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Global Commodity Prices and Inflation in a Small Open Economy

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Abstract

Global commodity prices surge of 2007-08 sent an inflationary shock across the countries. 2014 global prices descend resulted in significant disinflation in many countries and even deflation in some economies. We have explored the linkages between global commodity prices fluctuations and inflation in small open economy, Pakistan. Global price fluctuations are found to be dominant sources of inflation dynamics in Pakistan during July 1992 to June 2014. Food inflation and overall inflation in Pakistan is linked to international food prices changes. Non-food and administered prices' inflation are result of global oil price increases. For core inflation, global prices of metal and cotton matter most. Global commodity prices changes impact overall inflation in Pakistan rather quickly compared to monetary policy actions. Core inflation takes longer to respond to all type of shocks including global price fluctuations. Monetary and exchange rate policies do have role in influencing inflation outcome in Pakistan (barring administrated prices' inflation).

JEL Classification Codes: E31, E51, F62

Key Words: Global Commodity Prices, Exchange Rate, Money Supply, Inflation

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1. Introduction

Interest of researchers in the 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 linkage of international commodity prices on domestic inflation in trading partners include Kwack (1973), Kravis and Lipsey (1977). Kwack (1973) presented a simple model which showed dependence of domestic inflation on the inflation in imported goods. Contrary to the conventional assumption (that country's export prices 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) prices 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) the 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 behaviour) of exporters, and d) domestic availability of exportable. Sharp fall in the 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 retard/stimulate productivity growth and raises/lowers 'inflation-accelerating-rate-of-unemployment' (Carruth, Hooker and Oswald 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, raw cotton for example). Another channel could be through indirect effects of fluctuations in US dollar prices of commodities in international market on 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 trade goods have implications for domestic income (Hanif 2012) and hence domestic demand and prices of nontradables (Deaton and Miller 1995) unless there is monetary policy response (to the changed domestic demand). Figure 2 (of Appendix) shows various channels through which global commodity prices are linked with the domestic prices in an open economy.

Notwithstanding the views of Moosa 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, Cheol (1999) established that each country's domestic inflation rate variance is attributable to foreign inflation shocks, and that flexible exchange rates do not insulate the domestic prices from global prices 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

[2] One quarter of input costs of manufacturing sector is upon imported intermediates. (Choudhary et al 2012).
[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 Pakistan economy.
[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

domestic inflation. Timmer (2008) found the international inflation and domestic inflation link 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 in emerging European economies and that inflation response was asymmetric during upturn and downturn. Akosy and Ng (2010) using Q1-2000 to Q3-2008 dataset of 90 countries 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 can respond to global prices even if no trade takes place but future trade is expected.

There are various empirical studies which have attempted to estimate 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 upon inflation in Pakistan[6].In most of such studies on Pakistan, (only) global oil price movement is considered as the representative of overall commodity prices' change to analyze the impact on inflation in the country. In Pakistan inflation becomes more correlated (Table 3a of Appendix) with the world inflation whenever world commodity market is hit by positive or negative shock as in early 1970s, in mid 1980s, in late 2000s, and now in 2014/15 (Figure 1 of Appendix). Hanif (2012) has documented the fact that following global commodity prices shock of 2008 the 'contribution of supply side factors to inflation in Pakistan' doubled (to half) in next five years compared to (one-quarter) that was during pre 2008 shock period. He also observed 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 descend in global commodity prices necessitates an analysis of the linkage between global commodity prices and inflation in Pakistan.

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 like exchange rate behaviour, broad money growth and dynamics in real economic activities. We have contributed in many ways: i) our is first study on Pakistan exploring impact of international commodity prices of 10 (internationally) traded commodities[7] upon domestic inflation; ii) we not only looked at the impact of global commodity price dynamics upon overall inflation but also upon food inflation, non-food inflation, core inflation, and more importantly, upon administrative prices changes; iii) starting with simple statistical analysis (like testing equality of mean-inflation in Pakistan and world) and econometric analysis (like Granger non-causality testing), we applied most rigorous modeling strategy - factor augmented Bayesian structural vector autoregression (Bernanke et al 2005); iv) rather than applying popularly used one standard deviation (SD) shocks for obtaining impulse response

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 of Appendix for other such studies description.

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

functions (IRFs) we have used 1 percentage point shock so that IRFs are (comparably) interpretable for policy discussions.

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 linkages with domestic inflation in a small open economy, we have considered Pakistan 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 (Pakistan's) data for overall inflation, and 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 of which prices are administered by the government of Pakistan.

Global prices are not the only one factor that impacts inflation in Pakistan. We start from what conceptually explains the overall inflation in the country. There are various explanations to the macro level behaviour of inflation including the quantity theory of money and Phillips curve. The contribution of broad money growth in explaining inflation in Pakistan (as has been documented by Nasim (1997), Hanif and Batool (2006), Riazuddin (2008) etc.), relationship between economic activity and inflation (as reported by Nasim (1997) and Khan (2008), and role of exchange rate in explanation of inflation 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 in inflation of Pakistan. Following literature on inflation in Pakistan, broad money growth, exchange rate (Pak Rupee per US dollar[8]) behaviour, and growth in real economic activities are used in this study as determinants of inflation in the country along with the behaviour of global commodity prices.

Out of the 10 commodities studied in this paper, Pakistan usually imports (petroleum) crude oil, palm oil, metal, and tea[9]. Those which Pakistan usually exports include rice, sugar, fish, and beef[10]. Wheat is such a commodity in which we were net importer during the 1990s. Later, we became self sufficient rather net exporter in 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].

[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. The remaining part of the middle staple cotton 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 stuff, 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 that the changes in their prices matter for inflation in the country.

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 (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. Some detail of the variables used in this study along with their data sources are given in Table 1b (of Appendix).

We start with graphical look at the linkages between global prices and 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 global commodity prices movements and inflation in prices of corresponding goods/baskets in Pakistani market. Lastly, we relate inflation in Pakistan with changes in global market prices of commodities we either import or export and 3 main macroeconomic determinants of inflation in the country using 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 number of variables (like several global commodity prices) impacting variable of interest (like inflation in a country) then solution to the degrees of freedom problem in VAR analysis is to augment the VAR with a single factor – single common stochastic factor - of large number of variables (usually with the help of principal component approach). This 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, we will be using Cholesky decomposition or in other words we will be estimating factor augmented structural VAR or FASVAR model. Expecting the improvement in the accuracy of the impulse response functions, we have estimated the factor augmented SVAR model using Bayesian approach. 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). 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 upon one SD shocks; and are quite useful academically. We think IRFs of 1 percentage point shock (instead of one SD shock) are relatively easy to interpret and communicate for policy debates. 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[13].

We do not expect all the variables in this study to be of same order of integration; rather we will have a set of variables which may be mixture of stationary and non-stationary ones. We will take difference of non-stationary variables and consider the stationary variables at levels following the practice in the literature. Notwithstanding the use of dummy variable for observed/estimated structural break in

[13] Here we explain how to get 1 percentage point 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).

