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# Intrinsic Inflation Persistence in a Developing Country

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## Abstract

This study estimates degree of intrinsic inflation persistence in Pakistan using aggregate price index, group level price indices, and individual commodity prices. We find no evidence of a unit root in (MoM) inflation at any level, except for house rent. Using monthly data from 1959 to 2011 we find that the estimate of (overall) inflation persistence is 0.16, which is low but significant. During 2001-2011 (overall) inflation persistence is insignificant. Food inflation does not exhibit any persistence during the last decade. However, the degree of persistence is very high (0.80) and significant for core inflation (NFNE), which weakens slightly (to 0.69) when we account for commodities price shock of 2008. At micro level, the estimated degree of inflation persistence for various groups is found to be relatively higher, in almost 60 percent of the cases, compared to corresponding degree of persistence at aggregate level. This may be because in micro analysis we consider only those commodities for which the estimated degree of inflation persistence is significant.

**Key Words:** Persistence, Inflation, Food Inflation, Core Inflation

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## 1. Introduction

The effectiveness of monetary policy in stabilizing prices depends largely upon inflation dynamics - in addition to the credibility of the central bank, the level of coordination between monetary and fiscal policies, the exchange rate regime and the degree of proactiveness of monetary policy. One of the determinants of inflation dynamics is the price setting behaviour of firms in the country. If a significant number of firms adjust their prices based on past information, the country will face inflation persistence (Gali and Gertler (1999)) – the tendency of inflation to converge slowly to its long-run level following a shock.

Choudhary et al (2011), based on a survey of a large number of firms in Pakistan, found that 71 percent of manufacturers in the country use backward looking information while setting prices. This gives rise to inflation inertia because when a large number of firms use backward looking information while setting prices, inflation cannot easily transition to a (new) lower steady state as a result of any unexpected announcement of a permanent and credible lowering of growth of the nominal anchor (Fuhrer, 2009).

In this paper we explore inflation persistence in Pakistan using month on month time series data of consumer price index (CPI), various group level consumer price indices, and 374 individual prices, released by the Pakistan Bureau of Statistics (PBS) – the country’s statistical agency. This study, to the best of our knowledge, is the first comprehensive study on inflation persistence in Pakistan. We investigate inflation persistence starting from the aggregate inflation, down to its micro level exploration based upon month on month (MoM) changes in the prices of commodities in the CPI basket of Pakistan. The dataset comprises of two periods: January 1959 to June 2011 (longer span) for aggregate level; and July 2001 to June 2011 (recent decade) for aggregate, group-wise, and micro level investigation. The shorter period for group-wise and micro level study is due to non-availability of data before 2001.

According to literature, for example Altissimo et al (2006), there are three types of persistence: (i) extrinsic, which is due to persistence in marginal costs changes, (ii) intrinsic, that is dependence of inflation on its own past and (iii) expectation based inflation persistence (which means if inflation is hit by a shock and firms and households do not have information about the nature of the shock, they start expecting inflation to follow historical trends). In this study, we focus on intrinsic inflation persistence. The reason for this focus is that we do not have the required data on inflation expectations and firm level costs.

There are various ways of approaching intrinsic inflation persistence: (i) an autocorrelation function of inflation, (ii) first order autocorrelation coefficient of the inflation series, and (iii) the sum of the autoregressive coefficients (SARCs) of the inflation process (see Marques (2004)) for discussion of various measures of persistence). Despite the fact that an inflation autocorrelation function might summarize much of the information about the underlying inflation process, it does not give us a single estimate, in order to describe the inflation persistence, which is more useful at the commodity level. Thus, we use the last two measures to investigate inflation persistence in Pakistan.

The paper proceeds as follows. Section 2 presents the methodological framework. Section 3 provides findings on inflation persistence in Pakistan. Section 3 has various subsections. First, we present results related to extreme form of inflation persistence based on unit root tests. Then, we discuss results on the non-extreme form of the inflation persistence based on AR(1) and SARC's approaches. In the next subsection we provide evidence for fall in the degree inflation persistence after considering structural breaks observed in the data. We also provide an international comparison of aggregate level inflation persistence with the findings of this study on Pakistan in a separate subsection. In the last subsection we present evidence of inflation persistence in Pakistan based on individual commodity prices. Section 4 concludes.

## 2. Methodological framework

Inflation persistence means dependence of current inflation on its past values. In this section we present the methodological steps to study inflation persistence<sup>1</sup>. First, we diagnose if the inflation series has infinite persistence<sup>2</sup> using Phillips-Perron unit root test<sup>3</sup>. A unit root implies that the inflation series have infinite memory and any current shock will influence all future outcomes (see Fuhrer, 2009). This is an extreme form of persistence. For non-extreme forms of persistence where inflation series is found to be stationary, we would like to investigate its degree. The higher the degree of inflation persistence, the longer time the inflation takes to return to its previous levels, in case of a shock<sup>4</sup>. For the degree of inflation persistence we run a first order autoregressive model AR(1) model, and check for the significance of a positive coefficient on the AR term which implies a positive serial correlation, and thus inertia, in the inflation series. This is the standard method in the literature to measure inflation persistence (see Cutler (2001), Batini (2002), Batini and Nelson (2002), Cecchetti and Debelle (2005), and Osborn and Sensier (2009), and Gupta and Saxegaard (2009)). A few authors, however, consider inflation to be persistent even if it is negatively autocorrelated (for details see Fuhrer (2009)). Based on our own simulation study, we consider positive serial correlation in inflation series as a measure of inflation persistence<sup>5</sup> using the equation

$$\pi_t = \mu + \alpha\pi_{t-1} + \epsilon_t \quad (1)$$

where  $\pi_t$  denotes the inflation at time  $t$ ,  $\mu$  is the mean inflation rate, and  $\alpha$  is the AR(1) coefficient.

Following Levin and Piger (2003), Williams (2006), Kota (2011), Tillmann (2011), and Zhang (2011), we also use SARC's as a separate measure of the degree of inflation persistence since the SARC's approximates the long run impulse response to a unit shock. The model we estimate is the  $p$  order autoregressive model. Lag length is selected using Akaike (1969) information criterion.

