© *The Pakistan Development Review*
58:1 (2019) pp. 65–81
DOI: 10.30541/v58i1pp.65-81

Oil Price Shocks, Systematic Monetary Policy and Economic Activity

MUHAMMAD ZESHAN, WASIM SHAHID MALIK, and MUHAMMAD NASIR

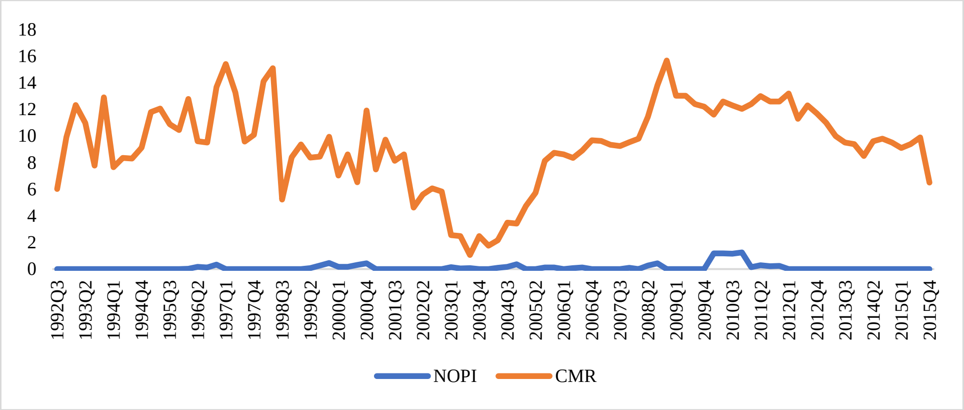
This study quantifies the impact of oil price shocks and the subsequent monetary policy response on output for Pakistan. It employs a quarterly Structural Vector Auto-regression framework for the period 1993–2015. It first discovers that Hamilton's (1996) Net Oil Price Increase indicator appropriately reveals most of the oil price shocks hitting Pakistan's economy. We find that a contractionary monetary policy, resulting from the oil price shocks, contributes to significant output loss in Pakistan. After encountering the Lucas critique, the present study finds that around 42 percent of the output loss is due to the ensuing tight monetary policy. This suggests that the central bank of Pakistan can reduce the impact of oil price shocks by reducing its intervention in the market.

JEL Classification: E1, E3, E5
Keywords: Oil Price Shocks, Monetary Policy, Structural Vector Autoregression

1. INTRODUCTION

Applying two simulation methods [Sims and Zha (1996); Bernanke, *et al.* (2004); Nusair (2016); Razmi, *et al.* (2016)], we find that a contractionary monetary policy resulting from the oil price shocks contributes to an output loss in Pakistan. Figure 1 elaborates a negative relationship between the oil price shocks and the tight monetary policy response pursued by the central bank of Pakistan.

Fig. 1. Oil Price Shocks and Monetary Policy in Pakistan



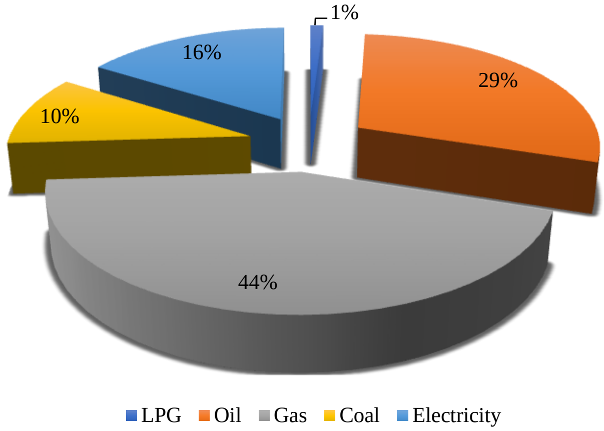
Note: NOPI is the oil price shock and CMR is call money rate. Further details of these variables are available in data section.

Muhammad Zeshan <muh.zeshan@gmail.com> is Senior Research Fellow, Pakistan Institute of Development Economics, Islamabad. Wasim Shahid Malik <wsmalick@gmail.com> is Associate Professor, Quaid-i-Azam University, Islamabad. Muhammad Nasir <nasirawan84@yahoo.com> is Senior Research Economist, Pakistan Institute of Development Economics, Islamabad.

Further, Knittel and Roberts (2005) suggest that a positive shock to oil price represents an unexpected demand shock driven by global economic activity. Each simulation method gives the same message that a tighter monetary policy resulting from oil price shocks increases output loss. The output loss from the monetary policy is around 12 percent in the Sims and Zha (1996) scenario while it is around 42 percent in Bernanke, *et al.* (2004) scenario. It is important to note that the latter scenario provides robust results as it encounters the Lucas critique. On the other hand, the oil price shocks alone are responsible for the remaining 88 percent of output loss in Sims and Zha (1996) scenario and for a 58 percent output loss in Bernanke, *et al*. (2004) scenarios.

During the fiscal year 2012-13, primary energy supply in Pakistan was around 64, 727 thousand tons of oil equivalent (TOEs), as compared to 64,522 thousand TOEs during the last year. This indicates a growth rate of 0.32 percent. On the other hand, final energy consumption during 2012-13 was around 40, 026 thousand TOE. The growth rate of energy consumption has increased by 3.1 percent. This energy consumption is highly skewed in favour of natural gas and oil consumption, Figure 2 portrays a detailed analysis of the energy mix in Pakistan.

Fig. 2. Energy Mix in Pakistan for 2012-13



Source: Hydrocarbon Development Institute of Pakistan, 2012-13.
Note: During 2012-13, final energy consumption in Pakistan was around 40, 026 thousand TOE.

