Oil Price Shock, Pass - through Policy and its Impact on India

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Abstract

This paper analyses the impact of transmission of international oil prices and domestic oil price pass-through policy on major macroeconomic variables in India with the help of a macroeconomic policy simulation model. Three major channels of transmission *viz.* import channel, price channel, and fiscal channel are explored with the help of a structural macroeconomic framework. The policy option of deregulation of domestic oil prices in the scenario of occurrence of a one-time shock in international oil prices as well as no oil price shock situation analysed through its impact on growth, inflation, fiscal balances and external balances during the 12th Plan period of 2012-13 to 2016-17. The simulation results indicate that in the short run the deregulation policy would have adverse impact on the growth as well as on the inflation. But if this policy is complemented with the policy of switching of subsidy bill to capital expenditure it might result in positive growth effects in the medium and long run. Given, the current pass-through policy, one-time oil shock has adverse impact on growth and inflation in the year of shock while it mitigates slowly over time. The model shows that with the oil shock and with current partial pass-through regime, a 10 percent rise in oil prices result in a 0.6 percent fall in growth while in the full pass-through situation, it can reduce the growth by 0.9 percent. Overall, the paper argues that the pass-through has differential impact on growth and inflation over the 12th Plan period. Hence, the policy of oil price deregulation must be carefully weighed and prioritised.

Key Words: Policy simulation, International price shock, transmission channels, macroeconomic modelling, growth, inflation, current account deficit, subsidies, fiscal deficit, India.
JEL Classification Codes: C32, E10, E17, E30, E60, H60.

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Introduction

International oil prices have seen frequent sharp increases since 2002, spiking to more than $140 per barrel in mid-2008. UNCTAD (2008) calculations showed that in developed countries the fuel import bill increased from 1.6 percent of their GDP in 2002 to 3.6 percent in 2007. In developing countries, the fuel import bill rose from 2.7 percent of GDP in 2002 to about 5 percent in 2007. These ratios were estimated to amount to about 6 percent of GDP and 8 percent respectively at an average oil price of $ 125 per barrel in 2008 in the same study. In India, similarly, the net oil import to GDP ratio has gone up from less than 3 percent in 2003-04 to more than 5 percent during 2008-09. Though oil prices fell in the interim, current trends again show significant increases, with analysts predicting high oil prices in the foreseeable future (IMF 2011). Combined with the world-wide slowdown in economic activity and political instability in the MENA countries, the implications of a further rise in international oil prices could be alarming for oil importing economies.

While the oil importing countries, even large ones like India are price-takers in the international oil market, countries usually exercise discretion in passing on international price shocks to domestic prices. In India the administered price system has traditionally offered a mechanism to cushion the international price changes and achieve domestic policy objectives on inflation, growth and equity. The administered price system for oil is supported by budgetary expenditures (subsidies), even as revenues from oil constitute a significant portion of the overall revenues for the government. The pass-through policy, presently on the reform agenda, thus has important implications for the way international oil price changes impact the macroeconomy.

In this study, we analyse the impact of international oil price shocks and different configurations of pass-through policy for oil on the major macroeconomic variables in India with the help of a macroeconomic simulation model. Rsearchers have investigated the impact of oil shocks in the US and other developed economies, focusing mainly on supply side effects and the microeconomic foundations that transmit oil price shocks to the macroeconomy. We review this literature in *section II (A)*. For large oil importing developing countries with less than full-employment output, the demand side effects are of equal significance. For example, a rise in international oil prices translates to a higher import bill, worsens terms of trade and consequently results in a deterioration of the trade balance and a squeeze in aggregate demand over and above the supply side effects. *Section II (B)* reviews the literature on oil shock impacts transmitted *via* the demand side under positive output gap conditions. The transmission mechanism for oil shocks in India is discussed in *section III*. The theoretical model for understanding the impact of oil shocks on important macroeconomic variables like growth, inflation, current account and trade deficit, fiscal and revenue deficit has been discussed in *section IV*. The historical validation of the empirical model along with the simulation results are presented in *section V*. Various scenarios have been simulated to estimate the impact of one time shock in international oil prices as well as the continuous increase in oil prices under the assumption of various degrees of oil sector deregulation on important macroeconomic indicators. *Section VI* concludes.

II. Review of Literature

II. (A) Oil shock and its transmission through the supply side

There is substantial literature on the macroeconomic impact of oil price shocks, focusing on the response impact on aggregate output in the oil importing economies. A key insight from the studies on oil and the macroeconomy is that the magnitude of the effect of an effect of oil price shock on gross output must be small. Assuming an aggregate production function with three inputs (labour, capital, and oil), at full employment equilibrium marginal productivity of oil equals the ratio of oil to output prices, i.e., the marginal cost of oil measured in terms of domestic product. An increase in price of oil raises its cost above marginal product leading to a cutback in amount of oil used in the production. In the process, marginal productivity of labour and capital declines and there is a fall in output. Lower the elasticity of substitution between oil and other inputs, larger will be the fall in GDP.

These models predict only small changes in output when applied to real data, and are unable to explain why oil price shock should trigger downturns as sharp as those of the 1970s. A one percent reduction in oil usage reduces gross output by a percentage corresponding to the cost share of oil.[2] This share of oil in output is thought to be no larger than 4 percent and may be much smaller. Thus, a 10 percent increase in oil prices, for example, should result in a less than 0.5 percent reduction in gross output (Rotemberg and Woodford, 1996). However, following the Suez crisis in 1956, the drop in US real GDP was 2.5 percent, and the 1973 oil shock produced a 3.2 percent drop in US real GDP (Hamilton, 2003).

To explain the much higher real drop in GDP, researchers have turned to additional transmission mechanisms by which oil price shocks might contribute to lower growth, e.g., capital equipment utilisation; uncertainty and investment pauses; labour markets; sectoral shocks. Besides extending the number of channels through which the oil shocks play out, many of the models have invoked the theory of imperfect competition to explain the facts. The intuitive idea behind most of these models, as discussed below, is that an increase in the price of energy works like a negative technology shock to generate contraction in economic activity.

Finn (2000) develops a model with perfectly competitive markets, but incorporates energy as an essential input for the utilisation of capital. This creates an indirect channel, working through the capital stock, in addition to the usual direct production function channel, for transmitting the impact of fluctuations in energy usage to the macroeconomy. Oil price increases depress the future marginal product of capital, thereby reducing investment and the future capital stock, and thus can have long-term effects on output. Using this model, Finn was able to arrive at much larger quantitative effects than the traditional studies in this area.

[2] *See* Hamilton, 2008.

A related channel, capital equipment utilisation hypothesis, has been discussed by Bernanke (1983), who shows in a partial equilibrium model that oil price shocks will tend to lower value added, because firms will postpone investment as they attempt to find out whether the increase in the price of oil is transitory or permanent. But gauging the importance of such indirect effects of oil on output is far less straightforward than the corresponding exercise for the direct effects.

A different class of explanations emphasises the frictions in reallocating labour or capital across different sectors that may be differentially affected by an oil shock. For example, one common consequence of an oil price shock is a sudden drop in demand for certain kinds of cars, which leads to lower capacity utilisation at affected plants (Bresnahan and Ramey, 1993). Because labour and capital can move to alternative productive activities only at a cost, the result is idle resources that can signi?cantly multiply the effects described above.

Some of the channels described above have not been subjected to rigorous empirical testing, so caution is required in generalising from these results. Also, the very different response of real output and prices in recent episodes of oil price increases (IMF, 2007; Blanchard and Gali, 2009) requires fresh research on the theoretical and empirical relationship between oil price shocks and gross output.[3]

II. (B) Oil shock in a demand constrained economy

The following survey explores the impact of an oil-price rise for an economy with less than full-employment output, and with high levels of involuntary unemployment.

Trade channel

Given the preponderance of oil imports in the import basket of the developing countries and their growing energy needs, an increase in oil price would lead to a worsening of trade balance, *given a fixed exchange rate*.

The decline in trade balance works through movements in terms of trade. Rakshit (2005) points out that for examining the effect of an oil shock in terms of an open economy macro model we need to distinguish between two price ratios or terms of trade: (a) ratio of oil price to the domestic price level; and (b) the ratio of the price level of non-oil importables to that of domestic goods. The country's trade balance is negatively related to (a), but improves with an increase in (b). Since the proportional rise in the domestic price level is less than that in crude oil prices, an oil shock raises (a), but lowers (b). Thus, the result relating to worsening of the trade balance and the consequent fall in aggregate demand and GDP through the foreign trade multiplier is clear cut.

The assumption here is that the nominal exchange rate is fixed, so that a rise in domestic prices, ceteris paribus, results in real exchange rate appreciation. However, if the nominal exchange rate is flexible, oil importing country's currencies will depreciate, while oil exporters' currencies will appreciate in response to their real income gains. Over

[3] Literature has focused on the effect of oil price shocks on aggregate output and mostly left unexplored the notion that oil price shocks are inflationary. Barsky and Kilian (2002) have verified that an oil price shock is inflationary for the price of gross output. There is evidence of sharp changes in the CPI inflation rate following major oil price changes.

time, the initial oil trade deficit will decrease, and the non-oil trade balance will increase. Thus the fall in real output, or at least a part of it, might be temporary in the oil-importing economy.

The theoretical case for flexible exchange rates rests on the ability of flexible exchange rates to absorb adverse oil shocks that obviates the need for a prolonged adjustment through excess demand in the goods and labour markets to push prices and wages to the new equilibrium. This hypothesis was tested and affirmed by Al-Abri (2007) for nine major OECD countries between 1973 and 2004.

Consumption and investment channel

In a recent survey on the effects of energy price shocks, Hamilton (2008) stresses that a key mechanism through which energy price shocks affect the economy is the disruption in consumers' and firms' spending on goods and services other than energy. This view is consistent with evidence from industry as most U.S. firms perceive energy price shocks as shocks to the demand for their products rather than shocks to the cost of producing these products.

There are four complementary mechanisms by which energy price changes may directly affect consumer expenditures (*see,* Edelstein and Kilian, 2009).

1. First, higher energy prices reduce discretionary income, as consumers have less money to spend after paying their energy bills. Other things being equal, this discretionary income effect will be larger the less elastic the demand for energy. But even with perfectly inelastic energy demand, the magnitude of the effect of a unit change in energy prices is bounded by the energy share in consumption.
2. Second, changing energy prices may create uncertainty about the future path of the price of energy, causing consumers to postpone purchases of consumer durables (*see,* Bernanke, 1983). Unlike the first effect, which applies to all forms of consumption, this uncertainty effect is limited to consumer durables.
3. Third, consumption may fall in response to energy price shocks, as consumers increase their precautionary savings.
4. Finally, consumption of durables that are complementary in that their operation requires energy will tend to decline even more, as households delay or forego purchases of energy-using durables.

Contractionary tendencies could be strengthened by a hardening of interest rates due to the rise in prices and by investors turning extra cautious because of concerns about heightened uncertainty.

Financial channel

It is useful to distinguish the traditional channels of external adjustment, the trade channel, and the financial (or valuation) channel of adjustment. The trade channel works through changes in the quantities and prices of goods exported and imported; whereas the financial channel works through changes in external portfolio positions and asset prices.

The financial channel could either cushion or exacerbate the effect of oil price increases on oil-importing countries' external balances. A decrease in asset prices and dividends in oil-importing countries in response to an oil price increase will affect all asset owners, including residents of oil exporting countries. Conversely, asset prices in oil exporting countries will increase, again affecting all asset owners, including residents of oil importing countries. As a result, capital gains and income flows may blunt the impact of oil-price changes on the current account and on net foreign assets (NFA) changes. Bond and equity prices and exchange rates typically respond much faster than the prices and quantities of goods (and faster than portfolio positions). In practice, the response will depend on the precise configuration of countries' portfolios, and the extent to which these portfolios can be rebalanced effectively.

With certain portfolio configurations, the financial consequences of the shock could even completely offset the need for short-term external adjustment. A case in point is the US, which mostly has fixed income liabilities denominated in its own currency, while equity and foreign direct investment holdings are denominated in foreign currency. Using the Lane-Milesi-Ferretti net foreign asset data set, Kilian *et. al* (2007) show the presence of large and systematic valuation effects in response to oil shocks, not only for the United States, but also for other oil-importing economies and for oil exporters. Their estimates suggest that increased international financial integration will tend to cushion the effect of oil shocks on NFA positions for major oil exporters and for the United States, but may amplify it for other oil importers.

