SBP Research Bulletin
Volume 13, Number 1, 2017

Global Commodity Prices and Domestic Inflation: A Case Study of Pakistan

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Abstract: *The surge in global commodity prices in 2007-08 sent an inflationary shock across the world. The collapse in global prices in 2014 resulted in significant disinflation in many countries and even deflation in some countries. We have explored the linkages between global commodity prices' fluctuations and inflation in a small open economy, Pakistan. Global price fluctuations are found to be dominant source of inflation in Pakistan during July 1992 to June 2014. Food inflation and overall inflation in Pakistan is linked to changes in international food prices. Increase in global oil price results in non-food and administered prices' inflation in Pakistan. For core inflation, changes in global prices of metal and cotton matter most. Global commodity prices' changes impact overall inflation in Pakistan rather quickly compared to impact of changes in monetary aggregates. Core inflation takes longer to respond to all types of shocks, including global prices' fluctuations.*

JEL Classification: E31, E51, F62

Keywords: Global Commodity Prices, Exchange Rate, Money Supply, Inflation Rate

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1. Introduction

Interest of researchers in linkages of international commodity prices with domestic prices is as old as international trade itself. International trade results in global commodities price movements to pass on to trading countries' inflation. Seminal studies on the linkage of international commodity prices with domestic inflation rate in trading partners include Kwack (1973), Kravis and Lipsey (1977). Kwack (1973) presented a simple model which showed dependence of domestic inflation rate on the rate of inflation in imported goods. Contrary to the conventional assumption (that country's export price for a particular good is same as domestic price) in international trade models, Kravis and Lipsey (1977) found that (US) domestic prices of exported goods responded to foreign (UK) price changes.

The channels through which changes in foreign currency prices of commodities in global market may impact prices in a small open economy (like Pakistan) include: a) imported intermediates being used in manufacturing[2] of goods, b) use of imported consumer goods by the society[3], c) changes in income (and thus demand behavior) of exporters, and d) domestic availability of exportables. Sharp fall in crude oil prices in global markets during late 2014 and early 2015 was passed on by the government to the domestic consumers in Pakistan; rather higher than (what was passed on by) many countries including India, Sri Lanka, Bangladesh, Thailand, France and Australia.[4] Rising/falling imported crude petroleum oil price retards/stimulates productivity growth and raises/lowers 'inflation-accelerating-rate-of-unemployment' (Carruth et al., 1998), and thus, influences inflation dynamics. Prices of Pakistani exportable commodities in international market also guide the prices of respective goods in domestic market (like those of wheat, sugar, and raw cotton for example). Another channel could be through indirect effects of fluctuations in US dollar prices of commodities in international market on local currency prices in Pakistan. These may include a) movements in traded goods prices induced changes in nominal wages in the country (Kwack, 1973), and b) changes in the prices of substitutes in domestic economy following fluctuations in traded goods' prices. Furthermore, changes in prices of traded goods have implications for domestic income (Hanif, 2012) and hence domestic demand and prices of non-tradables (Deaton and Miller, 1996) unless there is monetary policy response (to the changed domestic demand). Figure 2 (in Appendix) shows various channels through which global commodity prices are linked with the domestic prices in an open economy.

Notwithstanding the views of Mussa et al. (2000) that floating exchange rate helps countries absorb international commodities' prices shocks, using monthly inflation datasets of G7 countries for 1973-1996 period, Eun and Jeung (1999) established that each country's domestic inflation rate variance is attributable to foreign prices' shocks, and that flexible exchange rates do not insulate the domestic prices from global prices

[2] One quarter of input costs of manufacturing sector is on imported intermediates. (Choudhary et al., 2011).
[3] The share of imported goods in total consumption in Pakistan is one-fifth (Ali, 2014).
[4] State Bank of Pakistan's Report for Q2FY2015 on the state of Pakistan economy.

shocks. Global commodity prices shock of 2008 raised the interest of researchers in the linkages between shocks to international prices of commodities, particularly link of food and oil prices shocks[5], to domestic inflation outcome. Timmer (2008) found the international inflation and domestic inflation links for a number of commodities like rice, wheat, corn and edible oil. Zoli (2009), while controlling for movements in other determinants of inflation (like interest rate and exchange rate), established that international food and oil prices' shocks had an impact on the domestic inflation rate in emerging European economies. Akosy and Ng (2010) using dataset of 90 countries for the period Q1-2000 to Q3-2008 found higher domestic food price increases (compared to overall domestic inflation) after 2008 global prices shock. Robles and Torero (2010), while analyzing transmission of international prices of wheat, corn, and rice to domestic prices of Guatemala, Honduras, Nicaragua, and Peru, found empirical evidence of linkages of international prices of several commodities with domestic food prices in these four countries. More recently, Kalkuhl (2014), while exploring the transmission of global food prices to domestic food price and grain price indices for 180 countries, established that domestic prices could respond to global prices even if no trade takes place but future trade is expected.

Various empirical studies have estimated the contribution of foreign prices as a determinant of inflation in Pakistan. For example, Khan and Ahmed (2011) explored the impact of global prices changes on rate of inflation in Pakistan.[6] In studies on Pakistan, only global oil price movement is considered as representative of overall commodity prices' change to analyze the impact on inflation rate in the country. For the case of Pakistan, the rate of inflation becomes more correlated with the world inflation rate whenever world commodity market is hit by a positive or a negative shock (Table 3a in Appendix). This has been observed in early 1970s, in mid 1980s, in late 2000s, and now in 2014/15 (Figure 1 in Appendix). Hanif (2012) has documented the fact that following global commodity prices shock of 2008 the 'contribution of supply side factors to rate of inflation in Pakistan' doubled (to half) in next five years compared to (one-quarter) during pre 2008 shock period. He remarked that "despite the fact that food inflation volatility in Pakistan was found to be half of that observed in the world food market during the period of analysis (January 1992 to December 2011), higher global food prices in 2008 resulted in higher (than historical average) food inflation in the country". This evidence coupled with disinflation in Pakistan during 2014-15 following downturn in global commodity prices necessitates an analysis of the nexus between global commodity prices and inflation rate in Pakistan.

[5] Within the global commodity prices; international food prices and international crude oil prices are linked – along with other factors (like government policy, in the form of support prices, subsidies etc.), the former is driven by the later being intermediate (directly, to run say tractors to plough fields, and indirectly, to influence for example fertilizer prices through oil-gas price nexus) as well as substitute (biofuel). Exploring such linkages, at international level, is beyond the scope of this study.

[6] See Table 1a in Appendix for a review of other such studies.

In this study we have explored the linkages of 10 global commodities' price changes with overall, food, nonfood, core and administered prices' inflation in Pakistan; controlling for other major determinants of inflation in the country such as exchange rate changes, broad money growth and dynamics in real economic activities. We have contributed in three ways. First, this is first study on Pakistan exploring impact of prices of 10 internationally traded commodities[7] on domestic inflation. Second, we have looked at the impact of global commodity price dynamics on overall inflation as well as on food inflation, non-food inflation, core inflation, and administrative prices' inflation. Finally, we applied most rigorous econometric modeling strategy of factor augmented Bayesian structural vector autoregression.

In the following section we have described the data used and the methodology we have applied. In section III empirical observations and findings are discussed. Paper ends with concluding remarks.

2. Data, Model and Methodology

For purpose of exploring global inflation rate linkages with domestic inflation rate in a small open economy, we have assumed Pakistan as being a small open economy in global market. The period of analysis for this study is July 1992 to June 2014 for which we have monthly data for overall inflation rate, and the rate of inflation in the prices of different baskets of our interest like a) food, b) non food, c) non food – non energy i.e. core, and d) the basket of goods for which prices are administered by the government (of Pakistan).

Our empirical framework is based upon theoretical underpinnings pertaining to inflation in an open economy. Usually global commodity prices impact domestic inflation rate indirectly as well as directly through inputs/intermediates prices and finished goods prices (Figure 2 in Appendix). Prices of imported goods in the international market directly impact import decisions, wholesale market prices - of final as well as intermediates - and retail prices –of imported as well as substitutes - in the importing country. Prices of exportable goods in the international market and subsequent export decisions in the exporting country directly impact the domestic supply of those goods and thus their wholesale market prices and the retail prices. Global prices, however, are not the only factor that impacts inflation rate in Pakistan. There are various explanations to the macro level behavior of inflation including the quantity theory of money and Phillips curve. The contribution of broad money growth rate in explaining the rate of inflation in Pakistan (as has been documented by Nasim (1997), Hanif and Batool (2006), Riazuddin (2008) etc.); relationship between economic activity and inflation rate (as reported by Nasim (1997) and Khan (2008)); and the role of exchange rate in explanation of inflation rate in the context of developing countries like Pakistan (as discussed in Hyder and Shah, (2004)); deserve attention along with estimation of impact of global commodity prices fluctuations on the rate of inflation in Pakistan. Following literature on the determinants of inflation

[7] These commodities are rice, sugar, fish, beef, tea, petroleum crude oil, palm oil, metal, wheat and cotton.

rate in Pakistan; broad money growth, exchange rate (Pak Rupee per US dollar[8]) behavior, and growth in real economic activities are used in this study as explanatory variables of inflation rate in the country along with the behavior of global commodity prices.