With the increasing importance of inflation persistence for policy, there is much interest in testing and considering the stability of inflation persistence. Ignoring the structural break in the average inflation rate creates an upward bias in the estimates of inflation persistence (O'Reilly

and Whelan, 2005). However, there is no conclusive evidence on whether or not inflation persistence has changed in different countries of the world (see Taylor (2000), Stock (2001), Cogley and Sargent (2001), Willis (2003), Pivetta and Reis (2007), Kim et al (2004), and O'Reilly and Whelan (2005)). With the mixed evidence from different countries on the presence of break(s) in the inflation persistence, it is important to see if there are changes in the mean inflation rate and/or in the inflation persistence over time in Pakistan. This becomes even more important to see it at those points where inflation fluctuates substantially in Pakistan (see figure 3.1). The degree of its persistence is expected to be higher, when inflation moves in a relatively larger range (see footnote 7). In order to capture possible structural break(s) we employ the rolling Chow break point test (see Chow (1960)). While applying the Chow break point test if we are unable to reject the null hypothesis (at 5 percent confidence level) throughout the sample range, it is evidence of lack of any structural break. If there is only one point where the p-value for rejecting the null hypothesis is smaller than 0.05, this may be an outlier. However, when there are more than one but consecutive points with p-value less than 0.05, the one with the lowest p-value is considered as a break point. If there are two or more sequences with p-values less than 0.05, at different periods, then this is evidence of multiple structural breaks. As a robustness check of a structural break test, we re-estimate our autoregressive model by using a dummy variable both for intercept and slope. In case we find the evidence of structural break, the dummy variable approach helps us in distinguishing whether the break is in the mean inflation rate or in the inflation persistence or both.

Furthermore, evidence of inflation persistence or lack of it, at the aggregate or group level, does not necessarily mean the same at commodity level. We, therefore, investigate the inflation persistence in Pakistan based on monthly changes in prices of (374) individual commodities as reported by PBS for July 2001 to June 2011. We apply the Levin-Lin-Chu (2002) and the Im-Pesaran-Shin (2003) panel unit root tests to detect if there is any extreme form of inflation persistence. While exploring the non-extreme form of inflation persistence at this micro level we use both the AR(1) and the SARC's approaches. Since CPI is the weighted average of individual price indices, we calculate the weighted (as per CPI basket) average of estimated autoregressive coefficient(s) to find the degree of inflation persistence in Pakistan. Following Cutler (2001) and Gupta and Saxegaard (2009) zero weight is assigned to commodities for which the estimated autoregressive coefficient is found to be negative or not (statistically) different from zero. The same exercise is also carried out for core inflation as measured by the non-food no-energy group (NFNE) items. The NFNE group has 232 commodities. We specifically focus another group NFNE-Non HRI consisting of 231 items (because HRI has the highest single commodity weight and thus can impact results significantly). As an indirect approach to consider the 2008 commodity price shock in our micro level analysis, we also estimate, separately, the degree of inflation persistence for a shorter span of time - like the last 36 months (to reduce the impact of structural break). We call this the fixed window (FW) approach, as against the historical window (HW) for a relatively longer period of time, which in this study is July 2001 to June 2011 for commodity level analysis.

### 3. Findings on Inflation Persistence in Pakistan

#### 3.1 Results of Unit Root Tests

In Table 3.1 (Appendix A), we present the results of Phillips-Perron unit root test. We could not find any evidence of unit root for the aggregate (MoM) inflation series, both for the longer period of 1959-2011 as well as for 2001-2011. For later, we have luxury of group level price indices. Groups are classified (by PBS) as: ‘food, beverages & tobacco’, ‘apparel, textile & footwear’, ‘house rent index’, ‘fuel & lighting’, household furniture & equipment’, ‘transport & communication’, ‘recreation & entertainment’, ‘education’, ‘cleaning, laundry & personal appearance’, and ‘medicare’. Furthermore, some other groups of interest like ‘excluding HRI or CPI-NHRI’, ‘non-food or NF’, ‘non-food non-energy or NFNE or core’, and ‘NFNE-non HRI’ are also analysed to see the drivers of inflation persistence in various categories. We also explore the unit root in MoM changes in these group level indices and could not find the evidence of non-stationarity except in the case of HRI. Evidence of a unit root in MoM changes in HRI is not surprising. It is evident in the construction of HRI<sup>6</sup>.

#### 3.2 Estimated Degree of Inflation Persistence Based upon AR(1) and SARCs

Thus far we have established that there is (infinite) persistence in the inflation series for HRI while all the other series explored above are stationary. For these stationary series, we consider non-extreme form of persistence using equation (1) in aggregate and group level inflation. For the aggregate and for the group level inflation series we estimated the first order autoregressive model (with drift). The results are presented in Table 3.3 (column 3) of Appendix A.

The estimate of inflation persistence in Pakistan for aggregate MoM inflation for 1959-2011 is 0.19 which is (statistically) significant. Interestingly, we find this number to be higher by 0.09 for the recent decade (2001-2011). However, once we exclude HRI from the overall basket, the estimated AR(1) coefficient turns to be much lower (from 0.28 to 0.18) and insignificant. Thus, inflation for non-HRI basket is not persistent for 2001-2011.

Exploring inflation persistence at the group level helps in identifying which sector’s inflation persistence drives overall inflation persistence. Doing so also helps distinguish the groups with high, low or no inflation persistence. There is no inflation persistence for food basket of Pakistan – a result similar to Khundrakpam (2008) in India where both the primary and manufactured food inflation series do not exhibit persistence. These results are contrary to Walsh (2011) that food inflation is persistent in most of 91 countries studied. Within the non-food basket we could not find any evidence of inflation persistence for ‘fuel & lighting’, ‘recreation and entertainment’, and ‘medicare’ groups. Most of the commodities in these groups belong to the services sector.



Other groups – except HRI - in the non-food category which show inflation persistence are ‘apparel, textile & footwear’, ‘household furniture & equipment’, ‘transport & communication’, ‘cleaning, laundry & personal appearance’, and ‘education’. Inflation persistence in these groups drives persistence in non-food (NF), non-food non-energy (NFNE) and NFNE-non-HRI categories. The highest inflation persistence coefficient is found for the core or NFNE group which is 0.80, and is significant. Thus core inflation follows a persistence stationary process in Pakistan. Majority of commodities in non-food non-energy categories are manufactured goods.

We also present the results (in Table 3.4 (column 3), Appendix A) of an alternate measure of persistence “the sum of autoregressive coefficients (SARCs)” following Levin and Piger (2003), Williams (2006), Kota (2011), Tillmann (2011), and Zhang (2011). Lag length is selected using Akaike (1969) information criterion<sup>7</sup>. Overall, the degree of persistence is higher than what we found based on AR(1) approach and we can see the core inflation is found to be highly persistent.

