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Intrinsic Inflation Persistence in a Developing Country

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Abstract: *Persistence in inflation is important because it dictates the costs associated with monetary policy actions. We conduct a detailed analysis of the degree of intrinsic inflation persistence in Pakistan using aggregate price index, group level price indices, and individual commodity prices. Barring the case of food basket, inflation is found to be (significantly) persistent in Pakistan. As against the overall inflation, the degree of persistence is found to be very high for core inflation. These results are robust to structural shocks consideration and hold at aggregate as well as at commodity level analyses.*

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1. Introduction

The effectiveness of monetary policy in stabilizing prices depends largely upon inflation dynamics. Factors such as the credibility of the central bank, the level of coordination between monetary and fiscal policies, the exchange rate regime and the ability of the monetary authority to act proactively also play an important role.

Fundamentally, inflation dynamics depend on the price setting behavior of firms. 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.

Whether inflation persistence is good or bad depends upon i) the level of inflation, ii) the degree of inflation persistence, iii) the underlying drivers of inflation and inflation persistence, iv) level of development of economy- inflation is volatile in developing world compared to developed one[2], and v) focus of monetary policy - price stability versus financial stability or growth or some combination – which would obviously be the function of the current state of underlying economy.[3] For example, if the source of inflation persistence is a technological shock, it contributes to (extend the period of) economic growth in the country (Charemza and Makarova, 2009). In case inflation is in the neighborhood of (medium term) target inflation rate, inflation persistence could be something desirable[4] since it is close to the target.

Generally, some low level of inflation is good for the economy to mobilize the markets. Hence, some inflation persistence may be considered as good, as it facilitates the transmission of monetary policy to real economy at low levels of inflation. However, a very higher degree of inflation persistence necessitates large number of monetary policy action(s) especially when inflation deviates significantly from announced inflation target. An extreme example is the case when the economy is experiencing hyperinflation along with a high degree of inflation persistence. Inflation persistence increases the cost of monetary policy (in terms of output) to keep inflation under control

[2] Li and Wei (2015)

[3] Deflation persistence could be as bad as inflation persistence. Supply driven deflation (like through improved productivity, higher competition, cheaper labour and/or inputs) depresses prices while raising output and income. Where deflation signals aggregate demand short fall it pushes down prices along with output and income. Demand driven deflation could necessitate negative interest rates to encourage spending. Deflation persistence in such case delays economic recovery for extended period of time despite prolonged accommodative macroeconomic policies. Negative interest rates for longer period of time could delay achieving inflation target through (deflation) expectation channel. Longer the period of aggressive accommodative monetary policy, higher the probability of building a financial boom which could be one of the causes of next bust during or immediate after the economic recovery.

[4]Inflation persistence will be even desirable when economy is experiencing high economic growth coupled with low inflation.

(Oliveira and Petrassi (2014)).[5] The cost of implementing a stabilization programme could be higher in case the policy maker 'overestimates' the degree of inflation persistence. The job of monetary policy authority could be complicated in case there is heterogeneity in inflation persistence across the subgroups of commodities represented in consumer price index (CPI) basket.

Using a survey of a large number of firms in Pakistan, Choudhary et al (2016) find that 71 percent of manufacturers in the country use backward-looking information for setting prices. This gives rise to inflation inertia because 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). On the basis of these survey findings, we expect inflation persistence in Pakistan, at least in the case of manufactured goods. However, the survey also documents a high frequency of price adjustments for such goods.

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 that 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 paper we explore intrinsic inflation persistence in Pakistan using monthly seasonally-adjusted for: (i) aggregate time series data of consumer price index (CPI), (ii) group level seasonally adjusted -indices, and (iii) 342 individual prices. The data is collected from Pakistan Bureau of Statistics (PBS)–the country's statistical agency. To the best of our knowledge, this is the first comprehensive study on inflation persistence in Pakistan. The dataset comprises of two periods: January 1959 to June 2011 (longer span) for aggregate level analysis; and July 2001 to June 2011 (the recent decade) for group-wise and micro level investigations. The shorter period for group-wise and micro level study is due to non-availability of data prior to 2001.

There are various ways of determining intrinsic inflation persistence: (i) an autocorrelation function, (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). An autocorrelation function of the inflation series might summarize much of the information about the underlying inflation process, it does not, however, give us a precise single estimate to capture inflation persistence and is thus not useful at the commodity level. Thus, we use the last two measures to investigate inflation persistence in Pakistan.

[5] Our view on desirability or otherwise of 'inflation persistence' is summarized in Appendix C Table C1, considering various combinations of states of inflation and real GDP growth.