Pakistan's inflation series (during Jul 2007 to Jun 2009 and Jan 1998 to Sep 2004); the impulse response functions based upon first differencing approach 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): change in global prices, broad money growth in Pakistan, movement in PKR (per US dollar), Pakistan's industrial production[14] index (IPI) growth, and change in prices (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[15] with only 0.15 percent share in world export receipts (during 2013), and b) absence of causality from inflation in Pakistan to global commodity prices' fluctuations.

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 SVAR model of inflation by using all the 10 global commodity prices' (YoY) inflation along with the 3 macroeconomic determinants (of inflation) with the available monthly data for July 1992 to June 2014. To address this problem we used following proxies for global commodity prices 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 directly (being part of CPI basket) and indirectly (as it affects the cost of production and delivery) and ii) representation of behaviour of global prices of a set of commodities by a single factor. These factors include a) principal component (PC) of 7 food items' inflation (F7FPI) as one factor, and b) a PC of metal and cotton prices changes (FMCPI).

We have used various combinations/models to empirically assess the impact of different representations of global commodity prices upon corresponding baskets of consumer prices in Pakistan while incorporating the influences of other relevant macroeconomic determinants of respective domestic price measures. The baskets range from overall basket to the basket of goods for which prices are administered by the government directly (like announcement of petroleum products prices) or indirectly (like announcement of wheat support price). Table 2 of Appendix spells out specification of each of the FABSVAR model we have estimated. In addition to 3 main determinants of inflation in Pakistan this table also describes which proxy for the global prices and the prices in Pakistan has been linked in each model to exhibit the transmission of global commodity price movements to various price indicators of Pakistan economy.

As can be seen from the Figure 1 (of Appendix), there was significant impact of global commodity prices shock of 2008 upon inflation in Pakistan when it increased from single digit level to double digits. Thus,

[14] It is used to proxy real economic activity in the absence of high frequency GDP data for Pakistan. 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.

[15] Pakistan has been ranked at 114 among the 138 countries being evaluated on the Global Trade Enabling Index (World Economic Forum, 2014).

it is important to see if there are breaks in Pakistan's overall inflation series during the study period. We found two breaks[16] in overall, non-food, food, and administered prices inflation 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 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 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 model). We mainly discuss the impulse responses of inflation in Pakistan (in the baskets selected for this study) to shocks to relevant proxy for global price changes. We also report the percentage variance shares of domestic inflation (in selected commodity groups) that are due to shock to the global commodity prices movements (along with shocks to the other variables in the underlying FASVAR model). IRFs and variance decomposition (VD) are presented considering three year horizons.

3. Empirical Findings

3.1. Bivariate Analysis

From Figures 3a to 3i we can see that global prices of the commodities considered in this study and consumer price 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 in these goods in Pakistan and in the world seem co-moving (Table 3a of 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 of Appendix). Interestingly, in most of the cases we find 'average inflation' 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[17]. We can see how the global inflation and 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 in Pakistan and global markets have similar averages 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 happens then it is less than proportionate), global commodity prices and prices of respective goods in Pakistan are linked irrespective of direction. In 36 out of 44 cases analysed in Table 3a (of Appendix) we find unconditional correlation coefficient between YoY inflation in Pakistan and in world to be positively and statistically significantly different from zero[18]. These positive significant

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

[17] Such few 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 has been in 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.

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

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 of Appendix). In cotton and wheat, we observed bi-directional causality[19].

3.2 Multivariate Analysis

Above analysis, however, does not tell us 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 rigorously the linkage between global commodity price fluctuations with inflation in Pakistan. We have related YoY inflation 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 in the country[20]. 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 (F7FPI) inflation and b) metal & cotton inflation (FMCPI). These components extracted from 9 commodity prices' inflation series are consistent estimates of the factors [21]. These components explain a large proportion of fluctuations in the global commodity prices. The loading (i.e. the correlation coefficients between the variable and the principal component[22]) of the two components are shown in Figure 3j (of Appendix). It shows loadings are clustered in respective group - the loadings of food products are clustered in lower right corner and those of cotton & metal appear in the upper left corner of the figure (except for beef, but that is low).

3.2.1 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 & cotton in international markets impact overall inflation in Pakistan; while considering other major relevant macroeconomic determinants of inflation in the country (model (a) in the Table 2 of Appendix). Based upon an estimated FABSVAR model we find that, from amongst the list of global commodity prices, (YoY) inflation in Pakistan responds most to (1 unit positive) shock in global crude petroleum products inflation compared to those in metal & 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 (during the next month). Change in fuel prices in the country impacts electricity charges, the cost of goods production (where petroleum products are used as an input) as well as the cost of transportation of goods and provision of

[19] 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 will 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.

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

[21] Principal component is consistent estimator of factor (Banerjee and Marcellino (2008)).

[22] Factor loadings represent how much a factor explains a variable in factor analysis.

services to customers in addition to inflation expectations of households. 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, Beg, and Choudhary 2015). One can see, in the accumulated response of overall inflation in Pakistan to increase in global crude petroleum products 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 could be explained by the fact that the indirect impact of oil price changes upon overall inflation in prices of goods/service at retail level may take longer. The impact of (1 unit positive) shock in changes in the global prices of metal & cotton upon overall (YoY) inflation in Pakistan is low (by almost half) and slower compared to that of global crude petroleum products inflation. The reason is simple that crude oil products are directly imported and have far reaching impact whereas metal & cotton are not imported in that proportion of domestic consumption in which oil is imported. Furthermore, imported crude oil prices have more direct and indirect linkages with the production and supply chain of other products in Pakistan compared to the metal & cotton.

Such transmission and linkages become relatively weaker in the case of global food items considered in this study. Pass through of food prices to respective food prices (say, from global palm oil price to domestic cooking oil price) in Pakistan is not that quick, frequent and regulated as that of petroleum products' prices which are administered by the federal Government. Thus, we observe low response of overall inflation in Pakistan to (1 unit positive) shock to the factor of food prices (of wheat, sugar, rice, sugar, fish, beef, tea and palm oil) in international markets[23].[24] Impact of 1 percent shock to change in exchange rate upon overall inflation is more than double (specifically 2.2 percent) in just 12 months (Figure 5a) and it reaches to its peak (3.5 percent) in 30 months (Figure 5b). It is the highest impact of 1 percent shock to change in exchange rate upon any of the baskets compared (Figure 5a, 5b); except administered price changes at short horizons (less than a year, Figure 5a). The results from this study are not directly comparable to past studies on Pakistan. It is simply because in this study we have used a novel way to look at IRFs by giving unit shocks instead of popular approach of one-standard deviation shocks.

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 of Appendix indicates that changes in overall inflation 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 in total are, however, more important than shocks to overall inflation (in Pakistan) itself

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

[24] It is important to note that overall CPI basket also include food items which are almost immune to global food prices changes (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 unit positive) shock to international food prices inflation.

and innovations in money supply growth in the country. Innovations in money supply growth in Pakistan do not impact overall inflation 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 in Pakistan quite early. Shocks to Pakistan's industrial production growth do not explain any sizable variation in overall inflation in the country. This result is also similar to that found by Khan (2008) for the case of Pakistan.

