Subsidy Elimination With and Without a Global Price Shock
The Macroeconomics of Oil Price Policy Reform

by

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Abstract of the paper

'Subsidy Elimination With and Without a Global Price Shock The Macroeconomics of Oil Price Policy Reform'

Oil is a strategic commodity. The disruption of oil supplies, a quantity shock, can drive an economy to a grinding halt. The price of oil is an equally sensitive subject, both internationally and at home. Whenever global oil prices increase, it triggers a spike in inflation. In India, where the domestic price of most oil products are still largely administered, whenever global oil prices rise, the government is faced with a dilemma whether or not to pass on the price increase to domestic consumers. The oil price policy debate is often animated but rarely takes into account the complex mechanisms through which changes in the global price of oil effect macroeconomic outcomes such as inflation, growth, and the fiscal deficit. The present paper attempts to inform the policy debate by doing precisely this. It traces the linkages through which a change in the global price of oil impacts macroeconomic outcomes and quantifies these impacts. The main channels through which the impact plays out are then integrated into an empirically estimated macroeconomic model. The estimated model is then used to simulate different policy and oil price shock scenarios: a one shot full pass through without a global oil price increase, a gradual pass through without a global price increase, a one shot full pass through with a global price increase., and a gradual pass through with a global price increase. The main policy conclusions emerging from a comparison of these simulation exercises suggest that a full pass through is desirable for fiscal consolidation and macroeconomic stability, as also to eliminate distortions in resource allocation. However, it would be prudent to eliminate the subsidies in a phased manner, rather than in a single shot, to avoid excessive macroeconomic instability.

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I. Introduction

Dr Vijay Kelkar is one of India's pre-eminent economic mandarins. Throughout his long and distinguished career in the economic policy establishment Dr.Kelkar combined his operational skills in policy design and implementation with a keen eye for rigorous policy analysis. It is a privilege to have this opportunity to contribute a paper to a Feschschrift in his honour on a subject that has been one of his abiding concerns: oil and the price of oil.

Oil is a strategic commodity. The disruption of oil supplies, a quantity shock, can drive an economy to a grinding halt. Modern economies are all heavily dependent on oil as a basic intermediate input that goes into the production of most other goods and services either directly or indirectly. It is the fear of such a disruption that drives so much of global geo-politics today. The price of oil is an equally sensitive subject, both internationally and at home. Whenever global oil prices increase, it triggers a spike in inflation. This happens because oil prices carry a large weight in price indices, and also because a rise in the price of a basic intermediate good like oil pushes up the cost of a wide range of other products.

In India, where the domestic price of most oil products are still largely administered, whenever global oil prices rise, the government is faced with a dilemma whether or not to pass on the price increase to domestic consumers. If the price increase is passed through, it leads to an increase in short term inflation. Opposition parties attack the government for pursuing policies that hurt the common man. The media, analysts and researchers all get into the act. Even members of the ruling party start complaining, and the government finds itself on the defensive. On the other hand, if the government decides not to pass on the price increase, the widening gap between global and domestic oil prices erodes the bottom line of oil companies. Their under-recoveries[2] have to be offset through budget subsidies, which balloon with the rising international – domestic oil price gap. This crowds out other social or developmental expenditure, either directly or through the increasing cost of financing a growing fiscal deficit.

[2] Under-recoveries arise when the prices of fuel is fixed by the government well below the 'market price' and is treated as losses to the oil marketing companies. Subsidies are part of the under-recoveries that are being transferred by the government to the oil companies.

Large deficits also expand aggregate domestic demand with all its attendant consequences when the macroeconomy overheats.

The oil price policy debate is often animated, and even makes headline news. However, the discussions rarely take into account the complex mechanisms through which changes in the global price of oil effect macroeconomic outcomes such as inflation, growth, and the fiscal deficit. The present paper attempts to inform the policy debate by doing precisely this. It traces the linkages through which a change in the global price of oil impacts macroeconomic outcomes and quantifies these impacts. The main channels through which the impact plays out, the price channel, the fiscal channel, and the import channel are described in Section II These channels are then integrated into an empirically estimated macroeconomic model. The estimated model is used in Section III to simulate different policy and oil price shock scenarios: a one shot full pass through without a global oil price increase, a gradual pass through without a global price increase, a one shot full pass through with a global price increase., and a gradual pass through with a global price increase. The main policy conclusions emerging from a comparison of these simulation exercises are summarized in Section IV.