For decades, oil price shocks have been held responsible for prolonged recessions worldwide. This assertion is based on the close correlation between the oil price shocks and economic downturns. The fact that oil price shocks precede all the major recessions further strengthens this claim [Hamilton (1983)]. Nonetheless, all the economists do not share the same opinion. A few believe that neither oil price shocks [Bruno and Sachs (1985)] nor the oil intensity has something to do with the recession [Baily (1982)], as the energy expenses account for a meagre share in the total cost. There appears to be some other factor worsening the situation and Bohi (1991) believes that it is a tighter monetary stance of the monetary authorities in the face of oil shocks.

Being a net oil importer, Pakistan is prone to international oil price shocks in terms of output loss and inflation. This also points to the importance of variations in the nominal and real exchange rates for the reason that a decrease in the value of rupee will increase the burden of import bill, thereby affecting the economic activity. Figure A1 (Appendix B) shows the variations in the real and nominal exchange rates for Pakistan in the first decade of the new millennium. Moreover, given a narrow oil supply base, an unexpected increase in oil price (which is a demand shock) makes the economy more fragile. Consequently, any oil price shock becomes a matter of concern for the monetary authorities in setting the policy rate, so as to minimise the welfare loss to the society. However, the dilemma is that a tight monetary stance to limit inflation may result in more output loss through the investment channel of demand. In this backdrop, it is very important to investigate the nature of the relationship between oil price shocks and the subsequent monetary policy.

The only study in Pakistan in this perspective is that of Malik (2008), who finds that oil price shocks have a significant and asymmetric relationship with macroeconomic variables. Nevertheless, the study is limited in the sense that it does not discriminate between the anticipated and unanticipated policy responses.[1] Unfortunately, no study till date, including the aforementioned one, has explicitly distinguished between the output loss, associated with oil price shocks and the one due to the endogenous monetary policy response. Hence, the present study finds an opportunity to fill this gap in the literature.

The rest of the study is organised as follows: the literature review is given in Section 2. The third section describes the theoretical framework and econometric modelling. Section 4 presents a brief description of data and variables. The results are discussed in Section 5 while Section 6 concludes the study and provides policy recommendations.

2. LITERATURE REVIEW

There is extensive literature on the nexus between oil price (demand) shock, economic fluctuations and monetary policy [Nusair (2016); Razmi, *et al.* (2016); Elwell (2013); Alquist and Coibion (2013)]. Macro-economists differ on the appropriate policy response by the monetary authorities to oil shocks [Hetzel (2013); Meltzer, *et al.* (2013)]. Gordon (1975), for instance, favoured monetary accommodation, in case the economy is hit by an adverse supply shock. Blinder (1981) argued in favour of monetary contraction in such situations. Nonetheless, Fischer (1985) advised the monetary authorities to restrain from any response as long as the workers do not resist any real change in wages.

It was believed for years that output loss in an economy facing oil price shocks is entirely the consequence of these shocks. However, it was the pioneering work of Bohi (1991) which considered the tight monetary policy following oil price shocks as the main cause of the output loss. Dotsey and Reid (1992) also shared the same view. However, these studies fail to quantify the production shortfall associated with the oil price shocks and the systematic monetary policy. This gap was filled by Bernanke, *et al*. (1997) by employing monthly VAR for this purpose. Results showed that oil price shocks induced a significant policy response in the form of increased interest rate. The identification problem made it difficult for them to separate the production loss associated with both the shocks and the subsequent monetary policy. To deal with this problem, the study employed Sims and Zha (1996) counterfactual experiments to observe that oil price

[1]Also, this study has not considered the financial reforms of 1990s that allowed the State Bank of Pakistan (the central bank of Pakistan, SBP) for market determined policy rate.

shocks have a minor negative impact on the real GDP, while the resulting tight monetary policy was responsible for 2/3 to 3/4 of the output loss. This was the first effort of sorting out the effect of the systematic monetary policy on the economic activity in the face of oil shocks. Following Bernanke, *et al*. (1997), Lee, *et al.* (2001) uncovered that oil price shocks had the potential to predict movements in the monetary policy in response to the oil shocks in Japan with 30 percent to 50 percent of the output loss attributable to the systematic monetary policy.

Nonetheless, the findings of Bernanke, *et al*. (1997) were questioned for two reasons. First, the strength and accuracy of the counterfactual experiments were doubtful, thereby leading to the so called Lucas critique. Secondly, the lag length selected by Bernanke, *et al*. (1997) was not appropriate [Hamilton and Herrera (2004)]. This second query is raised on the basis that oil shocks take three to four quarters in revealing their impact on output [Herrera (2007); Hamilton (2003)]. Therefore, for monthly data, it is advisable to place 12 lags instead of 7 as was done in Bernanke, *et al*. (1997). Hamilton and Herrera (2004) exercised the same dataset used in Bernanke, *et al*. (1997) and employed VAR framework for analysis. The study concluded that the lag length mis-specification in Bernanke, *et al*. (1997) was behind the huge output loss that was assumed to be associated with the systematic monetary policy. The study further claimed that the monetary policy would no more be responsible for output loss if the lag length is extended to 12.

Bernanke, *et al*. (2004) tried to settle the issues contemporaneously. The study argued that excessive lags could enhance the uncertainty in the model rather than avoiding the variable omission bias. Consequently, they employed 4 lags but with quarterly data, so as to ensure a more parsimonious model along with minimum uncertainty and mean square error. Moreover, they preferred to delay the policy response for four quarters instead of completely shutting it off in the model. Because a transitory deviation cannot deform the structure of the economy completely, it provided a possible solution for the Lucas critique as well. This experiment exhibited that the endogenous monetary policy was still responsible for half of the output loss, a bit lesser than their previous findings. Working with 6 lags, it again verified association of the output loss with the ensuing tight monetary policy.

Following Bernanke, *et al.* (2004), Herrera and Pesavento (2009) used quarterly data to minimise uncertainty in the sample data. With 4 lag length and delayed policy response for 1 year, the study came up with the same view as asserted previously. Splitting the data into two sets, owing to some structural break, it declared that the systematic monetary policy had some dampening impact on the economy during the 1970s with no contribution in the economic downturn in the later years.