3.2.2 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 even 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 (Hanif 2012). Now we see how global crude petroleum oil price changes and fluctuation in international food prices influence food inflation in Pakistan; while controlling for other food inflation determinants for the country. We have estimated FABSVAR model (model b in Table 2 of Appendix) and found that not all the errors' cross correlation coefficients are insignificant. Table 4b of Appendix shows that food inflation forecast error variance is actually explained by shocks to global food prices; after its own shocks. 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 start explaining variance in food inflation in Pakistan much earlier (within three months) than impacts of changes in money supply growth (after 12 months). Relatively later impact of changes in broad money growth upon food inflation in Pakistan does not in any way mean that monetary policy has no influence on food inflation in the country[25]. 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 of 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 strong are global oil and food prices linkages with food inflation in Pakistan. These results vindicate findings of Hanif (2012) that Pakistan and world food inflation commove 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 not much different lags, suggests that food inflation is as much as monetary phenomenon in Pakistan as is overall inflation.

Now we see how 1 percent change in global crude oil price change and 1 percent change in international food prices inflation impact food inflation in Pakistan, using IRF from estimated FABSVAR models b and d (in Table 2 of Appendix). Both of these models incorporate money supply growth as one of the determinants of food inflation in Pakistan (along with changes in exchange rate and industrial production growth)[26]. We can see that 1 percent positive shock to international food prices results in close to 3.5 percent increase in food inflation in Pakistan (Figure 4d of Appendix) in less than two year period.

[25] We know if we estimate such model we will see all that impacts relates to global food prices in explaining Pakistan food inflation error variance (Figure 4c of Appendix).

[26] We can see that when we do not consider money supply growth in modeling food inflation in Pakistan, the IRFs do not make economic sense as shock to global oil inflation seems to reduce food inflation in Pakistan after one and half 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 within one year[27]. Impact of 1 percent shock to change in exchange rate (PKRAD) upon food inflation in Pakistan is minimum 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 reducing, though very slowly, after this (Figure 5a).

3.2.3 Global prices changes and inflation in non-food commodities' prices in Pakistan

In exploring the link of global commodity prices change with non-food inflation in Pakistan we have estimated a FABSVAR model excluding food items (Model (e) in Table 2 of Appendix). From Table 4e (of Appendix) we can see that shocks to international oil prices changes start impacting non-food inflation forecast error immediately after the first month and turns maximum during 12-18 month (ahead of the shock). Shocks to cotton and metal global prices' changes contribute to explaining non-food inflation forecast error rather late – after 12 months. Both the commodities - cotton and metal are not even in the basket of non-food group (directly) but have indirect impacts, through cotton made-ups' and metal-products' prices, upon non-food inflation in the country.

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 & cotton prices' changes takes some time (about a year) and then impacts changes in non-food prices in the country rather sharply and reaches to 1.5 percent in 3 years. It could be because unlike most of the items considered in this study (such as crude oil, tea, palm oil), cotton and metal are intermediates in relatively longer and sophisticated manufacturing processes.

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

3.2.4 Global prices changes 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' impacts of oil and food prices inflation in Pakistan upon non-food non-energy prices in the country (see Hanif (2012)), we have estimated FABSVAR model considering dynamics of all the 10 commodities' prices we have considered in this study (Model (f) in Table 2 of Appendix). From Table 4f (of Appendix) it is evident that one-fourth contribution in the core inflation forecast error comes from shocks to the global cotton & metal prices changes only. The contribution to the core inflation forecast error from shocks to global oil and food price dynamics is observed to be around one-fifth. That shows how important are second round impact of food and

[27] One may wonder why in the end of third year response of food inflation in Pakistan to unit shock to world oil price changes goes slightly in the negative quadrant (Figure 4d in the Appendix). If we exclude the perishable food items (tomatoes, potatoes, onions fresh fruits and fresh vegetables; prices of which are domestic supply driven instead of international market) 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 on 36th month.

petroleum prices inflation upon core inflation in Pakistan. Interestingly, if we look at IRFs (Figure 4f) the impact of 1% shock to global oil prices change upon core inflation in Pakistan is quicker and is slightly less than four times higher compared to that of similar shock to cotton and metal prices inflation which is 1% (after 36 months)). Even the impact of 1% shock to global food prices upon core inflation in Pakistan is higher than that of similar shock to cotton and metal prices inflation. The most durable and longest (as stabilizes after 33 months) impact of 1 percent shock to change in exchange rate (PKRAD) is upon core inflation in Pakistan and is 1.5 percentage points (Figure 5b).

3.2.5 Global prices changes and administered prices' inflation in Pakistan

This is the most interesting case and as far as we know it is for the first time being discussed 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 of 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 of Appendix). The least contribution in the variance of inflation in administered prices is from shocks to monetary supply, which is not surprising. If we look at IRF (Figure 4j) we can observe that 1% positive 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 in very quickly and half of it is completed in just 6 months. The remaining half completes in next 12 months. Former one is related to the pass through of global oil price to domestic petroleum prices and transport fares whereas the latter one is pertaining to subsequent impact of oil prices changes upon electricity charges in the country. Highest impact of 1 percent shock to exchange rate appreciation/depreciation (PKRAD) is upon regulated prices' changes which is 2.1 percent in just 8 months. It fades as quickly after 9th month as sharply it increases in first 8 months (Figure 5a). During the longer period it is the overall inflation which responds most to the exchange rate dynamics in Pakistan, as discussed above.

4. Conclusion

Global economy witnessed an upward global commodity prices shock during 2007-08. Now the opposite is happening almost around the world. There is need to know about the transmission of such shocks to inflation in small open countries like Pakistan. In this study we have explored global commodity price (YoY) inflation linkages with (YoY) inflation in Pakistan while analyzing monthly dataset for July 1992 to June 2014. Following literature on inflation in Pakistan economy, broad money growth, exchange rate behaviour, and growth in real economic activities are also used as determinants of inflation in the country along with the behaviour 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 any sort of VAR, SVAR, or even Bayesian VAR model is almost impossible, we have combined the information in the various global commodities prices' inflation in couple of factors (like one factor for inflation in prices of global food items) and applied FABSVAR approach. 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 controlled by the government of Pakistan, are impacted by shocks to international commodity prices; along with other traditional explanatory variables.

While exploring the linkages of global commodity prices with prices in Pakistan we find that they largely move in tandem and inflation in the prices of these commodities in international and Pakistani markets are not only correlated but have similar means during different regimes of interest. 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 in small open economy of Pakistan.

