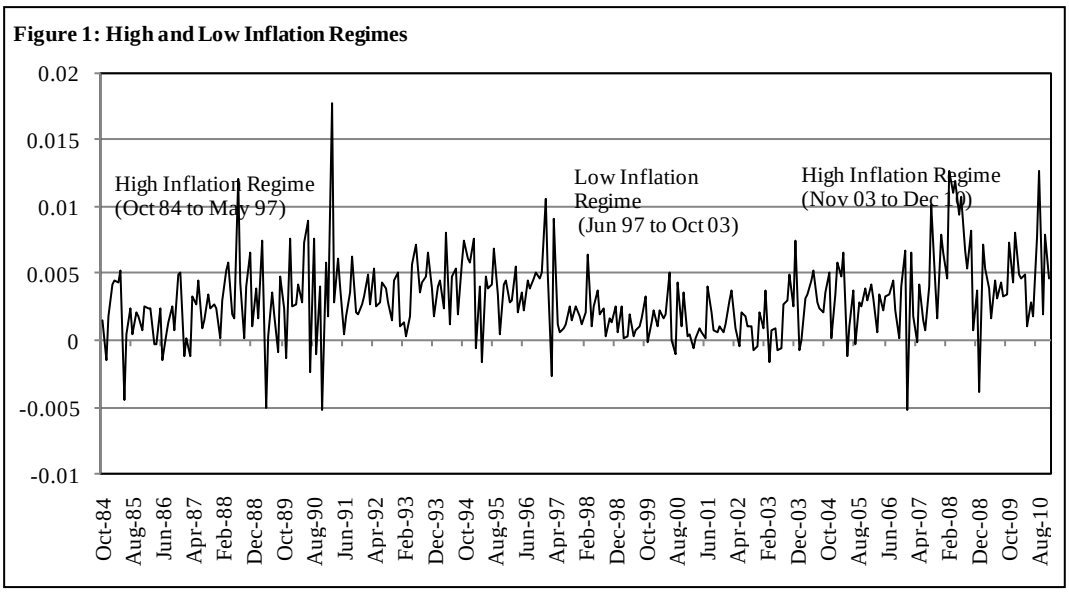
2. The Data

In this study I will be focusing inflation and relative price variability. Inflation rate can be calculated directly from the price indices. I have used commodity group-wise data in this paper that is available on 10 commodity groups since September 1984 that provides enough information for structural change and regime shift. From the same data set I calculated core inflation by excluding food and energy items as the prices of these are considered more volatile in many countries including Pakistan. The data was obtained from Federal Bureau of Statistics; country's statistical agency. CPI inflation and core inflation (NFNE) data series were seasonally adjusted using the census X-12 method. Then headline and core inflation measures were calculated using monthly log difference of their respective indices. The information about these commodity groups is given in the Table 1. The following method was used to calculate the inflation.

$$\text{Inflation} = \Pi_t = \ln CPI_{it} - \ln CPI_{i,t-1} \quad (1)$$

Where CPI_{it} is the consumer price index of i^{th} commodity group at time 't'. I distributed the data into three self explanatory inflation regimes; (a) high inflation regime from Oct 1984 to May 1997. Average monthly inflation remained at 0.97 percent during this period, (b) low inflation regime from Jun 1997 to Sep 2003 when average monthly inflation remained around 0.54 percent, and (c) high inflation regime covering the period from Oct 2003 to Dec 2010 when average monthly inflation was around 0.86 percent.

Figure 1: High and Low Inflation Regimes



Relative Price Variability

Our next step is to define and calculate RPV. As discussed earlier, in this study the inflation is measured by monthly log-difference of the CPI computed from seasonally adjusted price indices using X-12 method and RPV was calculated by the weighted average of the sub aggregate inflation series by using:

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

Where $\Pi t = \ln CPI_{it} - \ln CPI_{i,\, t-1}$, $\Pi_t = \Sigma\, \omega i\, \Pi it$, ωi denotes the fixed expenditure weight of i^{th} commodity group. This measure has been widely used in the literature since the influential paper by Parks (1978). Many researchers have also used this measure in recent times including Nautz and Scharff (2005) for Germany, Fielding and Mizen (2008), Choi and Kim (2010) and Choi (2010) for US and Japan.