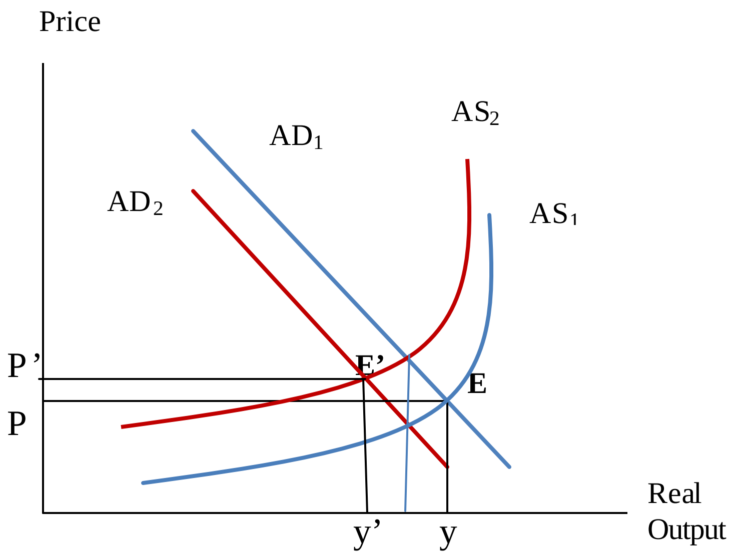
What should be the monetary policy response?

Faced with an oil shock and higher prices, the monetary authorities have often tightened monetary policy. Bernanke, Gertler, and Watson (1997) have shown that the Federal Reserve, when faced with potential or actual inflationary pressures triggered by a positive oil price shock, responds by raising the interest rate, amplifying the decline in real output associated with oil price shocks. In assessing the effect of this policy response from vector autoregressive (VAR) models, Bernanke, Gertler, and Watson postulated a counterfactual in which the Federal Reserve holds the interest rate constant. In other words, the Fed is not responding to any of the effects of the oil price shock on the economy. They conclude that the Fed's systematic and anticipated response to oil price shocks is the main cause of the recessions that tend to follow oil price shocks and that these recessions could have been avoided (at the cost of higher inflation) by holding the interest rate constant.

Bernanke, Gertler, and Watson's results have not remained unchallenged. Hamilton and Herrera (2004) showed that their estimates are sensitive to the choice of the VAR lag order. They also demonstrated that implementing a constant interest rate policy would have required policy changes so large to be unprecedented historically and hence not credible in light of the Lucas critique, a point acknowledged by Bernanke, Gertler, and Watson (2004).

It is obvious that in a demand constrained economy the tendency of the central banks to tighten monetary policy when faced with an oil shock will result in further losses in output and employment though it can neutralise the cost-push effect of the shock on the price level. In *figure 1*, the shift in aggregate supply from AS_1 to AS_2 begins a chain of adjustment that creates an upward pressure on price level and a decline in real output. If the monetary policy is tightened, the aggregate demand curve will shift inwards from AD_1 to AD_2 and real output contract from y to y', which is more than what would have resulted had there been no monetary policy intervention. In fact, the shock results in a shift from one equilibrium to another so that policy-makers are not confronted with an output-inflation trade-off or any danger of an unabated rise in prices. Unless a good case for the existence of a wage-price spiral can be made, oil price shocks would not be expected to cause sustained inflation. (*see*, Kilian, 2009)

Figure 1: Impact of Monetary Tightening Following an Oil-Shock



Hence monetary (or fiscal) contraction for curbing prices cannot be an optimal response to an oil price shock in a demand deficient economy.

Nakov and Pescatori (2010) demonstrate that a welfare-maximising central banker should not respond to increases in the price of oil. As long as the monetary policy regime is credible, the central bank may allow for drift in the price level without jeopardizing the objective of stable medium-term inflation.

Since the 2003–2008 oil price shock reflected a shift in the real scarcity of resources, there is nothing a central bank could or should have done in response, beyond making sure that inflation expectations remained anchored by way of following say, an interest rate rule, in the face of inflationary pressures arising from both oil and industrial commodity prices is Kilian's (2009) view.

III. Macroeconomic Transmission Mechanism of International Oil Price Rise: The Indian Situation

In this section, we trace the impact of an increase in international oil prices on Indian economy outlining the various transmission mechanisms. These transmission mechanisms take into account some of the important macroeconomic relationships, as relevant to the Indian context, and the administered nature of domestic oil price in India.

The three broad channels through which the international oil prices impact the macroeconomy are identified as the (a) import channel, (b) price channel and (c) the fiscal channel.

(a) A rise in international price of oil will translate to higher import bill for oil for the net oil importing countries like India (*see, Table 1* and *2 in Appendix 1*). Under the reasonable assumption of low price elasticity of demand for oil, *ceteris paribus*, the trade balance will worsen due to an increase in international oil price. Rise in inflation due to increase in oil prices means that the growth in real GDP is even lower. The compression in aggregate domestic demand dampens growth. In *figure 2*, **the import channel** is indicated by the link from international oil prices to current account balance to nominal GDP.

    Although managed float, the nominal exchange rate in India is observed to be determined solely by the capital account and not by the current account in the present Indian context. The second order adjustment to higher import bill and worsened trade balance occurs only through contraction in aggregate demand and decline in imports and it does not occur through movements in exchange rate (depreciation).

    Finally, it is expected that the slowdown in economic growth would subsequently reduce the demand for imports which, in turn, would partially mitigate the adverse impact of high international oil prices on trade balance.

(b) The **price channel** links the international prices to domestic inflation. For a typical developing country like India facing an oil price hike in the international market, an unhindered pass-through of oil price increase leads to a jump in the general price level on account of direct use of oil at higher prices plus increase in costs of production of final goods using oil as an input. Modelling the pass-through of oil prices through an input-output system, Jha and Mundle (1987) estimated that in India if the administered prices of crude oil, gas and petroleum products increase by 7 percent, the overall WPI increases by 1 percent (i.e. the total elasticity to be 0.14). Recently the Reserve Bank of India (2011) has estimated that every 10 percent increase in global crude prices, if fully passed through to domestic prices, could have a direct impact of 1 percentage point increase in overall WPI inflation and the total impact could be about 2 percentage points over time as input cost increases translate to higher output prices across sectors. Greater the share of fuel in total consumption basket, larger would be the influence of international commodity prices on inflation. (*see*, *Table 2* for other empirical studies relating to India)

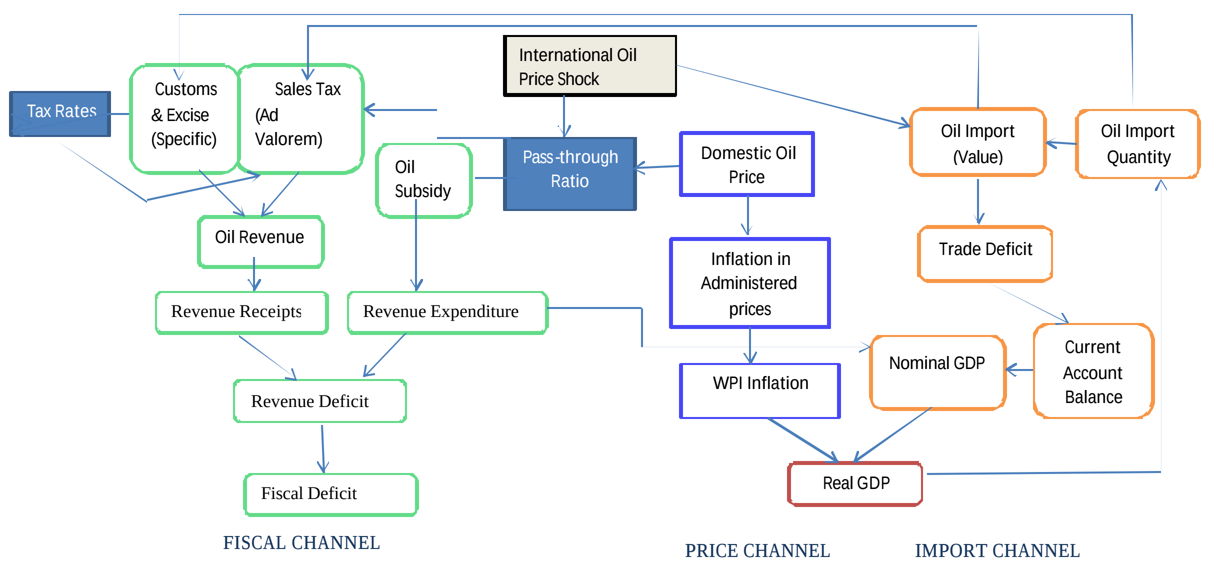
In India, a large proportion of the international oil price increase has traditionally been absorbed by the government (and shared with public sector oil producing and retailing companies). The objectives for regulation of price of oil have been three-fold: (a) to protect the domestic economy from volatility in international oil prices; (b) to provide merit goods to all households, e.g., clean cooking fuels like LPG, natural gas and kerosene to replace use of biomass-based fuels such as firewood and dung; and (c) to protect poor consumers so that they may obtain kerosene (through PDS) and LPG at affordable rates. In the recent years, there has been a change in the oil pricing policy with a move towards market determined oil prices. The extent of price regulation varies across products in the oil basket, with minimum control existing for petrol and very little pass-through for LPG and kerosene.[4]

The domestic price of oil is administered, which is essentially a policy decision, and thereby determines the degree of pass-through of the change in international prices to domestic oil prices. *In figure 2*, the **price channel** is indicated by the link from international oil prices to increase in administered prices to WPI inflation.

(c) The **third** channel of transmission of oil price shock considered here is the **fiscal channel**. In the absence of a complete pass-through, an international oil price increase will raise the subsidy on oil and therefore the revenue expenditure of the government. Furthermore, in India, the oil prices are subsidised, but they also generate substantial tax revenues both for the centre and the states (*see, Box 1*). A rise in the international price of oil would entail higher revenue receipts because of an increase in *ad valorem* tax collections on oil and petroleum products that would have to be netted out to arrive at the net addition to oil subsidy given by the government.[5]

[4] *See* report of the Rangarajan Committee, GOI, 2006 and Kirit Parikh Committee, GoI, 2010 for the broad direction and the specific recommendations relating to issues of pricing, taxation and subsidy on petroleum and oil products in India. Sethi (2010) presents a critical overview of the Kirit Parikh recommendations.

[5] About three-fourth of the total revenues from oil are due to revenues collected from indirect taxes, mainly customs, excise, and sales taxes. According to information provided by the Petroleum Planning and Analysis Cell, GoI, the total excise and custom duty collected on petroleum is slightly less than Rs.30 per litre (as from 25/06/2011). While customs and excise duties have traditionally (and still is mostly) levied as specific duty, the sales tax is an *ad valorem* tax. The average sales tax rate on petrol is roughly 24 percent and that on diesel is 17 percent of the value of sales in India. The sales tax is collected by the State governments and other revenues accrue to the Central exchequer. The rest one-fourth of revenue from this sector consists of dividends of PSUs, corporate tax, and so on, which essentially accrues to the Central government exchequer.


International Oil Price Shock
Tax Rates
Customs & Excise (Specific)
Sales Tax (Ad Valorem)
Oil Subsidy
Pass-through Ratio
Domestic Oil Price
Oil Import (Value)
Oil Import Quantity
Oil Revenue
Inflation in Administered prices
Trade Deficit
Revenue Receipts
Revenue Expenditure
Current Account Balance
Nominal GDP
WPI Inflation
Revenue Deficit
Real GDP
Fiscal Deficit
FISCAL CHANNEL
PRICE CHANNEL
IMPORT CHANNEL

Box 1: Contribution of Petroleum Sector in Government Exchequer

On the revenue side, the contribution of the petroleum sector to the exchequer of both Central and the State governments combined was 2.8 percent of GDP in 2009-10, with more than 60 percent share of the Central exchequer. The Central government's earning from this sector has been higher than the total revenue expenditure of the Central government in this sector. Although, the direct subsidy figures vary widely from source to source, the bulk of the revenue expenditure of the Central government on petroleum consists of petroleum subsidy. In 2009-10, the total revenue expenditure in petroleum was less than 0.4 percent of GDP. Even if we include the issue of special securities in lieu of subsidies to the oil marketing companies, it does not exceed 0.55 percent of GDP during 2009-10. Clearly, the contribution of this sector in exchequer has always been much higher than the sum of total revenue expenditure on petroleum and the petroleum bonds. Thus, in effect there is no net subsidy accruing to this sector.

Also, it is important to note here that the total revenue expenditure has always been lower than the net profit (after tax) of the public sector oil companies including the upstream, downstream companies and the stand alone refineries barring the exceptional year of 2008-09, when the international price of oil touched historic peak.