In order to understand how shocks to global commodity prices are transmitted to change in prices in Pakistan we, using FABSVAR approach, find that overall inflation in Pakistan responds most to (1 unit positive) shock in global crude petroleum products inflation (by 2.3 percentage points) compared to those in metal & 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 upon inflation in Pakistan is quicker compared to that of changes in food prices or prices of cotton & metal. When we consider impact of 1 percent (positive) 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 prices is slightly higher than 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 that of overall inflation in the country) to 1 percent shock to global crude oil prices inflation (by 3.8 percentages) and to changes in global food prices fluctuation (by 2.5 percentages). However, core inflation 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 impacts of oil and food prices inflation upon non-food non-energy prices in the country. Sharpest response to 1 percent (positive) shock to global crude oil price changes is that of administered prices inflation in Pakistan and that is an increase by close to 2 percentage points in just one year – half of which is spread 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. Least impact of 1 percent shock to change in Pak Rupee is upon food inflation in Pakistan (less than half percent), then upon 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 shocks to global commodity prices in overall (50.3 percent) are more contributory to Pakistan's inflation forecasts errors than shock to broad money supply growth (16.8) in the country. Shocks to innovations in global commodity prices fluctuations start explaining variance in inflation forecast errors in Pakistan relatively earlier (sometime after a month) than impacts of changes in money supply growth (after 12 months). These results are close to what is documented in past studies on inflation in Pakistan. Contribution of Pakistan's money supply shocks in variance of forecast errors is almost similar in all the cases (overall, food, non-food and core inflation in the country). However, as expected, there is very low (3.8 percent) contribution of M2 growth in 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.

Monetary policy related variables do have significant role in influencing inflation outcome in the country (barring administrated prices' inflation). As expected, innovations in money supply growth in the Pakistan do not impact inflation in the country until 18 months as against quite early response of 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 is upon administered prices fluctuations (2.1 percent), which completes in 8 months, and lowest impact is upon 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.

We can say that inflation targeting regimes may not be suitable 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 changes, and b) a sizable proportion of CPI basket consists of commodities prices of which are controlled (by the government).

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 prices changes and inflation in Pakistan are strongly linked)* have implications for the duration and amplitude of inflation in Pakistan: we can expect ongoing low inflation regime in Pakistan to last for some time following continued slump in the global commodity prices on account of slower than expected growth in US, decelerating Chinese economic growth and continued worries about European economic performance[28]. Low inflation, particularly low food inflation, itself is blessing for poor (Hanif 2012) since they spend higher proportion of their income on food compare to rich.

[28] This study was submitted in May 2015.

References

Abbas, H., Beg, S. and Choudhary, M. A. (2015). Inflation expectations and economic perceptions in a developing country setting. dsqx.sbp.org.pk/ccs/survey%20information/paper.pdf.

Ahmad, E. and Ram, H. (1991). Foreign price shocks and inflation in Pakistan: A monetarist approach. *Pakistan Economic and Social Review* 29:1-20.

Ahmad, E. and Ali S. A. (1999). Exchange rate and inflation dynamics. *The Pakistan Development Review* 38: 235:251.

Ahmed, Q. M., Muhammad, S. D., Noman M. and Lakhan, G. R. (2014). Determinates of recent inflation in Pakistan revisit. *Pakistan Journal of Commerce and Social Science* 8: 170-184.

Ahmed, S., Choudhary M. A., Ghouri S. P., and Pasha F. (2016). A pragmatic model for monetary policy analysis II: The case of Pakistan. *Unpublished memo. State Bank of Pakistan*.

Aksoy, M. A. and Ng, F. (2010). The Evolution of Agricultural Trade Flows. *Policy Research Working Paper 5308. The World Bank.*

Ali, A. (2014). Share of imported goods in consumption of Pakistan. *SBP Research Bulletin* 10: 57-60.

Asghar, N., Jaffri, A. A. and Asjed, R. (2013). An Empirical Investigation of Domestic and External Determinants of Inflation in Pakistan. *Pakistan Economic and Social Review* 15: 55-70.

Bai, J., and Perron, P. (2003). Critical Values for Multiple Structural Change Tests. *Econometrics Journal* 6: 72-78.

Banerjee, A. and Marcellino, M. (2008).Factor-augmented error correction models. *European University Institute Working Paper* 2008/15: Department of Economics:

Bernanke, B. S., Bovin J. and Eliasz, P. (2005). Measuring the effects of monetary policy: A factor augmented vector auto regressive (FAVAR) approach. *The Quarterly Journal of Economics* 120:387-422.

Bokil, M. and Schimmelpfennig, A. (2006). Three attempts at inflation forecasting in Pakistan. *The Pakistan Development Review* 45: 341-368.

Canova, F. (2007). G-7 Inflation forecasts: Random walk, Philips curve or what else?. *Macroeconomic Dynamics*11: 1-30.

Carruth, A. A., Hooker, M. A., and Oswald, A. J. (1998). Unemployment equilibria and input prices: Theory and evidence from the United States. *Review of Economics and Statistics* 80: 621-628.

Cashin, P., McDermott, C. J., and Scott, A. (2002). Booms and slumps in World commodity prices. *Journal of Development Economics* 69: 277-296.

Choudhary, M. A,, Naeem, S., Faheem, A., Hanif, M. N. and Pasha, F. (2011). Formal Sector Price Discoveries – Preliminary Results from a Developing Country. *Working Paper 42. State Bank of Pakistan*.

Choudhary, M. A., Khan, S., Hanif, M. N. and Rehman, M. (2012). Procyclical monetary policy and governance. *SBP Research Bulletin* 8: 33-43

Choudhri, E. U. and Khan, M. S. (2002). The exchange rate and consumer prices in Pakistan: Is rupee devaluation inflationary?. *The Pakistan Development Review* 41: 107:120.

Deaton, A. and Miller, R. (1995). International commodity prices, macroeconomic performance, and politics in Sub-Saharan Africa. *Princeton Studies in International Finance* 79.

Eun, C. S., and Jeong, J-G. (1999). International Price Level Linkages: Evidence from the Post Bretton Woods Era. *Pacific-Basin Finance Journal* 7: 331-349.

Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica* 37: 424:438.

Hanif, M. N. (2012). A note on food inflation in Pakistan. *Pakistan Economic and Social Review* 50: 183-206.

Hanif, M. N. (2014). Monetary policy experience of Pakistan. *MPRA Paper 60855. http://mpra.ub.uni-muenchen.de/60855/.*

Hanif, M. N. and Batool, I. (2006). Openness and inflation: A case study of Pakistan. *Pakistan Business Review* 7:

Hanif, M. N., Malik, M. J., and Iqbal, J. (2012). Intrinsic Inflation Persistence in a Developing Country. *Working Paper 52. State Bank of Pakistan.*

Hendry, D. F. and Clements, M. P. (2003). Economic Forecasting: some lessons from recent research. *Economic Modeling* 20:301-329.

Hyder, Z. and Shah, S. (2004). Exchange rate pass-through to domestic prices in Pakistan. *Working Paper 5. State Bank of Pakistan*

Jaffri, A. A., Mirza, F. M. and Bashir, S. (2014). Is pass-through of global food inflation to food inflation in Pakistan symmetric?. *Pakistan Economic and Social Review* 52: 35-43.

Kalkuhl, M. (2014). .How strong do global commodity prices influence domestic food prices? A global price transmission analysis. *Center for Development Research, University of Bonn, Germany*.

Khan, M. A. and Ahmed, A. (2011). Macroeconomic effects of global food and oil prices shock to Pakistan economy: A structural vector autoregressive (SVAR) analysis. *The Pakistan Development Review* 50: 1-26.

