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Macroeconomic Effects of Global Food and Oil Price Shocks to the Pakistan Economy: A Structural Vector Autoregressive (SVAR) Analysis

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INTRODUCTION

Recent rise in oil and food prices have been a major cause of concern for policymakers around the globe and Pakistan's economy is not the exception. Changes in the global oil and food prices have been viewed as major source of macroeconomic fluctuations. Upsurge in global commodity prices, particularly food and oil prices during 2007-2008 leads to increase cost of production which hinders industrial productivity and fall in output growth. An unprecedented rise in food and oil prices during 2007-2008, coupled with global recession, financial crises and slowdown in the US economy has posed a number of serious challenges to the world economy. Movements in international commodity prices have been largely considered as a main source of business cycle and there is a plethora of literature that shows a negative correlation between the international commodity prices and macroeconomic performance of oil importing countries through the supply-side and demand-side channels.

It is well documented in the literature that crude oil was trading between US$18 and US$23 in the 1990s. It crossed the US$40 mark in 2004, and rose to around US$60 in 2005. During the summer of 2007, the oil price jumped above US$70 per barrel and even crossed to US$174 per barrel mark in July 2008 before a sharp downturn. This upsurge of oil prices produces adverse impacts on oil-importing countries. The rise in the crude oil prices exerts adverse effect on consumers and producers via pass-through effect on petroleum products. From the consumer standpoint, rise in oil prices causes energy bills to grow, whereas from the producer standpoint, firms contend a rise in unit costs [Lescaroux and Mignon (2008)]. Similarly, food costs have increased sharply since 2007. Prices of rice, palm oil and wheat rose by 62 percent, 94 percent and 107 percent respectively in the first quarter of 2008, compared to 39 percent for overall food prices [Jongwanich and Park (2009)]. It can be argued that higher oil prices have indirect effect

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on consumer prices whereas higher food prices have more direct effect on inflation. This is because oil is productive input but food is consumed directly [Jongwanich and Park (2011)]. A rise in oil prices may causes a drop in productivity, which in turn produces adverse affects on real wages and employment, selling price and core inflation, profits and investment as well as stock market capitalisation [Lescaroux and Mignon (2008). On the other hand, increase in food prices has a sizable impact on overall consumer price level because food accounts for a sizable part in the consumption basket in developing countries [Jongwanich and Park (2011)].

Theoretical and empirical studies showed that increases in oil prices negatively affect macroeconomic activities of oil-importing countries through the supply-side and demand-side channels. Hamilton (1983) argued that seven of the eight postwar recessions in the United States were proceeded by a spike in crude oil prices. Similarly, Brown and Yucel (2002) concluded that rising oil prices proceeded eight of the nine post-World War II economic recessions.

Subsequent to Hamilton's seminal work, a large body of empirical work is devoted to explore the relationship between oil price shock and aggregate economic performance of various economies [for example, Burbidge and Harrison (1984); Gisser and Goodwin (1986); Mork (1989); Mork, *et al*. (1994); Lee, *et al*. (2001) and Cologni and Manera (2008), among other]. These studies can be divided in to three main categories [Tang, *et al*. (2010)]. The first category includes a number of studies that have investigated the theoretical transmission channels through which the oil price increase may reduce potential output and increase inflation [Bruno and Sachs (1982); Barro (1984); Rasche and Tatom (1981); Darby (1982); Burbidge and Harrison (1984); Gisser and Goodwin (1986); Mork (1989); Lee, *et al.* (1995); Hamilton (1996); Hooker (1996); Abel and Bernanke (20010; Pappetrou (2001), among others]. The second category of studies carried out by Mory (1993), Cunado and Perez de Gracia (2003), Lee, *et al*. (2001), Lee and Ni (2002) and Lardic and Mignon (2008) has focused on the empirical investigation on the relationship between change in oil prices and aggregate activities. These studies were verified linear, non-linear and symmetric or asymmetric, the mathematical relationship for developed countries over the period 1970s to the 1990s. The third group of studies, *inter alia,* by Haung, *et al*. (2005), Cologni and Manera (2008) and Leduc and Sill (2004) have targeted on the role of macroeconomic policies in dealing with the oil price shock. These studies have examined the possibility of weakening relationship between oil price fluctuations and macroeconomic activity. Some other studies conclude that oil price deteriorates terms of trade for oil importing countries [Dohner (1981) and Husain, *et al.* (2008)]. Oil prices affect real money balances as it increases money demand, interest rates and retard economic growth [Pierce and Enzler (1974) and Mork (1994)]. Hooker (2002) suggests that the reaction function of monetary authorities is the main driver of second-round effects of oil price shocks; fiscal and monetary policy response may not be neutral to positive oil price shock and negative food price shocks. Oil price generates inflation [Burbidge and Harrison (1984); Hamilton (1983, 1996)].

In developing countries like Pakistan, the government subsidises the food and fuel prices for political reasons and consumers do not face the true market prices of these commodities. The government subsidies distort the price of food and oil products; therefore, consumer prices will not fully adjust to higher international prices [Jongwanich and Park (2011)]. Producers also tend to shift the burden of higher input prices on consumer prices after a time lag. Similarly, exchange rate movements, particularly weakening of domestic currency against U.S. dollar also generate inflationary pressure because oil is denominated in U.S. dollars.

Since 2007-08 Pakistan is facing episode of stagflation—very low economic growth combined with very high inflation. The root cause of current stagflation includes a series of supply-side shocks.[1] These shocks adversely affect the supply-side performance through constraining output growth, which is not sufficient to meet the demand pressures.[2] As a result, there is unprecedented increase in domestic inflation, unemployment and poverty levels [Amjad, *et al.* (2011)].

Against this back drop, the main objective of this paper is to examine empirically the extent to which higher food and oil prices translate into higher domestic prices in Pakistan by employing Structural Vector-Autoregressive (SVAR) modeling approach and Generalised Impulse Response Functions (GIRFs) developed by Koop, *et al.* (1996) and Pesaran and Shin (1998). This technique is unique since it yields outcomes that are invariant to the ordering of variables. We examine the effects of food and oil price shocks on domestic output, inflation, interest rate and exchange rate of Pakistan using monthly data over the period 1990M1 to 2011M7. The rest of the paper is organised as follows: Section 2 discusses the transmission channels of oil and food price shocks. Methodology and specification of SVAR model is outlined in Section 3. Section 4 reports empirical findings. Policy implications are discussed in Section 5, while some concluding remarks are given in the final section.