In an attempt to evaluate the validity of Bernanke, *et al*. (2004), Carlstrom and Fuerst (2005) estimated a calibrated version of the General Equilibrium Model. It was suggested that unanticipated policy in terms of delayed policy response could minimise the output loss. Leduc and Sill (2004) also conducted various policy scenarios to evaluate the economic performance within the same framework and the results were consistent with the Bernanke, *et al*. (1997, 2004). Lee and Song (2009) concluded that the accommodative monetary policy trims down the output volatility without raising inflation significantly.

3. ECONOMETRIC METHODOLOGY

3.1. Structural Vector Autoregression (SVAR)

The SVAR is the most extensively used framework for the analysis of oil shocks and monetary policy. This framework is especially helpful in quantifying the output loss. Hence, following Kliem and Kriwoluzky (2013), Lange (2013) and Bernanke, *et al.* (1997, 2004) among others, we estimate a Structural VAR.[2]

However, Kilian and Vigfusson (2011) state that the presence of a censored variable (which is NOPI in the present case) will make the impulse responses inconsistent. To avoid this problem, Kilian and Vigfusson (2011) suggest to use oil price such that it is predetermined with respect to other macroeconomic variables. This is evident from Equation 1 where (domestic real) oil price is dependent only on the predetermined macroeconomic variables. Further, the study suggests to use NOPI in all other equations other than the oil price equation.

$$DROP_t = \alpha_{10} + \sum_{i=1}^{p}\alpha_{11,i}\, DROP_{t-i} + \sum_{i=1}^{p}\alpha_{12,i}\, CPI_{t-i} + \sum_{i=1}^{p}\alpha_{13,i}\, Y_{t-i} + \sum_{i=1}^{p}\alpha_{14,i}\, CMR_{t-i} + \varepsilon_{1,t} \quad \ldots \quad (1)$$

$$CPI_t = \alpha_{20} + \sum_{i=0}^{p}\alpha_{21,i}\, DROP_{t-i} + \sum_{i=1}^{p}\alpha_{22,i}\, CPI_{t-i} + \sum_{i=0}^{p}\alpha_{23,i}\, Y_{t-i} + \sum_{i=0}^{p}\alpha_{24,i}\, CMR_{t-i} + \sum_{i=0}^{p}\alpha_{25,i}\, NOPI_{t-i} + \varepsilon_{2,t} \quad \ldots \quad (2)$$

$$Y_t = \alpha_{30} + \sum_{i=1}^{p}\alpha_{31,i}\, DROP_{t-i} + \sum_{i=0}^{p}\alpha_{32,i}\, CPI_{t-i} + \sum_{i=1}^{p}\alpha_{33,i}\, Y_{t-i} + \sum_{i=0}^{p}\alpha_{34,i}\, CMR_{t-i} + \sum_{i=0}^{p}\alpha_{35,i}\, NOPI_{t-i} + \varepsilon_{3,t} \quad \ldots \quad (3)$$

$$CMR_t = \alpha_{40} + \sum_{i=0}^{p}\alpha_{41,i}\, DROP_{t-i} + \sum_{i=0}^{p}\alpha_{42,i}\, CPI_{t-i} + \sum_{i=0}^{p}\alpha_{43,i}\, Y_{t-i} + \sum_{i=1}^{p}\alpha_{44,i}\, CMR_{t-i} + \sum_{i=0}^{p}\alpha_{45,i}\, NOPI_{t-i} + \varepsilon_{4,t} \quad \ldots \quad (4)$$

Here $DROP_t$ is the domestic real oil prices, Y_t is the real GDP, CPI_t is the Consumer Price Index, CMR_t is the call money rate, $NOPI_t$ is Hamilton's (1996) oil price indicator and finally ε_i are the white noise structural shocks. The SVAR can be estimated with the help

[2]Initial literature considered the exclusion of commodity prices from a VAR framework as a reason for the price puzzle. Sims (1992) suggested the inclusion of commodity prices in order to avoid this puzzle. However, Leeper, *et al.* (1996) argued that the inclusion of commodity prices without theoretical justifications may also result in some serious specification bias. Fortunately, there is no price puzzle in the present study so it does not use commodity price index. It provides us two additional benefits. First it avoids the use of the *ad-hoc* based commodity price index in the VAR framework. Second, it makes the model more parsimonious and thereby reduces uncertainty in its estimates.

of Ordinary Least Square (OLS) technique, since it contains the same independent variables on the right hand side (RHS). Nonetheless, a different composition of the right hand side variables will require the Seemingly Unrelated Regression [Enders (2004)]. This estimation is performed in two steps. First, it estimates the reduced form parameters of the system. Second, it derives the structural parameters of the model for inferential analysis. Equations 1-4 summarise the identifying restriction for the estimation of structural parameters; it is based on Kilian and Vigfusson (2011). In these equations, oil price is predetermined with respect to other macroeconomic variables. It is domestic real oil price, dependent only on the predetermined macroeconomic variables. The rest of the identifying restrictions are as follows: since Pakistan is the net oil importer, it cannot affect international oil prices. However, being a net importer, it is affected by oil price shocks. Due to inertia, output is contemporaneously affected neither by oil price nor by interest rate. Finally, the interest rate does not affect prices in the same period due to rigidities in the economy.

3.2. Sims-Zha Counterfactual Experiments

Next we discuss how the output losses, due to the rising oil price and the subsequent tight monetary policy, can be separated, using the Sims-Zha framework. Sims and Zha (1996) made the first effort to quantify the impact of the endogenous monetary policy in the VAR framework, by shutting-off the monetary policy response.

Historically, a central bank tightens monetary policy in response to rising oil prices because it fears that higher oil prices would increase inflation and inflationary expectations. Hence, it is not only the oil price increase that is contributing to the macroeconomic changes but also tighter monetary policy. From a policy perspective, it would be important to know which factor (oil price increase or tight monetary policy) is contributing how much in the changing macroeconomic activity.