Table 1: Combined Government Revenue & Expenditure and PSU Profit from Petroleum Sector (In Rs. crore)

	2001-02	2002-03	2003-04	2004-05	2005-06*	2006-07	2007-08	2008-09	2009-10
Total Contribution to the Exchequer	-	96751	104375	120946	139083	157219	171731	161798	183860
Central Govt.	-	64595	69195	77692	87478	97264	108286	93512	111779
State Govt.	-	32156	35180	43254	51605	59955	63445	68285	72081
Total Revenue Expenditure	9000	5225	6901	2957	19946	26877	23377	78833	25297
Total PSU Profit After Tax	12192	22775	24235	26398	13194	33204	29041	26730	37319
Petroleum Bonds	-	-	-	9349	26611	50734	71288	133887	10306

Source**:** Compiled from various government sources.
Note**:** 2005-06 revenue figures are averages of 2004-05 and 2006-07 due to unavailability of data

In terms of the transmission mechanism, the impact of an oil price change on sales tax collection would be much more direct in case of full pass-through and would be realised both through quantity and prices of imported oil (or the value of net imports). On the other hand, international oil price change will not directly affect the revenue generated from excise and customs duties because of the specific nature of these taxes, but only indirectly through its effect on the quantity of oil imported, which is a function of the level of economic activity.

The fiscal channel as indicated in *figure 2* brings together both the revenue and expenditure effects of oil price change on the macroeconomy. There are two policy levers acting here: the administered price of oil (and hence subsidy) and the indirect tax rates on oil and petroleum products. The former determines the pass-through ratio that denotes how much of the change in international oil price change is to be passed on to domestic consumers as change in domestic oil price, and therefore the subsidy. The revenue from oil is a function of tax rates and the oil import quantity or value depending on the type of indirect tax. In the next section, the specification of the macro model is laid out.

Table 2: Recent Empirical Studies on the Impact of International Oil Price Shock on the Indian Economy

	Authors/ Year	Research Question	Method of Analysis	Findings
1.	Bhattacharya and Bhattacharya (2001)	The impulse response of a 'shock' in the prices of mineral oil on the prices of other commodities and to identify the lags through which oil prices affect the prices of other commodities.	VAR model to study the interaction of inflation in oil with non-oil inflation and growth in money and output using monthly data from April 1994 to December 2000.	A 20 percentage point shock in oil prices lead to a 1.3 percentage point increase in inflation in other commodities at its peak, which typically occur five to seven months the shock.
2.	Kumar(2005)	Impacts of oil price shocks on the growth of industrial production for the Indian economy	Multivariate VAR using both linear and non-linear specifications over the period 1975Q1-2004Q3.	Oil prices granger cause macroeconomic activities and negatively affects the growth of industrial production with a 100% rise in oil prices lowering growth of industrial production by 1 percent.
3.	Bhattacharya and Kar (2005)	Impact of international oil price shock on the domestic economy in the short run and long run	Macroeconomic modelling; Estimation period 1970 to 2003. Simulation period 1997 to 2003.	Oil price shock is stagflationary. For 100 percent increase in international price of oil, growth rate falls by 3% and inflation rises by 18 percent in the short run. The impact on growth does not become weaker in the long run.
4.	Bhattacharya and Batra (2009)	To examine the impact of a formula based automatic adjustment of fuel prices on inflation and output growth in India.	Structural VAR with exchange rate, fuel price, money supply, WPI and IIP using monthly data for the period (April 1994 to December 2008).	a) change in international prices and domestic fuel price change in India do not move in a synchronous fashion. b) when domestic prices are allowed to reflect changes in international oil prices the contribution of the latter to domestic inflation increases to about 39% by the sixth month. c) The response of IIP to fuel prices is evident in the form of a negative trend over the short run.
5.	IMF (2011)			If global oil prices average US$ 150/barrel in 2011, it would lower real GDP growth in advanced economies and in Asian economies by 0.75 percent.

IV. The Model

The model is an extension (disaggregating the oil sector) of the core model presented in Mundle *et. al* (2011). Based on the framework that is specified in *figure 2*, this core model has been expanded with an oil sector specific satellite model. The model has been developed in the Tinbergen-Goldberger-Klein (1955 & 1967) tradition. It is a simultaneous equations system model developed for *policy simulation.* The main outcomes of this model are conditional indicators of what would be the outcome for, say, growth or inflation if a particular set of policies were adopted and under an assumed, but realistic, set of exogenous conditions. In this exercise, an attempt has been made to capture the impact of oil price shock on various macroeconomic indicators of India. It is a fairly simple model, consisting of only 31 equations in the reduced form. There are 18 behavioural relationships and 13 identities. The model is theoretically eclectic.

An important limitation of the model is that it does not provide for economic agents *ex ante* anticipation of policy actions that can influence the impact of such action. i.e. the Lucas critique.[6]

There are four blocks in our model *viz.* the macroeconomic block, the government block, the external block, and the monetary block. The macroeconomic block comprises of equations determining the nominal GDP, WPI inflation, and private investment to GDP ratio. The government block comprises of equations determining the combined current expenditure (oil subsidy and the expenditure other than oil subsidy), the combined revenue receipts (tax revenues from oil and other revenues) of central and state governments along with the public investment and the fiscal deficit. The external block comprises of equations determining the export, import (oil and non-oil), trade balance, net invisible, net capital inflow, exchange rate and change in foreign exchange reserve. The monetary block contains equations determining the change in high-powered and narrow money, the public borrowing and the rate of interest.

The scope of the model is limited to the study of macro-behaviour of the oil sector and macro-relationships of this sector with rest of the economy. It doesn't cover relative price impacts, energy efficiency, technological changes, alternative fuels and the linkages with financial markets. The internal structure of the oil industry including upstream and downstream companies and sharing of under-recoveries between the government and these companies is assumed to be unchanging. The participation of the public and private sector companies and distinction between the domestic production and imported value of oil has not been considered in a disaggregated manner.

Macroeconomic Block[7]

The model is specified below in terms of equations (1) to (31) For explanations to specific equations refer to Mundle et al (2011). The aggregate (nominal) demand in the economy in period t (Y_t) is given by

$$Y_t \equiv C_t + I_t^p + I_t^g + G_t + B_t^t + L_t \qquad (1)$$

[6] For details see Mundle et. al, 2011, p. 2658.

[7] In the following system of equations the notation convention adopted is to denote all exogenous variables with a bar [$\overline{x}$], all policy variables with a hat [$\hat{x}$], and growth rates with a dot [$\dot{x}$].

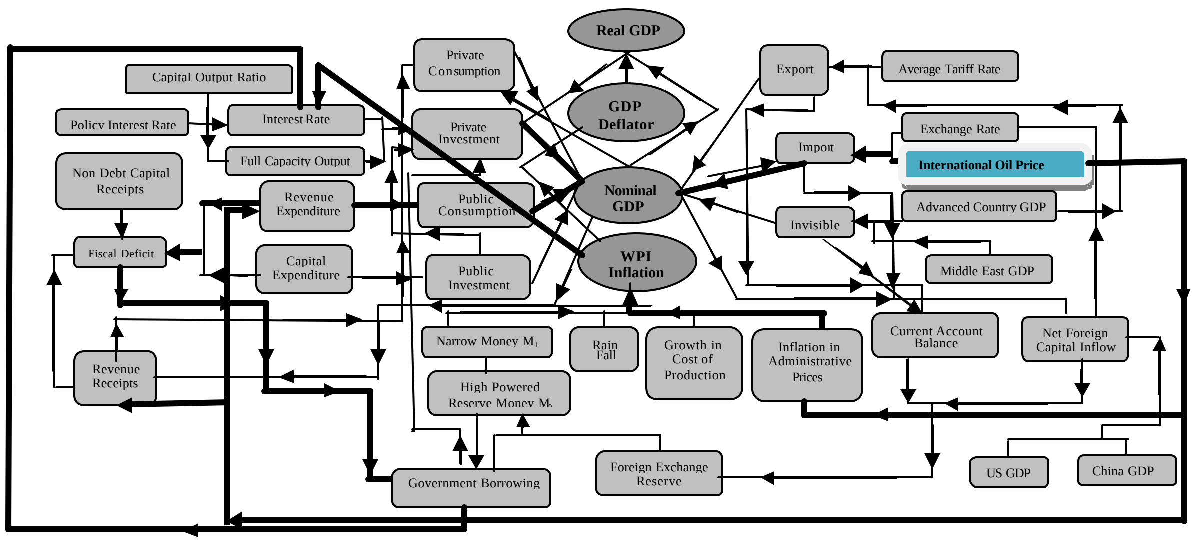
where C_t is aggregate private consumption expenditure, which is assumed to be a positive function of aggregate disposable income, I_t^p is aggregate private investment demand, I_t^g is aggregate government investment, G_t is aggregate government consumption expenditure, B_t^t is the aggregate balance of trade in goods and services, and L_t is net inflow of invisibles (remittances etc.). Therefore, $B_t^t + L_t$ is the net current account balance.

Inflation in period t ($\dot{p}_t$) is given by

$$\dot{p}_t = f(\dot{M}_{1t}, \hat{\dot{p}}_t^a, \overline{\dot{A}}_t, \overline{V}_t) \qquad (2)$$

where $\dot{M}_{1t}$ is the growth rate of narrow money, $\hat{\dot{p}}_t^a$ is the rate of change in the level of administered prices, $\overline{\dot{A}}_t$ is the rate of change in factor costs (wage, rent and interest costs), and $\overline{V}_t$ is the index of rainfall in period t. In the estimated equation system (reported in the *section V.A*) all the inflation determinants are significant with expected signs. Within the administered prices, there are oil and non-oil commodities that need to be disaggregated to analyse the oil price impact. This is disaggregated

Figure 3: Flow Chart of the Model



Note: Thick lines specify the oil price impact transmission path.

as follows.

$$\hat{\dot{p}}_t^{\,a} \equiv 0.26 \times \hat{\dot{p}}^{\,aO} + 0.74 \times \hat{\dot{p}}_t^{\,anO} \qquad (3)$$

Where $\hat{\dot{p}}_t^{aO}$ is the administered price of the oil basket and $\hat{\dot{p}}_t^{anO}$ is the price of the non-oil administered commodity basket.[8] Here both the components are multiplied by their respective shares in the overall administered commodities basket in WPI series.

The rate of private investment ($\frac{I_t^p}{Y_t}$) is given by:

$$\frac{I_t^p}{Y_t} = f\left(r_t, \frac{I_t^g}{Y_t}, \frac{Z_t^e}{Z_t^c} \right) \qquad (4)$$

where r_t is the average cost of borrowing from the domestic credit market (i.e. average nominal interest rate of scheduled commercial banks and some of the major term lending institutions *viz.* ICICI, IDBI etc.) I_t^g is government investment in period t, Z_t^e is the expected real[9] output in year t and Z_t^c is the real full capacity output in period t. The latter (Z_t^c) is based on the capital stock existing at the beginning of the year t.

$$Z_t^c \equiv \frac{1}{k} \times K_{t-1} \qquad (5)$$

where k is the capital-output ratio and K_{t-1} is the real capital stock at the beginning of period t.

$$K_{t-1} \equiv K_{t-2} + I_{t-1}^p + I_{t-1}^g \qquad (6)$$

Following an adaptive expectations approach (Enders 2004), expected real output in period t (Z_t^e) is given by:

$$Z_t^e \equiv Z_{t-1} + \Delta \tilde{Z}_t \qquad (7)$$

where Z_{t-1} is actual GDP of the previous period and $\Delta\tilde{Z}_t$ is the predicted first difference of GDP in period t. This is derived fom equation 7.

[8] The inflation in administered price component of WPI has been calculated in the following manner. We have considered six main broad commodity groups – *viz.* cereals, fertiliser, iron & steel, mineral oil, electricity and coal from the WPI basket – prices of which are significantly influenced by the government (if not controlled directly). We calculate the relative weights of each commodity group by dividing their respective weights in the overall WPI basket by the total weight of all these six commodity groups taken together – separately considering 1980-81 base for the years 1990-91 to 1993-94, considering 1993-94 base for 1994-95 to 2004-05 and considering 2004-05 base for the years 2005-06 onwards. The relative weights remain constant for each commodity groups unless the base changes. We apply simple splicing technique to calculate a long time series of index numbers of the wholesale prices for each of the six administered commodity groups. Now we add the index numbers of each group multiplied by their respective relative weights to get a continuous series of composite index numbers from 1990-91 to 2010-11. The annual percentage changes in these index numbers give us the weighted average annual inflation in prices of administered commodities.

[9] Real and nominal outputs are linked through GDP deflator, which is a function of WPI.

$$\Delta\tilde{Z}_t = f(\Delta Z_{t-1}, \Delta^2 Z_{t-1}) \qquad (8)$$

where, ΔZ_{t-1} is the first difference of real output in the previous period and $\Delta^2 Z_{t-1}$ is the second difference of real output in the previous period. $\Delta Z'_{t-1}$ >0 & $\Delta^2 Z'_{t-1}$ <0. The r.h.s. determinants are all significant with expected signs in the estimated equations.