Khan, M.H. (2008). Short Run Effects of an Unanticipated Change in Monetary Policy: Interpreting Macroeconomic Dynamics in Pakistan. *Working Paper 22: State Bank of Pakistan*

Khan, R. E. A., and Gill, A. R. (2010). Determinants of Inflation: A case Study of Pakistan (1970-2007). *Journal of Economics* 1: 45-51.

Khan, M. S. and Schimmelpfennig, A. (2006). Inflation in Pakistan. *The Pakistan Development Review* 45:185:202.

Kravis, I. B. and Lipsey, R. E. (1977). Price behavior in the light of balance of payments theories. *Working Paper 0181: NBER.*

Kwack, S. Y. (1973). The effect of foreign inflation on domestic prices and relative import prices of exchange rate changes. *International Finance Discussion Papers 35: Washington, D.C. Board of Governors of the Federal Reserve Systems.*

Lombardi, M., Osbat, C. and Schnatz, B. (2012). Global commodity cycles and linkages: A FAVAR approach. *Empire Econ43*: 651-670.

Mubarik, Y. A. (2005). Inflation and growth: An estimation of the threshold level of inflation in Pakistan. *Working Paper 8: state Bank of Pakistan.*

Mussa, M., Masson, P. ,Swoboda, A., Jadresic, E., Mauro, P. and Berg, A. (2000). Exchange rate regimes in an increasingly integrated World economy. *Occasional Paper 193: International Monetary Fund*.

Nasim, A. (1997). Determinants of inflation in Pakistan. *State Bank of Pakistan*.

Price, S. and Nasim, A. (1999). Modeling inflation and the demand for money in Pakistan; Cointegration and the causal structure. *Economic Modeling* 16: 87-103.

Riazuddin, R. (2008). An exploratory analysis of inflation episodes in Pakistan. *The Lahore Journal of Economics. Special Edition.* 63-93.

Robertson, J. (2000). Central bank forecasting: An international comparison. *Federal Reserve Bank of Atlanta Economic Review. Second Quarter*. 21-32.

Robles, M. and Torero, M. (2010). Understanding the Impact of High Food Prices in Latin America. *Economia* . 117-159.

Shamsuddin, A.F.M., and Holmes, R. A. (1997). Cointegration Test of the monetary theory of inflation and forecasting accuracy of the univariate and vector ARMA models of inflation. *Journal of Economic Studies* 24: 294-306.

Timmer, C. P. (2008). Causes of high food prices. *Economics Working Paper 124: Asian Development Bank.*

World Economic Forum (2014),The Global Enabling Trade Report 2014, Geneva Switzerland. *http://www3.weforum.org/docs/WEF_GlobalEnablingTrade_Report_2014.pdf*

Zeileis, A., Kleiber, C., Kramer, W. and Hornik, K. (2003). Testing and dating of structural changes in practice. *Computational Statistics and Data Analysis* 44:

Zoli, E. (2009). Commodity price volatility, cyclical fluctuations, and convergence: What is ahead for inflation in emerging Europe?. *Working Paper 09/41. International Monetary Fund.*

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.
Qazi, Sulaiman, Noman, and Ghulam (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 rate	Oil prices, international food prices A structural vector autoregressive (SVAR) Analysis
Khan and Gill (2010)	Annual FY7-FY06 CPI, WPI, SPI, and GDP deflator	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 1973-2005 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- 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)	Annual 1982-2003 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 et al (1997)	Monthly Feb 1972-Apr 1993 CPI	Broad money, real output
Chaudhary, and Ahmad (1996)	Annual 1972-1992 CPI	Broad money, GDP growth, share of services sector, public debt, and import prices,
Ahmad and Ram (1991)	Annual 1960-188 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 factors. @: 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).	

Table2: Model specification to assess the impact of global price changes upon inflation in Pakistan

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)	Periodic Average YoY Inflation - Global (after global prices converted in Rs.)	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	0.0
	Inflation in Pakistan does not cause global inflation		4.0	0.0
Rice	Global inflation does not cause inflation in Pakistan	3	31.1	0.0
	Inflation in Pakistan does not cause global inflation		0.6	0.6
Sugar	Global inflation does not cause inflation in Pakistan	2	5.1	0.0
	Inflation in Pakistan does not cause global inflation		1.0	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	0.0
	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	0.0
	Inflation in Pakistan does not cause global inflation		1.5	0.2
Cotton	Global inflation does not cause inflation in Pakistan	3	5.3	0.0
	Inflation in Pakistan does not cause global inflation		2.9	0.0
POL	Global inflation does not cause inflation in Pakistan	2	6.7	0.0
	Inflation in Pakistan does not cause global inflation		0.0	1.0

*: P-value less than 0.05 mean the null hypothesis is rejected.

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

Up to months	Model a: Shock in innovation to						
	GOLPI	F7FPI	FMCPI	M2GPK	PKRAD	IPING	CPIOI
1	4.15	0.20	0.00	0.05	6.92	0.72	87.95
3	8.67	8.91	0.90	0.10	7.26	0.66	73.49
6	10.49	25.17	1.18	0.15	6.91	0.42	55.68
12	17.12	29.86	3.59	2.27	6.21	0.30	40.65
18	15.13	26.75	9.14	10.25	5.01	0.82	32.90
24	12.84	22.49	14.10	14.07	4.21	2.83	29.47
30	11.92	22.54	14.80	14.76	4.17	3.64	28.16
36	11.48	25.20	13.65	16.81	3.87	3.34	25.66

Model b: Shock in innovation to				
F7FPI	M2GPK	PKRAD	IPING	CPFDI
0.23	0.02	4.31	0.65	94.80
6.27	0.41	2.78	0.59	89.95
20.90	0.29	1.64	0.42	76.75
29.59	2.29	1.13	0.62	66.37
28.94	10.71	1.57	1.46	57.32
26.87	15.80	1.58	2.08	53.67
26.31	15.97	2.03	2.38	53.30
27.14	16.28	2.09	2.34	52.14

Up to months	Model c: Shock in innovation to				
	GOLPI	F7FPI	PKRAD	IPING	CPFDI
1	0.14	0.08	4.08	0.11	95.59
3	0.61	11.02	3.46	0.17	84.74
6	0.34	30.04	2.95	0.13	66.53
12	0.42	38.11	2.02	1.00	58.45
18	2.10	37.76	3.30	2.39	54.44
24	4.48	35.52	3.55	4.16	52.29
30	4.53	34.78	3.89	5.31	51.49
36	4.46	35.73	3.94	5.30	50.57

Model d: Shock in innovation to					
GOLPI	F7FPI	M2GPK	PKRAD	IPING	CPFDI
1.07	0.04	0.04	4.66	0.16	94.03
2.40	9.95	0.47	2.85	0.30	84.03
2.40	29.34	0.33	1.62	0.31	66.00
3.52	36.62	3.10	1.00	0.70	55.06
3.25	34.87	10.80	1.62	1.49	47.97
3.68	32.38	14.98	1.67	2.49	44.80
3.73	31.95	15.63	1.95	3.00	43.75
3.88	33.08	16.35	2.02	2.87	41.80