Out of the 10 commodities studied in this paper, Pakistan mainly imports (petroleum) crude oil, palm oil, metal, and tea.[9] Pakistan's primary exports include rice, sugar, fish, and beef.[10] Wheat is an exception. Pakistan remained a net importer during the 1990s. Later, the country not only became self sufficient but also turned a net exporter of wheat. In case of cotton[11], Pakistan is both importer and exporter. Overall, international trade in these 10 commodities is estimated to be above 40 percent of our total external merchandise trade.[12] These commodities constitute about 20 percent of overall basket of consumer price index in Pakistan. However, this proportion goes up significantly if we consider the uses of edible oil (e.g. in preparation of sweets), crude oil, (e.g. in generating electricity), metal (e.g. in house building) and cotton (e.g. in clothing). These proportions show the significance of the selected 10 commodities in our international trade and their importance in the household expenditures of an average Pakistani consumer. Necessary detail of the variables used in this study along with their data sources are given in Table 1b (in Appendix).

We start with graphs showing linkages between global price levels and the levels of prices in Pakistan (pertaining to selected goods). We then establish these linkages using unconditional correlation coefficients, bivariate Granger (1969) non-causality analysis, and tests for equality of means in the rate of growth in global commodity prices and the rate of inflation in prices of corresponding goods/baskets in domestic retail markets of Pakistan. Lastly, we relate inflation rate in Pakistan with changes in global market prices of commodities we either import or export and three main macroeconomic determinants

[8] Since almost 90 percent of international trade transactions of Pakistan are denominated in US dollars.

[9] Import of these 4 items constituted 41 percent of Pakistan's total imports during the last decade.

[10] Export of these 4 items constituted 11 percent of Pakistan's total exports during the last decade.

[11] Pakistan produces middle and short staple cotton. Short staple cotton is used within country for quilt and pillows. More than 90% middle staple cotton is also used in Pakistan textile industry while the rest is exported. Pakistan imports the long staple cotton. We do not produce long staple cotton owing to unfavourable weather conditions for its production in Pakistan.

[12] Though our (raw) cotton export has only been 1 percent of our total exports, our overall raw cotton, cotton yarn, cotton fabrics and cotton combined exports have been 20 percent of our total exports (during the last decade). This number goes up significantly if we include cotton textile products like bed sheets, towels garments etc. Since we do not have separate data for textile products made from cotton and from other material, we have not been able to include cotton made textile as part of the calculation to arrive at proportion of trade in selected commodities related international trade. But this exclusion does not alter our argument that the selected 10 commodities constitute significant proportion of Pakistan's international trade and changes in their prices matter for inflation rate in the country.

of inflation rate in the country using a sort of vector autoregression (VAR) approach. The VAR modeling is one of most successful, flexible and easy way for multivariate time series analysis. However, standard VAR models can rarely employ more than 6 to 8 variables. Since we have a large number of variables (like several global commodity prices) impacting variable of interest (like inflation rate in a country) therefore one solution to the degrees of freedom problem in VAR analysis is to augment the VAR with a single factor – single common stochastic factor - of a large number of variables, with the help of Principal Components.[13] This approach is called factor augmented VAR or FAVAR modeling in the literature. In order to have meaningful IRFs in VAR type analysis, shocks in different variables in the model need to be independent. To ensure independence of the shocks and to impose some desired restrictions (e.g., we restrict feedback of domestic inflation to global commodity prices), we will be using Cholesky decomposition or in other words we will be estimating factor augmented structural VAR (FASVAR) model. Expecting the improvement in the accuracy of the impulse response functions, we have estimated the FASVAR model using Bayesian approach.[14] This is what is known as Factor Augmented Bayesian Structural Vector Autoregression (FABSVAR) methodology of Bernanke et al. (2005) as implemented in Lombardi et al. (2012). Popularly used IRFs in the literature are those based on one standard deviation (SD) shocks; and are quite useful academically. We believe that IRFs of 1 percent shock (instead of one SD shock) are relatively easy to interpret and communicate for (monetary) policy debate when all the variables are in rates. In this study, we have used IRFs generated by one percentage point shock because such IRFs are also useful in comparison of two different IRFs being results of same (one percentage) shock instead of two different (respective SD) shocks.[15]

All the variables used in this study are either in growth form or in rates. We do not expect these variables to be non-stationary. Notwithstanding the use of dummy variable for observed/estimated structural break in Pakistan's inflation series (if any); the impulse

[13] Following Stock and Watson (1998, 1999), we use principal components to estimate the factors F_t in the dynamic factor model. The factor obtained by the largest eigenvalue is the most representative of variables in the group in the sense of explaining highest part of the total covariance.

[14] In case of SVAR modeling, even with moderate number of variables, we know that the usual (maximum likelihood) estimators may not have desirable properties. However, in case of the Bayesian SVAR approach we can expect improved accuracy of estimated impulse response functions (Canova 2007 and Robertson 2000).

[15] Here we explain how to get 1 percent shock instead of 1 SD shock while using Cholesky decomposition in the context of structural VAR model: Cholesky one SD shock involves Cholesky decomposition of positive definite symmetric variance covariance matrix of errors. The diagonal elements of resulting upper triangular matrix are SD's of errors. Standardizing these error terms will give us new variance covariance matrix with diagonal entries equal to one, using this matrix will give us IRFs pertaining to one percentage point shock (instead of one SD shock).

response functions based on growth rates would be robust to unobserved shifts (Hendry and Clements, 2003); if any, during the estimation period.

We include the following variables in Bayesian Structural Vector Autoregression (BSVAR) models we are going to estimate (and in the same order): rate of change in global prices, broad money growth rate in Pakistan, rate of appreciation/deprecation in Pak Rupee (per US dollar), Pakistan's industrial production[16] index (IPI) growth rate, and rate of change in price index of selected basket in Pakistan.

We have assumed no feedback from the inflation in Pakistan to the global commodity prices' dynamics because a) Pakistan is a (very) small open economy with only 0.15 percent share in world export receipts (during 2013), and b) absence of causality from rate of inflation in Pakistan to global commodity prices' fluctuations, barring a couple of commodities (Table 3b).

What constitutes the global price for Pakistan? Can we use the prices of all the 10 selected commodities in our BSVAR modeling? It may be impossible to estimate a BSVAR model of inflation by using all the 10 global commodity prices' (YoY) inflation along with the 3 macroeconomic determinants (of inflation rate) with the available monthly data for July 1992 to June 2014. To address this problem we used following proxies for global commodity price fluctuations: i) changes in global crude oil prices (GOLPI) as it is of particular interest being one-third of Pakistan's overall imports and the main non-monetary determinant of inflation in Pakistan both directly (being part of CPI basket) and indirectly (as it affects the cost of production and delivery), and ii) representation of behavior of global prices of a set of commodities by a single factor. These factors include a) first principal component (PC) of 7 food items' inflation rate (F7FPI) as one factor, and b) first PC of changes in metal and cotton prices (FMCPI).

We have used various empirical specifications to assess the impact of different representations of global commodity prices on relevant baskets of consumer prices in Pakistan while incorporating the influences of other generally considered macroeconomic determinants of domestic inflation rate. The baskets range from overall basket to the basket of goods for which prices are administered by the government directly (e.g., announcement of petroleum products prices) or indirectly (e.g., announcement of wheat support price). Table 2 in Appendix spells out specification of each of the FABSVAR model we have estimated. In addition to 3 main determinants of inflation rate in Pakistan, this table describes the relevant proxy for the global prices and the domestic prices in Pakistan that has been linked in each model to exhibit the transmission of global

[16] It is used to proxy real economic activity in the absence of high frequency GDP data for Pakistan. It may serve as a supply side determinant of inflation rate in the country. One may argue that it is not as good as overall GDP because it covers less than one-fifth of GDP in Pakistan. But, we think industrial production has strong backward (agriculture sector) and forward (services sector) linkages with overall economic activity and that industrial sector is mostly the largest recipient of banking credit in Pakistan. Thus, it can be used as a proxy for real economic activity in Pakistan.

commodity price movements to changes in various price indicators of the Pakistan economy.

As can be seen from the Figure 1 (in Appendix), there was significant impact of global commodity prices shock of 2008 on the rate of inflation in Pakistan when it increased to double digits. Thus, it is important to see if there are breaks in Pakistan's overall inflation rate series during the study period. We found two breaks[17] in overall, non-food, food, and administered prices inflation rate in Pakistan. In order to capture this structural break period we have used a dummy variable (1 for Jul 2007 to Jun 2009 period) while estimating FABSVAR models. In case of core inflation rate in Pakistan, another structural break period was found during Jan 1998 to Sep 2004. That led us to use two dummy variables for estimating FABSVAR models using core inflation rate as a variable of interest.

Impulse response functions (IRFs) from the FABSVAR models are obtained using Cholesky decomposition (to impose minimum restrictions for exact identification of structural models). We mainly discuss the impulse responses of inflation rate in Pakistan (in the selected baskets) to shocks to relevant proxy for global price changes. We also report the percentage share in domestic inflation rate's 'forecast error variance' associated with shock to the global commodity price movements. IRFs and variance decomposition (VD) are presented considering three-year horizons.

3. Empirical Findings

A. Bivariate Analysis

From Figures 3a to 3i we can see that the levels of global prices of the commodities considered in this study and consumer prices of similar goods in Pakistan move in tandem. Not only the prices (in same currency – PKR - as shown with green and red lines in Figure 3a to 3i); the YoY inflation rates pertaining to these goods in Pakistan and in the world seem co-moving (Table 3a in Appendix). In our simple analysis, we have shown that price movements in these commodities in international market and in Pakistan are highly correlated (Table 3a in Appendix). Interestingly, in most of the cases we find 'average inflation rate' in different regimes of interest (July 1992 to June 2007, July 2007 to June 2009, June 2009 to June 2014 and July 1992 to June 2014) in 'Pak rupee prices of goods in international markets' and 'local currency prices of same goods in Pakistan' are not statistically significantly different except for a few cases.[18] We can see how the

[17] For identifying the structural break(s) we followed Bai and Perron (2003) dynamic programming algorithm as implemented in R by Zeileis et al. (2003).