Government Block

Nominal aggregate revenue expenditure of government (W_t) is given by government subsidy on oil (W_t^O) and the rest

$$W_t = W_t^O + \hat{W}_t^{NO} \qquad (9)$$

$$G_t = f(G_{t-1}, W_t) \qquad (10)$$

where $\hat{W}_t$ is the revenue expenditure of government in period t, a policy variable. Equation (11) links two data sources *viz*. national accounts statistics (NAS) and Indian public finance statistics (IPFS) for consistency.

Revenue expenditure on oil W_t^O is essentially subsidy to the oil companies, which is a function of domestic price of oil and international price of POL basket. Conceptually, subsidy on oil is expected to be a function of the quantity of oil sold domestically and the extent of oil price pass-through[10]. Lower the pass-through of international price increases on to domestic administered price of oil, and higher the quantity of oil sold domestically, higher would be the subsidy. However, the Indian data on oil subsidies seems to be dependent solely on the price differential and not on the quantity sold. It seems the oil subsidy in India is determined through a far more complex process.

$$W_t^O = f(\hat{p}_t^{ao}, \overline{p}_t^o) \qquad (11)$$

Where $\overline{p}_t^o$ is international oil price of the Indian import POL basket.

Note that there is a likely link between the subsidy on oil and other subsidies by the government. With reduction in petro-subsidy and greater degree of pass-through, some of the other subsidies of the government such as fertiliser and food subsidies are likely to go up in reality. But we assume that the government decides not to raise other

[10] The under recovery of oil marketing companies is the difference between administered domestic price and import parity price of oil multiplied by the quantity sold. Under recoveries are financed by absorption by the oil companies, the oil bonds and the government subsidies. If the government has to compensate the oil companies fully for their under recovery, then the subsidy bill of the government becomes equal to total under recovery. Between 2004-05 to 2009-10 (*see table 1*), the companies were allowed to float special oil bonds with sovereign guarantee for covering up part of their under recoveries. Since 2010, these oil bonds have become part of the fiscal deficit in the Central government budget. Therefore, effectively the under recoveries have become equivalent to oil subsidy barring the component of under recovery, which is absorbed by the oil companies themselves.

subsidies due to increased price of oil and petroleum products. This has been assumed partly because of the unavailability of time series data on other subsidies for the combined government and partly because there is no such obvious one to one correspondence – ultimately, this is a matter of policy choice of the government in power.

The level of government revenue (tax and non-tax) in period t is given by (T_t) which consists of excise and customs revenues on oil T^{ECO}, sales tax revenue on oil T^{STO} and other tax and non-tax revenue of the government, T_t^N.

$$T_t \equiv T_t^N + T^{ECO} + T^{STO} \qquad (12)$$

$$\Delta T_t^N \equiv \hat{b} \times \frac{\Delta Y_t}{Y_{t-1}} \times T_{t-1} \qquad (13)$$

where revenue buoyancy $\hat{b}$ is a policy variable. It is assumed that government can set this through adjustments in tax rates and the administrative tax effort.

Sales tax revenue from oil T^{STO}, levied at an *ad-valorem* rate, is a function of administered domestic price of oil and quantity of oil imports. Revenue from excise and custom duty from oil T^{ECO}, levied as specific duty, is obtained by applying the effective customs and excise tax rate $\hat{\Phi}$ to quantity of oil import, QM_t^O.

$$T_t^{STO} = f(\hat{p}_t^{ao}, QM_t^O) \qquad (14)$$

$$T_t^{ECO} \equiv \hat{\Phi} \times QM_t^O \qquad (15)$$

$$QM_t^O = f(Z_t) \qquad (16)$$

where QM_t^O is a function of real GDP.

Public investment is assumed to be a function of government capital expenditure:

$$I_t^g = f(\hat{S}_t^g) \qquad (17)$$

where, $\hat{S}_t^g$ is the capital expenditure of government in period t, a policy variable. The right hand side variables in behavioural equations are all significant with expected signs in the estimated system of equations.

The fiscal deficit in period t (F_t) is given by

$$F_t \equiv W_t + \hat{S}_t^g - T_t - \hat{N}_t^g \equiv D_t^g + \Delta\hat{O}_t^g \qquad (18)$$

where D_t^g is the aggregate market borrowing of the government in period t, $\hat{N}_t^g$ is non-debt capital receipts of the government (disinvestment etc.) and $\Delta\hat{O}_t^g$ is the change in fiscal reserves.

External Block

The trade balance in terms of domestic currency in period t (B_t^t) is given by

$$B_t^t \equiv X_t - M_t - M_t^O \qquad (19)$$

where X_t is the value of exports (including services) and M_t is the value of non-oil imports (including services) and M_t^O is oil import in period t.

Hence, we have

$$X_t = f\left(\hat{U}_t, \overline{Y}_t^a\right) \qquad (20)$$

where $\hat{U}_t$ is the policy determined average tariff rate and $\overline{Y}_t^a$ is the *GDP* of advanced countries, an exogenous variable.

The value of non-oil imports is assumed to depend on the exchange rate, and domestic income. Hence,

$$M_t = f(e_t, Y_t) \qquad (21)$$

where e_t is the nominal exchange rate (Rs/US$), and Y_t is nominal GDP in period t. The r.h.s. variables are significant with expected signs in the estimated equations.

$$M_t^O = f(e_t, \overline{P}_t^O, Z_t) \qquad (22)$$

$$NM_t^O = f(M_t^O) \qquad (23)$$

where, $\overline{P}_t^O$ is the weighted average import price of oil and petroleum products of Indian basket in terms of domestic currency, an exogenous variable. Net oil import NM_t^O (i.e. oil import minus oil export) as used in equation (15) is a linear function of oil imports, M_t^O.

The nominal exchange rate is assumed to be a function of the net inflow of foreign capital. Thus:

$$e_t = f(J_t) \qquad (24)$$

where J_t is net foreign capital inflow. It has also been verified that other variables such as the trade balance and interest rate do not have a significant effect on the exchange rate at present. The determinant is significant with expected sign in the estimated equation.

Net capital inflow J_t is assumed to be a function of the level of income in the United States ($\overline{Y}_t^{us}$), the major origin of foreign capital flows to India, and China ($\overline{Y}_t^c$), the main competing destination for these flows, and Indian GDP (Y_t) as a proxy for domestic demand.

$$J_t = f(\overline{Y}_t^{us}, \overline{Y}_t^{c}, Y_t) \qquad (25)$$

It has been verified that capital inflow is not causally dependent on either the domestic-external interest rate differential or the exchange rate.

The net inflow of invisibles (L_t) is assumed to be a function of aggregate output of advanced (OECD) countries ($\overline{Y}_t^{a}$) and the Middle East ($\overline{Y}_t^{me}$), these being the two major sources of remittances.

$$L_t = f(\overline{Y}_t^{a} + \overline{Y}_t^{me}) \qquad (26)$$

The explanatory arguments are all significant and have the expected signs. The balance of payments identity in period t (B_t^p) is given by

$$B_t^p \equiv B_t^t + L_t + J_t + \Delta\overline{R}_t \equiv 0 \qquad (27)$$

where $\Delta\overline{R}_t$ is the change in foreign exchange reserves.

Monetary Block

Given the value of the money multiplier, the change in narrow money supply ($\dot{M}_{1t}$) in period t is given by

$$\dot{M}_{1t} = f(\dot{H}_t) \qquad (28)$$

where $\dot{H}_t$ is the change in high-powered money supply in period t . The growth of high powered money ($\dot{H}_t$) is in turn assumed to be a function of total government borrowing (D_t^g) and change in foreign exchange reserves ($\Delta\overline{R}_t$), i.e.,

$$\frac{\dot{H}_t}{H_{t-1}} = f(D_t^g, \Delta\overline{R}_t) \qquad (29)$$

where H_{t-1} is the volume of high-powered money in the previous period. Total government borrowing is given by

$$D_t^g \equiv \hat{D}_{ct}^g + \hat{D}_{mt}^g \qquad (30)$$

where $\hat{D}_{ct}^g$ is government borrowing from RBI and $\hat{D}_{mt}^g$ is government borrowing from the market.

Finally, the average nominal rate of interest is assumed to be a function of the rate of inflation, the policy rate and the volume of government borrowing from the market, the potential crowding out element. Hence,

$$r_t = f(\dot{p}_t, \hat{i}_t, \hat{D}_{mt}^g) \qquad (31)$$

where $\hat{i}_t$ is the repo rate (bank rate before 2004-05) of RBI in period t. The r.h.s variables are significant with expected signs in the estimated equations.

V. Empirical Results

The key policy variables in solving this model include revenue and capital expenditure to GDP Ratio, non-oil revenue buoyancy, the rate of change in administered prices (apart from oil), the domestic oil price/oil price pass-through ratio, the rate of excise and customs duties on oil and petroleum products, the policy interest rates and the import weighted average tariff rate, the non-debt capital receipts of the government, the change in fiscal reserves, the ratio of government borrowing from market to that from (formerly) RBI and the change in foreign exchange reserve. The important exogenous variables include the growth of output in OECD countries as a group as well as in the USA, China, and the Middle East; world oil prices; the rainfall index; the capital-output ratio, the cost of production (wage, rent and interest cost). A scenario is designed by setting the value of both the policy variables as well as the exogenous variables based on certain assumptions as specified in section V(C). The outcome variables of interest in each scenario include the growth rate, the inflation rate, the current account deficit to GDP ratio and the fiscal deficit-GDP ratio as well as some other key macroeconomic ratios, i.e., the trade deficit relative to GDP; the combined tax and non-tax revenue to GDP ratio and the revenue deficit to GDP ratio and the total liability of the government considering the Central and the State governments together as proportion to the GDP.

V (A). Estimated Equations:

Macroeconomic Block:

Detailed results of the estimated individual functions used for running the simultaneous equation system model are described below along with the analysis.[11] Variable abbreviations are presented in Appendix.

1) Private nominal consumption (CPR) has been hypothesised to be positively dependent on disposable income (YMPD) i.e. aggregate income less taxes and on its own past values (CPR (-1)).

Sample size = 19 (1991-92 to 2009-10)

$$\underset{(5.01)}{CPR = 38903.56} + \underset{(11.27)}{0.31*YMPD} + \underset{(13.66)}{0.63*CPR(-1)} + \underset{(13.26)}{76023.89*DUMCPR}$$

Adj R^2 = 0.99 DW Stat = 2.45

The explained variation is almost 100 percent and the Durbin-Watson statistic is 2.45. Both the coefficients are positive and significant with a positive significant intercept.

[11] Compared to Mundle *et. al* (2011) the equations have been re-estimated with the most recent data points.

2) Nominal consumption expenditure of the central and state governments taken together (CPU) has been hypothesised to be positively dependent on the combined revenue expenditure of government (ECURR) and on its own past values (CPU(-1)).

Sample size = 19 (1991-92 to 2009-10)

$$CPU = \underset{(2.59)}{7924.09} + \underset{(11.99)}{0.36}*ECURR + \underset{(3.44)}{0.26}*CPU(-1) + \underset{(7.43)}{25246.11}*DUMCPU$$

Adj R^2 = 0.99 DW Stat = 1.57.

The explained variation is almost 100 percent and the Durbin-Watson statistic is 1.57. Both the coefficients are positive and significant with a positive significant intercept.

3) The first difference of GDP at factor cost at constant price (DZYF) has been hypothesised to be negatively dependent on its one year lagged second difference D(DZYF(-1)) and on its own past values (DZYF(-1)).

Sample size = 18 (1992-93 to 2009-10)

$$DZYF = \underset{(1.73)}{20574.37} + \underset{(10.09)}{0.88}*DZYF(-1) - \underset{(-1.75)}{0.29}*D(DZYF(-1)) + \underset{(3.93)}{70896.45}*DUMDZYF$$

Adj R^2 = 0.89 DW Stat = 2.77.

The explained variation is almost 90 percent and the Durbin-Watson statistic is 2.77. The coefficient of one year lagged second difference is negative and insignificant while the coefficient of one year lag of the dependent variable is positive and significant with a positive significant intercept.

4) Investment by the government and public sector enterprises (IPU) has been hypothesised to be positively dependent on combined capital expenditure of government (ECAP) and on its own past values (IPU(-1)).

Sample size = 16 (1994-95 to 2009-10)

$$IPU = \underset{(2.97)}{6226.40} + \underset{(19.2)}{1.08}*ECAP + \underset{(13.84)}{0.51}*IPU(-1) + \underset{(6.51)}{15128.45}*DUMIPU$$

Adj R^2 = 0.99 DW Stat = 2.79.

The explained variation is almost 100 percent and the Durbin-Watson statistic is 2.79. Both the coefficients are positive and significant with a positive significant intercept.

5) The private investment to GDP ratio (IPV/YF) has been hypothesised to be negatively dependent upon the average prime lending rate and positively dependent on the ratio of expected real output to full capacity real output (RATIO) and the government investment rate (IPU/YF).