II. Framework for Analyzing the Impact of Oil Price Shocks

In this section, we trace the transmission channels through which changes in oil prices impact the Indian economy. The macroeconomic impact of oil price changes has to be analyzed in a framework that captures the specific institutional structure and other features of India's oil economy. These include the quasi - administered nature of domestic prices for oil products, the revenue expenditure by the government on subsidies in the oil sector, the particular nature of taxation of this sector, and India's huge dependence on crude oil imports. The following discussion on the three transmission channels (price channel, fiscal channel and import channel) details the institutional structure and policy changes relating to the oil economy and their implications for the important macroeconomic relationships. These relationships form the basis of the analytical model which is then used to quantify the impact of oil price shocks under alternative scenarios.

II.1 Price Channel

In India the selling prices of petroleum products have been determined by the government through an administered pricing mechanism since the mid-seventies. The objectives have been

three-fold: (a) to protect the domestic economy from volatility in international oil prices, (b) to ensure an assured supply of hydro-carbon merit goods to all households, e.g., clean cooking fuels like LPG, natural gas and kerosene to replace the use of coal and 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.

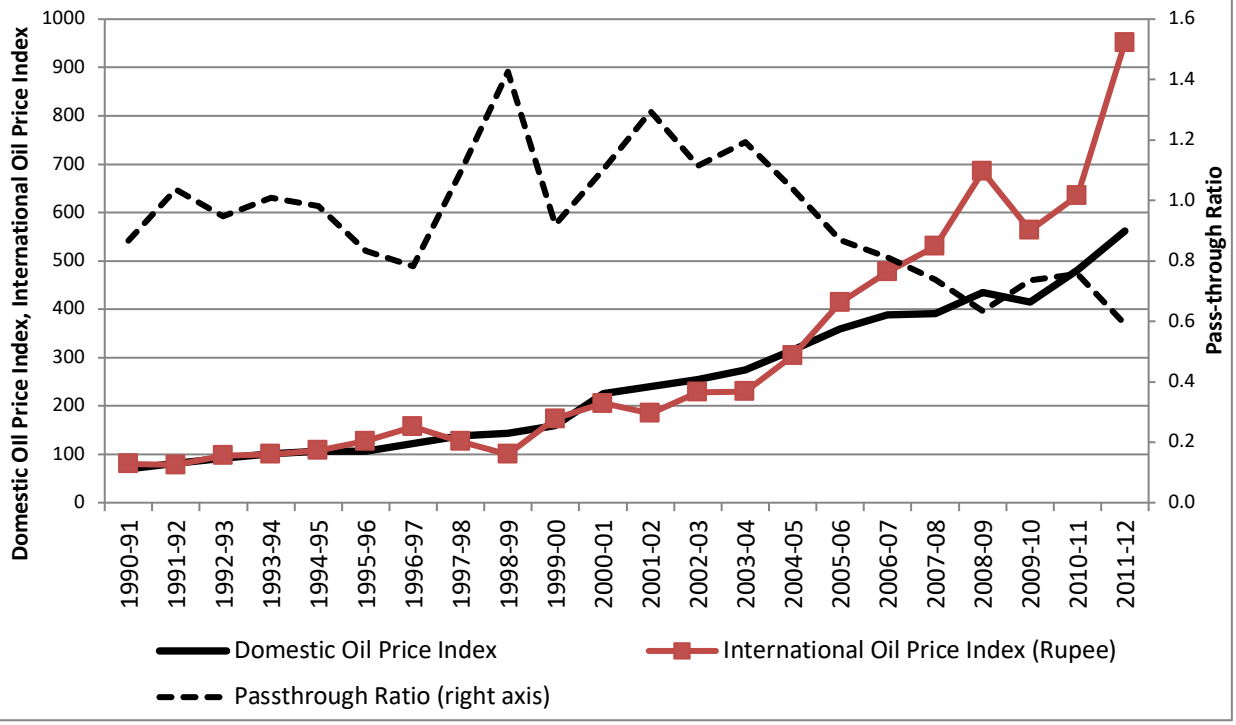
The importance of these considerations notwithstanding, the administered price mechanism has created two kinds of problems in the economy. First, price controls have introduced distortions that prevent efficient uses of fuels and have encouraged inefficient choice of products and techniques. Second, setting administered prices below cost has entailed some entities having to bear the financial burden of this gap. With rising international price of oil and relatively slow adjustment of administered oil product prices, this burden has snowballed, putting pressure on the profitability of oil companies as well as on the exchequer.