[18] Such cases deserve a few words. The most important is the case of petroleum products prices. In Pakistan 'Oil and Gas Regulating Authority' announces the petroleum product prices and thus it falls under administered regime. The observed empirical results in Table 3a could be due to changes in government taxes (for example sales tax) in local prices of petroleum products for revenue management purposes.

global inflation rate and the rate of inflation in Pakistan has been statistically 'same' for all the commodities studied in this paper particularly during the period of global commodity prices shock (2007-2009). In case of wheat, fish, beef, and cotton we can see inflation rates in Pakistan and global markets have (statistically same) means during all the regimes of interest considered in this study. Thus we can say that, contrary to the popular perception in Pakistan (that when there is increase in international commodity markets, prices increase in Pakistan quickly and proportionately, and when there is decrease in global commodity prices, price fall in Pakistan is rare and if it happens then it is less than proportionate), global commodity prices and prices of respective goods in Pakistan are linked irrespective of direction. In 34 out of 44 cases analysed in Table 3a (in Appendix) we find unconditional correlation coefficient between YoY inflation rates in Pakistan and in world to be positive, and (statistically significantly) different from zero.[19] These positive significant unconditional correlation coefficients range from 0.15 to 0.91. We also find causality from global inflation to inflation in Pakistan for all the commodities studied in this paper, except for meat products (Table 3b in Appendix). In cotton and wheat, we observed bi-directional causality.[20]

B. Multivariate Analysis

Above analysis, however, does not guide us about how shocks to global commodity price inflation are linked to change in prices in Pakistan. For this purpose we use vector autoregression type analysis and analyze the linkage between global commodity price fluctuations with inflation rate in Pakistan rigorously. We have related YoY inflation rate in Pakistan with changes (YoY) in global market prices of commodities Pakistan either imports or exports and main macroeconomic variables which are reported in relevant literature as determinants of inflation rate in the country.[21] We estimate the factors, representing global prices' inflation in various commodities considered in this study, using principal component analysis approach. These factors are a) food inflation rate (F7FPI) and b) metal and cotton inflation rate (FMCPI). These components extracted

[19] We do not find any significant negative correlation coefficient between YoY inflation in Pakistan and in world.

[20] One may ask why we have assumed no feedback from Pakistan's price dynamics to global commodity price movements as we mentioned in Section II. The reason is simple, out of cotton and wheat, cotton is clubbed with metal and wheat is grouped with other food items like rice, meat etc. (rather than considering alone) in our FABSVAR analysis. We are not 'price maker' in metal and grouping it with cotton may render Pakistan as price taker for the overall group. In food items like rice, meat etc., we know Pakistan is not a price maker. For example, in case of rice though we have a respectable share in global exports (9.0 percent), we rank low (14th) among rice producing countries (for 2014). Similarly, Pakistan ranked at 14th position in the world during 2014, in case of beef and veal meat exports. Even in the case of wheat, Pakistan ranked on 8th position in wheat production during the 2014 crop year and ranked 18th in the list of wheat exporting countries.

[21] We tried to see if there is any role of seasonality in exploring linkages between international commodity prices' inflation and inflation rate in Pakistan. We could not find any seasonal dummy variable to be statistically significant in all the models estimated in this study.

from 9 commodity prices' inflation series are consistent estimates of the factors.[22] These components explain a large proportion of fluctuations in the global commodity prices. The factor loading (i.e. the correlation coefficients between the variable and the principal component) of the two components are shown in Figure 3k (in Appendix).[23] It shows loadings are clustered in respective group - the loadings of food products are clustered in lower right corner and those of cotton and metal appear in the upper left corner of the figure (except for beef, but that is low).

B1. Global prices changes and overall inflation in Pakistan

We start with exploring how a) crude oil price change, b) various food items' price inflation, and c) changes in the prices of metal and cotton in international markets impact overall inflation rate in Pakistan; while considering other major relevant macroeconomic determinants of inflation rate in the country (model (a) in the Table 2 in Appendix). Based on an estimated FABSVAR model we find that, from the list of global commodity prices, (YoY) inflation rate in Pakistan responds most to (1 percent) shock in global crude petroleum products inflation compared to those in metal and cotton prices inflation or in food prices changes (Figure 4a). The reason, we think, is the simple fact that global crude petroleum price changes are passed on to the retail customers in Pakistan in an administered manner (in the following month). Change in fuel prices in the country impacts electricity charges, the cost of goods produced (where petroleum products are used as an input) as well as the cost of transportation of goods and provision of services to customers in addition to inflation expectations of households in Pakistan. Increase in the cost of raw material is found to be the most important factor justifying increase in the prices of manufactured goods in Pakistan in a formal sector price setting survey of more than 1000 firms in Pakistan by Choudhary et al. (2011). According to same survey, it takes up to 9 months for firms to pass on the increased cost of production to the consumers. Furthermore, households anchor their inflationary outlook to retail fuel prices (Abbas et al. 2015). One can see, in the accumulated response of overall inflation rate in Pakistan to increase in global crude oil price inflation, that overall inflation increases (rather sharply) in the first 12 months (by 1.8 percentage) and then slows (after it is increased by 2.3 percentage in total) before reaching maximum in 32 months. This lag length of 32 months can be explained by the fact that the indirect impact of oil price changes on overall inflation in prices of goods/service at retail level may take longer. The impact of (1 percent) shock in changes in the global prices of metal and cotton on overall (YoY) inflation rate in Pakistan is low (by almost half) and slower compared to that of global crude oil price changes. The reason is simple: crude oil products are directly imported and have far reaching impact whereas metal and cotton are not imported in the same proportion of domestic consumption as oil.

Such transmission and linkages become relatively weaker in the case of global food items considered in this study. Pass through of international food prices to respective domestic

[22] Principal component is consistent estimator of a factor (Banerjee and Marcellino (2008)).
[23] Factor loadings represent how much a factor explains a variable in factor analysis.

food prices (say, global palm oil price to domestic cooking oil price) in Pakistan is not that quick, frequent and regulated when compared with petroleum products' prices which are administered by the federal government. Thus, we observe low response of overall inflation rate in Pakistan to (1 percent) shock to the factor of food prices (of wheat, sugar, rice, fish, beef, tea and palm oil) in international markets.[24,25] Impact of 1 percent shock to change in exchange rate on overall inflation rate is more than double (specifically 2.2 percent) in just 12 months (Figure 5a) and it reaches its peak (3.5 percent) in 30 months (Figure 5b). It is the highest impact of 1 percent shock to change in exchange rate on any of the baskets compared (Figure 5a, 5b); except administered goods' basket at short horizons (less than a year, Figure 5a).[26]

While impulse response functions tell the path of response of the variable of interest (overall inflation here) to shock in innovations to one variable in the system (global commodity prices inflation in our study), the relative importance of shocks to innovations in explaining total variation in variable of interest is given by variance decomposition. Table 4a in Appendix indicates that changes in overall inflation rate are seemingly explained by shocks to itself, which is simply the phenomenon of inflation persistence in Pakistan which has been documented in the literature by Hanif et al. (2012). Shocks to global commodity prices inflation, however, more important than shocks to overall inflation rate (in Pakistan) itself, and innovations in money supply growth in the country. Innovations in money supply growth in Pakistan do not impact overall inflation rate in the country until 18 months. This result is in line with the finding by Khan (2008). As expected, the shocks to innovations in global commodity price inflation start explaining variance in overall inflation (forecast errors) in Pakistan quite early. Shocks to Pakistan's industrial production growth do not explain any sizable variation in overall inflation (forecast errors) in the country. This result is also similar to the findings of Khan (2008) for the case of Pakistan.

B2. Global prices changes and food inflation in Pakistan

The most significant group with slightly higher than one-third weight in the overall CPI basket (of 2007-08) is food group. Weight of food group was much higher (40.34%) in 1995 and 2001 baskets of CPI in Pakistan. Food inflation hurts the poor more than the rich as poor spend higher share of their overall expenditures on food compared to the rich

[24] We find relatively high impact of shock to the factor of food prices in international markets to food inflation in Pakistan. See next subsection.

[25] It is important to note that overall CPI basket also include food items which are almost immune to changes in prices of global food items (like tomatoes, onion and potatoes, etc.). If we exclude these and other types of perishable food items from the CPI basket we find that the accumulated response (in 3 years) of (non-perishable goods) inflation in Pakistan becomes higher to (1 percent) shock to international food prices inflation.

[26] The results from this study are not directly comparable with past studies on Pakistan. It is simply because in this study we have used a novel way to look at IRFs to unit shocks instead of (popular approach of) one-standard deviation shocks.

(Hanif, 2012). Now we see how global crude petroleum oil price changes and fluctuations in international food prices influence food inflation in Pakistan; while controlling for other food inflation rate determinants for the country. We have estimated FABSVAR model (model b in Table 2 in Appendix) and found that not all the errors' cross correlation coefficients are insignificant. Table 4b in Appendix shows that food inflation forecast error variance is actually explained by shocks to global food prices. Even the contribution of broad money supply growth in explaining errors in the food inflation predictions for Pakistan comes after the global food prices inflation shocks. More importantly, the shocks to innovations in global food prices inflation rate start explaining variance in food inflation in Pakistan much earlier (within three months) than impact of changes in money supply growth (after 12 months). Relatively late impact of changes in broad money growth on food inflation in Pakistan does not, in any way, mean that monetary policy has no influence on food inflation in the country. Since petroleum prices have significant role in transportation costs of food items (particularly, agriculture commodities) we have also attempted to estimate the model by including global crude oil prices fluctuations in explaining food inflation in Pakistan. We can see in the Table 4d in Appendix that global oil price fluctuations and changes in international food prices explain almost one third of Pakistan's food inflation forecast error variance. These results show how strongly global oil and food prices are linked with food inflation in Pakistan. These results vindicate findings of Hanif (2012) that Pakistan and world food inflation co-move and that global food inflation caused food inflation in Pakistan during the period he studied. Almost similar contributions of innovations to money supply growth in food inflation forecast error variance, with similar lags, suggests that food inflation is as much a monetary phenomenon in Pakistan as is overall inflation.