Sample size = 19 (1991-92 to 2009-10)

$$IPV/YF = \underset{(-27.20)}{-0.66} - \underset{(-26.80)}{0.01}*PLR + \underset{(42.80)}{0.89}*RATIO + \underset{(4.42)}{0.36}*(IPU/YF) + \underset{(33.54)}{0.06}*DUMIPV$$

Adj R^2 = 0.99 DW Stat =1.96.

The explained variation is almost 100 percent and the Durbin-Watson statistic is 1.96. All the coefficients are significant with a negative significant intercept. We have added a crisis dummy here following the 'financial crisis' of developed world.

6) The wholesale price index based inflation (GPWPI) has been hypothesised to be positively dependent on the increase in administered commodity prices (AINF), the growth rate in narrow money supply (GM1) and the increase in cost of production (GCP) and negatively dependent on the rainfall index (RAIN) in India.

Sample size = 17 (1993-94 to 2009-10)

GPWPI=-5.89+0.21*AINF+0.08*GM1+ 0.02*GCP+ 0.01*RAIN+ 2.28*DUMPWPI
(-4.91) (11.80) (2.77) (2.25) (5.77) (15.60)

Adj R^2 = 0.98 DW Stat = 3.33.

The explained variation is almost 98 percent and the Durbin-Watson statistic is 3.33, which is higher than the acceptable limit. All the coefficients are significant. We have added one auto regressive term (AR2) in order to take care of time series property. We have also added a crisis dummy here following the 'financial crisis' of developed world.

7) The inflation in GDP deflator (GPGDP) has been hypothesised to be positively dependent on the inflation based on WPI (GPWPI).

Sample size = 20 (1990-91 to 2009-10)

GPGDP = 0.08 + 0.98*GPWPI + 3.82*DUMPGDP
(1.18) (9.42) (5.75)
Adj R^2 = 0.93 DW Stat =3.06.

The explained variation is 93 percent and the Durbin-Watson statistic is 3.06. The coefficient is significant with a positive intercept.

8) The first difference of capital stock at the beginning of any period (CAPSTOCK) has been hypothesised to be positively dependent on the total investment of last period (i.e. private investment plus government investment IPV(-1)+IPU(-1)).

Sample size = 17 (1992-93 to 2008-09)

D(CAPSTOCK) = 80351.29 + 0.43*(IPV(-1)+IPU(-1)) + 137422.67*DUMCAPS
(9.87) (34.24) (5.61)
Adj R^2 = 0.99 DW Stat = 1.44.

The explained variation is almost 100 percent and the Durbin-Watson statistic is 1.44. The coefficient is significant with a positive significant intercept.

9) The constant price GDP at factor cost (ZYF) has been hypothesised to be positively dependent on GDP at constant market price (ZYMP) and its lag.

Sample size = 19 (1991-92 to 2009-10)

ZYF = -37152.17 + 0.73*ZYMP + 0.22*ZYMP(-1)
(-5.35) (15.45) (4.23)

Adj R^2 = 0.99 DW Stat = 2.20.

The explained variation is almost 100 percent and the Durbin-Watson statistic is 2.20. The coefficient is significant with a negative significant intercept.

Government Block:

10) The combined revenue expenditure of government apart from petroleum subsidy (NETECURR) has been hypothesised to be positively dependent on the nominal GDP at market price (YMP) and on its own past values.

Sample size = 19 (1991-92 to 2009-10)

NETECURR=-892.86+0.47*NETECURR(-1 +0.13*YMP+72151.41*DUMNETECURR
(-0.13) (4.83) (6.97) (7.77)

Adj R^2 = 0.99 DW Stat =1.59.

The explained variation is almost 100 percent and the Durbin-Watson statistic is1.59. The coefficients are positive and significant with a negative intercept. We have added a crisis dummy here following the 'financial crisis' of developed world to capture the fiscal stimulus including the 6th Pay Commission impact.

11) The petroleum subsidy bill of the government (PETROSUBSIDY) has been hypothesised to be dependent negatively on the ratio of domestic to international prices of oil and petroleum products of the Indian basket (OILPRRATIO).

Sample size = 9 (2001-02 to 2009-10)

PETROSUBSIDY=53466.41-39471.24*OILPRRATIO+ 50703.48*DUMCRISIS
(5.43) (-3.99) (7.48)

Adj R^2 = 0.94 DW Stat = 2.23

The explained variation is 94 percent and the Durbin-Watson statistic is 2.23. The coefficient is negative and significant with a positive significant intercept. We have added one dummy variable here due to financial crisis.

12) The sales tax revenue of the State governments from the petroleum products (PETROSALESTAX) has been hypothesised to be positively dependent on the oil import quantity (OILIMPORTQTY) as a proxy of quantity sold of oil and petroleum products and positively dependent on the domestic oil price index (DOMOILPRINDEX).

Sample size = 8 (2002-03 to 2009-10)

PETROSLSTAX=-21327.59+155.36*OILIMPORTQTY+141.04*DOMOILPRINDEX
(-19.20) (9.32) (19.91)

Adj R^2 = 0.99 DW Stat = 1.60

The explained variation is almost 100 percent and the Durbin-Watson statistic is 1.6. The coefficients are positive and significant with a negative significant intercept.

13) The market borrowing of the government (MB) has been hypothesized to be positively dependent on the fiscal deficit of last year (FD (-1).

Sample size = 16 (1993-94 to 2008-09)

$$MB = -33415.12 + 0.85*FD(-1) + 88827.23*DUMMB$$

(-1.94) (8.32) (8.59)

Adj R^2 = 0.89 DW Stat = 2.76.

The explained variation is 89 percent and the Durbin-Watson statistic is 2.76. The coefficient is significant with a negative significant intercept. We have added a dummy here also due to fiscal stimulus following the 'financial crisis' of developed World.

External Block:

14) The first difference of exports in rupee terms (D(EXPORT)) has been hypothesized to be positively dependent on the first difference of GDP of advanced countries (ADVGDP) and negatively dependent on the import weighted average tariff rate (DUTY).

Sample size = 17 (1992-93 to 2009-10)

$$D(EXPORT) = 171078.22 + 7982.42*D(ADVGDP) - 7025.84*DUTY + 52547.36*DUMXTO$$

(21.63) (11.06) (-21.70) (12.55)

Adj R^2 = 0.99 DW Stat = 2.40.

The explained variation is almost 100 percent and the Durbin-Watson statistic is 2.40. All the coefficients are significant with a positive significant intercept. We have added one export dummy.

15) The international oil price index of Indian basket in terms of rupees (INTOILPRINDEX) has been hypothesised to be positively dependent on the index of the international price of oil in US$ terms (OIL) and the exchange rate (ER).

Sample size = 16 (1991-92 to 2009-10)

$$INTOILPRINDEX = -159.51 + 1.06*OIL + 3.61*ER - 41.68*DUMCRISIS + 20.99*DUMRECOVERY$$

(-25.08) (116.91) (20.74) (-7.54) (4.05)

Adj R^2 = 0.99 DW Stat = 2.36.

The explained variation is almost 100 percent and the Durbin-Watson statistic is 2.36. The coefficients are significant and positive with a negative significant intercept. We have added two dummy variables here due to financial crisis and recovery from the crisis.

16) The value of total import of oil and petroleum products in Indian rupees (OILIMPORT) has been hypothesised to be dependent positively on the international price of oil of Indian basket in US$ (OIL) and on domestic GDP in factor cost (YF) and negatively dependent on the exchange rate (ER).

Sample size = 16 (1991-92 to 2009-10)

$$OILIMPORT = -3673.24 + 268.83*OIL + 0.06*YF - 2273.18*ER + 23389.83*DUMOIL$$

(-0.38) (11.27) (21.74) (-8.50) (9.88)

Adj R^2 = 0.99 DW Stat = 1.62.

The explained variation is almost 100 percent and the Durbin-Watson statistic is 1.62. The coefficients are significant with expected signs and with a negative significant intercept. We have added one dummy variable here due to financial crisis.

17) The value of non-oil import in rupees (NONOILIMPORT) has been hypothesised to be dependent positively on the domestic GDP at factor cost (YF) and negatively depend on the exchange rate (ER).

Sample size = 16 (1992-93 to 2009-10)

$$NONOILIMPORT = 154021.93 + 0.27*YF - 9137.79*ER + 72870.20*DUMNONOIL$$

(18.70) (293.43) (-39.89) (32.06)

Adj R^2 = 0.99 DW Stat = 2.53

The explained variation is almost 100 percent and the Durbin-Watson statistic is 2.53. The coefficients are significant with expected signs and with a positive significant intercept. We have added one dummy variable here due to financial crisis.

18) The quantity in million tones of import of the oil and petroleum products in India (OILIMPORTQTY) has been hypothesised to be positively dependent on the domestic GDP at factor cost and at constant prices (ZYF).

Sample size = 16 (1992-93 to 2009-10)

$$OILIMPORTQTY = -29.42 + 5.63e\text{-}05*ZYF - 11.54*DUMCRISIS$$ [12]

(-4.77) (23.29) (-4.75)

Adj R^2 = 0.99 DW Stat = 1.45

The explained variation is almost 100 percent and the Durbin-Watson statistic is1.45. The coefficient is positive and significant with a negative significant intercept. We have added one dummy variable here due to financial crisis. We have also added one autoregressive (AR1) term in order to take care of time series property.

19) The oil import net of oil export (NETOILIMPORT) has been hypothesised to be positively dependent on the total import of oil and petroleum products of the Indian basket (OILIMPORT).

Sample size = 16 (1992-93 to 2009-10)

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[12] The relation between oil import quantity and index of domestic price of oil is (counter intuitively) tested to be positive:

$$OILIMPORTQTY = 16.25 + 0.29*DOMOILPRINDEX$$

(5.71) (25.64)

NETOILIMPORT=12455.53+0.65*OILIMPORT+13732.39*DUMCRISIS- 10280.05*DUMCRISIS1
(3.18) (38.14) (3.22) (-2.55)

Adj R^2 = 0.99 DW Stat = 2.20

The explained variation is almost 100 percent and the Durbin-Watson statistic is 2.20. The coefficient is positive and significant with a positive significant intercept. We have added one dummy variable here due to financial crisis. We have also added one autoregressive (AR1) term in order to take care of time series property.

20) The net capital inflow (CAPINFLOW) has been assumed to be a function of GDP of China (CHINAGDP) that of United States (USGDP) and Indian domestic real GDP (ZYMP) at market price.

Sample size = 18 (1991-92 to 2008-09)

CAPINFLOW=-134998–18.51*CHINAGDP+10.78*USGDP+0.07*ZYMP+
(-3.09) (-1.42) (2.40) (1.69)

170383*DUMCAP-48302.9*DUMCRISIS
(13.02) (-3.08)

Adj R^2 = 0.98 DW Stat = 1.82.

The explained variation is 98 percent and the Durbin-Watson statistic is 1.82. The coefficients are significant with a negative significant intercept. We have added a crisis dummy here following the 'financial crisis' of developed world.

21) The net invisible flow of current account of balance of payment (INVISIBLE) has been hypothesised to be a function of joint GDP of the advanced countries (ADVGDP) and the Middle East (MEGDP).

Sample size = 19 (1991-92 to 2009-10)

INVISIBLE=-79208.49+110.72*(MEGDP+ADVGDP)+608.61*ER+42200.7*DUMINVISIBLE
(-8.10) (27.06) (2.16) (7.43) (2.90)

Adj R^2 = 0.99 DW Stat = 2.41.

The explained variation is almost 100 percent and the Durbin-Watson statistic is 2.41. The coefficients are significant with a negative significant intercept.

22) The rupee-dollar exchange rate (ER) has been hypothesised to be negatively dependent on the net capital inflow (CAPINFLOW).

Sample size = 14 (1995-96 to 2008-09)

ER = 45.97 - 3.78e-05*CAPINFLOW + 6.41DUMER +1.51* AR(1) - 0.64 AR(2)
(26.9) (-13.84) (5.40) (10.44) (-4.94)

Adj R^2 = 0.98 DW Stat = 1.55.

The explained variation is 98 percent and the Durbin-Watson statistic is 1.55. The coefficient is negative significant with a positive significant intercept. We have added two auto regressive terms (AR1 & AR2) in order to take care of time series property.

Monetary Block:

23) The average prime lending rate (PLR) has been hypothesised to be positively dependent on the WPI inflation rate (GPWPI), the RBI determined repo rate (REPO) and the market borrowing of the government (MB).

Sample size = 15 (1995-96 to 2009-10)

PLR = 5.83 + 0.10*GPWPI + 0.78*REPO + 2.72e-06*MB + 0.72*DUMPLR
(75.19) (8.77) (90.48) (19.77) (24.89)

Adj R^2 = 0.99 DW Stat = 1.91

The explained variation is almost 100 percent and the Durbin-Watson statistic is 1.91. The coefficients are significant with a positive significant intercept.