### *3.3 Estimated Degree of Inflation Persistence and Structural Breaks*

We now consider the impact of structural break(s) on the estimated coefficient(s) of the autoregressive model employed above to investigate the inflation persistence. We apply rolling Chow break point test on the aggregate inflation series for 1959-2011 and on aggregate as well as group level inflation series for 2001-2011. There is evidence for a structural break in the intercept of the autoregressive model, in 1973 and 2008 (see column 4 of Table 3.3 in Appendix A) for longer aggregate inflation series and in 2008 for short span aggregate/group level inflation series (except for ‘transport & communication’ group). We are not surprised over the detection of these structural breaks as we have pointed out in the Figure 3.1 (Appendix A). We also confirmed the break points by introducing an intercept dummy after the break point (in the autoregressive model used for investigating the inflation persistence) in respective series, which was found to be significant (except for ‘transport & communication’ group). However, the slope dummies introduced (for the autoregressive coefficients) were found to be insignificant. Thus, there is a break in only the (mean) inflation of Pakistan for aggregate as well as group level series (except for ‘transport & communication’ group) and not in the corresponding series’ inflation persistence. Ignoring the structural break results in (an upward) biased estimate of the degree of inflation persistence (Altissimo et al. (2006)).

Once the structural break point is considered in the inflation persistence exploration process, the estimated degree of inflation persistence gets revised downwards<sup>8</sup> for all the cases (see figure 3.2 in Appendix A) but so much so for ‘overall (2001-2011)’ and ‘education’ that the degree of inflation persistence becomes insignificant (see column 5 of Table 3.3 in Appendix A). Thus, ignoring the structural break could have been misleading at least for these two cases.

While it weakens after considering the structural break, we find that core inflation shows a high degree of persistence which is 0.69. However, it is important to mention that NFNE basket

includes HRI. The degree of inflation persistence in NFNE non-HRI basket is 0.43 and is significant. Thus, it is not just HRI which makes core inflation to be persistent; rather most of the groups in core inflation drive persistence.

Since the evidence of break pertained to the mean inflation rate, we also estimated and reported the degree of inflation persistence using SARCs approach by considering break point [Table 3.4 (column 3)]<sup>9</sup>. As in the case of AR(1), the degree of persistence declined when the break point was considered (see figure 3.4 in Appendix A). Again, the degree of persistence is higher than what we found based on AR(1) approach while considering the structural break. Core inflation is found to be highly persistent as well.

This degree of persistence for core inflation around 0.69 is very close to one of the findings of Choudhary et al (2011) based on individual companies' price setting survey results that 71 percent of manufacturing firms in Pakistan use backward looking information while setting prices. Another finding of Choudhary et al (2011) is that the frequency of price change is considerably high in Pakistan: the median frequency of price change is 4 (times a year) in Pakistan's manufacturing sector compared to 1 in Euro Zone. 32 percent of firms in Pakistan change price within a month compared to 16 percent such firms in Euro Zone. As far as the evidence of core inflation persistence in the presence of frequent price changes is concerned, it is possible that firms change their prices frequently but follow the backward looking price setting behaviour. Furthermore, the survey of price setting behaviour in Pakistan by Choudhary et al (2011) was conducted around the period of global commodity prices shock when international prices were changing more frequently (than historically) and our firms at that time might simply be following international prices' behaviour as a quarter of inputs used in Pakistan's manufacturing industries are imported (Pakistan, 2006). Another possible explanation for core inflation persistence in the presence of frequent price changes is the higher frequency of price changes itself: when firms change price frequently they need not to pass on all the impact of changes in cost of production to consumers in one go due to 1) expecting a possible reversal in input cost, and 2) fear of losing customers/profits if all changes in prices are passed on in one go.

### *3.4 International Comparison of Aggregate Inflation Persistence*

In order to compare Pakistan's inflation persistence, during 2001-11, with that in 'similar' countries we selected 17 (inflation) peer countries<sup>10</sup>. The results of inflation persistence in (inflation) peer countries based on both the AR(1) and SARCs approach are presented in Table 1B of the Appendix B. We find that Pakistan's degree of overall inflation persistence is lower compared to the average of 17 (inflation) peer countries both for AR(1) and SARCs measures. It is important to note that Pakistan's (aggregate) inflation persistence is insignificant compared to significant inflation persistence in 15 (13) countries based on AR1 (SARCs) measure out of the 17 countries reported in Table 1B in the Appendix B. Comparing across a larger set of countries, we can see that the estimated degree of persistence in aggregate inflation for Pakistan (0.25 based on SARCs approach; as reported in column 4, and row 3 of Table 3.4 in Appendix A) is

low compared to median persistence (0.27; based on SARCs) for 91 countries reported by Walsh (2011). We do not have group wise prices data for such countries for group level inflation persistence comparisons.

### *3.5 Micro Evidence on Inflation Persistence in Pakistan*

By now, we have classified the groups as those showing (aggregate) inflation persistence and those which do not. But, does inflation persistence or its absence for any aggregate imply that all commodities in it show similar behaviour? Obviously, it may not be a necessary case. We now proceed to individual commodities based exploration of inflation persistence in Pakistan.

As in the case of aggregate level exercise, we first examine micro data to see if there is an extreme form of inflation persistence in Pakistan based on panel unit root test. The exercise is done for 342 non seasonal commodities (to have a balanced panel)<sup>11</sup>. We apply the Levin-Lin-Chu (2002) and Im-Pesaran-Shin (2003) tests to see if there is a panel unit root in the month-on-month changes in the commodity prices in the CPI basket (Table 3.2 of Appendix A). We could not find the evidence of panel unit root in the MoM changes in commodity prices of 342 (non-seasonal) items in the CPI basket. Now, we further explore the degree of (non-extreme form of) inflation persistence based on micro data following AR (1) and SARCs approach.

We present the results of this investigation of inflation persistence in Pakistan on the basis of monthly changes in the prices of all 374 individual commodities as reported by PBS, for the period of July 2001 to June 2011, using both the AR(1) as well as the sum of autoregressive coefficients approach in Tables 3.5 and 3.6 respectively. In addition to overall 374 commodities in the CPI basket, the analysis has been extended to different groups in the CPI. In Tables 3.5 and 3.6 (of Appendix A) each group name has been suffixed with the number of commodities in the group.

The exercise is done not only for the historical (starting from July 2001) but also for a short span (last 36 months) window (which is an indirect way to consider the structural break of 2008 in the price data). We report the results of the weighted (as per CPI basket) average of estimated autoregressive coefficients as the degree of inflation persistence in Pakistan (Tables 3.5 and 3.6, columns 8-10), ignoring the commodities for which estimated autoregressive coefficient is found to be negative or statistically insignificant following Cutler (2001); and Gupta and Saxegaard (2009). Since this analysis is based on individual items, we also report (in columns 2-4) the number of commodities (and their share in respective group in the parenthesis) showing significant inflation persistence in addition to the weight of such commodities (columns 5-7) in the underlying basket.