Focusing on the more recent decade of 2001-2011, overall inflation persistence was found to be low but significant at 0.19. Food inflation, being more volatile in general, does not exhibit any persistence. To the contrary, the degree of persistence is very high (0.86) and significant for core inflation (excluding food and energy), which weakens slightly (to 0.78) when we account for commodities price shock of 2008. At a granular level, the estimated degree of inflation persistence for commodities in various groups is found to be relatively higher, in almost 64 percent of the cases, compared to corresponding degree of persistence at aggregate level. This may be because for the micro analysis we consider only those commodities for which the estimated degree of inflation persistence is significant.

This paper proceeds as follows. Section 2 presents the methodological framework. In section 3 we present findings of this study. Section 4 concludes.

2. Methodological Framework

In this section we present the methodological steps to study intrinsic inflation persistence.[6] First, we diagnose if the inflation series has infinite persistence[7] using Phillips-Perron unit root test.[8] 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 the inflation series is stationary, we investigate the degree of persistence. The higher the degree of inflation persistence, the longer time the inflation takes to return to its previous levels following a shock.[9] To estimate the degree of inflation persistence we run a first order autoregressive model AR(1) model, and check the significance of the coefficient on the autoregressive series. A positive coefficient implies a serial correlation, and thus inertia in the inflation series. This is the standard method in the

[6]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.

[7] For a discussion on the advantages and disadvantages of various measures of persistence see Marques (2004).

[8] 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.

[9]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 B1 in the Appendix B). 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 B2 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.

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 simulations, using equation (1), we consider positive serial correlation in inflation series as a measure of inflation persistence. [10]

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

where π_t denotes the inflation at time t, μ is the mean inflation rate, and α is the AR(1) coefficient.

Following Levin and Piger (2003), Williams (2006), Kota (2011), Tillmann (2011), and Zhang (2011), we also use the sum of autoregressive coefficients (SARC) as another measure of the degree of inflation persistence in that SARCs approximates the long run impulse response to a unit shock. The model we estimate is the p order autoregressive model where lags are selected using Akaike (1969) information criterion.

With the increasing importance of inflation persistence for policy making, there is much interest in the evaluation of the stability of inflation persistence. This exercise requires taking into account structural breaks. Ignoring such breaks would create 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 (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 mixed evidence from different countries on the presence of breaks in the inflation persistence, it is still important to consider if there are changes in the mean inflation rate and/or in the inflation persistence over time in Pakistan. This is an important point considering the history of substantial inflation fluctuations in Pakistan (see Figure A1). For example, it is reasonable to anticipate a degree of persistence when inflation moves in a relatively high zone (also see footnote 8). 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

[10] We conducted a simulation study to see how 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. So higher is the inflation persistence, higher could inflation go. When first order autocorrelation coefficient is negative, there is no upward/downward trend and series oscillates around a trend parallel to horizontal axis (as is common knowledge).

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 based on monthly changes in prices of 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 again use both the AR(1) and the SARCs 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 non-energy group (NFNE) items. We specifically focus on another group NFNE-Non House Rent Index(because house rents carry the biggest weight in NFNE group, and thus can influence 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 of the sample (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

3.1 Results of Unit Root Tests

In Table A1 (Appendix A), we present the results of Phillips-Perron unit root test. We could not find any evidence of unit root for the aggregate seasonally-adjusted (MoM) inflation series, both for the longer period of 1959-2011 as well as for the shorter period of 2001-2011. For later period, we have the luxury of data availability for group level price indices. Groups are classified by PBS as: (i) food, beverages & tobacco (FBT), (ii) apparel, textile & footwear (ATF), (iii) house rent index (HRI), (iv) fuel & lighting (FL), (v) household furniture & equipment (HFE), (vi) transport & communication (TC), (vii) recreation & entertainment (RE), (viii) education, (ix) cleaning, laundry & personal appearance (CLPA), and (xii) medicare. Furthermore, some other groups of interest like ‘excluding HRI (CPI-NHRI), non-food (NF), non-food non-energy (NFNE)

or more commonly known as core, and NFNE-non HRI (NFNE-NHRI) 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. [11]

3.2 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 are stationary. For these stationary series, we consider non-extreme form of persistence using equation (1) for 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 A3 (column 3) of Appendix A. [12]

The estimate of inflation persistence in Pakistan for aggregate seasonally-adjusted MoM inflation for 1959-2011 is 0.21; which is also statistically significant. Interestingly, we find this number to be 0.33 for the recent 2001-2011 period. However, once we exclude HRI from the overall basket, the estimated AR(1) coefficient turns to be much lower (from 0.33 to 0.20), but it is still significant.

Exploring inflation persistence at the disaggregate level helps in identifying group and sector level contributions to overall inflation persistence, a task we turn to next.