Alternatively I could have used coefficient of variation as suggested by Silver and Ioannidis (2001) however, in Pakistan's case this might have not been a good measure as many RPV values will be undetermined as inflation has remained negative in some months. The most important in such kind of studies are the weights for calculating RPV.

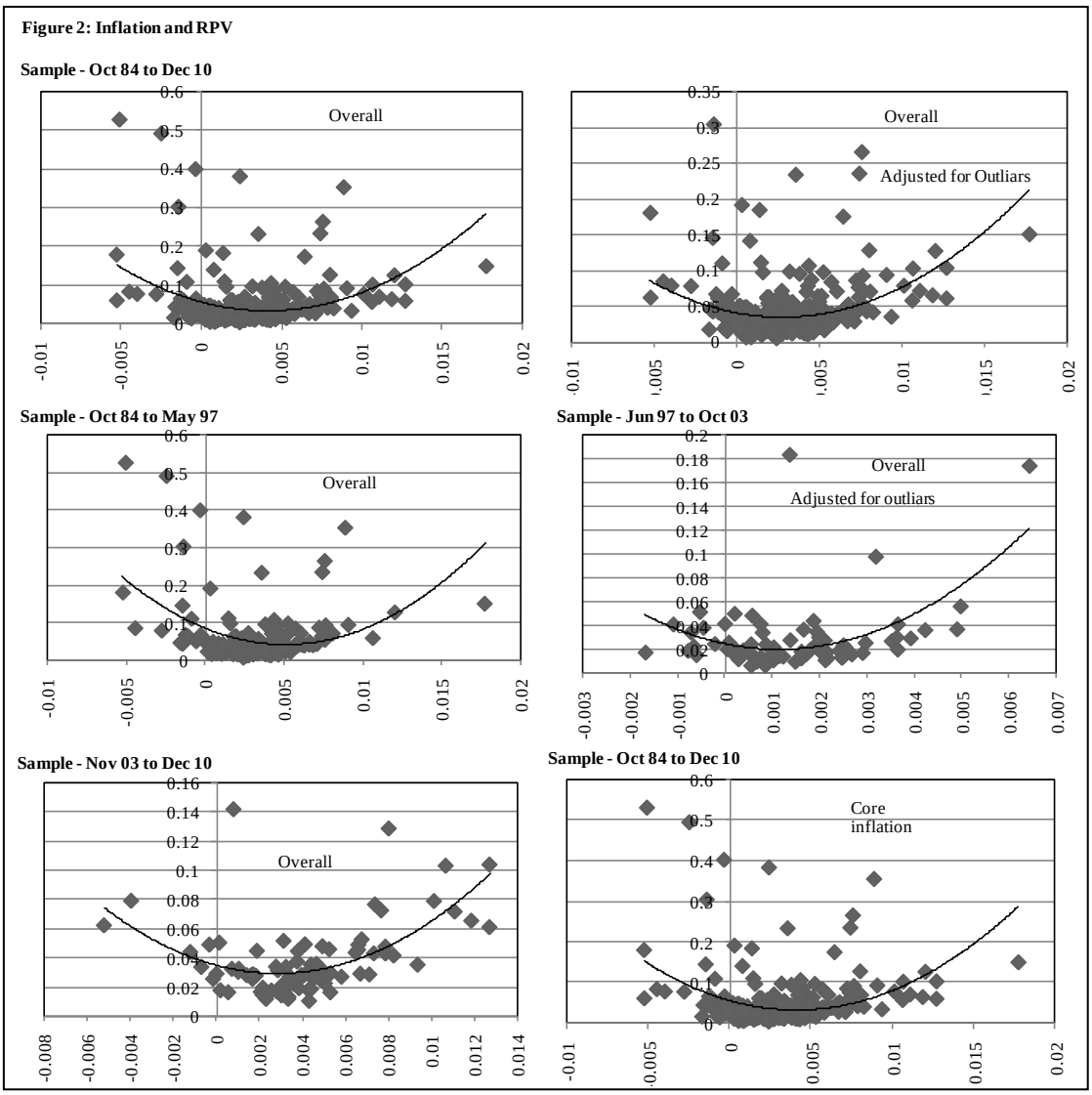
3. Stylized Facts

Visual depiction of the data shows that the relationship between inflation and RPV is approximately U-shaped[3]. This is true across all three inflationary regimes, and for headline as well as non-food non-energy core inflation abbreviated as NFNE that means while deciding monetary policy one must take into account the phase of the relationship irrespective of inflation measure whether headline or core. According to figure 2, it clearly seems that the relationship between RPV and inflation is not linear but approximately U-shaped. The relationship persists even after I adjust the data for outliers.

It implies that before a threshold level of inflation, higher inflation leads to lower RPV, while for inflation levels above the threshold, inflation increases RPV. It means that the marginal effect of inflation on RPV differs at various levels of inflation. The U-shaped relationship also holds for the core inflation, which excludes volatile prices such as those of food and energy items, does not alter these results.

But before I jump to the conclusion about the U-shaped relationship, this requires to be supported empirically. Now I can further investigate whether the relationship is stable over time, across different inflationary measure and regimes or not by way of econometric analysis.

[3] The U-shaped relationship between inflation and RPV in a scatter plot is drawn from the predetermined polynomial functional form of order 2.



4. Econometric Analysis

4.1. A non linear specification of the relationship between inflation and RPV