The estimated degree of persistence in micro level investigation is higher, in 75 percent of the cases, than the counterpart in aggregate/group level investigation in this study when AR(1) approach is used (See figures 3.6 and 3.8 in Appendix A). This may be due to the reason that in micro level averaging (the degree of inflation persistence), we consider only those commodities

for which there is (statistically) significant inflation persistence and thus ignore those for which estimated AR(1) coefficient is found to be negative or statistically insignificant. Furthermore, the share of commodities showing persistence is less than half except for couple of groups. Thus, we cannot deduce here that aggregation leads (MoM) inflation persistence to be biased downward. Although the share of commodities showing inflation persistence, using SARC's approach, is more than half (except for 'fuel and lighting' group), the estimated degree of persistence in micro level investigation is higher, only in 46 percent of the cases, than the counterpart in aggregate/group level investigation (see figures 3.7 and 3.9 in Appendix A). Thus, we cannot deduce here again that aggregation leads (MoM) inflation persistence to be biased downwards. As a matter of fact, the micro level results are not comparable with aggregate level findings unless we consider only those commodities in aggregations which are found to have statistically significant inflation persistence at micro level. Since commodities (with significant inflation persistence) need not necessarily be the same every month, throughout July 2001 to June 2011, there is no way to generate such an index for this period<sup>12</sup>.

We would like to state that despite its use in this study and its use by Kota (2011), Tillmann (2011), Osborn and Sensier (2009), Angeloni et al (2006), Cecchetti and Debelle (2005), and Bilke (2005); autoregressive models give a purely statistical measurement of persistence and show how inflation has behaved. These models cannot, however, say anything about why persistence arises. Therefore, further investigation of inflation persistence is required by considering the variables influencing the inflation and its dependence on its own or other relevant variables' past.

#### **4. Conclusion**

We studied inflation persistence in Pakistan based upon month on month changes in the aggregate and group level consumer price indices, and in individual monthly prices of 374 commodities. The individual prices and consistent group level consumer price indices data are available for 2001 to 2011 while aggregate consumer price index data go back to 1959. For 1959-2011, the degree of inflation persistence is low but significant. For 2001-2011, we could not find any evidence of extreme form of persistence (unit root) at any level in MoM inflation in Pakistan except for house rent. Overall inflation during 2001-2011 is found to exhibit low and insignificant persistence. At group levels, food inflation does not show significant inflation persistence. In most of the other groups the degree of inflation persistence is found to be less than half, except for core inflation and some of its components. At the micro level, the estimated degree of inflation persistence in various categories is found to be relatively higher in 60 percent of the cases and this may be because we considered only those commodities for which estimated degree of persistence is found to be significantly greater than zero.

Analyzing inflation persistence at the group level helps in identifying which group's inflation persistence behavior is driving persistence related behaviour in overall inflation. Estimated low degree of overall inflation persistence may be driven by the small estimated autoregressive

coefficients for some subgroups like food group. Food inflation does not exhibit any significant inflation persistence and it may be because most of the commodities in food group (with above 60 percent of weight in food basket) are raw items like onion, fruits and fresh milk, and are directly prone to supply shocks and their prices are more volatile (compared to manufactured items in which manufacturers have capacity to absorb some of the changes in inputs costs and to pass these changes to consumers in parts which generates inertia in inflation).

As far as the reasons of persistence of core inflation in Pakistan is concerned, there can be various reasons ranging from backward looking price setting behaviour of the firms to the framing and conduct of monetary policy. Some of the reasons of inflation persistence reported in the literature on other countries include: higher proportion of firms setting prices backward looking, larger number of firms following time dependent price changing policy, change(s) in the steady state level(s) of inflation in the country, changing inflation targets, changes in exchange rate regime, non-cooperation in monetary and fiscal policies, persistence in the cost push inflation, gradualism in monetary policy, and imperfect credibility (of the central bank). We know that majority of commodities in non-food non-energy categories are manufactured goods. Based on Choudhary et al (2011) we have evidence that 71 percent of the manufacturing firms in Pakistan use backward looking price setting behaviour. Thus, one of the reasons of core inflation persistence in Pakistan is the backward looking price setting behaviour of a large number of manufacturing firms in Pakistan. We propose further investigation to explore if there are some other reasons of core inflation persistence in Pakistan. Unless we empirically find Pakistan specific reason(s) for core inflation persistence we cannot have relevant policy prescription(s).