Now we shall see how 1 percent change in global crude oil price inflation and 1 percent change in international food prices inflation impact food inflation in Pakistan, using IRFs from estimated FABSVAR models b and d (in Table 2 in Appendix). Both these models incorporate money supply growth as one of the determinants of food inflation rate in Pakistan (along with industrial production growth and change in exchange rate).[27] We can see that 1 percent shock to change in international food prices results in about 3.5 percent increase in food inflation rate in Pakistan (Figure 4d in Appendix) in less than two year period. Considering the importance of fuel price in transportation cost of food items when we also included the link of global crude oil prices to food inflation in Pakistan we see that 1 percent shock to global crude petroleum price change results in around 1.0 percentage rise in Pakistan's food inflation rate within one year.[28] Impact of 1

[27] Excluding money supply growth while modeling food inflation in Pakistan, the IRF does not make economic sense as shock to global oil inflation seems to reduce food inflation in Pakistan (after one and half year period).

[28] One may wonder why in the end of third year response of food inflation in Pakistan to unit shock to world oil price change goes slightly in the negative quadrant (Figure 4d in the Appendix). It could be result of too much volatility in prices of perishable food items in Pakistan. If we exclude the perishable food items (tomatoes, potatoes, onions fresh fruits and fresh vegetables; prices of which are more domestic supply driven compared to non-perishable food

percent shock to change in exchange rate (PKRAD) on food inflation in Pakistan is lowest among the responses of other CPI baskets studied in this paper, to same shock. Specifically, it is less than half percent in 8 months and starts fading, though very slowly, thereafter (Figure 5a).

B3. Global price changes and inflation in prices of non-food commodities in Pakistan

In exploring the link of global commodity prices change with the rate of inflation in the prices of non-food items in Pakistan, we have estimated another FABSVAR model - model (e) in Table 2 (in Appendix). From Table 4e (in Appendix) we can see that shocks to international oil price changes start impacting non-food inflation rate forecast error immediately after the first month and reach maximum between 12-18 month (following the shock). Shocks to cotton and metal global price' changes contribute to non-food inflation rate forecast error rather late – after 12 months. These two commodities, cotton and metal, are not included in the basket of non-food group yet they affect non food inflation in the country indirectly, through cotton made-ups' and metal-products' prices.

While analyzing the IRFs (Figure 4e), one can easily spot that again 1 percent shock in international oil price changes impacts non-food prices' inflation in Pakistan immediately (after first month) and significantly (close to 1.5 percent within first 9 months). However, 1 percent shock to global metal and cotton prices' changes takes a while (about a year) and then impacts changes in non-food prices in Pakistan rather sharply reaching 1.5 percent in 3 years. This (sluggishness) could be due to very nature of cotton and metal. These two are intermediate goods in production of final goods which go through longer and sophisticated manufacturing processes.

Similar to overall inflation rate, impact of 1 percent shock to change in exchange rate (PKRAD) on non-food inflation rate in Pakistan is close to 2 percent in 12 months but starts falling beyond that (Figure 5b).

B4. Changes in global prices and core inflation in Pakistan

By core inflation in this study we mean exclusion based measure of core inflation that is non-food non-energy (NFNE) inflation (in Pakistan). On the basis of its composition, one may be tempted to estimate a model of core inflation by excluding both or any of the international food and crude oil prices' dynamics. But knowing that there are 'second round' effects of oil and food prices inflation in Pakistan on non-food non-energy prices in the country (Hanif, 2012), we have estimated FABSVAR model considering dynamics of all the 10 commodities' prices analyzed in this study - model (f) in Table 2 (in Appendix). From Table 4f (in Appendix) it is evident that one-fourth contribution in the

items) from the basket of food groups, the impact of 1 percent shock to global crude petroleum price inflation to food inflation in Pakistan remains positive (0.06 percent) even at 36th month.

core inflation rate forecast error comes from shocks to the global cotton and metal prices changes only. The contribution to the core inflation rate forecast error from shocks to global oil and food price dynamics is estimated to be around one-fifth. It shows the importance of second round effects of food and petroleum prices inflation on core inflation rate in Pakistan. Interestingly, if we look at IRFs (Figure 4f) the impact of 1 percent shock to global oil prices change on core inflation rate in Pakistan is quicker and is about four times higher compared to that of similar shock to cotton and metal prices inflation which is 1 percent (after 36 months). Even the impact of 1 percent shock to global food prices on core inflation rate in Pakistan is higher than that of similar shock to global cotton and metal prices inflation. The most durable and longest (as it stabilizes after 33 months) impact of 1 percent shock to change in exchange rate (PKRAD) is on core inflation rate in Pakistan at 1.5 percentage point (Figure 5b).

B5. Global prices changes and administered prices' inflation in Pakistan

We believe it as the most interesting case and as far as we know it is being discussed for the first time in literature on 'inflation in Pakistan and global prices nexus'. The most significant commodities in the list of commodities, prices of which are administered in Pakistan, are the petroleum products. Petroleum products prices in Pakistan are linked to the movements in global crude oil prices changes. After estimating a structural BVAR model (model (j) in Table 2 in Appendix), we find that more than one-third of the variation in administered price changes in Pakistan, at a year and longer horizons, is due to shocks in global oil prices fluctuations (Table 4j in Appendix). The smallest contribution in the variance of inflation rate in administered prices is from shocks to money supply, which is not surprising. If we look at IRF (Figure 4j) we can observe that 1 percentage point shock to global oil prices causes more than 2 percentage points rise in inflation in administered prices in Pakistan. More importantly almost all of this impact is passed on very quickly and half of it is completed in just 6 months. The remaining half completes in next 12 months. Former is related to the pass through of global oil price to domestic petroleum prices and transport fares whereas the latter is pertaining to subsequent impact of oil prices changes on electricity charges in the country. Largest impact of 1 percent shock to exchange rate appreciation/depreciation (PKRAD) on regulated prices' changes is 2.1 percent (in just 8 months). It fades as quickly after 9 months as it rises in the first 8 months (Figure 5a). During the longer period it is the overall inflation rate which responds strongly to the exchange rate dynamics in Pakistan, as discussed above.

4. Conclusion

Global economy witnessed an upward international commodity prices shock during 2007-08. Opposite happened in 2014. There is a need to know about the transmission of such shocks to inflation rate in small open economies like Pakistan. In this study, we have explored global commodity price (YoY) inflation linkages with (YoY) inflation in Pakistan using monthly dataset for the period July 1992 to June 2014. Following

empirical literature on inflation in Pakistan economy, broad money growth rate, exchange rate changes, and growth in real economic activities are used as determinants of inflation rate in the country along with the behavior of global commodity prices of rice, sugar, fish, beef, tea, petroleum crude oil, palm oil, metal, wheat and cotton. Since using these many variables in VAR model is infeasible, we have (statistically) summarized the information in the various global commodities prices in a couple of 'factors' and applied a factor augmented Bayesian structural VAR model. We analyzed variance decomposition and IRFs from estimated FABSVAR models to understand how inflation, food inflation, non-food inflation, core inflation, and changes in prices of goods for which prices are administered by the government of Pakistan, are impacted by shocks in international commodity prices; while considering the behavior of other relevant explanatory variables.

While exploring the linkages of global commodity prices levels with levels of prices in Pakistan we find that they largely move in tandem. Inflation rates in the prices of these commodities in international and Pakistani markets are not only correlated but have similar averages during different inflation regimes. More importantly, bivariate causality analysis shows causality runs from global inflation to inflation in Pakistan for all the commodities studied in this paper, except for meat. These findings show how strongly and positively global commodity price changes impact inflation rate in small open economy like Pakistan.

We find that overall inflation rate in Pakistan responds most to (1 percent) shock in global crude petroleum products' prices inflation (by 2.3 percentage points) compared to those in metal and cotton prices inflation (by 1.5 percentage point) or inflation in food prices (up to 2.0 percentage points). The impact of global oil price changes on inflation in Pakistan is quicker compared to that of changes in food prices or prices of cotton and metal. When we consider impact of 1 percent shock in global food inflation, we find relatively higher response of food inflation in Pakistan (close to 3.5 percentage points) whereas the response of food inflation in Pakistan to similar shock in global crude oil price change is around half percentage point. Contrary to common perception – that it is food and energy prices' changes in Pakistan which are impacted most by shocks to global food and crude oil prices fluctuations- it is the core inflation in Pakistan which responds higher (than overall inflation in the country) to 1 percent shock to global crude oil price inflation (by 3.8 percentages) and to changes in global food prices fluctuation (by 2.5 percentages). However, core inflation rate in Pakistan responds relatively slowly compared to overall inflation in the country; to shocks in global food and crude oil price changes. It shows the importance of second round effects of oil and food prices inflation on non-food non-energy prices' inflation in the country. Sharpest response to 1 percent shock to global crude oil price changes is that of administered prices inflation in Pakistan and that is an increase of about 2 percentage points in just one year – half of which spreads over just 6 months. In case of exchange rate (Pak Rupee per US dollar) too, quickest response (to 1 percent shock in movement in PKR) comes from the administered prices inflation (2.1 percent) in 6 months. Smallest impact of 1 percent shock to change in Pak Rupee value is seen in food inflation in Pakistan (less than half a percent), then on core

inflation (close to 1.5 percentage points), non-food inflation (close to 2 percentage points) and overall inflation (2.2 percentage points) in three years.