Up to months	Model e: Shock in innovation to					
	GOLPI	FMCPI	M2GPK	PKRAD	IPING	CNFDI
1	3.45	0.05	0.02	2.21	0.81	93.46
3	9.58	1.69	0.16	6.50	2.49	79.57
6	19.62	2.06	0.18	8.40	2.31	67.44
12	39.62	5.62	1.62	7.24	1.68	44.22
18	39.94	11.50	4.63	6.45	1.47	36.01
24	35.75	16.59	5.81	6.42	1.83	33.60
30	32.06	18.65	9.06	5.73	2.02	32.48
36	29.06	18.92	16.27	5.06	1.90	28.79

Model f: Shock in innovation to						
GOLPI	F7FPI	FMCPI	M2GPK	PKRAD	IPING	CNFEI
4.31	0.43	0.00	0.21	0.08	0.02	94.94
7.68	3.42	1.08	1.17	1.75	0.68	84.23
14.36	10.87	0.70	0.74	4.14	3.62	65.57
17.13	18.87	1.47	0.62	3.16	5.30	53.45
12.62	16.57	9.56	6.92	4.74	6.46	43.13
8.78	10.44	21.32	15.22	7.37	6.87	30.01
6.74	10.13	26.13	19.34	7.01	6.89	23.77
5.99	13.17	25.27	21.94	6.63	6.21	20.78

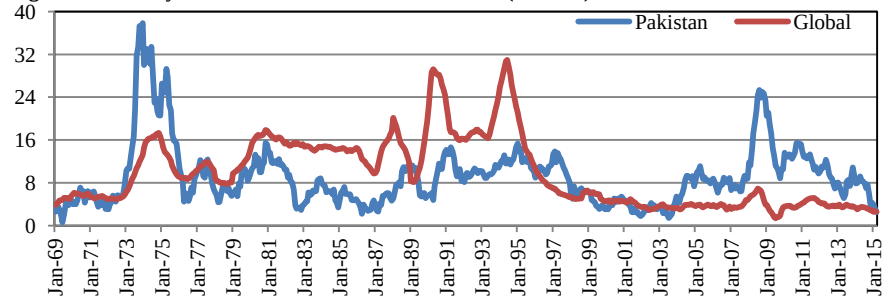
Up to months	Model g: Shock in innovation to					
	F7FPI	FMCPI	M2GPK	PKRAD	IPING	CNFEI
1	0.61	0.01	0.00	0.03	0.27	99.09
3	2.69	0.44	2.84	0.71	1.47	91.84
6	8.93	0.26	3.05	0.79	5.27	81.69
12	17.81	0.27	1.68	1.16	8.72	70.37
18	16.01	4.22	8.62	6.82	9.39	54.94
24	10.60	15.33	14.69	10.07	9.01	40.30
30	9.01	21.22	14.87	10.33	9.46	35.10
36	10.07	21.22	15.71	10.81	9.39	32.80

Model h: Shock in innovation to					
GOLPI	FMCPI	M2GPK	PKRAD	IPING	CNFEI
5.89	0.14	0.50	0.42	0.00	93.04
13.47	2.74	0.20	2.13	0.30	81.16
25.20	3.33	0.66	2.86	2.24	65.71
31.83	7.50	2.77	1.78	5.42	50.71
25.02	16.82	6.42	5.05	7.62	39.07
21.34	23.34	10.17	11.36	6.47	27.32
17.57	26.09	17.13	12.82	5.26	21.13
14.88	26.24	24.32	11.89	4.71	17.95

Up to months	Model i: Shock in innovation to				
	FMCPI	M2GPK	PKRAD	IPING	CNFEI
1	0.08	0.09	0.65	0.10	99.10
3	1.56	0.67	2.04	0.79	94.95
6	1.53	0.34	1.63	3.30	93.20
12	3.25	1.58	1.91	8.42	84.83
18	9.18	7.73	9.25	10.54	63.30
24	17.31	12.03	15.00	9.00	46.67
30	22.73	14.42	15.69	8.00	39.15
36	24.08	17.20	14.98	7.84	35.89

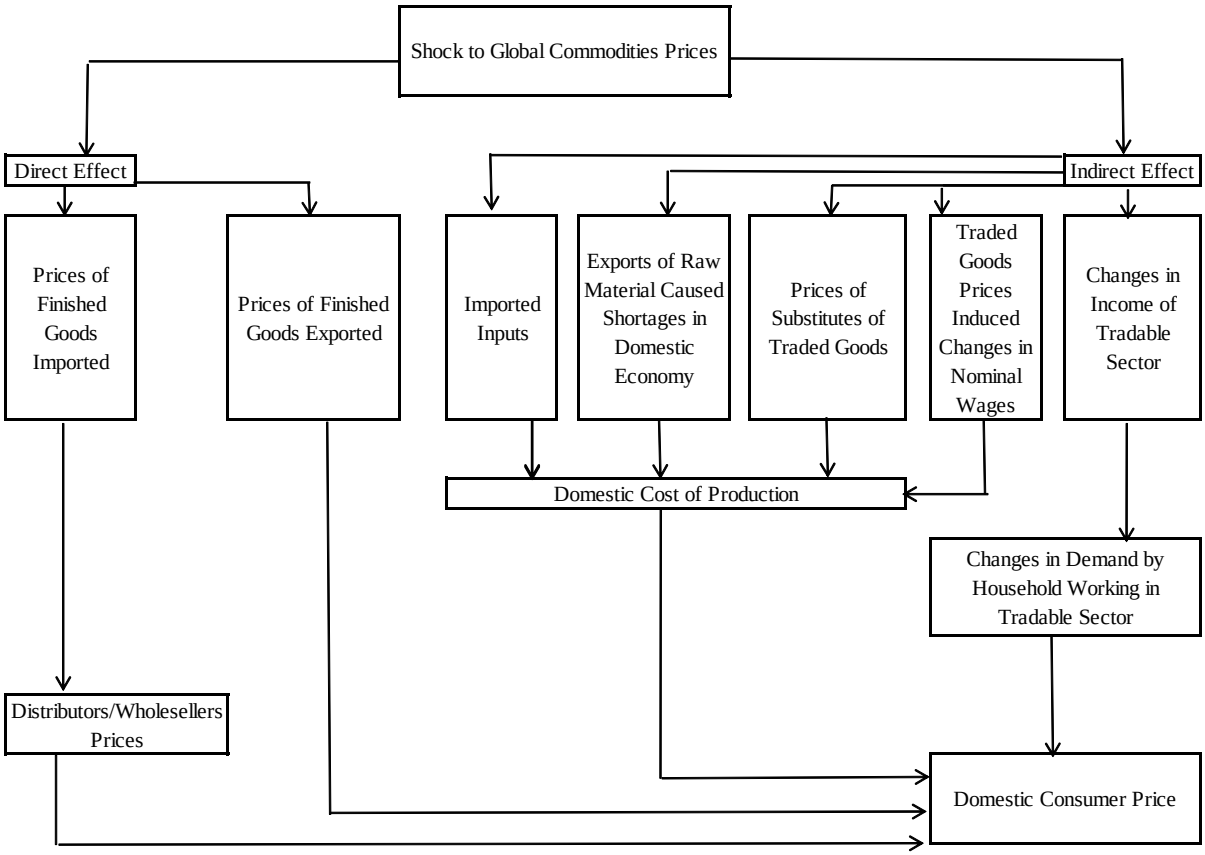
Model j: Shock in innovation to				
GOLPI	M2GPK	PKRAD	IPING	APINF
2.30	0.19	0.75	0.43	96.33
6.13	0.15	6.53	0.31	86.89
14.51	1.07	8.09	1.08	75.25
36.49	1.00	5.48	3.81	53.22
41.65	0.90	7.09	4.43	45.93
40.42	1.91	8.64	4.69	44.34
36.96	1.88	16.11	4.58	40.47
35.44	3.75	17.08	4.58	39.16