Market reforms in the oil sector have sought to correct the distortions in pricing of oil, thereby eliminating or reducing the subsidy element, but also reducing the element of taxation, which has been traditionally very high on petroleum products. These principles are outlined in the recommendations of the Rangarajan Committee on Pricing and Taxation of Petroleum Products (GOI; 2006) The committee recommended (a) a shift to trade parity pricing formula to determine the refinery gate price for diesel and petrol; (b) allowing flexibility to oil companies to fix their retail price based on this trade parity pricing formula; (c) reduction in customs duties and restructuring excise duties, the latter to an ad valorem rate; and (d) restricting supply of subsidized kerosene to BPL families only and raising the price of LPG cylinder. The Expert Group on a Viable and Sustainable System of Pricing of Petroleum Products led by Kirit Parikh (GOI; 2010) reiterated the need for market determination of petrol and diesel prices at the refinery gate and at the retail level. The government subsequently decided to free the price of petrol from June 2010, but it retained control on other petroleum products.

The comparative movement of international oil prices and domestic oil prices in India is shown in Graph 1. Until around 2004- 2005 domestic oil prices rose more or less in line with international oil prices. Thereafter, international oil prices started rising quite steeply and also became more volatile, but domestic oil prices continued to rise at a moderate and relatively stable pace as before, resulting in a widening gap between the indices of international and domestic oil prices. Consequently, the pass-through ratio or the ratio of domestic to international oil prices started declining. It fell in all years except during 2009-10 and 2010-11, when international oil prices had moderated somewhat. In 2011-12, as the price of the Indian basket

of oil imports averaged an all-time high of $112 per barrel, the pass-through ratio was at its lowest. This declining pass through ratio has several adverse implications as mentioned above. These are further discussed in Section II.2 below.

Graph 1: Comparison of International and Domestic Oil Prices



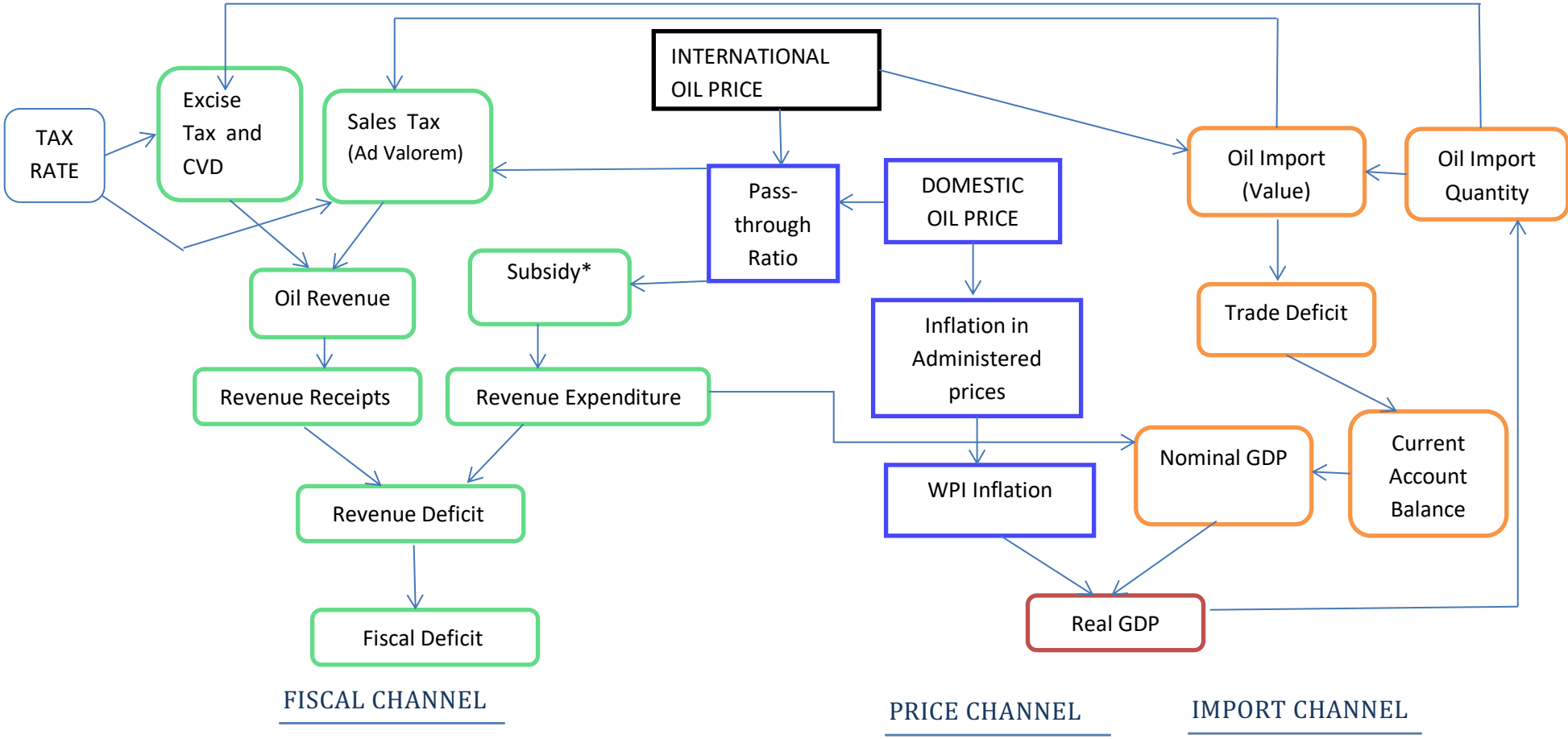
Source: Domestic Oil Price Index: Authors' calculation based on WPI series on Mineral Oil, Office of the Economic Advisor to the Government of India Ministry of Commerce and Industry, 1993-4 base; International Oil Price Index: Authors' calculation based on Table 34 and Table 132, RBI Handbook of Statistics on the Indian Economy, 2011-12; Pass-through Ratio: Domestic Oil Price Index/ International Oil Price Index.