While analyzing variance decomposition, we find that more contribution to Pakistan's inflation forecasts errors results from shocks to global commodity prices (50.3 percent) than from shock to broad money supply growth in the country (16.8 percent). Shocks to innovations in global commodity prices fluctuations start explaining variance in inflation forecast errors in Pakistan relatively earlier (even after a month) than impact of changes in money supply growth (which appears after 12 months). These results are in line with findings in past studies on inflation in Pakistan. Contribution of Pakistan's money supply shocks in variance of inflation forecast errors is almost same in all the cases (overall, food, non-food and core inflation in the country). However, as expected, there is very small (3.8 percent) contribution of M2 growth in the variance of forecast errors of administered prices' inflation in Pakistan; more than one third (35.4 percent) of which is contributed by global oil prices alone.

As expected, monetary policy related variables do have significant role in influencing inflation outcome in the country (barring administered prices' inflation). Not surprisingly, innovations in money supply growth in Pakistan do not impact inflation in the country until 18 months compared with a swift response in various CPI baskets in Pakistan to the shocks in global commodity prices (except cotton and metal). While we explored how movements in exchange rate are transmitted to overall, food, non-food, core and administered prices' changes in the Pakistan; we find that the highest impact of 1 percent shock to change in exchange rate on administered prices fluctuations is 2.1 percent, which completes in 8 months, and lowest impact is on food inflation (less 0.5 percent), which starts reducing after 9 months. Impact of 1 percent shock to exchange rate change is more than 1 percent in cases of core inflation (1.5 percent), non-food inflation (2 percent) and overall inflation (2.2 percent) in Pakistan.

Given asymmetries in the global commodity prices' cycles - slumps are larger and last longer than booms (Cashin et al. 2002) - our results (that international commodity price changes and inflation in Pakistan are strongly linked) can be interpreted in terms of duration and amplitude of inflation in Pakistan: we can expect low inflation regime in Pakistan to last until the slump in the global commodity prices continues.[29]

Results of this study have implications for monetary policy framework in countries where non-monetary shocks matter significantly in determining the inflation expectations and the actual inflation rate. Arestis and Sawyer (2008) questioned the ability of a central bank to tame inflation when factors like global commodity prices have significant impact on domestic inflation. Central bank is believed to have no control over such factors. Thus, one can question the viability of inflation targeting regime for a small open economy like Pakistan where (a) 33 percent (in case of overall inflation) to 40 percent (in case of core inflation) of forecast error variance is contributed by shocks to global commodity price

[29] This study was conducted in 2015.

changes, and (b) a sizable proportion of CPI basket (about one-eighth) consists of commodities whose prices are controlled (by the government). In such countries, a negative supply shock may result in rising inflation amid falling output. Inflation target pursuing central bank may be entrapped by deepening the recession if it attempts to contain inflation. However, flexible inflation targeting, where price stability is pursued while ensuring output stability[30] (around economy's potential level), can work in countries where supply shocks do matter in determining inflation rate. It requires a range[31] of inflation rate to target (rather than a point target surrounded by a tolerance band) so that central bank can have some room to allow inflation when it is due to 'factors beyond its control' (FBIC) knowing that any attempt to contain FBIC driven inflation may decelerate economic activity growth rather sharply and increase output volatility.

[30] Targeting inflation rate alone can lead to a suboptimal response, as noted by Pettinger (2017).
[31] According to Debelle et al. 1998, "The need to specify a bandwidth results from the imperfect control of monetary policy over the inflation rate."

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Appendix

Table 1a: Summary of past studies

Study	Frequency/ Sample/Variable of interest	Model and Inflation Determinants
Jaffri et al. (2014)	Monthly, Feb 1993-Feb 2012, Food Inflation	Output gap, foreign consumer price index for food and beverages, foreign consumer price index for industrial materials, foreign consumer price index for energy.
Ahmed et al. (2014)	Annual, FY72-FY13, Inflation CPI	Exchange Rate, Government Borrowing, Non-Government Borrowing, Real GNP, Indirect Taxes, Money Supply, Import Price Index, Real Demand relative to Real Supply and Wheat Support Price. Johansen Co-integration Analysis
Asghar et al. (2013)	Annual, 1972-2010, Inflation (CPI)	Output gap, growth in reserve money, expected future inflation (lagged inflation), NEER, US inflation. Augmented Philips Curve Model used for this study
Khan and Ahmed (2011)	Monthly, Jan 1990-Jul 2011, Inflation	Oil prices, international food prices. A structural vector autoregressive (SVAR) Analysis
Khan and Gill (2010)	Annual, FY7-FY06, CPI, WPI, SPI, and GDP	Budget deficit, Exchange rate, annual interest rate, value of import, wheat support prices, support prices of sugarcane, rice, wheat and cotton, money supply, adoptive expectation. OLS Methodology
Hanif and Batool (2006)	Annual, 1973-05, Inflation (CPI	Reserve money growth, GDP growth, overnight interest rate, changes in wheat support prices, and openness (growth in trade/GDP ratio).
Khan and Schimmelpfennig (2006)	Monthly, Jan 1998-Jun 2005, Inflation	Money supply, credit to private sector, exchange rate, interest rate, and wheat support prices
Bokil and Schimmelpfennig (2006)	Monthly Jul 1998-Dec 2004 Inflation	Broad money, reserve money, credit to private sector, six month T Bills rate, LSM and output gap
Mubarik (2005)	Annual,1973-2000, Growth, Inflation	Inflation, population investment and dummy for inflation threshold. Granger Causality, OLS method
Choudhri, and Khan (2002)	Quarterly,1982Q1-2001Q2, CPI, WPI	Exchange rate, foreign price index
Ahmad and Ali (1999)	Monthly, Feb 1982- April 1996, CPI	Exchange rate, import prices, world prices, money supply, GDP and foreign reserves
Price and Nasim (1999)	Annual,1974-1994, CPI	Broad money, world prices, GDP and deposit rate
Shamsuddin and Holmes (1997)	Quarterly, 1972Q2-1993Q4, CPI	Broad money, and industrial production
Chaudhary, and Ahmad (1995)	Annual, 1972-1992, CPI	Broad money, GDP growth, share of services sector, public debt, and import prices,
Ahmad and Ram (1991)	Annual, 1960-1988, CPI, WPI, GNP deflator	Real GNP growth, growth rate of unit value of imports, growth rate of M1/M2, lagged inflation

Table 1b: List of Variables

Variable*	Description	Source
CPIOI	Pakistan's consumer price change (inflation) – overall (487 commodities in the basket)	PBS[1]
CPFDI	Pakistan's consumer price inflation – food (139 commodities in the basket)	PBS[1]
CNFDI	Pakistan's consumer price inflation – non-food (348 commodities in the basket)	PBS[1]
CNFEI	Pakistan's consumer price inflation – non-food/non-energy (331 commodities in the basket)	PBS[1]
APINF	Pakistan's consumer price inflation – administered	PBS[1,@]
M2GPK	Pakistan's broad money (M2) growth	SBP[2]
PKRAD	Appreciation/depreciation of nominal exchange rate (Pak Rupee per US dollar)	SBP[2]
IPING	Pakistan's industrial production index growth	PBS[1]
GOLPI	Inflation in global (US dollar) spot crude oil prices of Brent, WTI[#] and Dubai Fateh (average)	IMF[3,^]
F7FPI	Factor of 7 food items (wheat, rice, sugar, palm oil, tea, beef and fish) global (US dollar) prices' inflation	IMF[3,^]
FMCPI	Factor of metal and cotton global (US dollar) prices' inflation	IMF[3,^]
	#: West Texas Intermediate. 1: Pakistan Bureau of Statistics. 2: State Bank of Pakistan. 3: International Monetary Fund (for global prices). ^: authors' calculation of factor (i.e. the first principal component). @: Administered price index is compiled by Research Department of SBP on the basis of prices data of PBS. It includes following items from consumer price index basket: wheat, sugar, electricity, piped gas, kerosene oil, petrol, high speed diesel, compressed natural gas, liquid petroleum gas (cylinder), car tax (800cc to 1300cc), train fares, railway platform ticket, postal envelop (domestic and Saudi Arabia), telephone charges, (local as well as intercity). TV license fee, government college/university fee. See Ahmed et al. (2015). *: CPIOI= Consumer Price Index overall inflation, CPFDI= Consumer Prices Food inflation, CNFDI= Consumer items' Non Food inflation, CNFEI= Consumer items' Non Food non Energy inflation, APINF= Administered Prices' inflation, M2GPK=M2 growth rate (of Pakistan) PKRAD= Pak Rupee Appreciation/Depreciation, IPING= Industrial Production Index Growth, GOLPI= Global Oil Price Inflation, F7FPI= Factor (of) 7 Food Prices' Inflation, FMCPI= Factor (of) Metal and Cotton Prices Inflation.	