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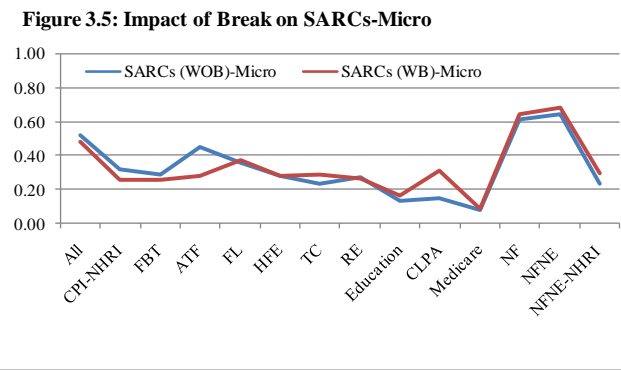
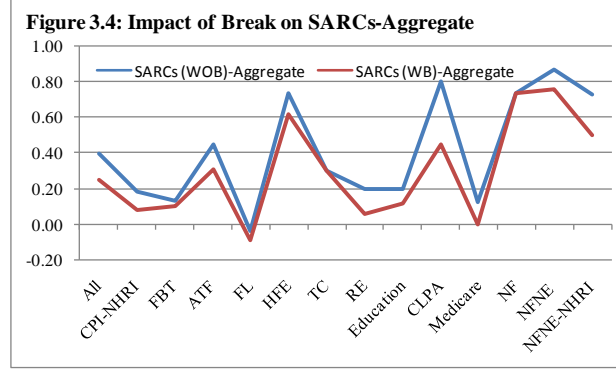
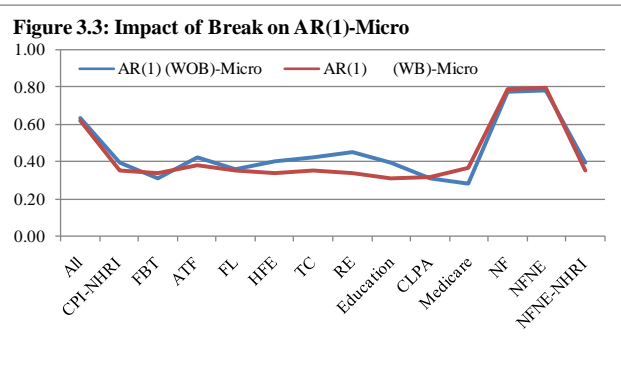
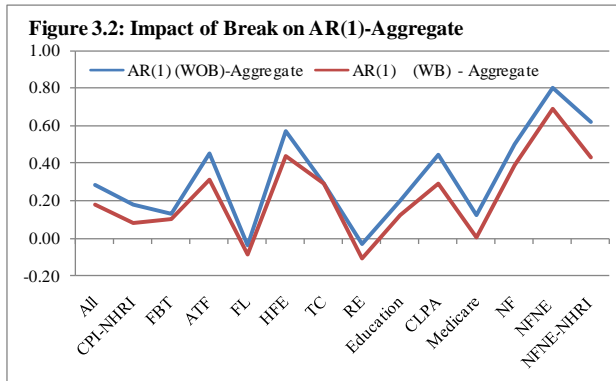
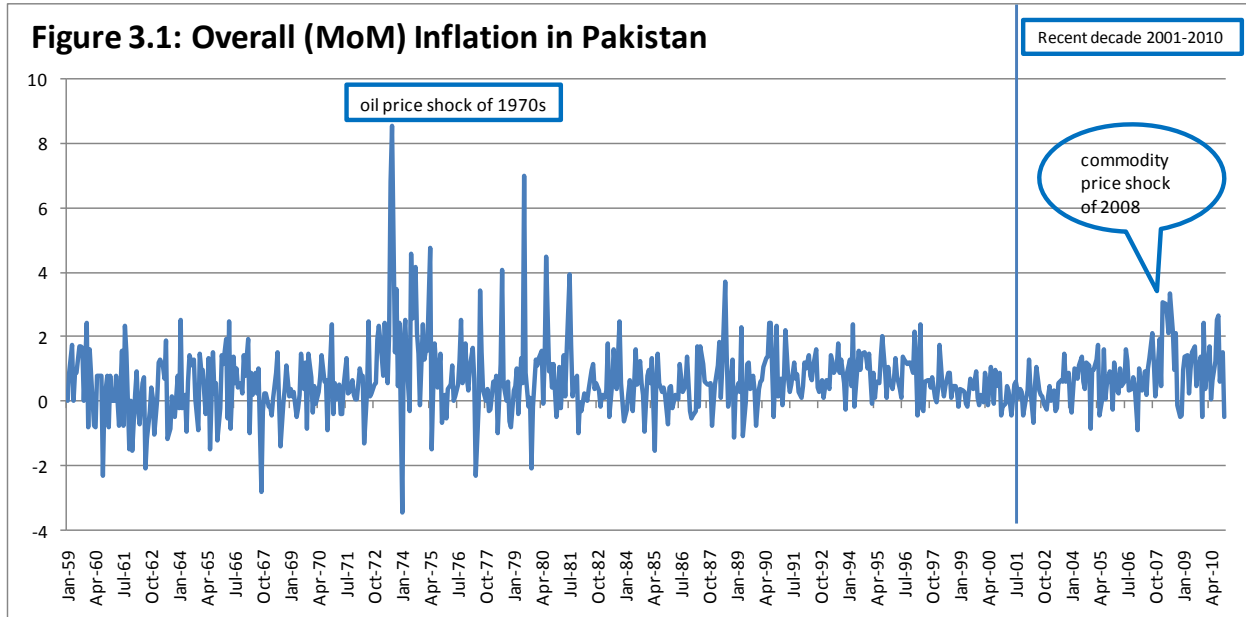
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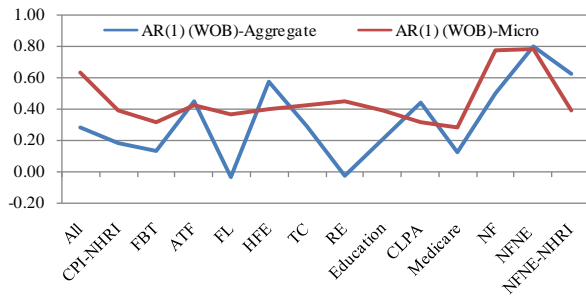
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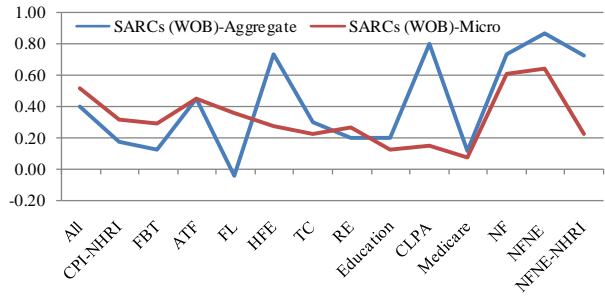
# Appendix A



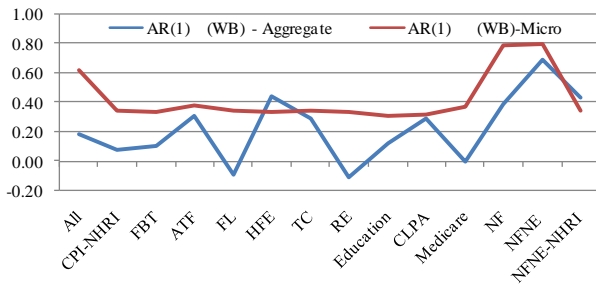
**Figure 3.6: Impact of Aggregate on AR(1)-WOB**



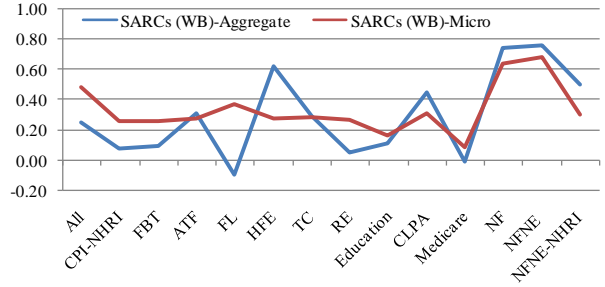
**Figure 3.7: Impact of Aggregate on SARC's-WOB**