Notes: Domestic price of petroleum products is measured as the price index of mineral oil in WPI basket (comprising of LPG, petrol, kerosene, aviation turbine fuel, high speed diesel, naphtha, light Diesel Oil, bitumen, furnace oil and lubricants) scaled up to 100 in the base year, 1993-4. International oil price index is calculated by (i) obtaining the price, in Rupees per ton, of the import basket of crude and petroleum products; and (ii) indexing the series with 1993-4 as base.

On the other hand, sharp increases in domestic prices of petroleum products also have an adverse short term impact on domestic inflation directly via consumer prices and indirectly via the intermediate input linkages of oil with the rest of the economy. In an early study, modeling the pass-through of oil prices in an input-output system, Jha and Mundle (1987) estimated that in India a 7% increase in the administered prices of crude oil, gas and petroleum products would lead to an the overall WPI increase of 1 %, i.e., a total elasticity 0.14. Recently the Reserve Bank of India (2011) has estimated that every 10 per cent increase in global crude prices, if fully

passed through to domestic prices, would have a direct impact of 1 percentage point increase in overall WPI inflation and a total impact of about 2 percentage points, i.e., a total elasticity of 0.20 The slightly higher elasticity of headline inflation to international oil prices in recent years reflects the rising share of oil in the total consumption basket as well as in the structure of production in the economy. The weight assigned to mineral oil group in the WPI basket has increased from 6.99 in 1993-4 to 9.36 in 2004-05. This link from international oil prices to domestic oil prices (administered) to changes in the overall administered prices index and consequently domestic inflation has been defined as the **price channel** in this paper. It has been displayed in Flowchart 1.

Flowchart1 Transmission Channels for impact of International Oil Price Shock on the Macroeconomy



Note: * Refers to under-recoveries of oil marketing companies, Table 3.
Upper case denotes exogenous / policy-determined variables.