Table2: VAR Model specification to assess the impact of global price changes on inflation in Pakistan (in order as in each row)

Model	Global Price Measure			Other Determinants of Inflation in Pakistan			Domestic Price Measure
a)	GOLPI	F7FPI	FMCPI	M2GPK	PKRAD	IPING	CPIOI (overall)
b)		F7FPI		M2GPK	PKRAD	IPING	CPFDI (Food)
c)	GOLPI	F7FPI			PKRAD	IPING	CPFDI (Food)
d)	GOLPI	F7FPI		M2GPK	PKRAD	IPING	CPFDI (Food)
e)	GOLPI		FMCPI	M2GPK	PKRAD	IPING	CNFDI (Non Food)
f)	GOLPI	F7FPI	FMCPI	M2GPK	PKRAD	IPING	CNFEI (Core)
g)		F7FPI	FMCPI	M2GPK	PKRAD	IPING	CNFEI (Core)
h)	GOLPI		FMCPI	M2GPK	PKRAD	IPING	CNFEI (Core)
i)			FMCPI	M2GPK	PKRAD	IPING	CNFEI (Core)
j)	GOLPI			M2GPK	PKRAD	IPING	APINF (Administered)

Table 3a: Domestic and Global Inflation Periodic Averages, Correlation and Test of Equal Mean

Items	Period (By Regime)	Periodic Average YoY Inflation (Pakistan) $\bar{X}_A$	Periodic Average YoY Inflation - Global (after global prices converted in Rs.) $\bar{X}_B$	Correlation Coefficient Between Global and Pakistan's (YoY) Inflation		Test for Equality of 'Periodic Average YoY' Global and Pakistan's Inflation (Ho:$\mu_A = \mu_B$^)
Overall	July 1992-June 2007	6.90	8.40	0.05		Reject
	July 2007-June 2009	14.44	17.95	0.61	*^	Unable to Reject
	July 2009-June 2014	9.28	12.27	0.81	*^	Reject
	Jan 1993-June 2014	8.16	10.19	0.38	*	Reject
Food	July 1992-June 2007	8.16	8.11	0.15	*	Unable to Reject
	July 2007-June 2009	25.58	19.45	0.42	*^	Reject
	July 2009-June 2014	11.64	12.30	0.50	*^	Unable to Reject
	July 1992-June 2014	10.54	10.09	0.35	*	Unable to Reject
Wheat	July 1992-June 2007	9.21	9.91	-0.27	*	Unable to Reject
	July 2007-June 2009	44.08	37.37	0.21		Unable to Reject
	July 2009-June 2014	9.14	13.60	-0.19		Unable to Reject
	July 1992-June 2014	12.36	13.24	0.08		Unable to Reject
Rice	July 1992-June 2007	7.76	8.66	0.09		Unable to Reject
	July 2007-June 2009	49.83	80.14	0.69	*^	Unable to Reject
	July 2009-June 2014	7.42	-0.15	0.32	*	Reject
	July 1992-June 2014	11.51	13.16	0.68	*	Unable to Reject
Sugar	July 1992-June 2007	8.48	12.51	0.57	*	Unable to Reject
	July 2007-June 2009	13.98	28.96	0.46	*	Unable to Reject
	July 2009-June 2014	10.65	16.38	0.61	*^	Unable to Reject
	July 1992-June 2014	9.47	14.88	0.56	*	Reject
Fish	July 1992-June 2007	7.81	6.74	0.01		Unable to Reject
	July 2007-June 2009	9.36	14.70	-0.05		Unable to Reject
	July 2009-June 2014	13.10	18.23	-0.29	*	Unable to Reject
	July 1992-June 2014	9.15	10.07	0.01		Unable to Reject
Beef	July 1992-June 2007	10.20	7.55	-0.02		Unable to Reject
	July 2007-June 2009	11.12	15.43	0.67	*^	Unable to Reject
	July 2009-June 2014	14.90	15.98	0.76	*^	Unable to Reject
	July 1992-June 2014	11.35	10.18	0.21	*	Unable to Reject
Tea	July 1992-June 2007	8.14	9.55	0.42	*	Unable to Reject
	July 2007-June 2009	18.26	31.04	0.73	*^	Unable to Reject
	July 2009-June 2014	12.93	4.35	0.11		Reject
	July 1992-June 2014	10.15	10.32	0.43	*	Unable to Reject
Edible Oil	July 1992-June 2007	9.47	14.29	0.67	*	Reject
	July 2007-June 2009	30.22	35.04	0.59	*^	Unable to Reject
	July 2009-June 2014	8.30	14.09	0.32	*	Unable to Reject
	July 1992-June 2014	11.09	16.13	0.60	*	Reject
Cotton	July 1992-June 2007	11.62	7.76	0.74	*	Unable to Reject
	July 2007-June 2009	16.79	19.00	0.91	*^	Unable to Reject
	July 2009-June 2014	24.01	24.84	0.89	*^	Unable to Reject
	July 1992-June 2014	14.91	12.66	0.81	*	Unable to Reject
POL	July 1992-June 2007	11.52	18.80	0.35	*	Reject
	July 2007-June 2009	11.12	28.58	0.68	*^	Unable to Reject
	July 2009-June 2014	11.48	19.51	0.65	*^	Reject
	July 1992-June 2014	11.47	19.85	0.48	*	Reject

* Significant at 5 percent. ^: Higher correlation during or immediate after the global prices' shock.

Table 3b: Bi-variate Granger Non-Causality Analysis (July 1992 – June 2014)

Commodity	Null Hypothesis	Lags included	F – statistics	P – value*
Wheat	Global inflation does not cause inflation in Pakistan	5	2.9	0
	Inflation in Pakistan does not cause global inflation		4	0
Rice	Global inflation does not cause inflation in Pakistan	3	31.1	0
	Inflation in Pakistan does not cause global inflation		0.6	0.6
Sugar	Global inflation does not cause inflation in Pakistan	2	5.1	0
	Inflation in Pakistan does not cause global inflation		1	0.4
Fish	Global inflation does not cause inflation in Pakistan	14	0.7	0.7
	Inflation in Pakistan does not cause global inflation		1.3	0.2
Beef	Global inflation does not cause inflation in Pakistan	6	1.3	0.3
	Inflation in Pakistan does not cause global inflation		1.4	0.2
Tea	Global inflation does not cause inflation in Pakistan	5	2.9	0
	Inflation in Pakistan does not cause global inflation		1.9	0.1
Edible Oil	Global inflation does not cause inflation in Pakistan	4	12.6	0
	Inflation in Pakistan does not cause global inflation		1.5	0.2
Cotton	Global inflation does not cause inflation in Pakistan	3	5.3	0
	Inflation in Pakistan does not cause global inflation		2.9	0
POL	Global inflation does not cause inflation in Pakistan	2	6.7	0
	Inflation in Pakistan does not cause global inflation		0	1

*: P-value less than 0.05 mean the null hypothesis is rejected. Lags are selected on the basis of AIC.

Tables 4a to 4j: Model-wise Variance Decomposition (Model a to Model i)

Up to months	Model a: Shock in innovation to							Model b: Shock in innovation to				
	GOLPI	F7FPI	FMCPI	M2GPK	PKRAD	IPING	CPIOI	F7FPI	M2GPK	PKRAD	IPING	CPFDI
1	4.15	0.2	0	0.05	6.92	0.72	87.95	0.23	0.02	4.31	0.65	94.8
3	8.67	8.91	0.9	0.1	7.26	0.66	73.49	6.27	0.41	2.78	0.59	89.95
6	10.49	25.17	1.18	0.15	6.91	0.42	55.68	20.9	0.29	1.64	0.42	76.75
12	17.12	29.86	3.59	2.27	6.21	0.3	40.65	29.59	2.29	1.13	0.62	66.37
18	15.13	26.75	9.14	10.25	5.01	0.82	32.9	28.94	10.71	1.57	1.46	57.32
24	12.84	22.49	14.1	14.07	4.21	2.83	29.47	26.87	15.8	1.58	2.08	53.67
30	11.92	22.54	14.8	14.76	4.17	3.64	28.16	26.31	15.97	2.03	2.38	53.3
36	11.48	25.2	13.65	16.81	3.87	3.34	25.66	27.14	16.28	2.09	2.34	52.14

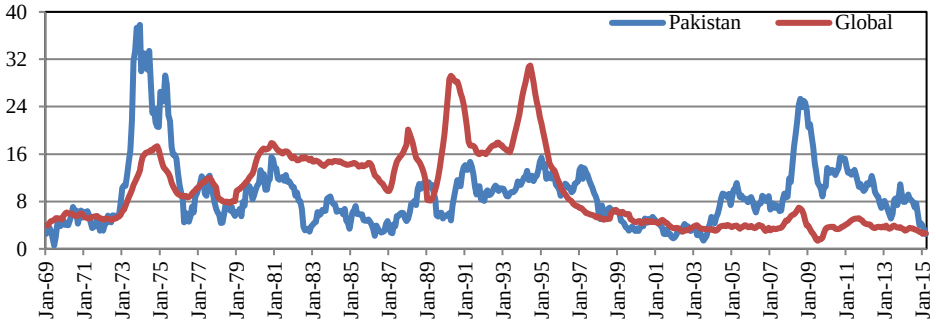
Up to months	Model c: Shock in innovation to					Model d: Shock in innovation to					
	GOLPI	F7FPI	PKRAD	IPING	CPFDI	GOLPI	F7FPI	M2GPK	PKRAD	IPING	CPFDI
1	0.14	0.08	4.08	0.11	95.59	1.07	0.04	0.04	4.66	0.16	94.03
3	0.61	11.02	3.46	0.17	84.74	2.4	9.95	0.47	2.85	0.3	84.03
6	0.34	30.04	2.95	0.13	66.53	2.4	29.34	0.33	1.62	0.31	66
12	0.42	38.11	2.02	1	58.45	3.52	36.62	3.1	1	0.7	55.06
18	2.1	37.76	3.3	2.39	54.44	3.25	34.87	10.8	1.62	1.49	47.97
24	4.48	35.52	3.55	4.16	52.29	3.68	32.38	14.98	1.67	2.49	44.8
30	4.53	34.78	3.89	5.31	51.49	3.73	31.95	15.63	1.95	3	43.75
36	4.46	35.73	3.94	5.3	50.57	3.88	33.08	16.35	2.02	2.87	41.8