2. THE TRANSMISSION CHANNELS OF OIL AND FOOD PRICES

It can be argued that in the short-run oil price shocks affect macroeconomic performance through various channels. Theoretical literature has identified six transmission channels through which oil price changes affect the performance of macroeconomic variables [Brown and Yucel (2002); Jones, *et al.* (2004); Tang, *et al.* (2010), among others]. These transmission channels include the supply-side shock effect, wealth transfer effect, inflation effect, real balance effect, sector adjustment effect and the psychological effect. Figure 1 depicts the transmission channels through which raising oil and food prices affect the macroeconomic variables.

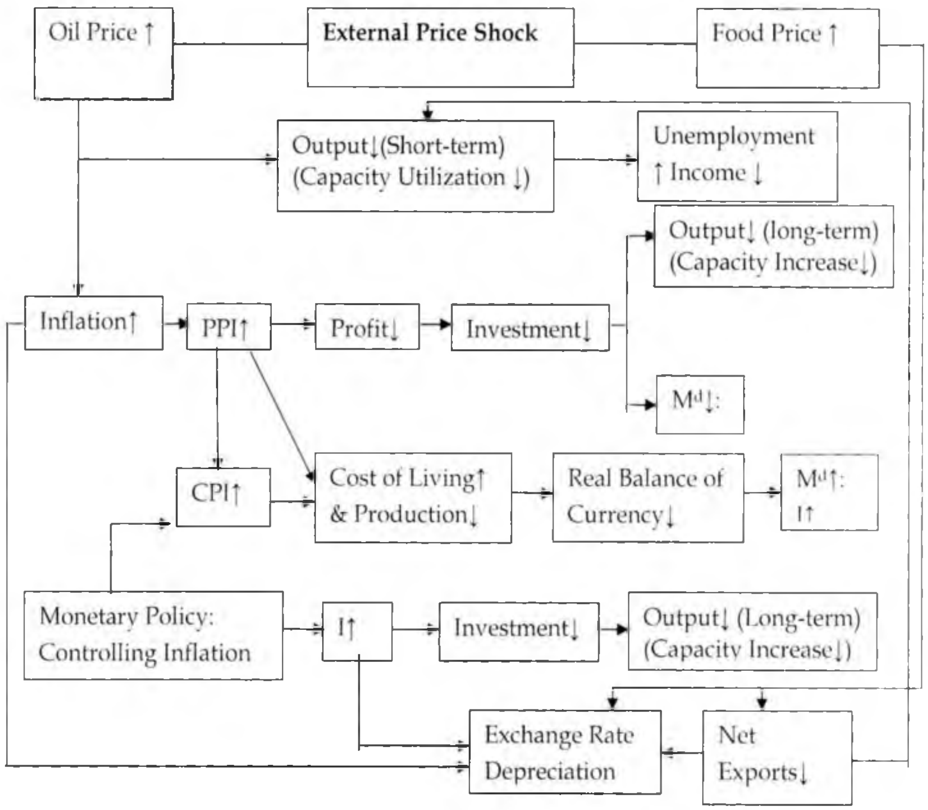
According to supply-side effect, rising oil prices are indicative of the reduced availability of a basic input to production, leading to a reduction of potential output [Lescaroux and Mignon (2008)]. Consequently, there is an increase in the marginal costs of production and the growth of output and productivity are slowed [Lescaroux and Mignon (20080 and Tang, *et al.* (2010)]. The decline in productivity growth negatively affects real wages and increases unemployment [Kumar (20090; Chuku, *et al.* (2010)]. Figure 1 provides an illustration of the supply-side shocks: increase in oil prices reduces

[1]Supply shocks include energy shortages, rising global commodity prices and unprecedented floods in the summer of 2010 [Amjad, *et al.* (2011)].

[2]High borrowings by the government of Pakistan from the State Bank of Pakistan and the Commercial Banking System to finance fiscal deficits, large increases in remittances, high government subsidized prices and large increases in the wages of government employees [Amjad, *et al.* (2011)].

output in the short-run due to the reduction of capacity utilisation which, in turn, increases unemployment and reduces income.[3]

Fig. 1. Transmission Channels of Oil and Food Shocks



Source: Constructed by authors following Tang, *et al*. (2010) and Alom (2011).

The second important transmission channel of oil price shocks is the wealth transfer effect. This channel suggests that increase in oil prices shifts purchasing power from oil-importing countries to oil-exporting countries. A persistent rise in oil price would consider being a significant windfall in revenue and improvement in balance of payments of oil-exporting countries. The transfer of wealth is expected to reduce the aggregate demand of the oil-consumer countries while opposite is expected in the case of oil-producing countries [Galesi and Lombardi (2009)], because it is assumed that marginal propensity to consume in the oil-exporting countries is higher. The oil price shocks in oil-importing countries are transmitted through the demand-side by triggering the reduction of demand for goods and services. High oil prices may affect consumer expenditures via four complementary channels: discretionary income effect, uncertainty effect, precautionary saving effect and operating costs effects [Kilian (2010) and Chuku, *et al.* (2010)]. This implies that an increase in oil prices deteriorates terms of trade for oil-importing countries [Dohner (1981)].

[3]Since oil is considered to be an important factor of production, an increase in its price raises the cost of production. As a result, domestic productivity will be slow.

Besides the slowing down total output, a hike in oil price generates inflationary pressures in the economy [Hooker (2002) and Tang, *et al.* (2010)]. Since oil-based products are an important components of consumer price index. The first round effect of high oil prices is a sudden increase of the headline inflation. However, the degree of pass-through effect depends on the domestic response to the shocks [Galesi and Lombardi (2009)]. Evidence suggests that reduced output and inflation are the two most likely effects of oil price shocks [Chuku, *et al.* (2010)]. An oil price shocks constitutes a cost of production shocks, operating through supply-side effect which produces upward pressure on labour costs and prices [*Ibid* (2010)]. Barsky and Kilian (2004) showed that increases in oil price generate high inflation. This can also be interpreted as price shock second round effects, giving rise to wage-price loops [Galesi and Lombardi (2009)].