In order to separate the output losses resulting from the oil price increase and the tight monetary policy, shutting-off the monetary policy would provide only the contribution of oil price increase to the change in macro-economy. It is important to note that the interest rate is primary policy rate used by the policy-makers. Shuting-off the monetary policy (interest rate) means that it should remain the same as it was before the oil price increase [Sims and Zha (1996)].

The monetary policy becomes non-responsive to the macroeconomic fluctuations and plays a passive role only. The output loss due to tight monetary policy is then the difference between the output losses occurred with and without shut-off cases. Nonetheless, this unexpected policy response results in the Lucas critique; the reason is that Sims and Zha (1996) scenario considers that the behaviour of economic agents is invariant to this policy change. In practice, any simulation in this way would lead to the Lucas critique as, in the shut-off case, the policy is not responding in a historical way.

Sims and Zha (1996) find that an unpredictable shift in the monetary policy accounts for a little variation in the historical macroeconomic fluctuations. Further, it finds a small variation in policy rate in response to such variations. It concludes that most of the monetary policy reactions are systematically in response to business cycle changes. In such situation, assessment of systematic monetary policy becomes more important.

This framework estimates such a monetary policy reaction function in which the policy variable is completely unresponsive to any shock. In other words, the central bank does not allow for any change in policy in response to a macroeconomic disturbance. Further, this framework does not allow for any change in behaviour of private sector agents. It assumes that private agents fully understand the new policy.

Data reveals that interest rate increases in response to an oil price shock, which is a historical fact, but the above mentioned practice with simulation is not conducted following this historical response to the interest rate. This is an alarming issue as in the presence of Lucas critique all the policy simulations would be worthless. Fortunately, this problem is solved in Bernanke, *et al*. (2004) by delaying the response of monetary policy for a year instead of completely shutting it off. Since a transitory deviation of the monetary policy from the traditional policy response will not deform the economic structure completely, the effect of Lucas critique is minimal in this case**.**

4. DATA AND VARIABLES

The present study uses the following main variables: real Gross Domestic Product (GDP), Consumer Price Index (CPI), domestic real oil prices (DROP), the Hamilton's (1996) oil price indicator (Net Oil Price Increase, NOPI) and the Call Money Rate (CMR).[3] It uses quarterly data for the period 1993 to 2015.[4] All these series are in real terms, denominated in the million rupees with 2000 as the base year.

Energy prices are state-controlled in Pakistan. These prices may not be perfect representatives of international oil price behaviour, yet we also use them in our analysis to judge their impact on the economy. Domestically controlled energy prices comprise of Gasoline, Kerosene, High Speed Diesel Oil (HSDO), Light Diesel Oil (LDO) and HOBC.

Data for quarterly GDP have been obtained from Kemal and Arby (2005). However, quarterly GDP available only till 2004-05. Data for the remaining period are acquired from Nasir and Malik (2011). The data for international oil prices are taken from the Illinois Oil and Gas Association (IOGA). The IOGA was established in 1944 in the United States to provide information to its stakeholders about the energy inputs. Pakistan Energy Year Book is consulted for data on domestic energy prices. The data for both prices and call money rate are taken from various reports of the State Bank of Pakistan.

5. RESULTS AND DISCUSSION

For the sake of convenience, this section has been divided into three subsections. The first subsection 5.1 provides the results of unit root test. The second subsection 5.2 portrays the impulse responses of output loss. Finally, the last subsection 5.3 sorts out the output loss, resulting from the oil price shocks and the systematic monetary policy.

[3]The selection procedure for an oil price indicator has been specified in Appendix.

[4]A model with monthly data may raise the sampling error significantly, for the uncertainty is intensified in the presence of large number of variables in the model. The issue even worsens if the lag length is also large. A quarterly series ensures a parsimonious model, with minimum uncertainty and mean square error [Bernanke, *et al.* (2004)]. This provides motivation for the use of quarterly data in this empirical analysis. One might argue to use the annual data for a more parsimonious model. However, annual data is unable to capture the true dynamics of the economy which the quarterly data can. The data is deseasonalised to control for seasonality effects.

5.1. Results of Unit Root Test and Lag Selection

Results of unit root tests indicate that three out of the four variables are non-stationary (see Table 1). More specifically, just NOPI is stationary while the CMR, CPI and the GDP are I (1). The standard econometric practice suggests to use the integrated variables with first difference. The results of the ADF test indicate that all the integrated variables are stationary at the first difference with varying level of significance. Hence, the present study employs CMR, CPI and the GDP with the first difference while the DROP and NOPI with level form.

Table 1

Results of Unit Root Test

	Augmented Dickey-Fuller (ADF) Test	
Variables	Level	First Differernce
CMR	–2.5	–7.2***
CPI	–0.98	–4.3**
GDP	–2.1	–3.2*
DROP	–3.9**	–9.15***
NOPI	–5.1***	–8.23***

Note: NOPI is stationary while the CMR, CPI and the GDP are integrated of I (1).
***, ** and * indicate 1 percent, 5 percent and 10 percent level of significance respectively.

The present study takes the help of HQC (Hannan-Quinn criterion) and AIC (Akaike criterion) for lag selection, see Table 3 for details. The former criterion specifies the use of 4 lags [consistent with Bernanke, *et al.* (2004)] while the latter criterion specifies the use of 5 lags. As Bernanke, *et al.* (2004) suggests the use of 4 lags with quarterly data, the primary study estimates the baseline estimation with the 4 lags. However, it also estimates a robustness test with a 5 lag model, suggested by our AIC test. The detailed results of both of these models (models with 4 lags and 5 lags) have been explained in the next section.