After obtaining RPV and inflation series, I specify a functional form of the relationship. A visual inspection has provided very useful information about the inflation – RPV relationship, however, such observation can carry drawback especially when structural changes are suspected to be present in the data. For this I apply more formal econometric tools to provide a better sense of the underlying relationship.

Two econometric methodologies were adopted: (i) rolling regression, and (ii) the multivariate multiple structural break test developed by Bai and Perron (1998, 2003). Following Fielding and Mizen (2008) and Choi (2010) among others the fuctional specification form for representing a quadratic relationship can be best described in inflation-RPV nexus as under:

$$RPV_t = \alpha_0 + \Sigma\, \alpha_h RPV_{t-h} + \Sigma\, \beta_i\, \Pi_{t-i} + \gamma_1\, \Pi_t + \gamma_2\, \Pi^2_t + \varepsilon_t \qquad (3)$$

The inclusion of the square term is supported by the U-shaped pattern shown in scatter plot and also supported by some earlier studies (Parks 1978, Domberger 1987, Hartman 1991, Van Hoomissen 1988).

Some important characteristics of quadratic functional form are as under:
$\boldsymbol{\gamma_2}$ captures the direction of the relationship and for U-shaped relationship to hold it should be significant and positive. Moreover, in quadratic model, the minimum point of the curve pertains to the value of Π at which RPV is the lowest. By differentiation equation 3 we get:

$$\Pi^* = -\gamma_1 / 2\gamma_2$$

This specification also helps deciding whether the threshold level of inflation is positive, zero or negative. The sign of threshold level of inflation with respect to RPV depends upon the signs of γ_1 and γ_2.

If $\gamma_1 > 0$ and $\gamma_2 > 0$; then threshold level of inflation would be negative.

If $\gamma_1 < 0$ and $\gamma_2 < 0$; then threshold level of inflation would be negative.

If $\gamma_1 > 0$ and $\gamma_2 < 0$; then threshold level of inflation would be positive.

If $\gamma_1 < 0$ and $\gamma_2 > 0$; then threshold level of inflation would be positive.