24) The narrow money (GM1) has been hypothesised to be positively dependent on the high-powered reserve money (GM0).

Sample size = 18 (1991-92 to 2008-09)

GM1 = -36346.31 + 1.37*M0 + 42635.34*DUMM1 - 80*4DUMCRISIS
(-10.03) (136.95) (10.76) (-8.13)

Adj R^2 = 0.99 DW Stat = 2.50.

The explained variation is almost 100 percent and the Durbin-Watson statistic is 2.50. The coefficient is positive and significant with a negative significant intercept. We have added a crisis dummy here also following the 'financial crisis' of developed world.

25) The stock of reserve money (M0) has been hypothesised to be positively dependent on foreign exchange reserves (FOREX) and market borrowing by the government (MB).

Sample size = 19 (1991-92 to 2009-10)

M0 = 118959.46 + 0.47*FOREX + 0.58*MB + 51197.06*DUMGM0
(20.79) (30.17) (10.45) (3.75)

Adj R^2 = 0.99 DW Stat =0.89.

The explained variation is almost 100 percent and the Durbin-Watson statistic is 0.89. The coefficients are significant with a positive significant intercept. We have added a crisis dummy here also following the 'financial crisis' of developed world.

V(B). Methodology and In-Sample Validation:

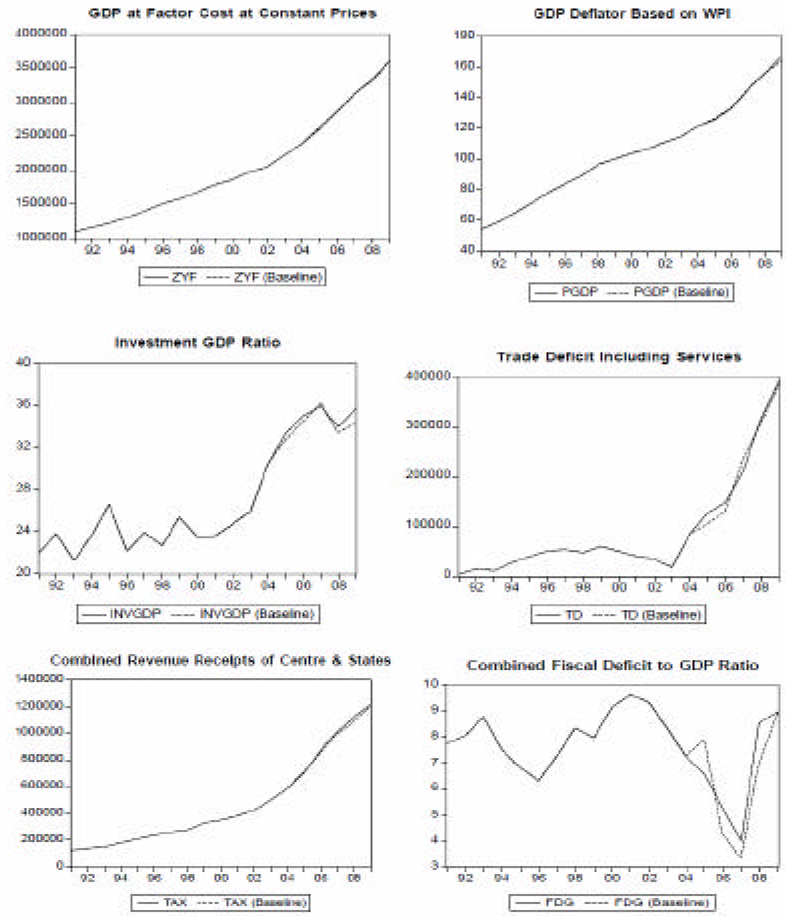
The behavioural equations in the model have been estimated one by one using annual data for the period 1991-92 to 2009-10 (reliable time series data on petroleum sector is available for the last decade only), taking care of time series properties. The data sources are given in details in *appendix II*. It is important to note here that we have introduced dummy variables, wherever required (details are given in the previous *section V(A)* containing estimated behavioural equations), to adjust for the unusual fluctuations during the financial crisis of 2007-08 in order to capture the basic behavioural relationships – uninfluenced by the exceptional years of exogenous shocks or the outliers. All the behavioural equations are linked through various identities to complete the simultaneous system of equations. Then the entire system of simultaneous equations (including all the behavioural equations and identities) has been solved for the sample period 2005-06 to 2009-10 (through maximum 5000 iterations in eviews) and validated for this period. The root mean square percentage errors (RMSPE) for all the key variables are shown in *table 3* (also in *graph 1*). Then the values of exogenous variables including government policy variables for the future period are put according to various assumptions specified in the next section and the model is solved in the above mentioned method to obtain future values of the endogenous variables. Various scenarios are obtained by changing some of the assumptions for some of the exogenous variables.

Table 3: In Sample Validation Root Mean Squire Percentage Error: 2005-06 to 2009-10

Description	RMSPE	Description	RMSPE
Private Consumption	0.79	Trade Deficit	3.51
Government Consumption	2.21	Net Capital Inflow	3.54
Govt. Current Expenditure	1.84	Invisible (Remittances)	3.14
Private Investment	2.68	Rupee/US dollar exchange rate	5.61
Public Investment	0.73	Prime lending rate	4.74
Govt. Capital Expenditure	1.15	Narrow Money Supply (M1)	6.29
Total Govt. Revenue	1.84	GDP Deflator	1.74
Revenue Deficit	2.18	Inflation (WPI)	8.65
Total Government Debt	1.47	Nominal output (factor cost)	2.30
Exports Including Services	1.39	Nominal Output (market price)	1.10
Non-oil Imports Including Services	1.80	Real Output (factor cost)	2.00
Oil Import	3.52	Real Output (market price)	2.68

The tests show that the model is robust and performs well against actual outcomes for the sample period with root mean squire percentage error being less than 10 percent for all the variables. In fact, apart from WPI inflation, exchange rate and money supply (M1), all other RMPSEs are less than 5 percent. It is noted that the estimated model captures many, though not all, of the turning points in actual outcomes.

Graph 1: In Sample Validation Graphically: 2005-06 to 2009-10



V (C). Analysis of oil shock impact on India

This section would discuss the impact of oil shock on major macroeconomic variables under various scenarios during the 12th Five year Plan period i.e. 2012-13 to 2016-17.

Baseline Scenario:

The business-as-usual outcomes for the future period result from the following assumptions about the various exogenous variables:

1. In the real sector the output-capital ratio is assumed to remain constant at its current level of 0.375 and factor costs (wage, interest payment and rent) are assumed to rise at the rate of 10 percent per year. Administered non-oil inflation is assumed to rise at the rate of 10 percent every year throughout the reference period. There would be normal rainfall in future according to the average rainfall of five years during 2004-05 to 2008-09.

2. In the monetary field, the policy (repo) rate has been held constant at 6.25 percent. The foreign exchange reserve of the government increases by 10 percent every year.

3. In the external sector the base case assumes that the advanced countries, India's major trading partners and important sources of remittances, will grow at the rates forecast by the IMF. USA, China and the Middle East, respectively the main source of foreign capital, the main competing destination of foreign capital, and one of the major sources of remittances, are also assumed to grow at the rate forecast by the IMF. The import weighted average tariffs are assumed to remain at the same level as at present, i.e., 9 percent.

4. The largest set of assumptions relate to the fiscal block. On the revenue side, after smoothening the recent spurt in corporate and income tax buoyancy, it is assumed that there will be no major policy or performance changes affecting revenue collection, implying that revenue buoyancy (excepting the oil sector) remains unchanged at its medium term level of 1.225. On the expenditure side, the capital expenditure of the combined government gradually increases to 6 percent of GDP by 2014-15 in line with the recommendations by the 13th Finance Commission and that to 6.5 percent of GDP by 2016-17. The effective rate of excise and customs duty would remain the same as it was during 2009-10 throughout the 12th Plan period. It is also assumed that there will be no off-budget items for the reference period and that there will be no change in fiscal reserves during this period. The non-debt capital receipts of the government is assumed to be 1 percent of GDP every year upto 2016-17.

5. Finally, the baseline scenario assumes that the international oil prices do not increase at all during 12th Plan period and remains at the 2008-09 level, which is historically highest weighted annual average till date, for the entire plan period and the index of domestic oil prices remains constant at the level of 2010-11, the latest available year for which data is available, throughout the plan period.

Other Scenarios:

The *scenario 1* is based on the assumptions that international oil prices increase by 50 percent in 2012-13 (i.e. the first year of 12th Five-year Plan) and then remain there throughout the plan period and domestic oil prices remain the same as in 2010-11 i.e. the case of zero pass-through of the rise in the international oil price on the domestic prices. *Scenario 2* is based on the assumptions that the international oil prices increase by 50 percent in 2012-13 and then remain there throughout the plan period and the domestic oil prices increases by 25 percent in 2012-13 and then remain constant at that level till 2016-17 i.e. the case for partial (50%) pass-through. *Scenario 3* is based on the assumptions that the international oil prices increase by 50 percent in 2012-13 and then remain there throughout the plan period and the domestic oil prices also increases by 50 percent in 2012-13 and then remain constant at that level till 2016-17 i.e. the case for full pass-through. Scenario 4 is based on the assumptions that the international oil prices increase by 50 percent in 2012-13 and then remain there throughout the plan period while the domestic oil prices increases by 65 percent in 2012-13 and then keeps rising by 15 percent every year so that the oil price subsidy gradually reduces to zero by the end of 12th Plan. This scenario has been formulated in line with the recommendations made by the Kirit Parikh Committee (GOI, 2010) to completely deregulate the oil sector over a period of time. The simulation results are tabulated in *table 4* below.

If we compare the case of no pass-through i.e. the *scenario 1* with business as usual scenario i.e. the baseline case, we see that the growth rate comes down by almost 1 percentage point in the year of shock and it comes down by 0.3 percentage point on average during the 12th Plan period. Growth comes down primarily because of worsening of the trade balance due to high oil prices, which sets in motion a negative multiplier effect. The current account deficit to GDP ratio also increases by 0.3 percentage point on an average. The inflation does not change in zero pass-through case but the subsidy bill of the government increases. As a result, on average, the fiscal deficit to GDP ratio and the revenue deficit to GDP ratio increases marginally by 0.1 percentage point. In absolute numbers, the average annual subsidy goes up by almost Rs.10,000 crores in case of no pass-through, while revenue also comes down in the absolute sense compared to the baseline because of the reduction in growth.

Table 4: Simulation Results on the Effect of Oil Price Shock during 12th Plan

Variable (%)	Year	Baseline Scenario	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Growth	2012-13	8.24	7.20	5.85	4.52	3.77
	2016-17	8.39	8.42	8.43	8.43	7.60
	12Plan Avz	**8.44**	**8.12**	**7.83**	**7.55**	**6.71**
WPI Inflation	2012-13	4.29	4.29	5.70	7.10	7.92
	2016-17	4.75	4.74	4.75	4.75	5.51
	12Plan Avz	**4.49**	**4.49**	**4.76**	**5.03**	**5.80**
Current Account Deficit to GDP Ratio	2012-13	2.62	3.22	3.22	3.21	3.21
	2016-17	3.73	3.83	3.79	3.74	3.61
	12Plan Avz	**3.50**	**3.80**	**3.76**	**3.71**	**3.64**
Total Government Revenue to GDP Ratio	2012-13	18.83	18.91	19.06	19.22	19.32
	2016-17	20.22	20.23	20.32	20.41	20.93
	12Plan Avz	**19.50**	**19.54**	**19.67**	**19.79**	**20.11**
Fiscal Deficit to GDP Ratio	2012-13	7.75	7.89	7.71	7.53	7.43
	2016-17	7.47	7.52	7.40	7.28	6.61
	12Plan Avz	**7.64**	**7.72**	**7.57**	**7.41**	**7.01**
Revenue Deficit to GDP Ratio	2012-13	3.45	3.59	3.41	3.23	3.13
	2016-17	1.97	2.02	1.90	1.78	1.11
	12Plan Avz	**2.74**	**2.82**	**2.67**	**2.51**	**2.11**

Note: Baseline Scenario is one with no increase in international and domestic oil prices.
Scenario 1: 50 percent increase in oil price in 2012-13 and no pass-through.
Scenario 2: 50 percent increase in oil price in 2012-13 and partial (50%) pass-through.
Scenario 3: 50 percent increase in oil price in 2012-13 and full pass-through.
Scenario 4: 50 percent increase in oil price in 2012-13 and more than full pass-through so that even the subsidy existing prior to the shock is gradually reduced to zero by the end of 12th Plan i.e. by 2016-17.