Table 2

Lag Selection Criteria

Lags	HQC (Hannan-Quinn Criterion)	AIC (Akaike Criterion)
1	–9.45	–9.66
2	–10.08	–10.42
3	–10.07	–10.53
4	–10.23*	–10.82
5	–10.14	–10.85*
6	–9.97	–10.81
7	–9.76	–10.73
8	–9.63	–10.72

* Indicates the best (that is, minimised) values.

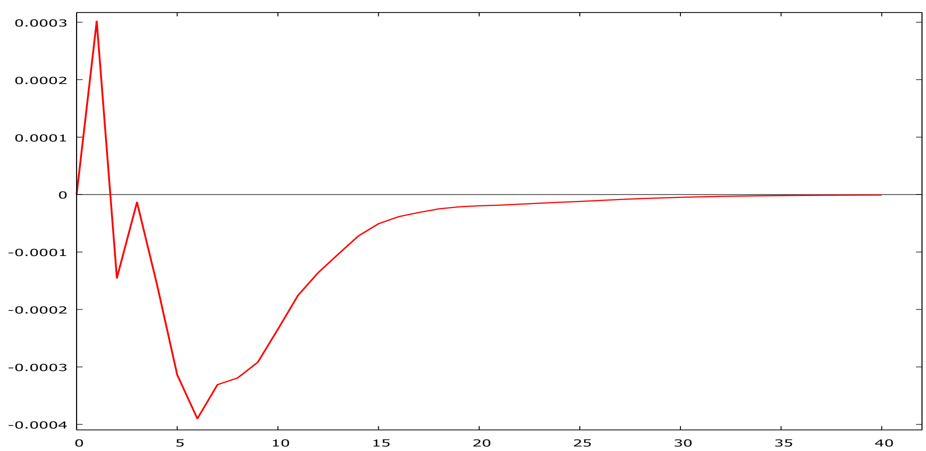
5.2. Impulse Responses of Output Loss

The Figures 3, 5 and 7 show the output loss, resulting from a systematic monetary policy, non-systematic monetary policy [Sims-Zha Scenario] and delayed monetary policy [Bernanke, *et al.* (2004) scenario]. All these models have been estimated with 4 lags.[5] Results show that the oil price shocks have an adverse impact on the economy. This impact is more pronounced if the monetary authorities operate aggressively with a systematic monetary policy to control the forthcoming inflationary episode. However, in the absence of a systematic (or with a delayed) monetary policy, the impact of the oil price shocks on the macroeconomic downturn can be reduced significantly. Further, it is evident that the economy has an early tendency of convergence after encountering the Lucas critique, see Figure 7, while there is no such tendency in the other case.

For a diagnostic analysis, the present study checks the distribution of residuals through the Doornik-Hansen test. Under the null hypothesis of normality, the Doornik-Hansen test determines the distribution characteristics of residuals of an estimated model. Test results show that the null of each of the three models is accepted. It means residuals of these models are normally distributed which signifies the robustness of all these models, see Table 4.

The present study also runs robustness tests, but with 5 lags. The Figures 4, 6 and 8 show the output loss resulting from a systematic monetary policy, non-systematic monetary policy [Sims-Zha Scenario] and delayed monetary policy [Bernanke, *et al.* (2004) scenario]. All these estimated models convey the same message but the 5 lag models are more volatile than the 4 lag models. Though the results of 5 lag models are consistent with 4 lag models, but they are less stable over time.

Fig. 3. Output Loss with Systematic Monetary Policy
(4 lag model)

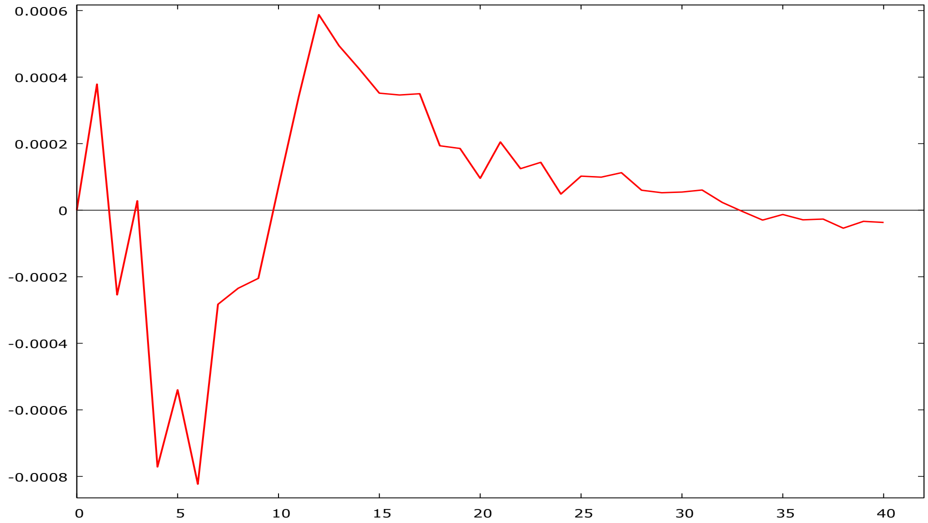


Source: Authors' calculations.

Note: The impact of oil price shocks is more devastating if the monetary authorities operate aggressively with a systematic monetary policy to control the forthcoming inflationary episode. (These are the standard results of gretl software with a 95 percent level of confidence.)