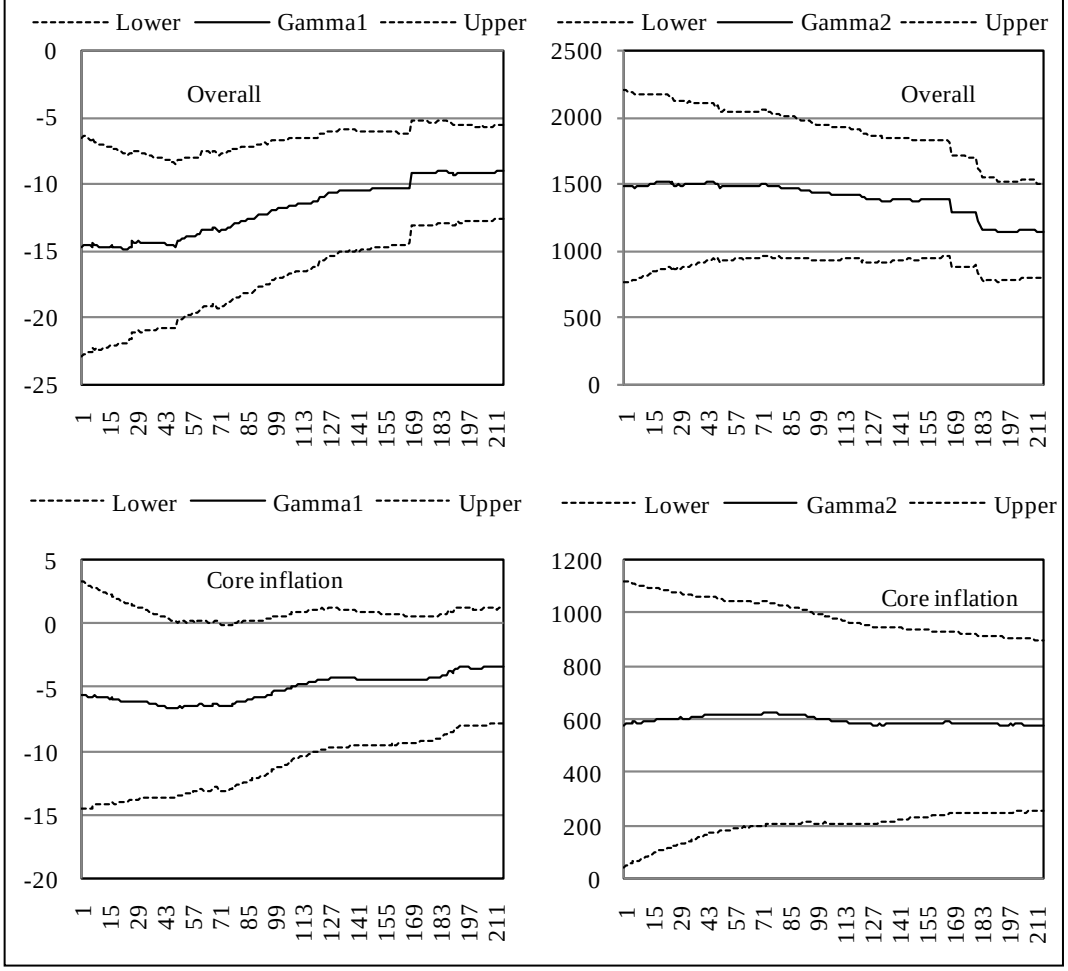
Here 2nd and 3rd possibility can be ignored as we know that in case of U-shaped relationship, the sign of γ_2 is positive, thus the sign of threshold level of inflation would solely depend on the sign of γ_1.

As a consequence, the relationship is U-shaped around a positive inflation if $\gamma_1 < 0$, but U-shaped around a negative inflation if $\gamma_1 > 0$. If $\gamma_1 = 0$, the U-shape would be around zero inflation. If γ_1 is equal to or close to zero, however, Π^* cannot be determined properly. Moreover, the time-varying behavior of Π^* also provides information about the stability of the relationship between inflation and.