Starting with food, we find that there is no inflation persistence in the food basket– a result similar to Khundrakpam (2008) for India where (both the primary and manufactured) food inflation series do not exhibit persistence. However, these results are contrary to Walsh (2011) findings that food inflation is persistent in most of 91 countries he studied. Food inflation impersistence in Pakistan may be because most of the commodities in food group (with above 60 percent of weight in food basket) are raw

[11]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.

[12]Conceptually it is possible that inflation persistence results are affected by seasonality in underlying monthly consumer price index. We think ignoring seasonality could under estimate the AR1 coefficient calculated from an inflation series. We have estimated inflation persistence (using AR1 as well as SARCs approach) both for seasonally adjusted and non-adjusted consumer price indices. We have reported results only from seasonally adjusted dataset. Results from non-seasonally adjusted prices indices can be obtained from State Bank of Pakistan Working Paper No. 52. Our findings on inflation persistence (for overall CPI and its various subgroups) for the case of Pakistan are almost same irrespective of seasonal adjustment of prices indices.

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). It may suggest supply side shocks are short term and thus do not obstruct food inflation reverting to its mean.

Turning to the non-food basket, significant inflation persistence coefficient is found for the core or NFNE group: 0.86. Majority of commodities in non-food non-energy categories are manufactured goods. On the basis of survey results in Choudhary et al (2016), we already expected inflation persistence at least for the group consisting of manufactured items. Delving further down: 'apparel, textile & footwear', 'household furniture & equipment', 'transport & communication', 'cleaning, laundry & personal appearance', and 'education' groups exhibit significant inflation persistence. Inflation persistence in these groups drives persistence in non-food (NF), non-food non-energy (NFNE) and NFNE-non-HRI categories. However, we could not find any evidence of inflation persistence for 'fuel & lighting', 'recreation and entertainment', and 'medicare' categories. Most of the commodities in these groups belong to the services sector.

We also present the results (in Table A4 (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. [13] Overall, the degree of persistence is higher than what we found based on AR(1) approach. This result is intuitive since the correlation of inflation with its lag-1 propagates to lag-2[14] (and to higher order lags) and SARCs is bound to be greater than AR(1). [15]

3.3 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 A3 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 A1 (Appendix A). We also confirmed the break points by introducing an intercept dummy after the break point (in the

[13] We have also conducted the lag selection procedure using Schwarz (1978) information criterion but the results were not much different.

[14] And that the amount of correlation at lag 2 is square of the correlation coefficient at lag-1.

[15] As discussed in Section 2, we consider positive serial correlation in inflation series as a measure of inflation persistence.

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 the estimated degree of inflation persistence are revised downwards[16]in all the cases (see Figure A2 in Appendix A). Such is the extent of revision that persistence levels for 'overall inflation excluding HRI' and education groups becomes insignificant (see column 5 of Table A3 in Appendix A). Thus, ignoring the structural break could have been misleading at least for these cases.

While weaker in the presence of structural breaks, we find that core inflation shows a high degree of persistence of 0.78. However, it is important to mention that NFNE basket includes HRI. The degree of inflation persistence in NFNE non-HRI basket is 0.50 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 the structural break pertains to the mean inflation rate, we also estimate and report the degree of inflation persistence using SARCs approach by considering break point [Table A4 (column 3)].[17] As in the case of AR(1), the degree of persistence declined when the break point was considered (see Figure A4 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 (0.78) is very close to one of the findings of Choudhary et al (2016) 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 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

[16] Levine and Piger (2004) also observed that inflation persistence falls considerably when structural breaks are considered.

[17] 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.

backward looking price setting behaviour. Furthermore, the survey of price setting behaviour in Pakistan by Choudhary et al (2016) 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 with similar' countries, we select 17 (inflation) peer countries[18] and estimate the aggregate inflation persistence for the period of 2001-2011. The results of inflation persistence in (inflation) peer countries based on both the AR(1) and SARCs approach are reported in Table B1 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 based on AR(1) measure but almost same in case of SARCs approach. Pakistan's (aggregate) inflation persistence is also significant like it is in 14 (out of 17) countries based on AR1 as well as SARCs measures (Table B1 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 (0.34 based on SARCs approach; as reported in column 4, and row 3 of Table A4 in Appendix A) is high compared to median persistence (0.27; based on SARCs) for 91 countries reported by Walsh (2011). However, median persistence (0.27) reported in Walsh (2011) could be under estimate of inflation persistence being based upon seasonally non-adjusted data series.[19]

3.5 Micro Evidence on Inflation Persistence in Pakistan

Thus far, we have examined inflation persistence tendencies at the aggregate level and for groups of commodities. Does this inflation persistence levels carry over to a more granular level? To answer, we now proceed to individual commodities.