According to the real balance effect transmission channel, an increase in oil prices would lead to increase in demand for money. Since the monetary authorities failed to meet growing money demand with increased money supply. Consequently, there is an increase of interest rates and retard of economic growth [Brown and Yucel (2002)]. Alternatively, working through the price-monetary transmission mechanism, oil price shocks can reduce investment due to the reduction in producer's profits and equally reduces money demand (Figure 1).

The monetary policy channel is another important channel through which monetary authorities respond to oil price shocks. For example, tightening of monetary policy through increased interest rates (Figure 1) to combat inflationary pressure caused by rising oil prices, discourage investment and worsens output in the long-run [Tang, *et al.* (2010)]. Brenanke, *et al.* (1997) documented that tightening of monetary policy and oil price shocks produced depressing effects on real economy.

The sectoral adjustment effect channel shed light on the asymmetric impact of oil price shocks within the sectors of the economy. Brown and Yucel (2002) offers the possible explanations for this asymmetry adjustment would be rely on monetary policy, adjustment costs, adverse effects of uncertainty on the investment environment and asymmetry in the petroleum product prices [Lardic and Mignon (2006, 2008, and Lescaroux and Mignon (2008)]. When oil price rises, slowing economic activities is further retarded by adjustment costs. Conversely, when oil price falls, stimulated economic activities is somewhat offset by adjustment costs [Brown and Yucel (2002 and Chuku, *et al.* (2010)]. Such costs could arise from sectoral imbalances and lack of coordination between firms or because energy-to-output ratio is embedded in the capital stock [Brown and Yucel (2002) and Lescaroux and Mignon (2008)]. In the presence of sectoral imbalances, an increase (decrease) in oil price would require contraction (expansion) of oil intensive sectors and expansion (contraction) of oil efficient sectors [Lilien (1982) and Hamilton (1988)]. These realignments in production require adjustments, which cannot be achieved in the short run-known as dispersion hypothesis [Kumar (2009)]. Furthermore, asymmetry in oil prices will result in under-utilisation of resources and rising unemployment.

Finally, psychological effect implies that given the uncertainty about how long will oil prices remain high can adversely affect economic activities by reducing investment demand of firms and consumer's demand-known as the uncertainty channel. Uncertainty causes firms and consumers to postpone irreversible investment and consumption decisions following positive oil price shocks [Burnanke (1983); Pindyck (1991); Ferderer (1996) and Galesi and Lombardi (2009)].[4] If energy-to-output ratio embedded in the capital stock, the firms must choose energy-intensive production process when purchasing capital. For consumer, the uncertainty mainly applies to consumer durables, especially energy-using consumer durables. Uncertainty about future oil price causes upward and downward movements in oil prices. It is worth noting that when future oil prices become increasingly uncertain, the value of postponing the investment (or consumption) decisions increases, and the net incentive to invest (or consume) decreases, thereby dampening long-term prospects of output [Chuku, *et al*. (2010)].

The literature also reveals that food and oil prices are responsible for slowing down world economic growth [Headey and Fan (2008); Abott, *et al*. (2009); Galesi and Lombardi (2009); Hakro and Omezzine (2010); Alom (2011) and Jongwanich and Park (2011)]. The transmission channel (Figure 1) suggest that increase in food prices leads to increase import bills which decreases net exports and causing domestic output to fall—referred net export channel. On the other hand, when food price increases globally the demand for food exports decreases which ultimately reduces net exports—a part of national income [Alom (2011)]. Increase in food and oil prices also increases the demand for money and interest rates which produces adverse effect on exchange rates.

In general it is very difficult to quantify the net effect of oil and food price hike. The pass-through effect of global commodity price changes on domestic prices can be analysed into three channels. First, the direct or the first-round effect, which refers to the rise in prices of energy products. Second, the indirect effect which refers pass-through of higher energy-related costs of production to the prices of other goods and services. Third, the second-round effect, which occurs due to an increase in the cost of living, worker's demands a higher wage in order to maintain their real income [Galesi and Lombardi (2009)]. The effect of the first two channels is likely in the short-to- medium term. However, the second-round effect is expected to be more prolonged and may result, wage-price spiral, causing inflation to accelerate [Galesi and Lombardi (2009)].

Bruno and Sachs (1985) suggest that after the oil price shocks of the 1970s, monetary authorities adopted expansionary monetary policies which eventually aggravated effects on inflation. However, nowadays monetary authorities commit themselves to rapidly counter inflationary measures to enhance the credibility of monetary authorities. Galesi and Lombardi (2009) argued that a credible inflation-countering strategy would create a stable environment of low inflation, anchoring the inflation expectations and influencing the price-setting behaviour.

3. METHODOLOGY: SPECIFICATION OF STRUCTURAL VECTOR AUTOREGRESSIVE (SVAR)

To address the issues related to food and oil price shocks, we make use of Structural Vector Autoregressive (SVAR) modeling approach. The advantage of the SVAR over the other classes of vector autoregressive models is that it has better empirical fit and allows indentifying structural shocks with respect to economic theory. Furthermore, SVAR also makes it possible to examine the net effects of unexpected

[4]It can be argued that when oil prices increase, consumers and producers could postpone their purchases of oil related products and reduce their oil consumption [Galesi and Lombardi (2009)].

change in one or more variables on other variables in the system [Chuku, *et al.* (2011)].[5] To analyse the transmission channels of oil price and food price shocks in Pakistan, we make use with a reduced form Vector Auto-Regressive (VAR) model. Since oil and food prices can directly increases domestic inflation and will cut producer's profit rates, which together with interest rate adversely influences domestic output through the channel of investment.