4.2. Rolling Regression Analysis

To ensure that the relationship between inflation and RPV changes over time, the rolling regression technique was applied. This approach retains the ability in detecting structural changes over time. It allows each rolling sample to have a completely different estimate. I used two kinds of rolling regressions; (a) rolling regression with flexible window that allows sample size to differ for each and every regression. Sample size started from first 100 observations then continued to grow with one additional observation for each regression. I estimated 215 rolling regressions in total; and (b) rolling regression with fixed window in which sample size does not change across different regressions. I fixed 100 observations for 1st regression and then onward I dropped 1st observation and continued to add another until the whole data is utilized. I estimated 215 rolling regressions with fixed window as well. The results are presented in the figures below.

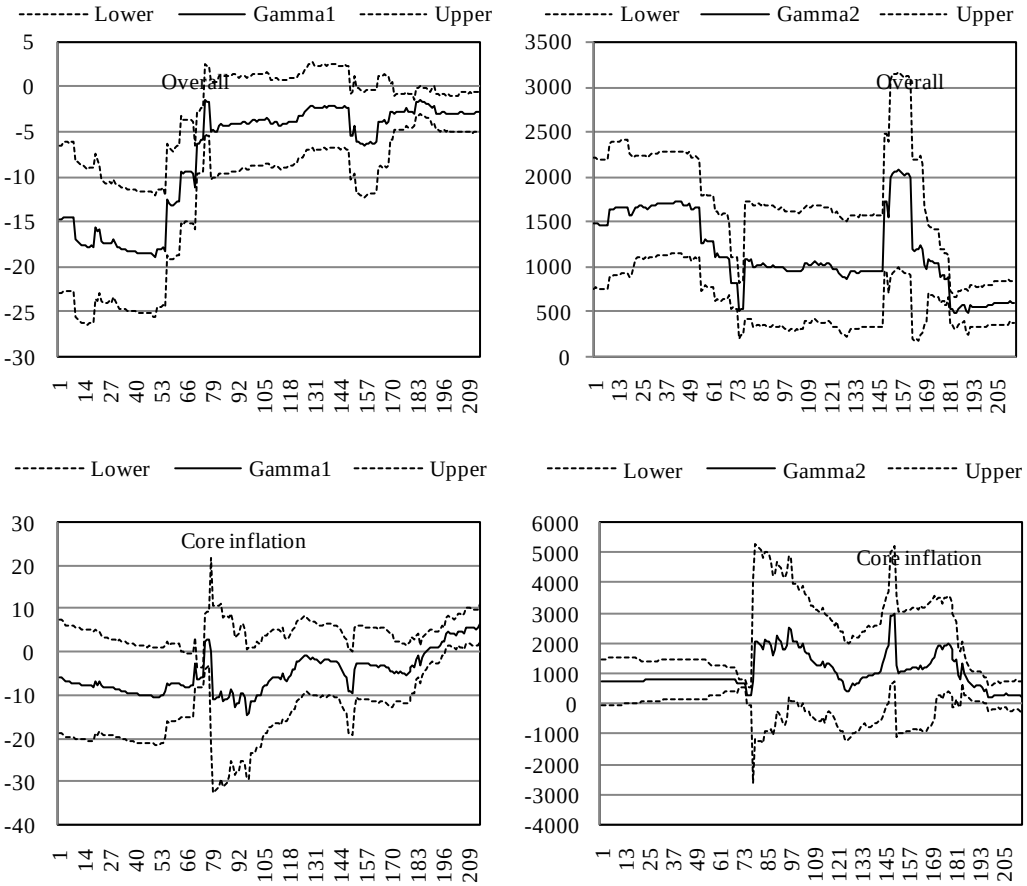
Figure 3. Rolling Regression with Flexible Window



The results from rolling regression (flexible and fixed window) representing coefficients on inflation (γ_1) and inflation square (γ_2) in the figures3 and 4. The left hand side columns represent the coefficient on inflation (γ_1) for overall and core inflation measures of inflation. Whereas right hand side column of the panel diagram represent the coefficients on inflation square (γ_2). In each panel the solid line represents the coefficient estimates for γ_1 and γ_2. Two dashed lines represent the 95% confidence interval based on pre whitening standard errors.