Following the aggregate level exercise, we first examine micro data to see if there is an extreme form of inflation persistence in Pakistan based on balanced-panel unit root test.

[18] Countries for which last decade's average inflation have been (statistically) equal to that of Pakistan's last decade's average inflation irrespective of their other socio-economic indicators. Monthly CPI data for these countries is taken from IMF-IFS online for July 01 to latest available.

[19] For the sake of completion here we like to mention that we do not have group wise prices data for other countries for group level inflation persistence comparisons.

The exercise is done for 342 non-seasonal commodities.[20] 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 A2 of Appendix A). We could not find the evidence of panel unit root in the seasonally-adjusted 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 342 non-seasonal individual commodities (out of overall 374 items) for which prices are collected throughout the year and reported by PBS, for the period of July 2001 to June 2011, using both the AR(1) as well as the SARCs approach in Tables A5 and A6 respectively. In addition to 342 non seasonal individual commodities in the CPI basket, the analysis has been extended to different groups in the CPI. In Tables A5 and A6 (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 (July 2008 to June 2011) 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 A5 and A6, 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 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 in the underlying basket.

The estimated degree of persistence in micro level investigation is higher, in 64 percent of the cases, than the counterpart in aggregate/group level investigation in this study when AR(1) approach is used (See Figures A6 and A8 in Appendix A). This may be due to the fact that at the 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 SARCs approach, is more than half (for most of the groups), the estimated degree of persistence in micro level investigation is higher, in 64 percent of the cases, than the counterpart in aggregate/group level investigation (see Figures A7 and A9 in Appendix A). Thus, we cannot deduce here again that aggregation leads (MoM) inflation persistence to be biased downwards. At the same time, we cannot refute that aggregation does not lead

[20] Prices for seasonal commodities are not reported for each of the 12 months in a year.

inflation persistence to be biased downward. 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 the 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.[21]

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 MoM changes in the aggregate and group level consumer price indices, and in individual monthly prices of 342 commodities. The individual prices and consistent group level consumer price indices data are available for 2001 to 2011 while overall consumer price index data goes back to 1959. Overall inflation in Pakistan is found to exhibit low but significant persistence. At group levels, during 2001-2011, 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 64 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.

These findings are consistent with the observations reported in Choudhary et al (2016). From their study we know that prices in Pakistan are relatively more flexible (compared to those in US and EU) but at the same time Pakistani manufactures set prices looking backward. (Relative) flexibility in manufactured items' prices and short-term nature of raw food's supply shocks in Pakistan explain why Pakistan's (overall) inflation persistence is low. Backward looking price setting behavior of a large number of manufacturing firms in Pakistan explains why we have higher degree of inflation persistence in some groups like NFNE.

Existence of low but significant persistence of (overall) inflation in Pakistan is important from monetary policy's perspective. Significant inflation persistence means

[21] 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.

SBP can have intended impact of its monetary policy actions (upon inflation) in Pakistan. Lower degree of inflation persistence suggests lower sacrifice ratio in Pakistan. It is heartening to note that food inflation is not persistent in Pakistan. Non-existence of inflation persistence in food group impacts the poor segment of the society favorably (larger share of their income is spent on food) due to quick reversion of inflation to its mean levels after a positive shock.

Inflation persistence in Pakistan also has implications for macro modeling of Pakistan economy for forecasting and policy analysis purposes as follows. Low degree of overall inflation persistence in Pakistan suggests lower weight to lagged inflation in NKPC compared to future inflation (expectations) and the real marginal costs. Furthermore, lower overall inflation persistence along with heterogeneity in degree of inflation persistence in various groups in inflation basket may require improving specification of macro models of Pakistan economy.

There is need to explore reasons of persistence in inflation in Pakistan. These can be from backward looking price setting behavior (of the firms) to the framing and conduct of monetary policy. Some of the other reasons of inflation persistence relevant to Pakistan could be i) change(s) in the steady state level(s) of inflation, ii) changing inflation targets, iii) changes in exchange rate regime, iv) lack of cooperation in monetary and fiscal policies, iv) change in monetary policy, and v) imperfect credibility of the central bank.