Following Breitung, *et al.* (2004) we start with the following structural *VAR*(*p*) system:

$$AX_t = A_1 X_{t-1} + A_2 X_{t-2} + \ldots\ldots\ldots + A_p X_{t-p} + \varepsilon_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad (1)$$

Where X_t is a $(n \times 1)$ vector of endogenous variables ($X_t = (p_t^o, p_t^f, y_t, m_t, i_t, q_t, \pi_t)$), A is an invertible ($n \times n$) matrix of coefficients of contemporaneous relations on the endogenous variables; $A_i's$ are $(n \times n)$ matrices which captures dynamic interactions between the k variables in the model, and ε_t is a $(n \times 1)$ vector of structural error terms. p is the number of lags. It can be argued that VAR estimation is very sensitive to lag order of variables. A sufficient lag length may help to reflect the long term impact of variables on others. However, by selecting longer lag length may cause multicollinearity problems and will reduce the degrees of freedom (DOF) [Wooldbridge (2006); Tang, *et al.* (2010) and Chuku, *et al.* (2010)]. Tang, *et al.* (2010) argued that for any $p \geq 11$, the model will become divergent with at least one autoregressive roots greater then unit. Therefore, sequential modified Likelihood Ratio (LR) test suggest that lag order 1-3 is best for this nature of models [Wooldbridge (2006); Tang, *et al.* (2010) and Chuku, *et al.* (2010). SVAR models are more suited to track and identify structural shocks with respect to underlying economic theory [Chuku, *et al.* (2011)]. Hence, it is necessary to impose relevant restrictions on the system of equations to retrieve structural shocks of the model.

The model residuals are assumed to be linearly related to structural shocks, denoted by u_t, so that $u_t = B\varepsilon_t$, where B is $(n \times n)$ matrix of structural coefficients representing the effects of structural shocks. It is further assumed that ε_t is mutually orthogonal so that the dynamic impacts of each individual structural shock can be expressed in isolation. Thus, ε_t is a $n \times 1$ vector of the structural shocks assumed normally distributed with zero mean and normalised diagonal variance-covariance matrix $\Omega = I$. Therefore, system (1) can be expressed as:

$$AX_t = A_1 X_{t-1} + A_2 X_{t-2} + \ldots\ldots\ldots + A_p X_{t-p} + B\varepsilon_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad (2)$$

The structural model represented by system (2) must be identified for the purpose of policy analysis and must be given economic interpretation [Leeper, *et al.* (1996)]. The fundamental problem here is that model (2) is not directly observable and cannot directly estimated to derive the true values of ε_t and coefficients in A and $A_i's$. The reduced form of the model (2) can be obtained by pre-multiplying the model (2) with A^{-1} as written below:

[5]We include two external variables, such as oil price and food price.

$$X_t = A_1^* X_{t-1} + A_2^* X_{t-2} + \ldots\ldots\ldots + A_p^* X_{t-p} + u_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad (3)$$

Where $A_i^* = A^{-1} A_i$, u_t denotes the reduced-form VAR residuals vector uncorrelated with variables in X_t and normally independently distributed with variance-covariance matrix $\Omega = E(u_t u_t')$. Thus ordinary least squares (OLS) estimation gives consistent estimates of A_i^*. Similarly the estimates of Ω can be obtained from the fitted residuals.

Since only the lagged terms are listed on the right-hand side of the VAR equation and a reduced-form VAR is unable to trace the contemporaneous relationship among variables which causes cross-correlation among residuals series. Although, the covariance matrix of residuals $\Omega = E(\varepsilon_t \varepsilon_t') \neq 1$, but it does not influence the un-biasedness and efficiency properties of estimation [Tang, *et al.* (2010)]. The contemporaneous relationship may affect the impulse responses. As Equation (2) is not directly observable, the solution is obtained through another relation between the reduced form VAR model (3) and the structural VAR model (2) as:

$$Au_t = B\varepsilon_t = u_t = A^{-1} B\varepsilon_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (4)$$

The structural coefficients in Equation (2) can be recovered from the reduced-form Equation (3), using relations (4). To identify structural form parameters it is necessary to impose sufficient restrictions on either matrix of parameters A, B or both. For the just identification we need $(n^2 + n)/2$ restrictions on the A and B. Furthermore, we need additional $n^2 - (n^2 + n)/2$ restrictions on matrix B [Amisano and Giannini (1997)]. In our case we have seven variables model; therefore, we need 21 additional restrictions to estimate the model.

3.1. SVAR Model for the Pakistan Economy

There is no consensus on the number of variables required in SVAR model to provide a plausible interpretation of an economy. Dungey and Pagan (2000) included eleven variables in SVAR, while Kim and Roubini (2000) and Brichetto and Voss (1999) argued that seven variables are enough [Naqvi and Rizvi (n. d.)]. For the smaller economies like Pakistan, world oil and commodity prices are assumed to be exogenous. Hence, we specify a VAR model that involves a set of variables represented by the following vector X_t.

$$X_t = (p_t^o, p_t^f, y_t, m_t, i_t, q_t, \pi_t) \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (5)$$

Where p_t^o is the world oil price in terms of US dollar, p_t^f is the international food price index, y_t is the output proxied by industrial production index, m_t is money supply (M2 definition), i_t is the short-term interest rate proxied by the overnight call money rate, q_t is the real effective exchange rate and π_t^{cpi} is the consumer price inflation proxied by the log difference of consumer price index (CPI). Lower case letters represents the logarithmic form of the variables except for interest rate.

World oil prices and international food prices are the key variables of interest. The variables p_t^o and p_t^f are determined exogenously relative to the policy shocks. They serve as instruments to isolate exogenous monetary policy shocks. Furthermore, world oil and food prices are included to examine the international price shocks on domestic economy. Overnight call money rate and exchange rate are included to captures the effect of monetary policy shocks and exchange rate shocks on other variables.

For the identification, we impose following set of restrictions on the contemporaneous structural parameters following Kim and Roubini (2000), Naqvi and Rizvi (n. d) and Alom (2011). The summary of identification scheme based on the Equation (4), $u_t = B\varepsilon_t$ is as follows:

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ b_{31} & 0 & 1 & b_{34} & 0 & 0 & b_{37} \\ 0 & 0 & b_{43} & 1 & b_{45} & 0 & b_{47} \\ b_{51} & 0 & 0 & b_{54} & 1 & b_{56} & b_{57} \\ 0 & 0 & b_{63} & b_{64} & 0 & 1 & 0 \\ b_{71} & b_{72} & b_{73} & b_{74} & b_{75} & b_{76} & 1 \end{pmatrix} \begin{pmatrix} \varepsilon^o \\ \varepsilon^f \\ \varepsilon^y \\ \varepsilon^m \\ \varepsilon^i \\ \varepsilon^q \\ \varepsilon^\pi \end{pmatrix} = \begin{pmatrix} u^o \\ u^f \\ u^y \\ u^m \\ u^i \\ u^q \\ u^\pi \end{pmatrix} \quad \ldots \quad (5)$$

Where $\varepsilon^o, \varepsilon^f, \varepsilon^y, \varepsilon^m, \varepsilon^i, \varepsilon^q$ and ε^π are the structural disturbances, that is, oil price, food price, output, money demand, interest rate, real effective exchange rate and inflation rate shocks respectively, while $u^o, u^f, u^y, u^m, u^i, u^q$ and u^π are residuals in the reduced form equations.