In case of partial (50%) pass-through (*scenario 2*) and in case of full pass-through (*scenario 3*), we notice that the growth rate comes down even further. In case of full pass-through, the growth rate comes down by almost 4 percentage points in the year of shock and on an average the growth rate is likely to come down by almost 1 percentage point as compared to the base case during the 12th Plan period. In case of partial pass-through, the reduction in growth rate is relatively less. *In other words, contrary to existing beliefs oil price pass-through has an adverse effect on growth.* Greater the pass-through and lower the government subsidy, *ceteris paribus*, lower the growth. The intuition behind this result is that when the oil subsidy bill as part of the revenue expenditure comes down, without any corresponding increase in either capital expenditure or any other component of revenue expenditure, lower government expenditure would cause lower growth through negative Keynes-Kahn multiplier, for any given level of current account deficit. Also, higher cost-push inflation is expected to reduce growth.

Inflation rises by almost 3 percentage points in the year of shock in case of full pass-through as compared to the base case and the increase in inflation is around one and half percentage points in case of partial pass-through. On an average during the 12th Plan period, inflation is likely to go up by a little over half a percentage point in case of full pass-through. The trade deficit and the current account deficit rise by around 0.25 percentage point as compared to the base case. The total revenue of government as proportion to GDP goes up by 0.3 percentage point in case of full pass-through. The revenue deficit and the fiscal deficit as proportions of GDP are likely to come down as the degree of pass-through increases because of reduction in the subsidy bill of the government following an international oil price shock. Also, as the domestic price of oil increases, the *ad-valorem* sales tax revenue on petroleum also increases, although as the growth comes down, the total revenue apart from revenue from the petroleum sector declines. The combined effect of these two opposite forces is a net increase in the total revenue of the government. The reduction in government deficit, as we have noted above, comes at the cost of higher inflation and lower growth.

In *scenario 4*, we considered a special case when domestic price of oil rises at a faster rate than the international prices so that the petroleum subsidy bill of the government comes down to zero gradually by the end of the 12th Plan period. In this scenario, the growth rate comes down by almost 4.5 percentage points as compared to the base case, and inflation goes up by more than 3.5 percentage points in the year of shock. On average, growth is expected to come down by 1.75 percentage points and inflation is expected to rise by more than 1.3 percentage points during the 12th Plan period. The current account deficit to GDP ratio deteriorates by 0.14 percentage point and the revenue and fiscal deficit to GDP ratios improve by more than 0.6 percentage points on an average during 2012-13 to 2016-17.

Domestic Reforms on Oil Subsidy and its Impact

In this section, we evaluate the case where the international oil price remains the same for the Indian basket at the 2008-09 level throughout the 12th Plan period and consider the various schemes of reduction in domestic oil subsidies or deregulation of the oil prices (*scenarios 5 to 7 in table 5*).

Table 5: Simulation Results on Effect of Oil Subsidy Reduction during 12th Plan in the absence of oil price shock

Variable (%)	Year	Baseline Scenario	Scenario 5	Scenario 6	Scenario 7
Growth	2012-13	8.24	7.49	7.73	7.31
	2016-17	8.39	7.66	8.27	8.72
	12Plan Avz	**8.44**	**7.67**	**8.15**	**8.26**
WPI Inflation	2012-13	4.29	5.05	5.05	5.70
	2016-17	4.75	5.44	5.50	4.92
	12Plan Avz	**4.49**	**5.21**	**5.25**	**5.26**
Current Account Deficit to GDP Ratio	2012-13	2.62	2.62	2.68	2.74
	2016-17	3.73	3.62	4.31	4.46
	12Plan Avz	**3.50**	**3.43**	**3.80**	**3.92**
Total Government Revenue to GDP Ratio	2012-13	18.83	18.91	18.92	18.99
	2016-17	20.22	20.12	20.61	20.62
	12Plan Avz	**19.50**	**19.71**	**19.75**	**19.83**
Fiscal Deficit to GDP Ratio	2012-13	7.75	7.64	7.75	7.75
	2016-17	7.47	7.00	7.47	7.47
	12Plan Avz	**7.64**	**7.33**	**7.64**	**7.64**
Revenue Deficit to GDP Ratio	2012-13	3.45	3.34	3.31	3.19
	2016-17	1.97	1.50	1.34	1.32
	12Plan Avz	**2.74**	**2.43**	**2.33**	**2.21**

Note: Baseline Scenario is one with no increase in international and domestic oil prices and a status quo in the subsidy regime.
Scenario 5: The oil subsidy comes down to zero gradually by the end of 12th Plan i.e. by 2016-17 compared to the baseline case.
Scenario 6: The oil subsidy comes down to zero gradually by the end of 12th Plan i.e. by 2016-17 with a proportionate increase in the capital expenditure.
Scenario 7: The oil subsidy comes down to zero by the end of 12th Plan i.e. by 2016-17 on frontloading basis (by domestic oil price index increases by 25 percent in 2012-13, by 15 percent in 2013-14 & 2014-15, by 10 percent in 2015-16 and by 2.7 percent in 2016-17) with a proportionate increase in the capital expenditure so that the fiscal deficit to GDP ratio remains same as the baseline case.

Full pass-through of oil prices to the consumers over the 12th Plan period could be in two ways: gradual pass-through and the option of front loading. *Scenario 5* introduces the possibility of reducing the oil subsidy gradually to zero by the end of the 12th Plan period i.e. by 2016-17. Compared to the baseline the average growth rate comes down from 8.44 percent to 7.67 percent during the 12th Plan period and the average inflation rate goes up by 0.7 percent The inflation rises due to higher domestic oil prices as well as through second round impact through increase in cost of production. The growth rate falls because of reduction in aggregate demand due to higher prices. The current account deficit to GDP ratio improves marginally because of lower growth relative to the base case. The average fiscal deficit to GDP ratio comes down from 7.6 percent to 7.3 percent and the revenue deficit also comes down by 0.3 percentage points due to reduction in oil subsidy.

There could be a possibility of expenditure switching with reduction in revenue expenditure of the government due to reduction in petro-subsidy being offset by enhanced capital expenditure of the government to enhance growth. So far the capital expenditure of the government was increasing in line with the 13th Finance Commission recommendations i.e. the combined capital expenditure of the central and the state governments would be 6 percent of GDP by 2014-15. In the next two scenarios we relax this assumption.

In *scenario 6*, we consider the possibility of the reduction in oil subsidy gradually to zero by 2016-17 as the earlier case but with a corresponding increase in capital expenditure to GDP ratio so that the fiscal deficit to GDP ratio every year remains the same as in the base case. In this *scenario,* as capital expenditure increases, we find that the average growth rates improve over *scenario 5* but slightly lower than the base case. The inflation is higher than the base case due to subsidy reduction but comparable with *scenario 5*. The fiscal deficit to GDP ratios are the same, revenue deficit to GDP ratio is coming down because of subsidy reduction. The most interesting result is *vis-à-vis* the current account deficit in *scenario 6*. Although, the international price of oil remains the same, the current account deficit increases by 0.3 percent than the base case due to higher growth in nominal GDP.

Instead of gradual subsidy reduction at a uniform rate, there could be a subsidy reduction scheme where reduction in revenue expenditure is compensated by enhanced capital expenditure on a frontloading basis (i.e. the gap between domestic and international oil prices reduces substantially in first year). The simulation results are given under *scenario 7* in *table 5*. The average growth rate improves further, although it still remains lower than the base case. But one may note that there is an increasing trend in the growth and by 2016-17, the GDP growth in this scenario is higher than in the base case. The growth improves because the increased capital expenditure, with its crowding-in effects on the private investments, has a higher multiplier effect. As expected the inflation rate rises substantially in 2012-13, and thereafter declines. The revenue deficit reduces further because alongwith subsidy reduction, there is improved revenue collection through higher growth of nominal GDP, which creates more space for capital expenditure, given the same level of fiscal deficit to GDP ratio. The current account balance worsens further as the nominal growth improves because both oil and non-oil imports are positively linked with growth. By the year 2016-17, current account deficit to GDP touches 4.5 percent compared to the base case of 3.7 percent.

Therefore, front loading scheme of oil sector deregulation or oil subsidy reduction along with front loading scheme of enhanced capital expenditure would ensure relatively higher growth during the 12th Plan period but at the cost of higher current account deficit, even when the international price of Indian basket of oil and petroleum products remains constant. In this scenario, targeting around 8 percent growth in the 12^{th} Plan appears to be more sustainable both in terms of fiscal deficit as well as current account deficit.

A Few Caveats:

An analysis of the effects of subsidy reduction within an aggregate macro-framework as in this paper ignores the distributional and welfare implications of reduction in oil subsidy that would in turn affect important macroeconomic variables like growth. Also, subsidy reduction besides translating to higher price of oil would also affect a whole range of costs and prices throughout the economy, which would exert an upward pressure on price level (discrete shocks) or may give rise to cost-wage-price spiral and further inflationary pressures. These important features of the working of the economy are beyond the scope of our present model.

Then there are political economy considerations that we have assumed away. It is possible that with a reduction in subsidies on oil, there would be a rise in demand for other subsidies from the government, such as fertiliser and food subsidies. Oil is source of substantial revenues for the government. A deregulation of oil prices could quite naturally raise the demand to lower taxes on petroleum products as has happened in the recent past. We acknowledge these as limitations of our work.

V (D). Conclusion and Policy Implication

In this study an attempt has been made to understand the transmission of changes in international oil prices on major macroeconomic variables like growth, inflation, fiscal deficit, current account deficit in India by using structural macroeconomic model. For major oil importing countries such as India, we have seen that an international oil price shock is expected to result in lower growth and higher inflation, *via* the trade channel, the fiscal channel and the price channel. To model these channels, the paper develops a new analytical framework that can be appropriate and applicable for emerging and developing countries to analyse the macroeconomic impacts of exogenous shocks such as oil and food price shocks. The main empirical finding is that a shock in international oil prices does result in differential impacts on output growth, inflation, current account deficit and fiscal deficit and these impacts depend on the extent of pass-through as well as on the horizon of analysis.

In the year of shock, when there is no pass-through, inflation does not rise as the government absorbs the entire shock but growth declines than in the base case because of rise in current account deficit while fiscal deficit to GDP ratio increases marginally. In the partial pass-through case, a 10 percent rise in international oil prices brings down growth by 0.6 percent and raises inflation by 0.3 percent in the year of the shock. In full pass-through scenario, a 10 percent rise in international oil prices would cause a decline in real growth of 0.9 percent and increase in inflation by 0.6 percent. Over the period of the 12^{th} Plan, i.e., in medium to long term, the adverse impact of oil price shock on macro variables reduces in both the cases of no pass-through and full pass-through.

The paper also attempts to simulate scenarios where there is no oil price shock but at the same time, the domestic oil price deregulation is attempted. Our results show that deregulation of domestic oil prices over the 12^{th} plan period does reduce growth while increasing the inflation level. But this also results in improvement in the fiscal deficit and, marginally, the current account deficit. In case real growth has to be protected, say if the objective is to achieve more than 8 percent growth rate, this paper argues that the reduction in revenue expenditure due to reduction in oil subsidy be offset by enhanced capital expenditure of the government. Of the two options that were examined, front-loading the deregulation of oil prices with a corresponding enhancement in capital expenditure resulted in higher growth in the medium term, slightly higher than in the base case. This, however, comes with a trade-off. Not only does the fiscal deficit remain unchanged, current account deficit widens due to higher nominal growth.

From the point of view of macroeconomic policy, an important finding of this study is that in absence of any rise in international price of oil, a rise in the degree of pass-through and reduction in oil subsidy, *ceteris paribus*, is likely to have adverse impacts on growth and inflation only in the short run, while in the medium term, the growth improves provided the expenditure switching happens from oil subsidy to capital expenditure, and inflation declines. On the other hand, in case of no or partial pass-through, in the short run, the subsidy bill of the government obviously increases but fiscal deficit to GDP ratio increases only marginally because of relatively higher growth rate and higher revenue. But, as a ratio to GDP, this rise in oil subsidy bill could potentially reduce public investment and hence private investment through reduction in capital expenditure of government for any given level of fiscal deficit and revenue receipts, thus hampering growth prospects in the medium to long term. Given these differential impacts, the policy priority of price deregulation of petroleum products must be carefully weighed.