Up to months	Model e: Shock in innovation to						Model f: Shock in innovation to						
	GOLPI	FMCPI	M2GPK	PKRAD	IPING	CNFDI	GOLPI	F7FPI	FMCPI	M2GPK	PKRAD	IPING	CNFEI
1	3.45	0.05	0.02	2.21	0.81	93.46	4.31	0.43	0	0.21	0.08	0.02	94.94
3	9.58	1.69	0.16	6.5	2.49	79.57	7.68	3.42	1.08	1.17	1.75	0.68	84.23
6	19.62	2.06	0.18	8.4	2.31	67.44	14.36	10.87	0.7	0.74	4.14	3.62	65.57
12	39.62	5.62	1.62	7.24	1.68	44.22	17.13	18.87	1.47	0.62	3.16	5.3	53.45
18	39.94	11.5	4.63	6.45	1.47	36.01	12.62	16.57	9.56	6.92	4.74	6.46	43.13
24	35.75	16.59	5.81	6.42	1.83	33.6	8.78	10.44	21.32	15.22	7.37	6.87	30.01
30	32.06	18.65	9.06	5.73	2.02	32.48	6.74	10.13	26.13	19.34	7.01	6.89	23.77
36	29.06	18.92	16.27	5.06	1.9	28.79	5.99	13.17	25.27	21.94	6.63	6.21	20.78

Up to months	Model g: Shock in innovation to						Model h: Shock in innovation to					
	F7FPI	FMCPI	M2GPK	PKRAD	IPING	CNFEI	GOLPI	FMCPI	M2GPK	PKRAD	IPING	CNFEI
1	0.61	0.01	0	0.03	0.3	99.1	5.89	0.14	0.5	0.42	0	93
3	2.69	0.44	2.84	0.71	1.5	91.8	13.5	2.74	0.2	2.13	0.3	81.2
6	8.93	0.26	3.05	0.79	5.3	81.7	25.2	3.33	0.66	2.86	2.2	65.7
12	17.8	0.27	1.68	1.16	8.7	70.4	31.8	7.5	2.77	1.78	5.4	50.7
18	16	4.22	8.62	6.82	9.4	54.9	25	16.8	6.42	5.05	7.6	39.1
24	10.6	15.3	14.69	10.07	9	40.3	21.3	23.3	10.17	11.36	6.5	27.3
30	9.01	21.2	14.87	10.33	9.5	35.1	17.6	26.1	17.13	12.82	5.3	21.1
36	10.1	21.2	15.71	10.81	9.4	32.8	14.9	26.2	24.32	11.89	4.7	18

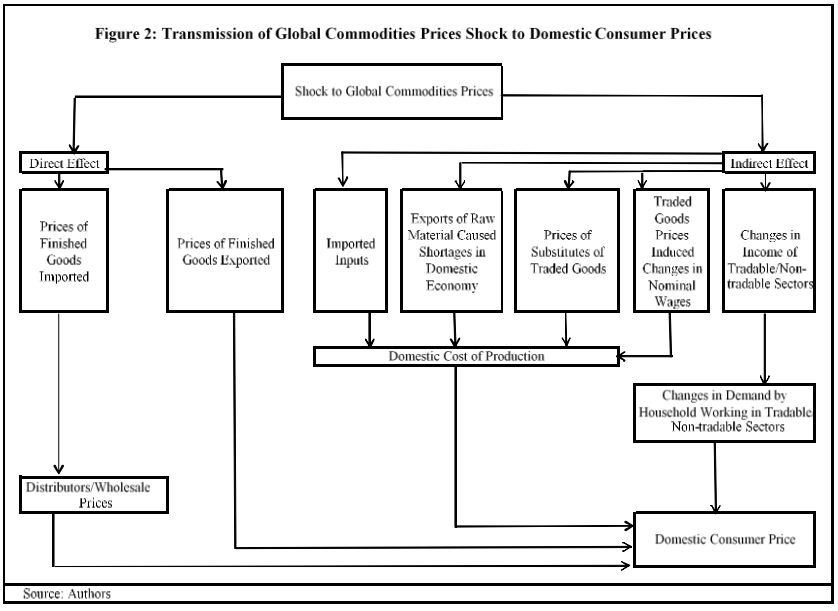
Up to months	Model i: Shock in innovation to					Model j: Shock in innovation to				
	FMCPI	M2GPK	PKRAD	IPING	CNFEI	GOLPI	M2GPK	PKRAD	IPING	APINF
1	0.08	0.09	0.65	0.1	99.1	2.3	0.2	0.75	0.4	96.3
3	1.56	0.67	2.04	0.79	95	6.13	0.2	6.53	0.3	86.9
6	1.53	0.34	1.63	3.3	93.2	14.5	1.1	8.09	1.1	75.3
12	3.25	1.58	1.91	8.42	84.8	36.5	1	5.48	3.8	53.2
18	9.18	7.73	9.25	10.5	63.3	41.7	0.9	7.09	4.4	45.9
24	17.3	12	15	9	46.7	40.4	1.9	8.64	4.7	44.3
30	22.7	14.4	15.7	8	39.2	37	1.9	16.1	4.6	40.5
36	24.1	17.2	15	7.84	35.9	35.4	3.8	17.1	4.6	39.2

Figure 1: Monthly Overal Consumer Prices' Inflation (Percent) - Year on Year



Source: IMF/Haver Analytics

Figure 2: Transmission of Global Commodities Prices Shock to Domestic Consumer Prices



Source: Authors

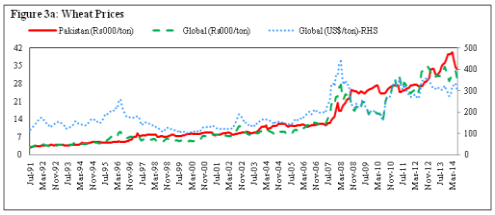


Figure 3a: Wheat Prices
Pakistan(Rs000/ton)
Global(Rs000/ton)
Global(US$/ton)-RHS

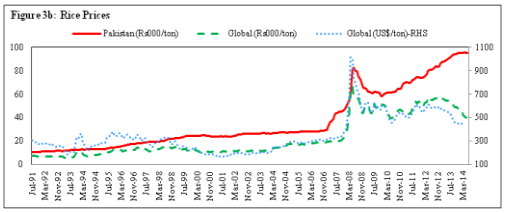


Figure 3b: Rice Prices
Pakistan(Rs000/ton)
Global(Rs000/ton)
Global(US$/ton)-RHS

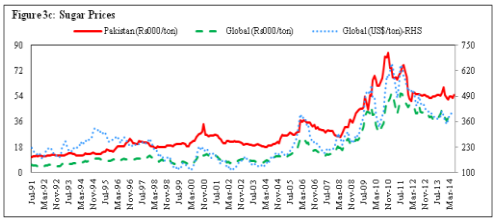


Figure 3c: Sugar Prices
Pakistan(Rs000/ton)
Global(Rs000/ton)
Global(US$/ton)-RHS

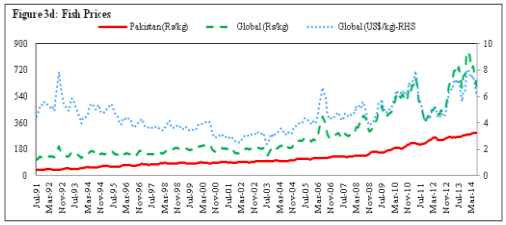


Figure 3d: Fish Prices
Pakistan(Rs/kg)
Global(Rs/kg)
Global(US$/kg)-RHS

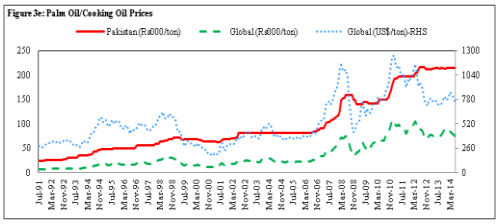


Figure 3e: Palm Oil/Cooking Oil Prices
Pakistan(Rs000/ton)
Global(Rs000/ton)
Global(US$/ton)-RHS

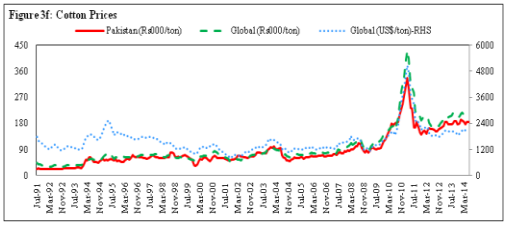


Figure 3f: Cotton Prices
Pakistan(Rs000/ton)
Global(Rs000/ton)
Global(US$/ton)-RHS