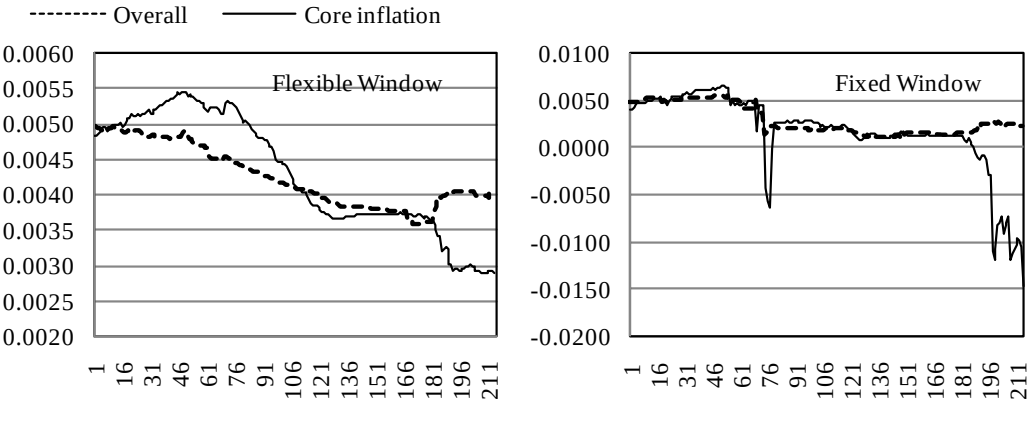
There are some interesting observations. The graph shows a significant variation over time in both coefficients (γ_1 and γ_2). Visually there are two obvious jumps. Moreover confidence interval narrows over time in most of the panels. As regards the signs of coefficients these are consistent with the earlier discussion in the previous section. In all cases the coefficient on inflation square (γ_2) is positive which is necessary for the relationship to be U-shaped. On the other hand the coefficient on inflation (γ_1) is negative consistently except for core inflation. It can be inferred from these results that; (a) the threshold level of inflation for Pakistan is positive; and (b) the relationship between inflation and RPV is non-linear. The sign of γ_1 is monotonically negative in all cases either it is flexible window or fixed window. This also has implications for the central bank as central bank must always announce a positive inflation if

Figure 4. Rolling Regression with Fixed Window



the objective is to maximize the social welfare. Although the coefficients on 'γ_1 and γ_2' are significant and positive most of the time, however, there are instances of negative and insignificant coefficients as well. Therefore the stability of U-shaped relationship cannot be ensured from rolling regression results.

Figure 5. Pi-Star



The time varying pattern of γ_1 and γ_2 shown in figure3 and 4, is also evident from Π^* values drawn in figure 5. This provides another possible argument that the relationship between inflation and RPV varies over time. It is also evident from the figure that Pi-star has been continuously declining over time but remained positive except for the core inflation fixed window rolling regression when it turned negative at the end.

5. Testing for Multiple Structural Breaks using Bai and Perron Test

Bai and Perron (1998, 2003) approach of testing multiple structural breaks has clear and appealing advantage that it allows locating endogenously multiple structural breaks from the data. The 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.
I used the multivariate equation with a general error process, in which I have allowed conditional hetroscedasticity and autocorrelation.

The Bai-Perron (BP) methodology considers the following multiple structural break model, with m breaks (m+1 regimes):
$y_t = x_t \,.\, \beta + z_t \,.\, \delta_i + u_t$
$t = T_{t-1}+1, \ldots, T;\ T_0 = 0;\ T_{m+1} = T;\ i = 1,\ldots,m+1$

Where 'y_t' is the observed dependant variable at time t; x_t is px1; and z_t is qx1; and, 'β' and 'δ_i' are the corresponding vectors of coefficients; and 'u' is the disturbance term at time 't'. The parameter 'δ' will experience 'm' structural breaks and have 'm+1' set of values in 'm+1' different regimes.