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

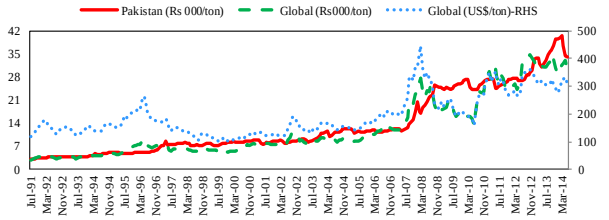


Figure 3b: Rice Prices

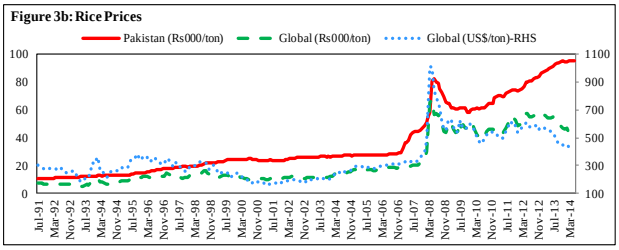


Figure 3c: Sugar Prices

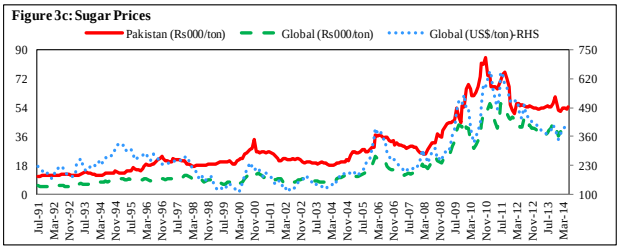


Figure 3d: Fish Prices

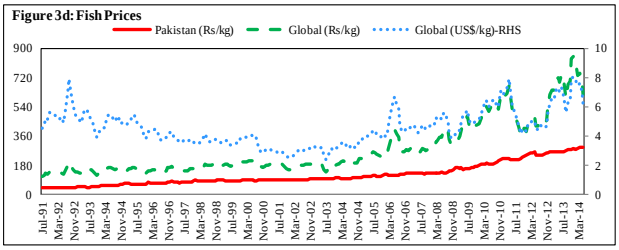


Figure 3e: Palm Oil/Cooking Oil Prices

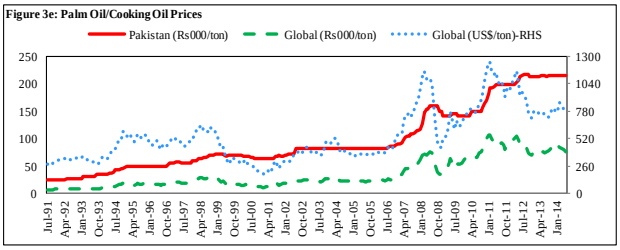


Figure 3f: Cotton Prices

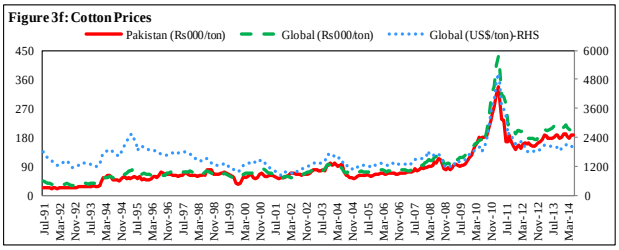


Figure 3g: Beef Prices

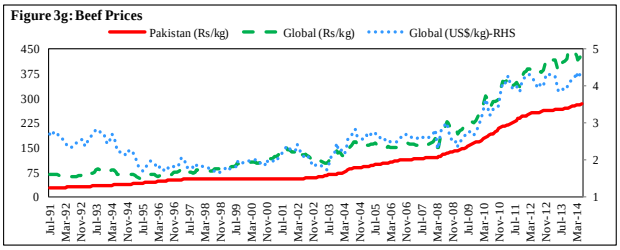


Figure 3h: Tea Prices

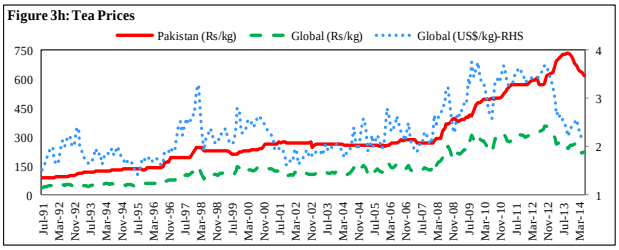


Figure 3i: Petroleum Products Prices

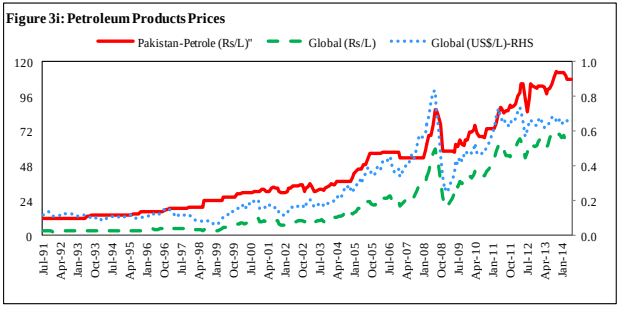


Figure 3j: :Loadings to the two factors

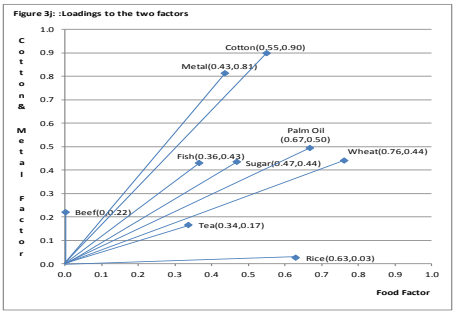


Figure 4a: Accumulated Response of Overall Inflation in Pakistan to Global Inflation Shocks