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Appendix A

Figure A1: Overall (MoM) Inflation in Pakistan

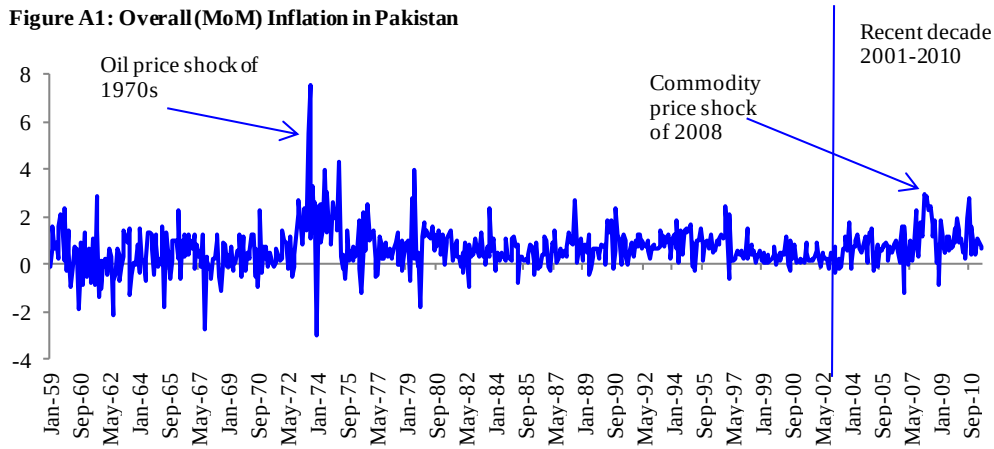

Figure A2: Impact of Break on AR(1)-Aggregate

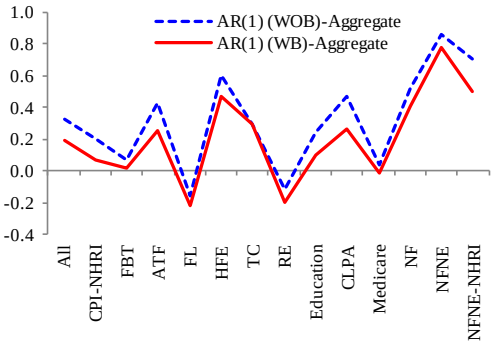

Figure A3: Impact of Break on AR(1)-Micro

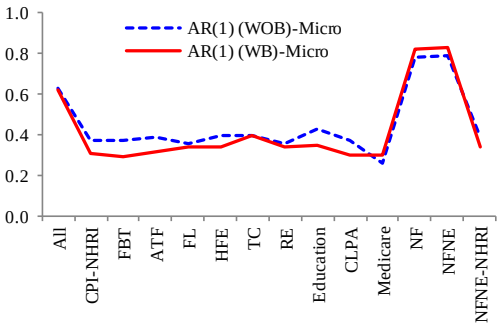

Figure A4: Impact of Break on SARCs-Aggregate

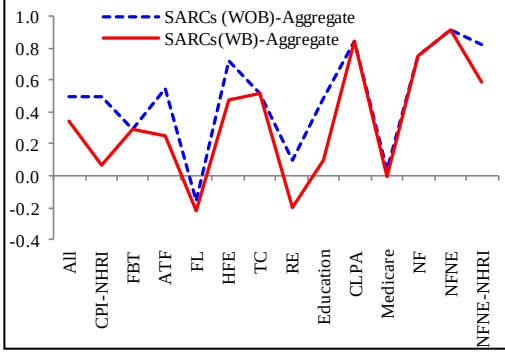

Figure A5: Impact of Break on SARCs-Micro

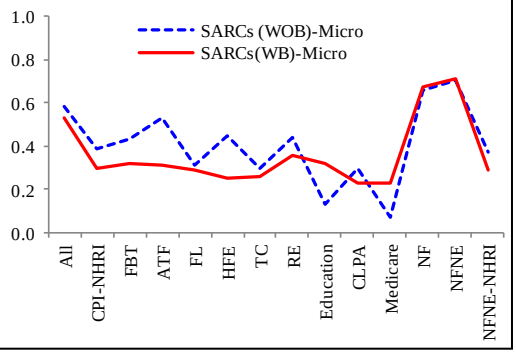

Figure A6: Impact of Aggregate on AR(1)-WOB

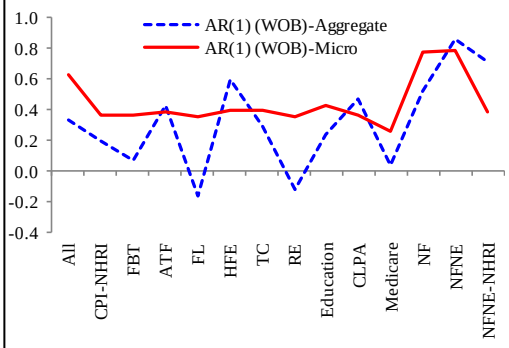

Figure A7: Impact of Aggregation on SARCs-WOB

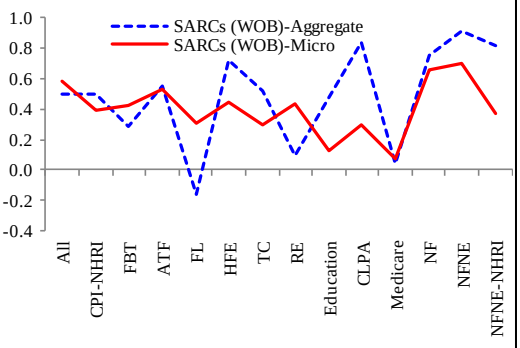

Figure A8: Impact of Aggregation on AR(1)-WB

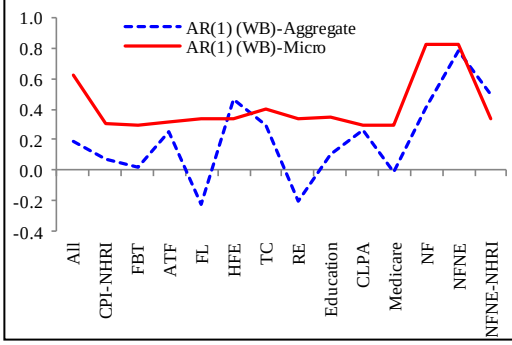

Figure A9: Impact of Aggregation on SARCs-WB

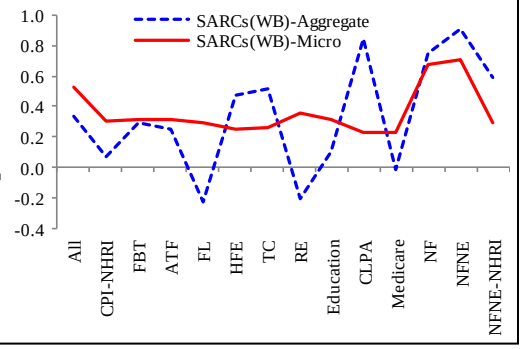

Table A1: Unit Root Test for MoM Inflation in Pakistan

Series (Period)	**Phillips-Perron Test**
CPI (1959:01 to 2011:06)	-24.36*
CPI (1959:01 to 2001:06)	-21.31*
CPI (2001:07 to 2011:06)	-9.26*
CPI – Non HRI (2001:07 to 2011:06)	-9.96*
Food beverages & tobacco (2001:07 to 2011:06)	-10.68*
Apparel textile and footwear (2001:07 to 2011:06)	-8.68*
House rent index (2001:07 to 2011:06)	-1.82
Fuel & lighting (2001:07 to 2011:06)	-12.97*
Household furniture & equipment (2001:07 to 2011:06)	-7.63*
Transport & communication (2001:07 to 2011:06)	-7.89*
Recreation & entertainment (2001:07 to 2011:06)	-12.42*
Education (2001:07 to 2011:06)	-9.33*