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Appendix-1

Table-1: Import of Petroleum, Crude and Petro-Products in India

	(US $ million)	(Rs. Crore)	Imports (in million tonnes)				
Year	**Petroleum crude and products**	**Petroleum, crude and products**	**Crude Oil**	**POL Products**	**Total**	**Price $/ Tonne**	**Price Rs/Tonne**
1991-92	5324.8	13126.7	30	10	40	133.12	3281.68
1992-93	6100.0	17141.7	30	12	42	145.24	4081.36
1993-94	5753.5	18046.2	31	12	43	133.80	4196.79
1994-95	5927.8	18612.6	27	14	41	144.58	4539.66
1995-96	7525.8	25173.6	27	20	47	160.12	5356.09
1996-97	10036.2	35628.5	34	20	54	185.86	6597.87
1997-98	8164	30341.2	34	23	57	143.23	5323.02
1998-99	6398.6	26919.3	40	24	64	99.98	4206.14
1999-00	12611.4	54648.6	58	17	75	168.15	7286.48
2000-01	15650.1	71496.5	74	9	83	188.56	8614.04
2001-02	14000.3	66769.9	79	7	86	162.79	7763.94
2002-03	17639.5	85367.0	82	7	89	198.20	9591.80
2003-04	20569.5	94520.0	90	8	98	209.89	9644.90
2004-05	29844.1	134094.0	96	9	105	284.23	12770.86
2005-06	43963.1	194640.0	99	13	112	392.53	17378.57
2006-07	56945.3	258571.8	112	17	129	441.44	20044.33
2007-08	79644.5	320654.5	122	22	144	553.09	22267.67
2008-09	93671.7	419967.6	128	18	146	641.59	28764.90
2009-10	87121.1	411579.1	159	15	174	500.70	23653.97

Source: Handbook of Statistics on Indian Economy, Reserve Bank of India.

Table-2: India's Foreign Trade – Rupees (Rupees/crore)

Year	Exports			Imports			Trade Balance		
	Oil	Non-oil	Total	Oil	Non-oil	Total	Oil	Non-oil	Total
1991-92	1022	43020	**44042**	13127	34724	**47851**	-12105	8295	**-3809**
1992-93	1379	52309	**53688**	17142	46233	**63375**	-15763	6076	**-9686**
1993-94	1248	68504	**69751**	18046	55055	**73101**	-16798	13449	**-3350**
1994-95	1309	81365	**82674**	18613	71358	**89971**	-17304	10007	**-7297**
1995-96	1518	104836	**106353**	25174	97505	**122678**	-23656	7331	**-16325**
1996-97	1710	117107	**118817**	35629	103291	**138920**	-33918	13816	**-20103**
1997-98	1311	128790	**130101**	30341	123835	**154176**	-29030	4955	**-24076**
1998-99	376	139377	**139753**	26919	151413	**178332**	-26543	-12036	**-38579**
1999-00	169	159393	**159561**	54649	160588	**215237**	-54480	-1195	**-55675**
2000-01	8542	195029	**203571**	71497	159376	**230873**	-62955	35653	**-27302**
2001-02	10107	198911	**209018**	66770	178430	**245200**	-56663	20482	**-36182**
2002-03	12469	242668	**255137**	85367	211839	**297206**	-72898	30829	**-42069**
2003-04	16397	276969	**293367**	94520	264588	**359108**	-78123	12382	**-65741**
2004-05	31404	343935	**375340**	134094	366971	**501065**	-102690	-23035	**-125725**
2005-06	51533	404885	**456418**	194640	465769	**660409**	-143107	-60884	**-203991**
2006-07	84520	487259	**571779**	258572	581935	**840506**	-174052	-94675	**-268727**
2007-08	114192	541672	**655864**	320655	691657	**1012312**	-206463	-149985	**-356448**
2008-09	123398	717357	**840755**	419968	954468	**1374436**	-296570	-237111	**-533681**
2009-10	132616	712509	**845125**	411579	944890	**1356469**	-278963	-232381	**-511344**

Source: Handbook of Statistics on Indian Economy, Reserve Bank of India.

Table-3: Under-recoveries of OMCs, compensation by upstream companies & Govt. (Rs. crore)

	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	Total
PDS Kerosene	3,751	9,480	14,384	17,883	19,102	28,225	92,825
Domestic LPG	5,523	8,362	10,246	10,701	15,523	17,600	67,955
Petrol		150	2,723	2,027	7,332	5,181	17,413
Diesel		2,154	12,647	18,776	35,166	52,286	1,21,029
Under Recovery, of which:	9,274	20,146	40,000	49,387	77,123	1,03,292	2,99,222
Upstream Sharing	3,123	5,947	14,000	20,507	25,708	32,000	101,285
Oil Bonds			11,500	24,121	35,290	71,292	142,203
Absorbed by OMCs	6,151	14,199	14,500	4,759	16,125		55,734

Source: Kirit Parikh Committee Report (2011).

Appendix 2: Data Sources

ADEBT is the accumulated combined aggregate liability of the centre and state governments. Data from *Handbook of Statistics on the Indian Economy*, RBI.

ADVGDP is the index number of GDP of all advanced countries taken together (1970=100). Data from the *World Econom ic Outlook*, 2009, IMF.

AINF is the WPI based inflation for commodities with prices that are largely administered. Data from *Office of the Economic Advisor*, Ministry of Commerce & Industry, GOI.

CAPINFLOW is the net foreign capital inflow to India. Data from the *Handbook of Statistics on Indian Economy*, RBI.

CAPSTOCK is the net capital stock at 1999-2000 prices available at the beginning of any period. Data from the *National Accounts Statistics*, CSO, GOI.

CHINAGDP is the index number of GDP of China (1970=100). Data from the *World Economic Outlook*, 2009, IMF.

CPR and CPU are respectively private final consumption expenditure and government final consumption expenditure. Data from *National Accounts Statistics*, CSO, GOI.

DEBT is the domestic debt of the Central and the State governments. Data from the *Handbook of Statistics on Indian Economy*, RBI.

DOMOILPRINDEX is the domestic oil price index. Data from the Data from *Office of the Economic Advisor*, Ministry of Commerce & Industry, GOI.

DUTY is the import weighted tariff rate. Data from website of the *Planning Commission of India*.

ECAP is the current price combined capital expenditure of the central and the state governments together. Data from *Indian Public Finance Statistics*, Ministry of Finance, GOI.

ECURR is the combined revenue expenditure of the central and state governments. Data from *Indian Public Finance Statistics*, Ministry of Finance, GOI.

ER is the exchange rate (Indian rupee per US$). Data from the *Handbook of Statistics on Indian Economy*, RBI.

EXPORT is the rupee value of aggregate export of India. Data from *Handbook of Statistics on Indian Economy*, RBI.

EXPORTNONOIL is the non-oil exports including services. Data from *Handbook of Statistics on Indian Economy*, RBI.

FD is the combined fiscal deficit of the central and state governments. Data from *Indian Public Finance Statistics*, Ministry of Finance, GOI.

FOREX is the foreign exchange reserves. Data from *Handbook of Statistics on Indian Economy*, RBI.

GCP is the growth rate of wages, rents and interest cost in organized sector manufacturing industries in India. Data from Annual Survey of Industries (ASI), GOI as reported in the *Handbook of Statistics on Indian Economy*, RBI.

GDPCAPRATIO is the 3-year moving average of the ratio of GDP at factor cost constant price to net capital stock at constant prices. Data for both variables from *National Accounts Statistics*, CSO, GOI.

GM1 and GM0 are the annual growth rates of narrow and high powered money supply respectively. Data from the *Handbook of Statistics on Indian Economy*, RBI.

GPWPI is the WPI based inflation of all commodities. Data from *Office of the Economic Advisor*, Ministry of Commerce & Industry, GOI.

IMPORTS is the non-oil imports including services. Data from *Handbook of Statistics on Indian Economy*, RBI.

INFLDOMOILPR is inflation in domestic oil price index. Data from *Office of the Economic Advisor*, Ministry of Commerce & Industry, GOI.

INTOILPRINDEX is inflation in international oil price index for the Indian basket of oil and petroleum products. Data from the *Handbook of Statistics on Indian Economy*, RBI.

INVGDP is investment to GDP ratio in India. Data from *National Accounts Statistics*, CSO, GOI.

INVISIBBLE is net invisible earnings, less earnings in services, in rupees crore. Data from the *Handbook of Statistics on Indian Economy*, RBI.

IPV and IPU are respectively gross private domestic capital formation, and gross domestic capital formation by the public sector. Data from *National Accounts Statistics*, CSO, GOI.

LIAB is the combined liability (domestic and international) of the Central and State governments taken together. Data from the *Handbook of Statistics on Indian Economy*, RBI.

MB is the aggregate market borrowing of the Government. Data from *Handbook of Statistics on the Indian Economy*, RBI.

MEGDP is the index number of GDP of Middle East countries taken together (1970=100). Data from the *World Economic Outlook*, 2009, IMF.

NDCR is the non-debt capital receipts of the government comprising dis-investment etc. Data from *Indian Public Finance Statistics,* Ministry of Finance, GOI.

NETECURR is the current revenue expenditure of the combined government excepting the petroleum subsidy bill. Data from *Indian Public Finance Statistics*, Ministry of Finance, GOI.

NETINVISIBLE is the net flow of invisibles in India consists mainly of remittances. Data from *Handbook of Statistics on Indian Economy*, RBI.

NETOILIMPORT is net oil imports. Data from *Handbook of Statistics on Indian Economy*, RBI.

NETREVENUE is total revenue of the combined government less the revenue from petroleum sector. Data from *Indian Public Finance Statistics*, Ministry of Finance, GOI and Finance Accounts of Union government, various years, GoI.

NONOILIMPORT is rupee value of import of non-oil commodities and services in India. Data from *Handbook of Statistics on Indian Economy*, RBI.

NTRT is the ratio of non tax revenue from the petroleum sector to value of oil import net of oil export. Data from *Handbook of Statistics on Indian Economy*, RBI.

OIL is the index number of international price of oil and petroleum products of the Indian basket in terms of rupees crore (1972-73 = 100). Data from the *Handbook of Statistics on Indian Economy*, RBI.

OILIMPORT is rupee value of import of oil and petroleum products in India. Data from *Handbook of Statistics on Indian Economy*, RBI.

OILIMPORTQTY is rupee value of import of oil and petroleum products in India. Data from *Handbook of Statistics on Indian Economy*, RBI.

OILPRRATIO is the ratio of domestic oil price index divided by the international oil price index.

PETROEXCSTM is the excise and custom duty revenues from the petroleum sector in India. Data from Rangarajan Committee Report and Petroleum Planning & Analysis Cell, Ministry of Petroleum, GoI.

PETRONONTAX is the non tax revenue of government from the petroleum sector in India. Data from Rangarajan Committee Report and Petroleum Planning & Analysis Cell, Ministry of Petroleum, GoI.

PETROREVENUE is total revenue of the Central and the State governments from the petroleum sector. Data from Rangarajan Committee Report and Petroleum Planning & Analysis Cell, Ministry of Petroleum, GoI.

PETROSLSTAX is sales tax revenues of the State governments

PETROSUBSIDY is revenue expenditure of the Central government on petroleum sector. Data from Finance Accounts of Union government, various years, GoI.

PLR is the average nominal (simple) prime lending rate calculated as the average RBI prescribed lending rate of all scheduled commercial banks including SBI and prime lending rates of term lending institutions like IDBI, IFCI, ICICI, IIBI/IRBI and that of SFCs. *Handbook of Statistics on Indian Economy*, RBI.

RAIN is the rainfall index for India is taken from NASA website.

RD is the combined revenue deficit of the central and state governments. Data from *Indian Public Finance Statistics*, Ministry of Finance, GOI.

REPO is the RBI determined bank rate taken up to 2003-04 and repo rate thereafter. Data from *Handbook of Statistics on Indian Economy*, RBI.

RUPEEPROIL is rupee value of importing per ton of Indian basket of oil and petroleum products. Data from *Handbook of Statistics on Indian Economy*, RBI.

SLSTAXRT is the average effective rate of sales tax on oil and petroleum products calculated as the total sales tax revenue from this sector divided by the rupee value of oil import in India. Data from *Handbook of Statistics on Indian Economy*, RBI.

TAX is combined revenue receipts of the central and state governments. Data from *Indian Public Finance Statistics*, Ministry of Finance, GOI.

TD is the trade deficit. Data from *Handbook of Statistics on Indian Economy*, RBI.

USGDP is the index number of GDP of USA. Data from the *World Economic Outlook*, 2009, IMF.

YMP, ZYMP, YF and ZYF are respectively GDP at current market prices, GDP at constant (1999-2000) prices, GDP at factor cost in current prices, and GDP at factor cost in constant (1999-2000) prices. Data from *National Accounts Statistics*, CSO, GOI.

DUMCRISIS takes 1 for 2008-09 to capture the impact of global financial crisis and 0 for rest of the period.

Dummy variables have been introduced in many of the equations largely to take care of the structural shifts and also the outliers in the estimated equations.

AR (Auto Regression) and MA (Moving Average) terms have been used to control the presence of autocorrelation in the estimated equations.

Data on petroleum subsidy (Q^O) is taken from the Kirit Parikh Committee Report, Govt. of India.