We imposes identifying contemporaneous restrictions on the structural parameters following the information-based approach of Sims (1999), Gordon and Leeper (1994), Sims and Zha (1998), Kim and Roubini (2000), Kim (2001) and Lee and Ni (2002). We assume that oil price is exogenous, this means that food price (p_t^f), output (y_t), money supply (m_t), short-term interest rate (i_t), real effective exchange rate (q_t) and consumer price inflation (π_t^{cpi}) are not determinants of oil prices at period t. Equation (2) is food price (p_t^f) function which is assumed to be affected only by changes in oil price (p_t^o). Both oil price and food prices capture the effect of international supply shock on inflation—the cost push inflation. Equation (3) is output (y_t) function which captures demand shock and is assumed to be affected by oil prices, money balances and inflation rate. The fourth equation is money demand function which depends upon the real income proxied by industrial production index, inflation rate and short-term nominal interest rate. The monetary policy reaction function is represented by Equation (5). Sek (2009) argued that interest rate respond contemporaneously, to inflation, output and exchange rate. Therefore, in line with Sek (2009) the monetary policy reaction function includes oil price, money supply, real effective exchange rate and inflation rate. Real effective exchange rate is included to capture the effect of exchange rate shocks on inflation and is assumed to be affected by interest rate, money supply, output, food and oil prices. Finally, inflation rate receives contemporaneous effects of all variables in the system. In other words, inflation rate responds contemporaneously to demand shocks, exogenous supply shocks, monetary policy shocks and exchange rate shocks.

On the whole, the structural shocks consist of various blocks. The first two equations represent exogenous shocks originated from the world economy, the oil price and food price shocks. The third equation describes the good market equilibrium. Equations four and five represent money market equilibrium condition and monetary policy reaction function. Equation six associates to foreign exchange market, while the last equation describing domestic price setting behaviour.

3.2. The Data

We employed monthly data over the period January 1990 to July 2011 for Pakistan. The rationale behind the selection of this period is to capture oil price and global food price shocks of the mid-2008. Our primary focus is to examine the impacts of oil price and international food price shocks on inflation rate, real income, money balances, nominal effective exchange rate and nominal short-term interest rate. To this end, we have selected five endogenous variables ($y_t, m_t, i_t, q_t, \pi_t$) and two external variables (p_t^o, p_t^f) to capture the inter-relationship with in the SVAR framework.

Real GDP (y_t) on monthly frequency is not available; hence we have used an industrial production index as proxy for real GDP. Inflation rate (π_t) is calculated by taking the log difference of the consumer price index (CPI) multiplied by 100. Money supply M2 definition (m_t) is included to capture the influence of monetary sector. This is because the State Bank of Pakistan responds oil price shocks, which may affect the economic activities in Pakistan. For the nominal short-term interest rate (i_t) we have used overnight call money rate. To capture the effects of oil price shocks and food price shocks on exchange rate, we have included trade weighted real effective exchange rate (q_t). For oil prices (p_t^o) we choose the West Texas spot crude oil price in dollar term. We eliminate the influence of exchange rate fluctuations by transforming the dollar price of Pak-rupee using the average corresponding Pak-rupee-U.S. dollar exchange rate. For global food price, we used food price index. Data on these variables are retrieved from the International Monetary Fund's International Financial Statistics-IFS CDROM-2008 and updated using monthly *IFS Bulletins* (various issues). All the variables are expressed in logarithmic form except for interest rate.

4. ESTIMATION RESULTS: STRUCTURAL VAR ANALYSIS

4.1. Impulse Response Analysis

The main objective of this study is to track out the impact of oil price and food price shocks on inflation rate, domestic output, money balances, interest rate and real effective exchange rate by mean of Generalised Impulse Response analysis. In other words, the study mainly traces how domestic variables respond to oil price and food price shocks. For this purpose we estimated SVAR model in levels of the variables. For the policy analysis it is important that one should add sufficient number of lags to remove serial correlation and make the errors stationary (i.e. I (0)) and proceed to the analysis. Hence, there is no need to worry about non-stationarity of the variables.[6] "Sims (1980) and Sims, *et al*. (1990) recommended against differencing even if the variables contain a unit root. They argued that the goal of a VAR analysis is to determine the interrelationships among the variables, not to determine the parameter estimates. Differencing of variables may lose important information concerning the co-movements in the data [Enders (2004), p. 270]". Similarly, McCallum (1993) argues that the estimation of SVAR in levels is appropriate if the error terms of each VAR equations are stationary and serially uncorrelated [Parrado (2001)]. Our preliminary results suggest that residuals characterise vector white noise processes.[7]

The SVAR model is estimated using three lags on the basis of Akiake Information Criteria (AIC). Given the structural factorisation specified by Equation (5), we impose 21 just-identifying restrictions on SVAR model. Table 1 reports the contemporaneous coefficient estimates based on the SVAR model. These coefficients provide baseline intuition of the basic relationship that exists among the variables.

Table 1

Contemporaneous Structural Coefficients

	Coefficients	Standard Error	Z-statistic	Probability
b_{21}	0.057	0.020	2.87	0.004
b_{31}	0.038	0.077	0.493	0.622
b_{34}	1.280	1.088	1.18	0.239
b_{37}	-0.007	0.017	-0.41	0.685
b_{43}	-0.066	0.141	-0.47	0.638
b_{45}	-0.025	0.026	-0.96	0.337
b_{47}	0.043	0.049	0.87	0.382
b_{51}	2.981	3.005	0.99	0.321
b_{54}	132.200	67.440	1.96	0.050
b_{56}	102.145	58.586	1.75	0.081
b_{57}	1.650	0.772	2.14	0.033
b_{63}	-0.002	0.015	-0.11	0.910
b_{64}	-0.323	0.390	-0.83	0.408
b_{71}	3.778	2.153	1.76	0.079
b_{72}	-19.509	9.494	-2.06	0.040
b_{73}	0.157	6.628	0.02	0.981
b_{74}	98.615	62.544	1.58	0.115
b_{75}	-0.257	0.262	-0.98	0.327
b_{76}	-13.026	38.943	-0.33	0.738

Likelihood Ratio (LR) test for over-identifying restrictions: $\chi^2(2) = 4.25[0.114]$.