Cleaning, laundry & personal appearance (2001:07 to 2011:06)	-8.35*
Medicare (2001:07 to 2011:06)	-11.53*
Non-Food (2001:07 to 2011:06)	-8.04*
Non-food non-energy (core) (2001:07 to 2011:06)	-4.14*
Non-food non-energy non HRI (2001:07 to 2011:06)	-5.98*

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

Table A2: 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)	-136.4*	-139.8*
342 commodities (constant & trend included)	-175*	-161.7*

@: 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 A3: 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	0.21*	1973: 07 2008:03	0.17*
CPI-overall	1959-2001	0.19*	1973:07	0.17*
CPI-overall	2001-2011	0.33*	2008:03	0.19*
CPI – Non HRI	2001-2011	0.20*	2007:07	0.07
Food beverages and tobacco	2001-2011	0.07	2008:03	0.02
Apparel, textile and footwear	2001-2011	0.43*	2008:03	0.25*
Fuel and lighting	2001-2011	-0.16*	2008:03	-0.22*
Household furniture and equipment	2001-2011	0.60*	2008:04	0.47*
Transport and communication	2001-2011	0.29*	none	0.29*
Recreation and entertainment	2001-2011	-0.12	2008:05	-0.20*
Education	2001-2011	0.24*	2008:05	0.10
Cleaning, laundry and personal appearance	2001-2011	0.47*	2008:03	0.26*
Medicare	2001-2011	0.04	2006:08	-0.01
Non-food group	2001-2011	0.52*	2008:06	0.41*
Non-food non-energy (core)	2001-2011	0.86*	2008:04	0.78*
Non-food non-energy non HRI	2001-2011	0.71*	2008:01	0.50*

#:Seasonally adjusted

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

Table A4: Degree of Inflation[#] Persistence in Pakistan – Sum of Autoregressive Coefficients