The break points (T) are treated as unknown, and are estimated together with the unknown coefficients when 'T' observations are available. We fixed the regime size equal to two years (24 months) which is around 7 percent of the overall sample. There is no hard and fast rule for specification of regime size.

Table 2: Summary Bai-Perron Structural Break Test

	Overall Groups Data	Core Inflation
Data Range	**Oct 1984 to Dec 2010**	
Span	24	24
Breaks	2	2
Break Dates	Jul 1988, Jul 1990	Jun 1988, Jul 1990
Regimes	3	3

Table 2 gives the summary of basic findings. I fixed the minimum spans 24 months for all four data sets. In order to identify the best structural break points, I incorporated break 1 to break 12 and obtained results for each of the break. After comparing the Bayesian Information Criteria (BIC) across all breaks, I selected the best number of breaks. The test also identified the dates when the regime shifted. There appeared two structural breaks and three regimes in the relationship between inflation and RPV for Pakistan. Bai-Parron assumes

Table 3: Bai - Perron Results

	Overall Inflation (Oct 1984 to Dec 2010)			Core Inflation (Oct 1984 to Dec 2010)		
Variables	**Coeff**	**Std Error**	**T-stat**	**Coeff**	**Std Error**	**T-stat**
C	0.03	0.01	5.91	0.03	0.01	3.39
Inf	-8.74	1.79	-4.89	-5.81	2.97	-1.96
Inf ^{2}	1131.55	175.26	6.46	804.60	221.48	3.63
RPV(-1)	0.23	0.05	5.41	0.43	0.06	7.69
RPV(-2)	0.16	0.05	2.98	0.11	0.06	1.98

that the break does not occur in the initial 15 percent and final 15 percent of the sample. The results ensure that the first break occurred not before the initial 15 percent and the second occurred at 23 percent of the sample period.

Table 3 reports the estimated coefficients that tell us about an important insight about the relationship between inflation and RPV. The coefficients are significant at 5 percent level of significance. Most importantly the coefficient on inflation is negative and on inflation square is positive that ensures; (a) non-linear U-shaped relationship between inflation and RPV, and (b) the threshold level of inflation is positive.

6. Conclusion

The issue of optimal level of inflation and the relationship between inflation and relative price variability (RPV) has been widely discussed. Following the work by Park (1978), it has long been believed that the relationship between inflation and RPV is linear and positive. It refers that higher inflation rates are associated with higher cross sectional variation in relative prices. However, with the developments in techniques to know about the functional form more accurately, it was observed that the relationship between inflation and RPV neither linear nor stable over time. In this study I found some interesting theoretical and empirical insights about the relationship between inflation and RPV by using disaggregated data for Pakistan. I have used three methods to assess the functional form and stability of the relationship between inflation and RPV; (a) visual assessment through scatter plots; (b) rolling regression analysis, and (c) Bai-Perron multiple structural break tests. Scatter plots and Bai-Perron methods confirm that the relationship between inflation and RPV is approximately U-shaped. Whereas the rolling regression approach shows that the relationship is not significant across all rolling samples, however, coefficients signs are in right direction. All three methods suggest that the relationship is unstable over time. The findings also show that for maximization of social welfare for the society as a whole, the inflation should be positive.

These findings have important policy implications. In an inflationary environment when RPV is positively correlated with inflation, central bank can always design a monetary policy to reduce inflationary pressures in order to improve welfare. On the other hand if the relationship between inflation and RPV is negative any policy to reduce inflationary pressures would not be good for welfare. Moreover, it is the time varying feature of the relationship between inflation and RPV that makes it more difficult for the central bank in policy decision making as the inflation persistence changes over time. Finally a proper understanding and knowledge about the threshold level of inflation is of great importance for policy making.

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