[6]There are two possibilities: (i) Use a recursive VAR (Cholesky decomposition), but this is *ad hoc* and results are order-dependent, (ii) Impose contemporaneous short-run restrictions on SVAR on levels whether the variables are I(1) or I(0). Add enough lags to get I (0) errors. With these "identifying assumptions", correlations can be interpreted causally. For example, Taylor rule sets the interest rate equal to lagged inflation and unemployment (instrumental variable regression) and is the interest rate equation in the VAR.

[7]The results are available from the authors.

The contemporaneous coefficients will indicate immediate response of domestic prices, domestic output, money balances, interest rate and exchange rate to world oil and food price shocks. We imposed 21 restrictions to just-identified the model. The LR test is 4.25 which indicate that restrictions are valid and hull hypothesis cannot be rejected.

In order to investigate the short-run dynamics we employ Generalised Impulse Response Functions (GIRFs) proposed by Koop, *et al.* (1996) and Pesaran and Shin (1998). GIRFs are more appealing compared to Sims's (1980) orthogonalised impulse response functions as they are invariant to the ordering of the variables [Galesi and Lombardi (2009)]. GIRFs trace out the responsiveness of dependent variable to shocks to each of the variables in the SVAR model. For each equation, a positive standard unit shock is applied to the oil and food prices respectively up to a limit of twenty four months horizon. Since our main interest is to measure the oil and food price shocks on selected macroeconomic variables, we only traces out the responses of independent variables. In our SVAR model we assume that oil prices do not react to disturbances to other macroeconomic variables. The literature suggests that oil price shock usually have immediate and direct effect on inflation and on output, so we choose the ordering $\pi_t, y_t, m_t, i_t, q_t$, while food price react positively to only oil prices.

4.2. A Shock to Oil Prices

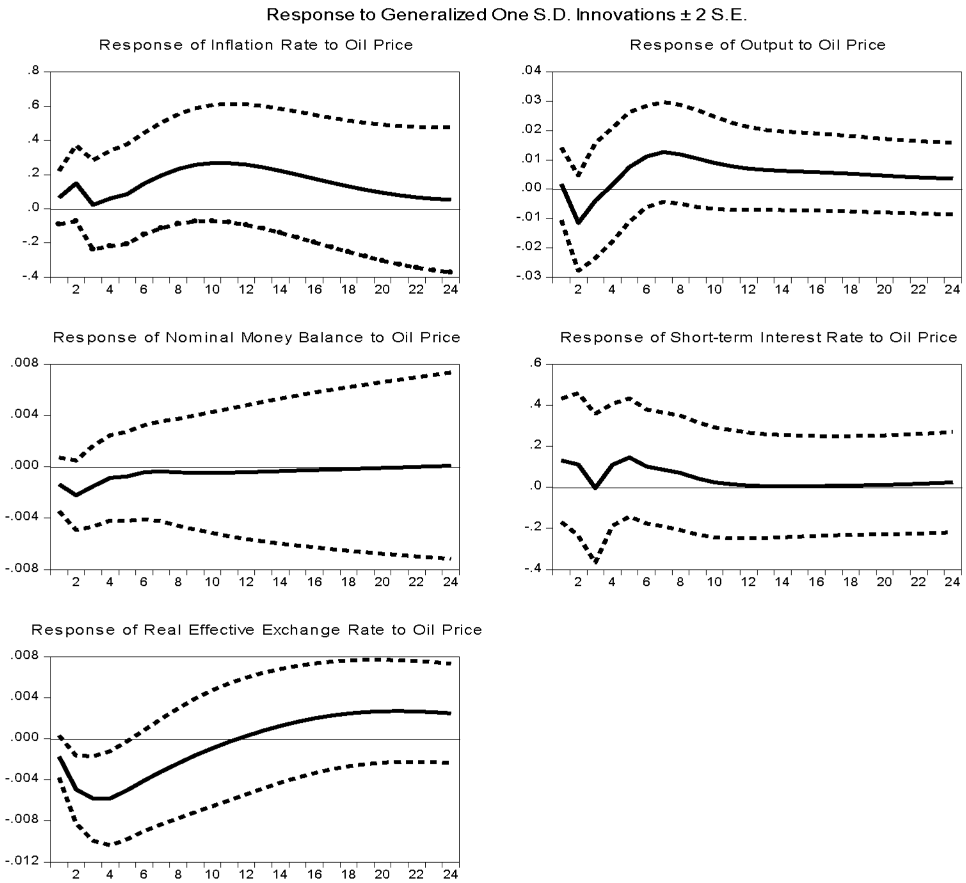
Figure 2 display GIRF of each variable to a positive one unit standard deviation shock to oil prices. As expected, initially inflation shoots up following the oil price shock and after one month it starts declining. After 3-month period inflation starts accelerating and the maximum impact is reaches around 11 to 12-months. This implies that oil price shocks cause inflationary pressure on the Pakistan's economy. Javid and Munir (2011) obtained almost similar results for Pakistan.

We observed negative responses of domestic output following oil price shock. In response to oil price shock, output falls down immediately and hits the bottom at around second month and starts increasing and attains the peak level in seventh month. However, after seventh month output starts declining and remains stagnant over next fourteenth to twenty-fourth month. This implies that after oil price shock output declines quickly and recovers slowly. The pattern of GIRF suggests that oil price increases may reduce the supply of intermediate goods industries and the demand for final goods industries [Lee and Ni (2002)]. Lee and Ni (2002) also obtained similar findings.

The response of money balances to oil price shock is initially negative and after a lag of two months money balances starts increasing and completely dies out after 17th month. This implies that the monetary authorities cut money supply following an oil price shock up to the second month. The rationale for this policy stance could be to check the inflationary pressure that may generated by oil prices. However, after the second month, money supply rises again over and above levels before oil price shock.