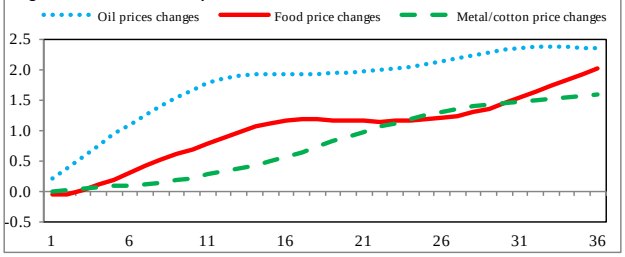


Figure 4b: Accumulated Response of Food Inflation in Pakistan to Global Inflation Shocks

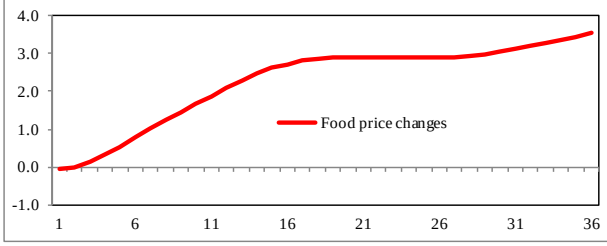


Figure 4c: Accumulated Response of Food Inflation in Pakistan to Global Inflation Shocks

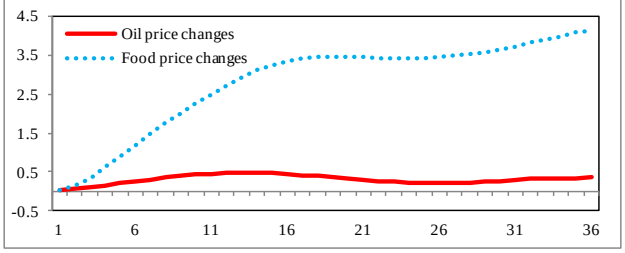


Figure 4d: Accumulated Response of Food Inflation in Pakistan to Global Inflation Shocks

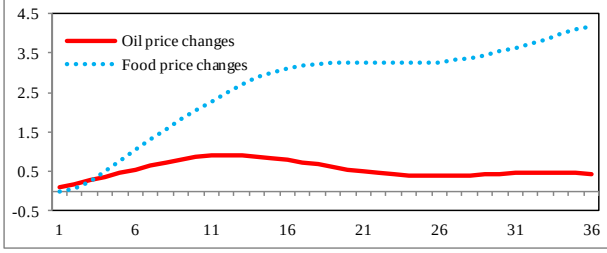


Figure 4e: Accumulated Response of Non-food Inflation in Pakistan to Global Inflation Shocks

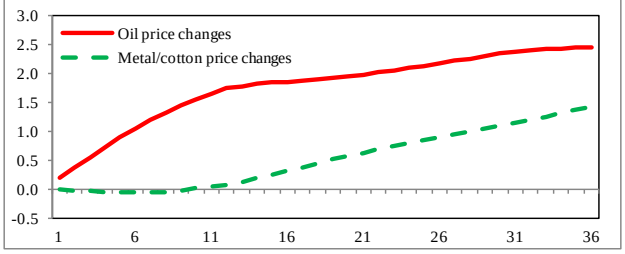


Figure 4f: Accumulated Response of Core Inflation in Pakistan to Global Inflation Shocks

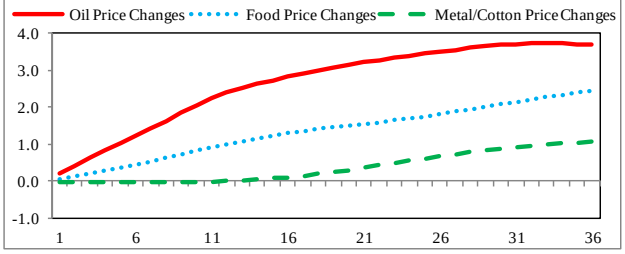


Figure 4g: Accumulated Response of Core Inflation in Pakistan to Global Inflation Shocks

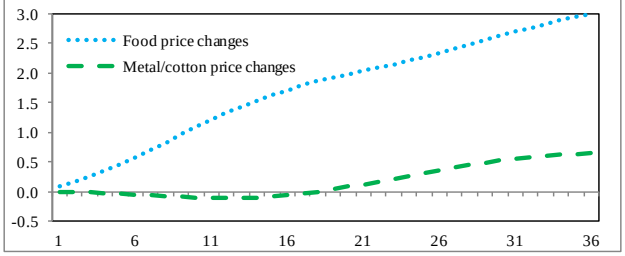


Figure 4h: Accumulated Response of Core Inflation in Pakistan to Global Inflation Shocks

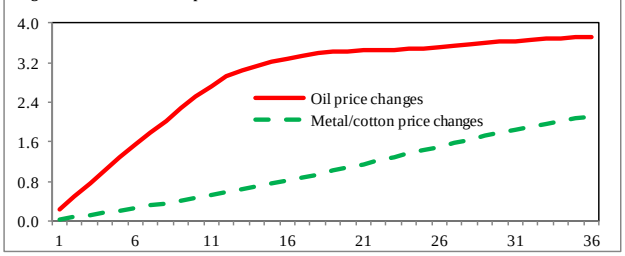


Figure 4i: Accumulated Response of Core Inflation in Pakistan to Global Inflation Shocks

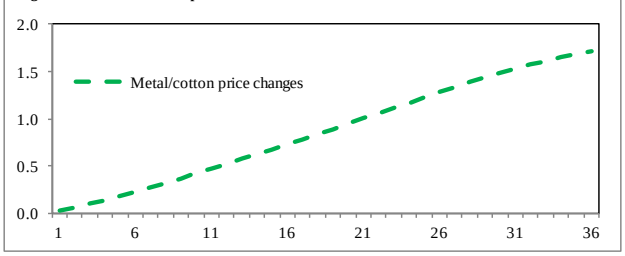


Figure 4j: Accumulated Response of Administrated Prices' Inflation in Pakistan to Global Inflation Shock

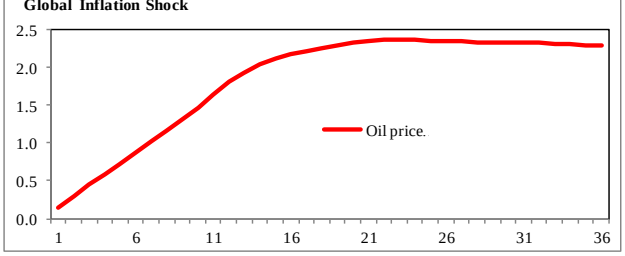


Figure 5a: Accumulated Response of Inflation in various sub-group of CPI to 1% Shock to Exchange Rate Movements

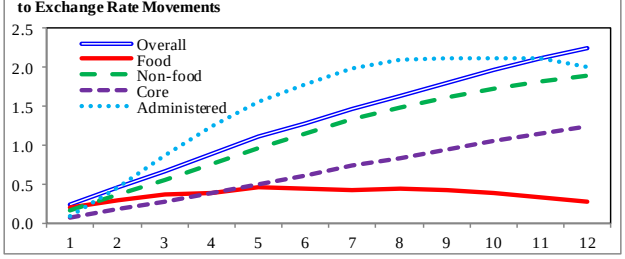


Figure 5b: Accumulated Response of Inflation in various sub-group of CPI to 1% Shock to Exchange Rate Movements