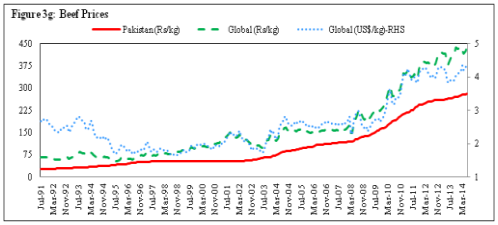


Figure 3g: Beef Prices
Pakistan(Rs/kg)
Global(Rs/kg)
Global(US$/kg)-RHS

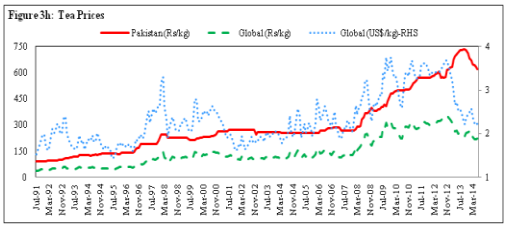


Figure 3h: Tea Prices
Pakistan(Rs/kg)
Global(Rs/kg)
Global(US$/kg)-RHS

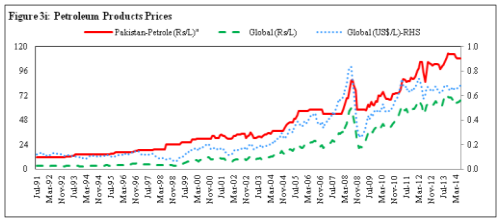


Figure 3i: Petroleum Products Prices
Pakistan-Petrole(Rs/L)*
Global(Rs/L)
Global(US$/L)-RHS

Figure 3k: Loadings to the Two Factors

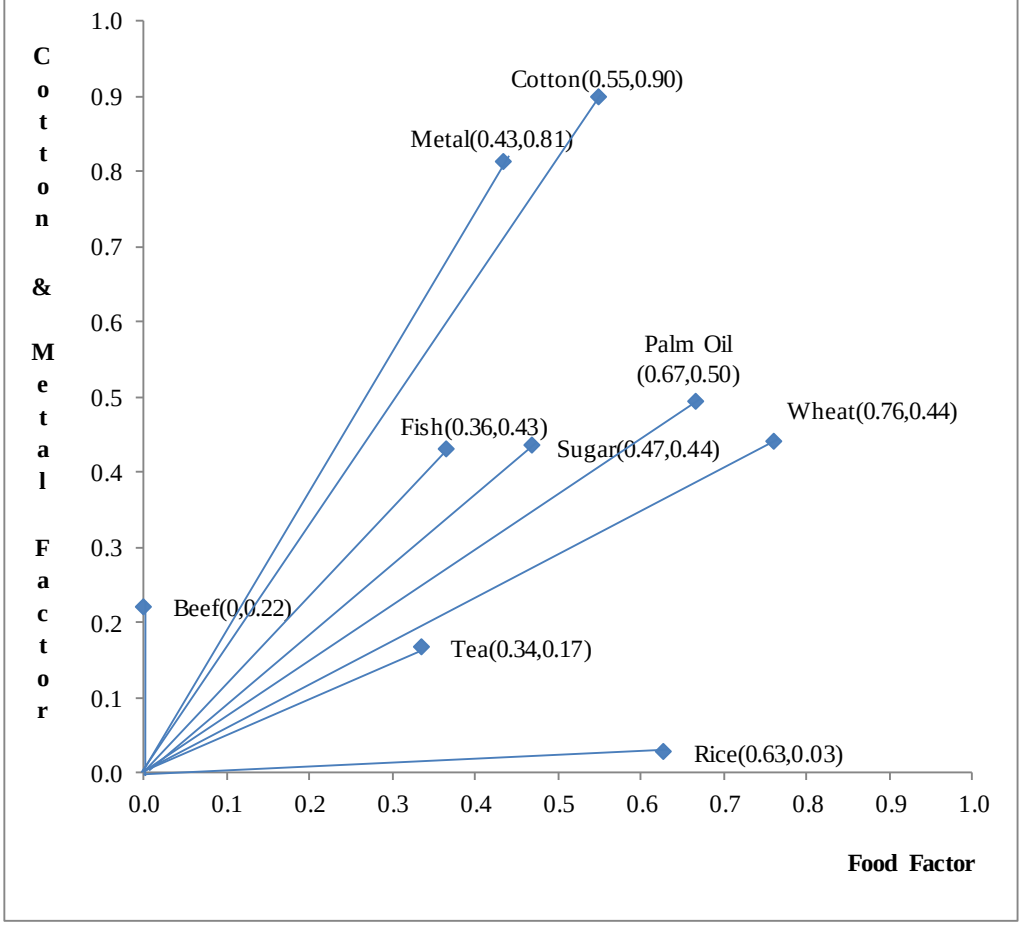


Figure 4a: Accumulated Response of Overall Inflation in Pakistan to Global Inflation Shocks

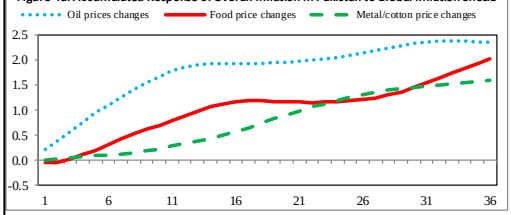


Figure 4b: Accumulated Response of Food Inflation in Pakistan to Global Inflation Shocks

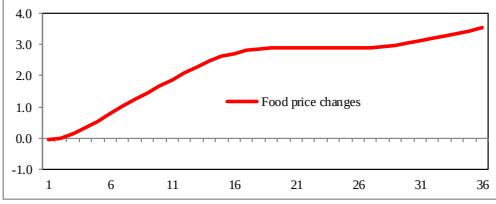


Figure 4c: Accumulated Response of Food Inflation in Pakistan to Global Inflation Shocks

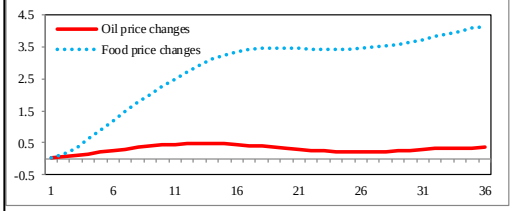


Figure 4d: Accumulated Response of Food Inflation in Pakistan to Global Inflation Shocks

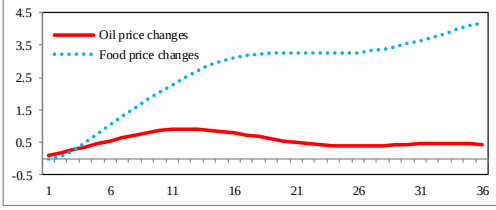


Figure 4e: Accumulated Response of Non-food Inflation in Pakistan to Global Inflation Shocks

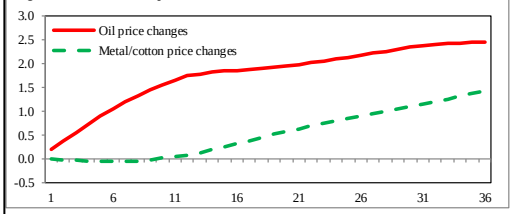


Figure 4f: Accumulated Response of Core Inflation in Pakistan to Global Inflation Shocks

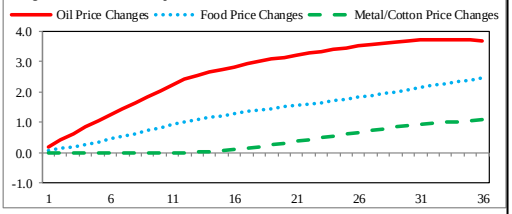


Figure 4g: Accumulated Response of Core Inflation in Pakistan to Global Inflation Shocks

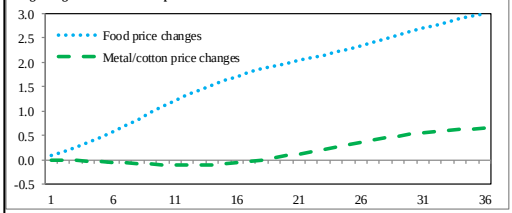


Figure 4h: Accumulated Response of Core Inflation in Pakistan to Global Inflation Shocks

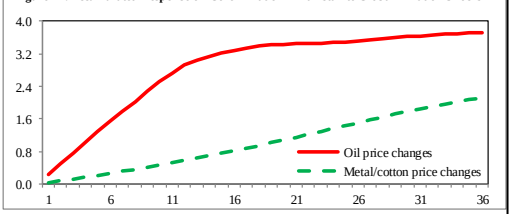


Figure 4i: Accumulated Response of Core Inflation in Pakistan to Global Inflation Shocks

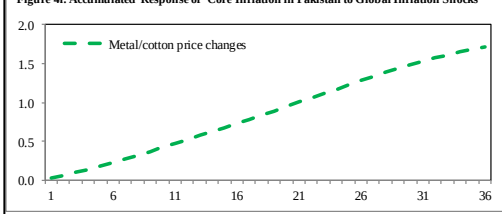


Figure 4j: Accumulated Response of Administrated Prices' Inflation in Pakistan to Global Inflation Shock

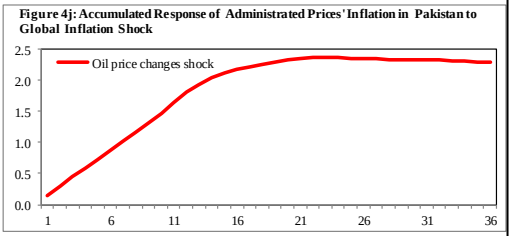


Figure 5a: Accumulated Response of Inflation in various sub-group of CPI to 1% Shock to Exchange Rate Movements

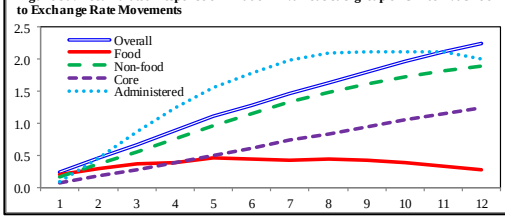


Figure 5b: Accumulated Response of Inflation in various sub-group of CPI to 1% Shock to Exchange Rate Movements