The response of short-term interest rate indicates that short-term interest rate declines immediately after the oil price shocks. However, after 3rd month it starts increasing and reaches its maximum level in 5th month, and then it falls slowly and completely dies out over the next 12th months. This result is consistent with monetary contraction after an inflationary oil price shock [Kim and Roubini (2000) and Javid and Munir (2011)].

Fig. 2. Generalised Impulse Responses of a Positive Unit (One S.D) Shock to Oil Prices



The real effective exchange rate appreciates immediately following the oil price shocks up to the fourth months. The real effective exchange rate revert its tendency and starts depreciation over the next 24-months. This implies that the exchange rate appreciation will be transitory and will revert to above its pre-shock levels after all prices and wages have adjusted. This mean-reverting behavior of real effective exchange rate is consistent with the long-run implications of overshooting monetary exchange rate models [Kim and Roubini (2000)].

4.2.1. *Generalised Forecast Error Variance Decompositions Analysis*

The Generalised Forecast Error Variance Decompositions (GFEVDs) analysis provides a tool of analysis to identify relative importance of each dependent variable in explaining the variations in the explanatory variables [Chuku, *et al.* (2010)]. Furthermore, GFEVDs provide insights on the transmission channels through which policy-specific shocks spillovers. The results of GFEVDs over a 24 months horizon for oil price shocks are displayed in Table 2.

Table 2

Generalised Forecast Error Variance Decompositions of Crude Oil Price

Period	Std. Error	p_t^o	p_t^f	y_t	m_t	i_t	q_t	π_t
1	0.080	100.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.177	93.630	2.340	0.089	0.064	2.538	1.271	0.068
8	0.235	75.661	7.844	2.224	0.183	4.932	7.859	1.296
12	0.268	62.808	8.361	4.734	0.608	6.402	15.242	1.845
16	0.288	55.352	7.373	6.080	0.920	7.438	21.183	1.654
20	0.301	50.992	7.134	6.675	1.086	8.378	23.898	1.837
24	0.310	48.431	7.636	6.784	1.164	9.393	24.201	2.391

Note: Cholesky Odering: $p_t^o, p_t^f, y_t, m_t, i_t, q_t$ and π_t.

As can be seen from the Table 2 that the contribution of oil price shock to output is 6.78 percent over the period of 24-months horizon. This implies that oil price shocks significantly affect real ouput and the impact is persistent over the longer horizon. This result confirms the earlier findings of Javid and Munir (2011). The results suggest that the contribution of the money supply is negilible, it is equal to 0.06 percent and 1.16 percent between 4-month and 24-month horizon respectively. Similarly, the impact of stort-term interest rate is 2.54 percent in 4-months. Its contribution increases over time and reaching 9.39 percent after two years. This implies that the monetary authorities react against oil price shocks.

The oil price shocks explain large part fluctuations in real effective exchange rate. The contribution of oil price shock to effective exchange rate is 1.27 percent in 4-month period. It increases gradually over time and passing over 24 percent after two years. Thus the exchange rate innovations tends to increase over time and more dominate source of fluctuations. This implies that exchange rate innovations may perceived more permanent and tend to pass-through to the domestic inflation faster than any other variable under investigation.

Finally, the impact of oil price shock to inflation over a 24-month horizon ranges between 0.07 percent to 2.39 percent. This low impact of oil price shock on inflation may suggest the existence of domestic price stickiness with respect to international oil prices. In other words, this implies the slow adjustment of domestic prices to international price level.

In overall term, the results suggest that oil price shock significantly affect domestic economic activities. Oil price shocks togather with exchange rate depreciation generates inflationary pressures in Pakistan. The inflationary shocks are mainly explained by real effective exchange rate (24.20 percent), short-term interest rate (9.39 percent) and domestic output (6.78 percent). Therefore, SVAR analysis reveals the topical role of the real effective exchange rate and stort-term interest rate in controling inflation in Pakistan.

4.3. A Shock to Food Prices

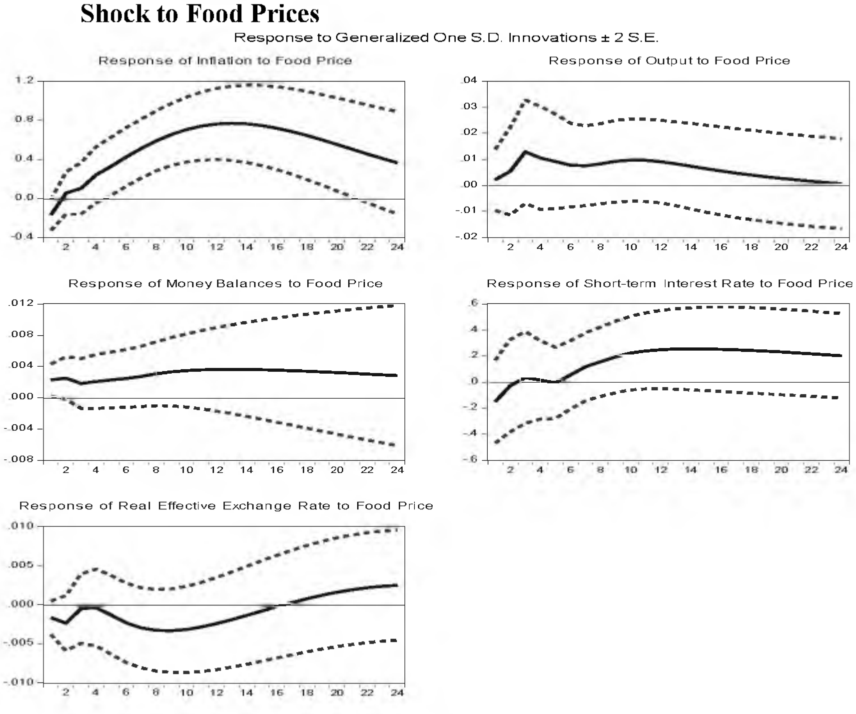
Figure 3 displays the GIRFs of each variable to a positive unit standard deviation shock to food prices. As expected, consumer price inflation shoots up immediately following the food price shock and reaches its maximum levels in 13th month. After 13th month it falls steadily over the next 11-months and remains to above the pre-shock level. This effect of food price shock partially reflects the weight that the food component has in consumer price basket. Since food price is important component of the CPI, therefore, food price shock significantly generates inflationary pressures on Pakistan's economy.