**Figure 3.8: Impact of Aggregate on AR(1)-WB**



**Figure 3.9: Impact of Aggregate on SARC's-WB**



**Table 3.1: Unit Root Test for MoM Inflation in Pakistan**

Series (Period)	Phillips-Perron test
CPI (1959:01 to 2011:06)	-22.13*
CPI (1959:01 to 2001:06)	-19.40*
CPI (2001:07 to 2011:06)	-8.96*
CPI – Non HRI (2001:07 to 2011:06)	-9.59*
Food Beverages & Tobacco (2001:07 to 2011:06)	-9.71*
Apparel Textile and footwear (2001:07 to 2011:06)	-7.82*
House Rent Index (2001:07 to 2011:06)	-1.82
Fuel & Lighting (2001:07 to 2011:06)	-11.45*
Household Furniture & Equipment (2001:07 to 2011:06)	-7.45*
Transport & Communication (2001:07 to 2011:06)	-7.98*
Recreation & Entertainment (2001:07 to 2011:06)	-11.45*
Education (2001:07 to 2011:06)	-9.09*
Cleaning, Laundry & Personal Appearance (2001:07 to 2011:06)	-7.96*
Medicare (2001:07 to 2011:06)	-10.61*
Non-Food (2001:07 to 2011:06)	-7.94*
Non-Food Non-Energy (Core) (2001:07 to 2011:06)	-4.70*
Non-Food Non-Energy Non HRI (2001:07 to 2011:06)	-6.25*

\*: Null hypothesis of Unit Root is rejected at 5 percent level of significance.

**Table 3.2: Panel Unit Root Test for MoM Inflation in Pakistan**

Series for period 2001:07 to 2011:06	Levin, Lin and Chu t-test@	Im, Pesaran and Shin W-stat#
342 commodities (only constant included)	-20.87*	-51.61*
342 commodities (constant & trend included)	-23.90*	-52.96*

@: Null hypothesis assumes common unit root process.

#: Null hypothesis assumes individual unit root process.

\*: Null hypothesis of Unit Root is rejected at 5 percent level of significance.

**Table 3.3: Inflation persistence in Pakistan - AR(1) approach (with and without break)**

Series	Period	AR(1) coefficient without considering break point (WOB)	Break Points	AR(1) coefficient while considering break point (WB)
(1)	(2)	(3)	(4)	(5)
CPI-overall	1959-2011	0.19*	1973:07 2008:03	0.16*
CPI-overall	1959-2001	0.17*	1973:07	0.15*
CPI-overall	2001-2011	0.28*	2008:03	0.18
CPI – Non HRI	2001-2011	0.18	2007:07	0.08
Food Beverages and Tobacco	2001-2011	0.13	2008:03	0.10
Apparel, Textile and Footwear	2001-2011	0.45*	2008:03	0.31*
Fuel and Lighting	2001-2011	-0.04	2008:03	-0.09
Household Furniture and equipment	2001-2011	0.57*	2008:04	0.44*
Transport and communication	2001-2011	0.29*	none	0.29*
Recreation and Entertainment	2001-2011	-0.03	2008:05	-0.11
Education	2001-2011	0.20*	2008:05	0.12
Cleaning, Laundry and Personal Appearance	2001-2011	0.44*	2008:03	0.29*
Medicare	2001-2011	0.12	2006:08	0.00
Non-Food Group	2001-2011	0.50*	2008:06	0.39*
Non-Food Non-Energy (Core)	2001-2011	0.80*	2008:04	0.69*
Non-Food Non-Energy Non HRI	2001-2011	0.62*	2008:01	0.43*

\*:Significantly different from zero at 5%. WOB mean without (considering) break. WB means with break.

**Table 3.4: Degree of inflation persistence in Pakistan – sum of autoregressive coefficients**

Series	Period	SARCs (WOB)	SARCs (WB)
(1)	(2)	(3)	(4)
CPI-overall	1959-2011	0.36*	0.30*
CPI-overall	1959-2001	0.34*	0.29*
CPI-overall	2001-2011	0.40*	0.25
CPI – Non HRI	2001-2011	0.18	0.08
Food Beverages and Tobacco	2001-2011	0.13	0.10
Apparel, Textile and Footwear	2001-2011	0.45*	0.31*
Fuel and Lighting	2001-2011	-0.04	-0.09
Household Furniture and equipment	2001-2011	0.74*	0.62*
Transport and communication	2001-2011	0.30*	0.30*
Recreation and Entertainment	2001-2011	0.20	0.06
Education	2001-2011	0.20*	0.12
Cleaning, Laundry and Personal Appearance	2001-2011	0.80*	0.45*
Medicare	2001-2011	0.12	0.00
Non-Food Group	2001-2011	0.74*	0.74*
Non-Food Non-Energy (Core)	2001-2011	0.87*	0.76*
Non-Food Non-Energy Non HRI	2001-2011	0.73*	0.50*

\*:Significantly different from zero at 5 percent

**Table 3.5: Commodities, Weight, and the Degree of Inflation Persistence - AR (1)**

Group	Number (and percent) of commodities in respective group showing Significant Persistence			Weight (out of 100) of Commodities Showing Significant Persistence			Weighted Average of Magnitudes of Significant Persistence		
	Historical Method (WOB)	Historical Method (WB)	Fixed Window (WOB)	Historical Method (WOB)	Historical Method (WB)	Fixed Window (WOB)	Historical Method (WOB)	Historical Method (WB)	Fixed Window (WOB)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
All 374	168 (45%)	137 (37%)	91 (24%)	56.60	52.97	43.18	0.63	0.62	0.70
CPI-NHRI 373	167 (45%)	136 (36%)	90 (24%)	33.17	29.54	19.75	0.39	0.35	0.43
FBT 124	62 (50%)	53 (43%)	39 (31%)	21.48	13.99	14.14	0.31	0.34	0.42
ATF 42	28 (67%)	21 (50%)	19 (45%)	4.16	3.07	2.84	0.42	0.38	0.50
HRI 1	1 (100%)	1 (100%)	1 (100%)	23.43	23.43	23.43	0.96	0.96	0.93
FL 15	3 (20%)	3 (20%)	1 (7%)	0.85	0.85	0.24	0.36	0.35	0.36
HFE 44	34 (77%)	28 (64%)	11 (25%)	1.83	1.45	0.61	0.40	0.34	0.45
TC 43	15 (35%)	15 (35%)	8 (19%)	2.08	2.08	0.66	0.42	0.35	0.39
RE 16	11 (69%)	3 (19%)	6 (38%)	0.33	0.09	0.25	0.45	0.34	0.40
Education 24	5 (21%)	3 (13%)	3 (13%)	0.35	0.31	0.10	0.39	0.31	0.32
CLPA 36	10 (28%)	5 (14%)	5 (14%)	1.81	0.82	0.95	0.31	0.32	0.51
Medicare 29	6 (21%)	4 (14%)	3 (10%)	0.27	0.10	0.15	0.28	0.37	0.44
NF 250	107 (43%)	83 (33%)	52 (21%)	34.91	32.20	29.05	0.77	0.79	0.84
NFNE 232	104 (45%)	80 (34%)	51 (22%)	34.06	31.35	28.80	0.78	0.80	0.85
NFNE-NHRI 231	103 (45%)	79 (34%)	50 (22%)	10.63	7.92	5.37	0.39	0.35	0.48