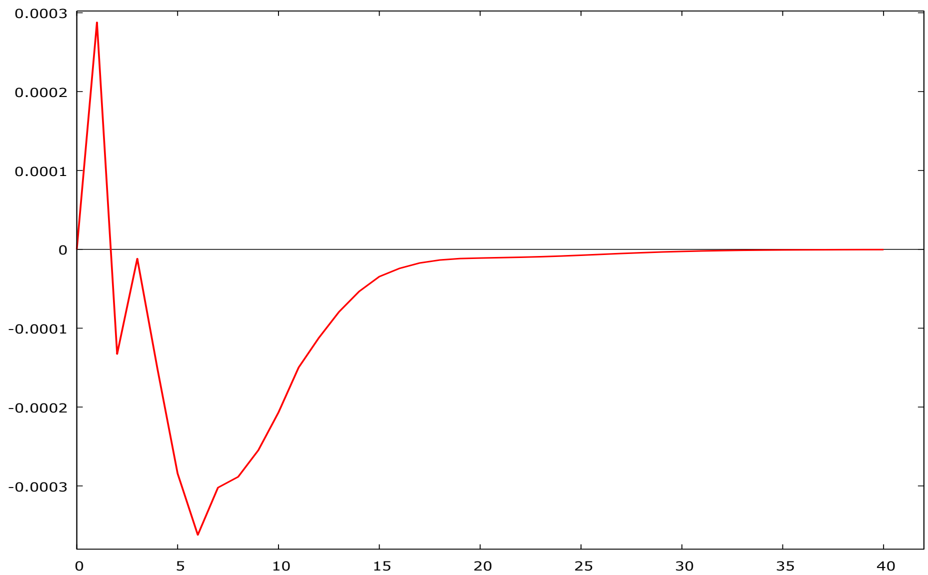
[5] Our model is identified locally and globally. Further, the covariance matrix of residuals is full and the matrix of structural shocks is diagonal.

Fig. 4. Output Loss with Systematic Monetary Policy
(5 lag model)



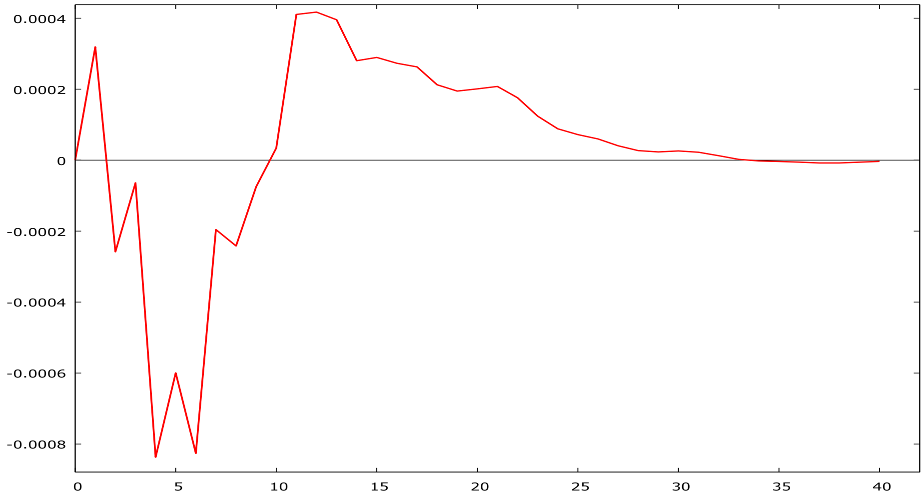
Source: Authors' calculations.
Note: The impact of systemetic monetary policy is devastating and more volatile with a 5 lag model. This model converges after a long period of time compared to a 4 lag model. (These are the standard results of gretl software with a 95 percent level of confidence.)

Fig. 5. Output Loss with a Non-systematic Monetary Policy [Sims-Zha Scenario]
(4 lag model)



Source: Authors' calculations.
Note: In the absence of a systematic monetary policy, the adverse impact of the oil price shock of macroeconomic downturn can be reduced by 12 percent. (These are the standard results of gretl software with a 95 percent level of confidence.)

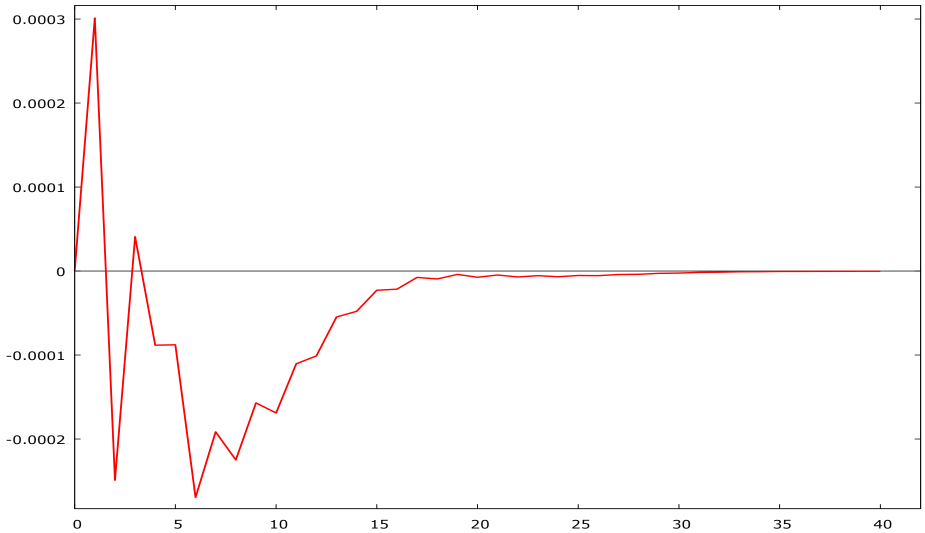
Fig. 6. Output Loss with a Non-systematic Monetary Policy [Sims-Zha Scenario]
(5 lag model)



Source: Authors' calculations.

Note: The impact of systemetic monetary policy is devastating and more volatile with a 5 lag model. This model converges after a long period of time compared to a 4 lag model. (These are the standard results of gretl software with a 95 percent level of confidence.)