Series	Period	SARCs(WOB)	SARCs(WB)
(1)	(2)	(3)	(4)
CPI-overall	1959-2011	0.52*	0.46*
CPI-overall	1959-2001	0.49*	0.45*
CPI-overall	2001-2011	0.50*	0.34*
CPI – Non HRI	2001-2011	0.50*	0.07
Food beverages and tobacco	2001-2011	0.29	0.29
Apparel, textile and footwear	2001-2011	0.55*	0.25*
Fuel and lighting	2001-2011	-0.16*	-0.22*
Household furniture and equipment	2001-2011	0.72*	0.47*
Transport and communication	2001-2011	0.52*	0.52*
Recreation and entertainment	2001-2011	0.10*	-0.20*
Education	2001-2011	0.48*	0.1
Cleaning, laundry and personal Appearance	2001-2011	0.84*	0.84*
Medicare	2001-2011	0.04	-0.01
Non-food group	2001-2011	0.75*	0.75*
Non-food non-energy (core)	2001-2011	0.91*	0.91*
Non-food non-energy non HRI	2001-2011	0.82*	0.59*

#: Seasonally adjusted

*: Significantly different from zero at 5 percent

Table A5: 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		Fixed Window	Historical Method		Fixed Window	Historical Method		Fixed Window
	(WOB)	(WB)	(WOB)	(WOB)	(WB)	(WOB)	(WOB)	(WB)	(WOB)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
All 342	150 (44%)	113 (33%)	91 (27%)	53.60	49.01	35.57	0.63	0.62	0.81
CPI-NHRI 341	149 (44%)	112 (33%)	90 (26%)	30.17	25.58	12.14	0.37	0.31	0.56
FBT 94	48 (51%)	40 (42%)	27 (29%)	19.59	18.43	6.38	0.37	0.29	0.59
ATF 42	26 (62%)	16 (38%)	15 (36%)	4.04	2.39	2.24	0.39	0.32	0.55
HRI 1	1 (100%)	1 (100%)	1 (100%)	23.43	23.43	23.43	0.96	0.96	0.94
FL 15	2 (13%)	2 (13%0	1 (7%)	0.61	0.61	0.13	0.36	0.34	0.84
HFE 44	33 (75%)	27 (61%)	16 (36%)	1.79	1.24	0.83	0.40	0.34	0.44
TC 43	15 (35%)	11 (26%)	9 (21%)	2.08	1.37	0.30	0.40	0.40	0.49
RE 15	5 (33%)	3 (20%)	1 (7%)	0.13	0.09	0.06	0.36	0.34	0.77
Education 24	5 (21%)	3 (13%)	5 (21%)	0.35	0.31	0.52	0.43	0.35	0.53
CLPA 35	10 (29%)	6 (17%)	7 (20%)	1.36	1.03	1.33	0.37	0.30	0.55
Medicare 29	5 (17%)	4 (14%)	9 (31%)	0.22	0.10	0.35	0.26	0.30	0.48
NF 248	102 (41%)	73 (29%)	64 (26%)	34.01	30.57	29.19	0.78	0.82	0.86
NFNE 230	100 (43%)	71 (31%)	63 (27%)	33.40	29.97	29.05	0.79	0.83	0.86
NFNE-NHRI 229	99 (43%)	70 (31%)	62 (27%	9.97	6.54	5.63	0.39	0.34	0.53

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

Table A6: 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		Fixed Window	Historical Method		Fixed Window	Historical Method		Fixed Window
	(WOB)	(WB)	(WOB)	(WOB)	(WB)	(WOB)	(WOB)	(WB)	(WOB)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
All 342	227 (66%)	193 (56%)	208 (61%)	70.63	64.33	54.51	0.58	0.53	0.57
CPI-NHRI 341	226 (66%)	192 (56%)	207 (61%)	47.20	40.90	31.08	0.39	0.30	0.34
FBT 94	73 (78%)	66 (70%)	61 (65%)	26.38	25.19	15.26	0.43	0.32	0.34
ATF 42	30 (71%)	25 (60%)	34 (81%)	4.54	3.71	4.63	0.53	0.31	0.38
HRI 1	1 (100%)	1 (100%)	1 (100%)	23.43	23.43	23.43	0.95	0.94	0.91
FL 15	6 (40%)	5 (33%)	3 (20%)	1.12	1.05	0.61	0.31	0.29	0.57
HFE 44	41 (93%)	37 (84%0	34 (77%)	3.20	3.08	2.75	0.45	0.25	0.31
TC 43	25 (58%)	23 (53%)	28 (65%)	5.17	4.96	2.15	0.30	0.26	0.35
RE 15	5 (33%)	5 (33%)	4 (27%)	0.13	0.13	0.14	0.44	0.36	0.38
Education 24	12 (50%)	7 (29%)	8 (33%)	2.26	0.45	0.75	0.13	0.32	0.21
CLPA 35	21 (60%)	14 (40%)	22 (63%)	3.03	1.99	3.40	0.30	0.23	0.40
Medicare 29	13 (45%)	10 (34%)	13 (45%)	1.37	0.34	1.38	0.07	0.23	0.16
NF 248	154 (62%)	127 (51%)	147 (59%)	44.25	39.14	39.25	0.66	0.67	0.67
NFNE 230	146 (63%)	121 (53%)	143 (62%)	41.20	36.36	38.64	0.70	0.71	0.68
NFNE-NHRI 229	145 (63%)	120 (52%)	142 (62%)	17.77	12.93	15.21	0.37	0.29	0.34