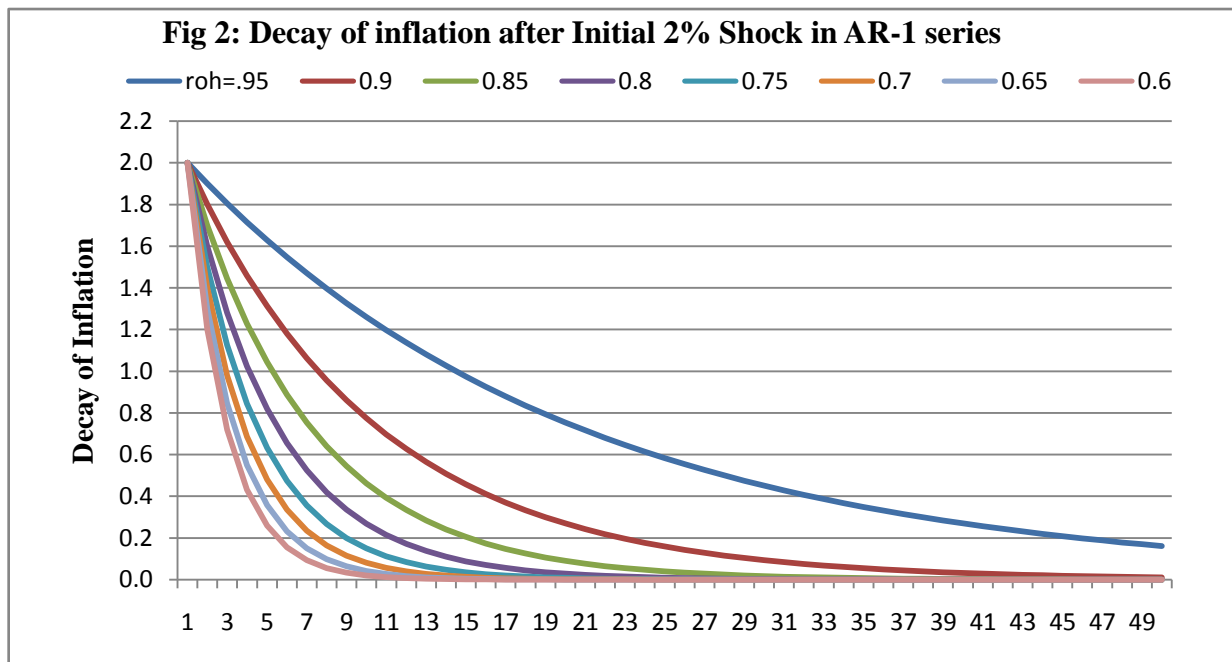
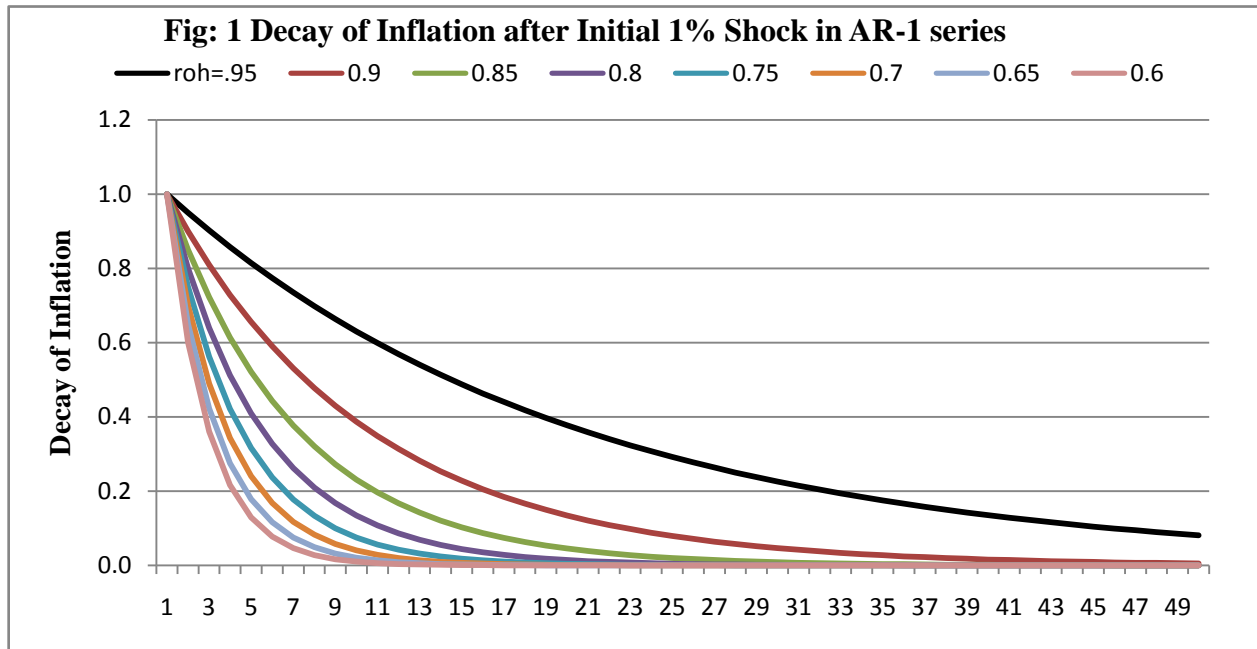
Note: Historical here means period 2001-2011 and Fixed window is for 2008-2011