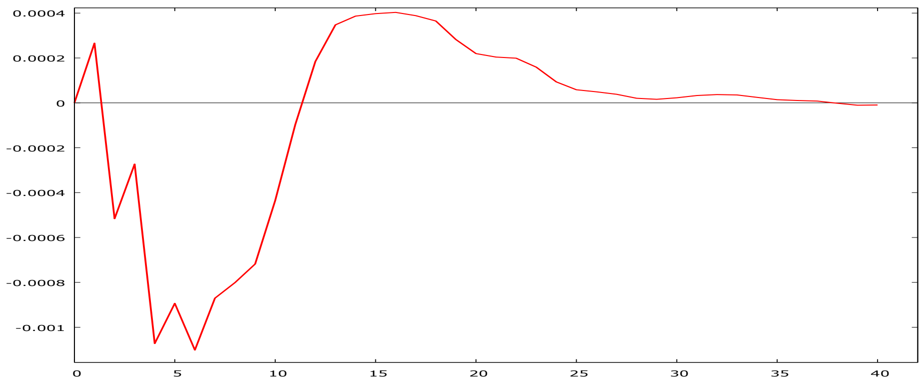
Fig. 7. Output Loss with a Delayed Monetary Policy [Bernanke, *et al.* (2004) Scenario]
(4 lag model)



Source: Authors' calculations.

Note: In the absence of a systematic monetary policy, the adverse impact of the oil price shock of macroeconomic downturn can be reduced by 42 percent. (These are the standard results of gretl software with a 95 percent level of confidence.)

Fig. 8. Output Loss with a Delayed Monetary Policy [Bernanke, *et al.* (2004) Scenario]
(5 lag model)



Source: Authors' calculations.
Note: The impact of systemetic monetary policy is devastating and more volatile with a 5 lag model. This model converges after a long period of time compared to a 4 lag model. (These are the standard results of gretl software with a 95 percent level of confidence.)

Table 3

Distribution of Residuals

Doornik-Hansen	Systemetic Monetary Policy Scenario	Bernanke Scenario	Sims-Zha Scenario
Test Statistic	9.12	9.59	10.04

5.3. Quantification of Output Loss

With the help of these three impulse response scenarios, we attribute the output loss to oil shocks and the subsequent tight monetary policy. This output loss, calculated for 12 quarters (three years) is given in Table 5. The table has 2 major blocks. The first block presents two different scenarios which control the systematic response of monetary policy, while the second block illustrates the respective shares of output loss due to the oil price shock and the monetary policy.

Two important points emerge from this table. First, the contractionary monetary policy contributes to output loss. Second, in Sims-Zha and Bernanke, *et al.* (2004) scenarios, the monetary policy contributes around 12 percent and 42 percent in the output losses respectively. It is important to note that the latter case is more robust as it encounters the Lucas critique. The oil price shocks are responsible for around 88 percent and 58 percent of the output losses in the respective scenarios. It indicates that an endogenous monetary policy contributes significantly in the output loss. In other words, if the State Bank of Pakistan avoids interfering the supply side shocks, to control inflation, the output loss will be minimal.[6]

[6]Same practice is repeated for the domestically controlled energy prices such as Gasoline, Kerosene, High Speed Diesel Oil (HSDO), Light Diesel Oil (LDO) and HOBC. No energy shock was able to produce any well behaved response in the series. One possible reason might be the presence of distortions in the energy prices due to state control. We omit its graphical analysis to save some space.

Table 4

Quantification of Output Loss

	Contribution in Output Loss by	
	Oil Price Shock	Monetary Policy
Shut-off Case	88%	12%
Delayed Monetary Policy	58%	42%

Source: Author's calculations.

Note: Two lessons can be learned. First, the contractionary monetary policy is the prime contributor to output loss. Second, the output loss is higher if the endogenous monetary policy is working endogenously.

6. CONCLUSION AND POLICY IMPLICATIONS

After encountering the Lucas critique in the Sims and Zha (1996) counterfactual experiments, this study finds that around 42 percent of the output loss is due to the ensuing tight monetary policy. The important policy implication of this study is that the State (Central) Bank of Pakistan should not intervene in the market process if the general price level is increasing due to an oil price shock. Hence, if the State Bank intervenes in the market mechanism to control the rising inflationary expectations from the increasing oil prices, it would further increase output loss.

As a higher interest rate increases the cost of doing business, resultantly it has a negative impact on business activity. The worst impact would be on investment which is much volatile to the increase in interest rate. Muhammad, *et al.* (2013) finds that a 1 percent increase in interest rate reduces investment by 0.44 percent. This crowing out would curtail the role of private sector in the market.

The macroeconomic effects of a demand based oil price shock are quite different in the presence of an ensuing tight monetary policy. After such an oil price shock, inflation rate and output both are expected to rise initially. However, given the commitment of a central bank to price stability, it increases interest rate to stabilise prices. As the investment is much volatile to increasing interest rate, output starts falling. The tight monetary policy hinders the economic growth rate and eventually results in output losses.