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

Appendix B

Fig B1: Decay of Inflation after Initial 1% Shock in AR-1 Series

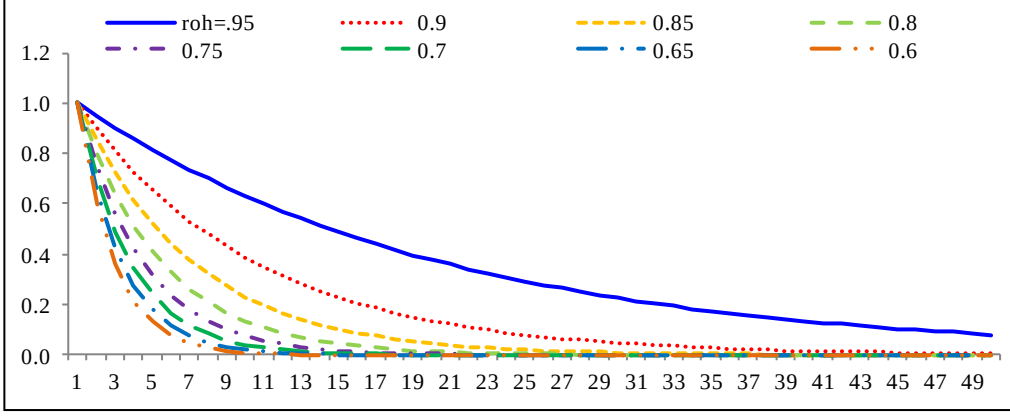

Fig B2: Decay of Inflation after Initial 2% Shock in AR-1 Series

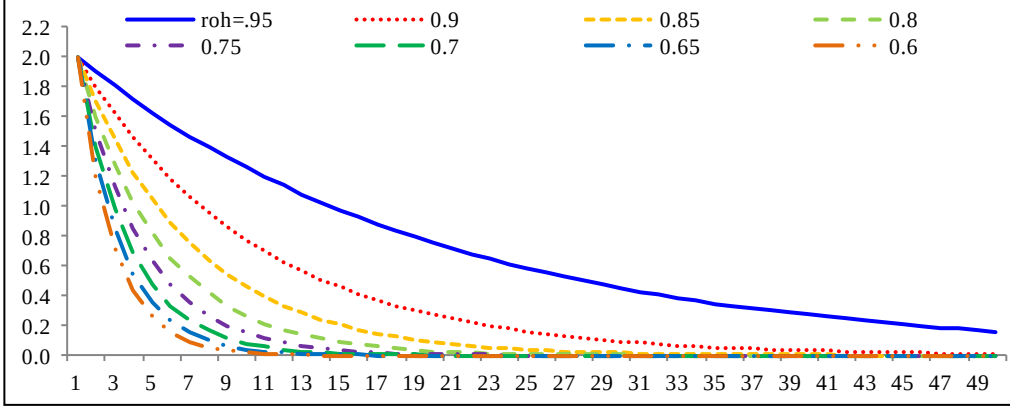

Table B1: Month on Month (Inflation) Persistence in Peer Countries[#](2001-2011)

Country	AR(1) Coefficient with Considering Respective Break Point	SARCs with Considering Respective Break Point
Argentina	0.51*	0.63*
Botswana	0.25*	0.25*
Burundi	0.06	0.06
Egypt	0.46*	0.46*
Indonesia	0.13*	0.13*
Kazakhstan	0.56*	0.53*
Kenya	0.20*	0.20*
Madagascar	0.28*	0.28*
Moldova	0.47*	0.44*
Mongolia	0.34*	0.34*
Nicaragua	0.43*	0.53*
Rwanda	0.28*	0.28*
Seychelles	0.16*	0.25*
Solomon Islands	0.13	0.13
Sudan	-0.04	0.03
Uruguay	0.45*	0.48*
Vietnam	0.64*	0.64*
Average (of above 17 countries)	**0.31**	**0.33**
Pakistan	**0.19***	**0.34***

#: Authors' calculations. *: Significantly different from zero at 5 percent.

Appendix C

Table C1: Desirability or Otherwise of Inflation Persistence

		Real GDP Growth	
		Low	High
Inflation	Low	Good	Desirable
	High	Undesirable	Bad