**Table 3.6: Commodities, Weight, and the Degree of Inflation Persistence - AR (p)**

Group	Number (and percent) of commodities in respective group showing Significant Persistence			Weight (out of 100) of Commodities Showing Significant Persistence			Weighted Average of Magnitudes of Significant Persistence		
	Historical Method (WOB)	Historical Method (WB)	Fixed Window (WOB)	Historical Method (WOB)	Historical Method (WB)	Fixed Window (WOB)	Historical Method (WOB)	Historical Method (WB)	Fixed Window (WOB)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
All 374	269 (72%)	245 (66%)	207 (55%)	74.75	71.14	63.96	0.52	0.48	0.54
CPI-NHRI 373	268 (72%)	244 (65%)	206 (55%)	51.32	47.71	40.53	0.32	0.26	0.32
FBT 124	98 (79%)	92 (74%)	84 (68%)	23.15	21.82	24.77	0.29	0.26	0.33
ATF 42	32 (76%)	28 (67%)	30 (71%)	4.57	3.62	4.16	0.45	0.28	0.38
HRI 1	1 (100%)	1 (100%)	1 (100%)	23.43	23.43	23.43	0.95	0.94	0.93
FL 15	5 (33%)	4 (27%)	2 (13%)	0.88	0.81	0.72	0.37	0.36	0.37
HFE 44	40 (91%)	38 (86%)	29 (66%)	3.17	3.12	2.79	0.41	0.28	0.28
TC 43	26 (60%)	26 (60%)	16 (37%)	5.34	5.34	2.02	0.29	0.23	0.29
RE 16	8 (50%)	8 (50%)	7 (44%)	0.19	0.19	0.20	0.33	0.27	0.27
Education 24	14 (58%)	12 (50%)	9 (38%)	1.67	1.57	0.61	0.18	0.13	0.17
CLPA 36	27 (75%)	20 (56%)	22 (61%)	4.20	3.24	4.03	0.21	0.15	0.31
Medicare 29	21 (72%)	19 (66%)	7 (24%)	1.63	1.49	1.23	0.09	0.08	0.09
NF 250	171 (68%)	154 (62%)	130 (52%)	44.88	42.65	41.59	0.63	0.61	0.64
NFNE 232	165 (71%)	148 (64%)	121 (52%)	42.09	39.88	38.47	0.67	0.64	0.68
NFNE-NHRI 231	164 (71%)	147 (64%)	120 (52%)	18.66	16.45	15.04	0.32	0.23	0.30

Note: Historical here means period 2001-2011 and Fixed window is for 2008-2011

## Appendix B





**Table 1B: Month on month (Inflation) Persistence in Peer Countries<sup>#</sup>**

Country	AR(1) coefficient with considering break point	SARCs with considering respective break point
Argentina	0.57*	-0.12
Botswana	0.36*	0.36*
Burundi	0.02	0.02
Egypt	0.43*	0.43*
Indonesia	0.18*	0.18*
Kazakhstan	0.56*	0.52*
Kenya	0.26*	0.26*
Madagascar	0.31*	0.31*
Moldova	0.51*	0.40*
Mongolia	0.45*	0.45*
Nicaragua	0.34*	0.54*
Rwanda	0.35*	0.25*
Seychelles	0.16*	0.22*
Solomon Islands	0.04	0.04
Sudan	0.22*	0.09
Uruguay	0.36*	0.33*
Vietnam	0.46*	0.46*
<b>Average (of above 17 countries)</b>	<b>0.33</b>	<b>0.28</b>
<b>Pakistan</b>	<b>0.18</b>	<b>0.25</b>

<sup>#</sup>: Authors' calculations. \*: Significantly different from zero at 5 percent.

## End Notes

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<sup>1</sup> Persistence can occur at high as well as low levels of inflation. Inflation persistence does not have similar connotations in case of high levels of inflation compared to low levels of inflation. It has negative connotation when we observe it in high inflation periods, which is not the case when there is low inflation.

<sup>2</sup> For a discussion on the advantages and disadvantages of various measures of persistence see Marques (2004).

<sup>3</sup> Phillips-Perron unit root test has advantage over the Augmented Dickey-Fuller test of being robust to general forms of heteroscedasticity in the error term.

<sup>4</sup> In order to explain the same, we have used an AR(1) to generate a series. We then perturbed the series by 1 percent and observed that it took almost 10 periods (when AR(1) coefficient is 0.60) to more than 50 periods (when AR(1) coefficient is 0.95) for the series to return to its previous levels (See Figure 1 in the Appendix A). In order to see what matters more; the degree of persistence or the shock, for a series to return to its earlier level we then shocked the series by 2 percent (double than earlier shock). We found that keeping the degree of persistence same, the size of shock does not matter as it took only a couple of period extra for the series to return to its earlier level when shock was doubled (see Figure 2 in the Appendix B). What matters more is the degree of persistence: higher the persistence, longer the time needed for series to return to its previous level when a shock hits.

<sup>5</sup> We conducted a simulation study to see does a (generated) series behave in case it is generated by an AR(1) model with drift; (separately) when AR(1) coefficient is positive, and when it is negative. Based upon 11000 (100 times size of our micro data set for inflation persistence analysis based on historical approach) iterations, we find that a series trends either upward or downwards (with equal probability) when the AR(1) coefficient is positive. Higher the magnitude of AR(1) coefficient, larger is the range within which values of individual observations of series fall. When first order autocorrelation coefficient is negative, there is no upward/downward trend and series oscillates around a trend parallel to horizontal axis.

<sup>6</sup> Prior to recent (July 2011) changes in house rent calculation procedure, PBS used to first compile a construction index by taking *24-month moving (geometric) average* of construction cost – both labour and material, in the ratio of 40:60 – prevailing in 35-urban centers. Then, weights for house rent of individual cities (obtained through family budget survey) were used to apply to the construction index to obtain an overall HRI. It is the ‘24-months moving average’ which generates inertia in the HRI.

<sup>7</sup> We have also conducted the lag selection procedure using Schwarz (1978) information criterion but the results were not much different.

<sup>8</sup> Levine and Piger (2004) also observed that inflation persistence falls considerably when structural breaks are accounted.

<sup>9</sup> We have also estimated the AR(1) coefficient as well as SARCs for the shorter span of time (last 36 months) - to reduce the impact of structural break in the mean inflation rate. But the results were found almost similar to what we obtained while estimating the degree of inflation persistence in the presence of structural break. These can be obtained on request.

<sup>10</sup> Countries for which last decade’s average inflation have been (statistically) equal to that of Pakistan’s last decade’s average inflation. Monthly CPI data for these countries is taken from IMF-IFS online for July 01 to latest available.

<sup>11</sup> Prices for seasonal commodities are not reported for each of the 12 months in a year.

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<sup>12</sup> Furthermore, in contrast to the finding on aggregate level analysis, the micro level inflation persistence results based on SARCs as measure of persistence are on lower side compared to those obtained using AR (1) approach.