The effect on the output proxied by the industrial production index is clearly different form oil price shocks. Initially output responds positively to food price shock, reached its peak levels in third month. Then it falls gradually and dies out after two years from the shock (i.e. 24th month). This implies that food commodities are different from crude oil prices and are not broadband production factors. Thus a rise in their prices does not generally lead to a decrease in output [Alom (2011)].

The effect on the money balances is not much significant and remains persistent over the horizon of 24-months. However, the response of short-term interest rate to food price shock is positive and reaches at the peak levels in third and 12th months respectively. Then it remains persistent over the next 12-months.

A positive one unit standard deviation shocks to international food prices appreciates real effective exchange rate up to 2-months and then starts depreciation over the next 2- months. Real effective exchange rate starts appreciation following the food price shock and reaches its peak levels in 9th month. Then it depreciates gradually and after 24-month the real depreciation is 0.03 percent. This mean-reverting behavior of real effective exchange rate is consistent with the long-run implications of overshooting monetary exchange rate models [Kim and Roubini (2000)]. However, the mean-reversion is relatively slow than that of oil price shocks.

Fig. 2. Generalised Impulse Responses of a Positive Unit (One S.D) Shock to Food Prices



On the whole, increases in international food prices significantly generates inflationary pressure on Pakistan's economy and also causes exchange rate fluctuations which may considered as major source of disturbance.

4.3.1. *Generalised Forecast Error Variance Decompositions Analysis*

The results of GFEVDs over a 24 months horizon for food price shocks are reported in Table 3.

Table 3

Generalised Forecast Error Variance Decompositions of Food Prices

Period	Std. Error	p_t^o	p_t^f	y_t	m_t	i_t	q_t	π_t
1	0.078	3.120	96.880	0.000	0.000	0.000	0.000	0.000
4	0.177	1.756	92.928	3.348	0.322	0.187	1.075	0.385
8	0.235	1.170	83.945	6.296	0.856	0.087	6.512	1.133
12	0.268	0.807	73.793	7.513	1.069	0.080	15.729	1.008
16	0.288	0.627	64.267	8.736	1.121	0.083	24.255	0.912
20	0.301	0.535	56.862	9.594	1.062	0.073	30.275	1.599
24	0.310	0.540	51.666	10.107	0.974	0.116	33.763	2.84

Note: Cholesky Odering: $p_t^o, p_t^f, y_t, m_t, i_t, q_t$ and π_t.

It can be seen fron the Table 3 that food price shocks explain 3.38-10.11 percent variations in domestic output, 1.08-33.06 percent variations in real effective exchange rate and 0.39-2.84 percent variations in inflation rate. However, GFEVDs reveals that money balances and short-term interest rate are mildly effected by food price shocks. The analysis suggest that the dominant source of inflation in pakistan is the persistent depreciation of exchange rate followed by the food price shocks.

5. POLICY IMPLICATIONS

We found that Pakistan's economy is relatively less affected by international oil and food price shocks. The findings related to oil price shocks suggest that oil price increases adversly affects industrial production. However, the effect of oil price shock on industrial production is relatively small. The reseaon could be that heavy industries in Pakistan are partially dependent on electricity generated by imported oil. Oil accounts for 29 percent of total energy used in Pakistan, while natural gas accounts for 40 percent [Malik (2010)]. The other reason for the reduction of industrial production could be that due to food price hike the labour force in the industrial sector may demand higher wages and thus demand for labour decreases which decreases output in the industrial sector [Alom (2011)]. Furthermore, increase in the price of food products put negative impact on import bills. Food and oil price shocks found to be transmit through interest rate and exchange rate chennels, therefore, other variables are not much responsive to the oil and food price shocks. This result is consistent with the earlier findings of Rafiq, *et al.* (2009). The reason could be the increase in money demand due to excess import bills. Exchange rate is again found to be important channel in terms of food price shock. Besides interest rate, the major channel through which oil and food price shocks transmit to Pakistan's economy are real effective exchange rate because real effective exchange rate is under pressures because of excess import bills due to oil and food price increase.

Our results imply that impact of international oil and food price shocks is transmitted through interest rate and exchange rate channels which create inflationary pressures and constraints economic activities in Pakistan. Therefore, there is need to reduce undue emphasis on international oil and food prices as key determinants of consumer prices inflation and place more emphasises on the prudent monetary, fiscal and exchange rate policies in macroeconomic policy formulation to deal with inflation, recession and poverty. Furthermore, the findings suggest that Pakistan may design effective policy measures to cope with oil price shocks. Renewable energy sources could be the important option to accommodate oil price shocks. To cope with the food price shocks there is need to increase food reserves and enhance domestic food production.

5. CONCLUSION

In this study we have applied SVAR methodology to investigate the short-run impact of oil and food prices on consumer price inflation for Pakistan using monthly data over the period 1990M1 to 2011M7. Generalised Impulse Response analysis reveals that oil and food price shocks have different inflationary effects. The impulse response analysis suggests that following oil price shocks, inflation immediately increases. After second month it follows downward trend up to 4-months. Then it again increases and reaches its maximum levels in 10th month and remains stable over the next 13-months. Whereas, following food price shock domestic price inflation gradually increases up to 12-months and then starts decreasing and remains above the pre-shock level by the end of two years. Furthermore, following a positive oil price shock, output initially decreases and after second month it tend to increases gradually between fourth to seventh month and stabilises over the next 17-months. On the other hand, following a positive food price shocks, output increases up to third month and then starts falling and completely dies out after two years. Similarly, interest rate responds positively following the oil and food price shocks. However, the variation in interest rate due to food price shock is relatively larger than that of oil price shocks. The GIRF reveals that real effective exchange rate is most important source of disturbance following either oil price or food price shocks. In either case initially exchange rate appreciates and then it depreciates gradually over the 24-month horizon.

Generalised forecast variance decompositions analysis also supports the findings based on GIRFs. The result clearly reveals that oil and food price shocks affect output, short-term interest rate, inflation rate and real effective exchange rate. However, among all, real effective exchange rate has seen a dominant source of variations in Pakistan. This implies that supply-side and demand-side disturbances due to external shocks are the major sources of stagflation in Pakistan.

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