APPENDIX A

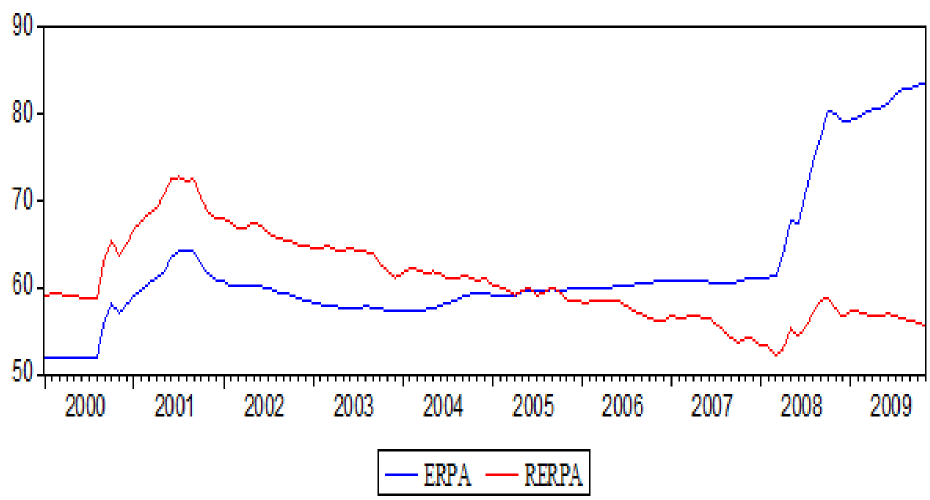
IDENTIFICATION OF APPROPRIATE OIL PRICE INDICATOR

It is not an easy task to uncover the appropriate measure for oil price shock. Change in the nominal oil price was the first indicator introduced by Hamilton (1983). However, this indicator was unable to add much in the empirical literature [Alquist and Coibion (2013); Hetzel (2013); Elwell (2013); Meltzer, *et al.* (2013); Prieto, *et al.* (2013)]. A more effective and comprehensive oil price shock indicator was required that could unearth the causal relationship among the macroeconomic variables. Subsequently, some other indicators such as log of the real oil price and log difference of real oil price among others were introduced. However, the most comprehensive and commonly used indicator is the Net Oil Price Increase (NOPI), presented by Hamilton (1996) [Lee, *et al.* (2001); Bernanke, *et al*. (1997)]. It is the log of the ratio of quarterly present time real oil price (denominated in local currency) to the previous year's maximum level.

The first task of this study, therefore, is to identify an appropriate indicator for oil price shock for Pakistan. Oil prices have asymmetric relationship with macroeconomic variables in Pakistan [Malik (2008)], and a positive change in the oil prices brings more variation in macroeconomic indicators than do the negative one [Hamilton (1996)]. Based on this reasoning, the Hamilton's (1996) Net Oil Price Increase (NOPI) indicator appears to be most appropriate. Moreover, Hooker (1996) also finds that this indicator remains stable over time. However, in order to come up with concrete conclusion, other indicators mentioned in the previous paragraph are also analysed, by observing the impact of these indicators on output, prices and policy rate. For an indicator to be appropriate, it should decrease output, increase prices and interest rate in the face of a positive oil price shock. Given these criteria, we found that Hamilton's (1996) NOPI is the most suitable indicator in this analysis because it produces the well behaved impulse responses in the face of oil shocks.

APPENDIX B

Fig. A1. Real and Nominal Exchange Rates Behaviours



Appendix Table 1

Regressions

	GDP_L	CPI_L	NOPI	CMR
GDP_L(-1)	1.6	–0.4	–1.7	100.6
	–0.1	–0.7	–6.9	–105.0
	[12.1]	[–0.6]	[–0.2]	[0.99]
GDP_L(-2)	–0.1	0.7	–11.0	–74.5
	–0.3	–1.4	–14.5	–221.5
	[–0.5]	[0.5]	[–0.7]	[–0.3]
GDP_L(-3)	–1.0	–0.5	29.3	–159.1
	–0.3	–1.5	–15.6	–239.2
	[–3.2]	[–0.3]	[1.8]	[–0.6]
GDP_L(-4)	0.5	0.3	–17.5	160.0
	–0.2	–0.8	–8.1	–124.6
	[3.4]	[0.4]	[–2.1]	[1.2]
CPI_L(-1)	–0.1	1.6	2.8	25.6
	0.0	–0.2	–1.7	–25.6
	[–2.3]	[9.9]	[1.6]	[0.9]
CPI_L(-2)	0.1	–1.0	–3.7	1.7
	–0.1	–0.3	–3.1	–46.7
	[2.1]	[–3.5]	[–1.2]	[0.0]
CPI_L(-3)	0.0	0.7	1.1	–36.9
	–0.1	–0.3	–3.4	–51.4
	[0.7]	[2.0]	[0.3]	[–0.7]
CPI_L(-4)	–0.1	–0.3	0.4	–8.4
	0.0	–0.2	–1.8	–28.0
	[–2.8]	[–1.6]	[0.2]	[–0.2]
NOPI(-1)	0.0	0.0	0.3	2.9
	0.0	0.0	–0.2	–2.4
	[0.6]	[0.7]	[1.9]	[1.2]
NOPI(-2)	0.0	0.0	–0.1	2.3
	0.0	0.0	–0.2	–2.5
	[–1.4]	[–1.2]	[–0.8]	[0.8]
NOPI(-3)	0.0	0.0	0.1	2.2
	0.0	0.0	–0.2	–2.6
	[–0.4]	[0.6]	[0.4]	[0.8]
NOPI(-4)	0.0	0.0	0.0	4.0
	0.0	0.0	–0.2	–2.3
	[–0.7]	[–0.6]	[–0.3]	[1.7]
CMR(-1)	0.0	0.0	0.0	0.2
	0.0	0.0	0.0	–0.1
	[–2.1]	[–1.2]	[–0.5]	[1.6]
CMR(-2)	0.0	0.0	0.0	0.1
	0.0	0.0	0.0	–0.1
	[–0.9]	[1.1]	[0.5]	[0.4]
CMR(-3)	0.0	0.0	0.0	0.1
	0.0	0.0	0.0	–0.1
	[–0.6]	[–0.6]	[–0.4]	[0.7]
CMR(-4)	0.0	0.0	0.0	0.5
	0.0	0.0	0.0	–0.1
	[–0.3]	[1.1]	[–0.3]	[3.7]
C	0.0	–1.5	9.7	–289.9
	–0.1	–0.6	–6.8	–103.9
	[–0.3]	[–2.3]	[1.4]	[–2.7]
R-squared	1.0	1.0	0.3	0.8
Adj. R-squared	1.0	1.0	0.0	0.7
Sum sq. resids	0.0	0.0	0.6	149.8
S.E. Equation	0.0	0.0	0.1	1.9
F-statistic	25423.2	2274.0	1.2	11.3
Log Likelihood	289.3	192.2	51.1	–112.6
Akaike AIC	–9.1	–5.8	–1.1	4.3
Schwarz SC	–8.5	–5.2	–0.5	4.9
Mean Dependent	13.9	4.7	0.1	8.8
S.D. Dependent	0.2	0.3	0.1	3.6

Standard errors in ( ) and t-statistics in [].

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