II.2 Fiscal Channel

Oil price changes affect both the revenue side and the expenditure side of the fiscal balance sheet. On the expenditure side, expenditure on oil subsidies is a large and rising component of revenue expenditure, and one of the major challenges to accomplishing the policy goal of fiscal consolidation. The oil subsidy is intended to partly compensate oil companies for their under-recoveries due to administered underpricing of petroleum products relative to cost. Conceptually, under-recovery is the difference between the administered price of oil and the competitive market price. However, the latter is unobserved, and there are several possible ways of computing the shadow market price. India is an importer of crude oil and also an exporter of refined oil products. Hence, the shadow price of oil, or the border price, can be computed as the import parity price, the export parity price, or the trade parity price.[3] The estimate of under-recoveries, and hence the volume of oil subsidies, is obviously very sensitive to which method is chosen to measure the shadow market price of oil. Since India is competitive in refining petroleum products, imports crude oil and exports refined products, some analysts have argued that the appropriate shadow market price of petroleum products is the export parity price (See Anand, 2012; Sethi, 2011; Chaturvedi Committee Report, GOI, 2008). This is lower than the import parity price as seen in Table 1, which gives the build up of price for diesel. It is also lower than the trade parity price, a weighted average of import parity price (0.8 weight) and export parity price (0.2 weight), which is currently being used to compute under-recoveries. For diesel the under-recoveries using the export parity price would be 15% lower than the present figure of Rs.11.65/liter. If export parity price is used for kerosene and LPG, their estimated under-recoveries are expected to be similarly scaled down.

In current practice, the trade parity price adjusted for inland freight and delivery, marketing margins and costs of oil marketing companies (OMCs) is the shadow market price (total desired price in Table 1). This is compared to the administered price (depot price in Table 1) to arrive at the under-recovery per unit of petroleum product. The sum of under-recoveries on diesel, kerosene and LPG (and petrol till June 2010), the total under-recovery for the oil sector, amounted to a massive Rs.1,41,561 crores in 2011-12 . A part of the under-recoveries is paid for by the Central government and enters the budget as revenue expenditure. In 2011-12, the Central government compensated the oil marketing companies to the extent of Rs.68,481

[3] Since India also produces petroleum products refined from domestic crude, the domestic cost of production, including refining cost and normal profits, could also be a basis of computing the shadow price. However, this alternative is not considered at present.

crores on account of under-recoveries, while the remaining part was shared between the upstream oil companies and the downstream oil companies.

Till 2009-10, along with direct revenue expenditure on oil the government was also issuing oil bonds/ special securities to the public sector oil companies to help finance the under-recoveries.

Table 1: Price Build up of Diesel in Delhi

Sr. No.	Elements	Unit	Effective 1st Oct'12
1*	FOB Price at Arab Gulf of Gasoil (Diesel) BS III equivalent	$/bbl	132.74
2*	Add: Ocean Freight from AG to Indian Ports	$/bbl	1.74
3	C&F (Cost & Freight) Price	$/bbl	**134.48**
	OR	Rs./Litre	45.22
4*	Import Charges (Insurance/Ocean Loss/ LC Charge/Port Dues)	Rs./Litre	0.42
5*	Customs Duty @2.58% (2.50% + 3% Education cess)	Rs./Litre	1.18
6*	Import Parity Price (at 29.5º C) (Sum of 3 to 5)	Rs./Litre	46.82
7*	Export Parity Price (at 29.5º C)	Rs./Litre	44.63
8*	**Trade Parity Price** (80% of (6)+20% of (7))	**Rs./Litre**	**46.38**
9*	**Refinery Transfer Price (RTP) for BS-III Diesel** (Price Paid by the Oil Marketing Companies to Refineries)	Rs./Litre	**46.38**
10	Add: Premium recovered for BS-IV Grade over BS-III	Rs./Litre	0.04
11*	Add : Inland Freight and Delivery Charges	Rs./Litre	0.85
12*	Add : Marketing Cost of OMCs	Rs./Litre	0.67
13*	Add : Marketing Margin of OMCs	Rs./Litre	0.72
14	**Total Desired Price** (Sum of 9 to 13) -Before Excise Duty, VAT and Dealer Commission	Rs./Litre	**48.66**
15*	Less: Under-recovery to Oil Marketing Companies	Rs./Litre	11.65
16	**Price Charged to Dealers (Depot Price)** (14-15) - Excluding Excise Duty & VAT	Rs./Litre	**37.00**
17*	Add : Specific Excise Duty @ Rs.3.56/Litre (Rs.3.46/Litre+ 3% Education cess)	Rs./Litre	3.56
18*	Add : Dealer Commission	Rs./Litre	0.91
19*	Add : VAT (including VAT on Dealer Commission) applicable for Delhi @ 12.50% and Air Ambience Charges @ Rs.250/KL.	Rs./Litre	5.47
20	**Retail Selling Price at Delhi** (Sum of 16 to 19)	Rs./Litre	**46.95**

Source: Price Build up of Petroleum Products, Ministry of Petroleum and Natural Gas, www.ppac.org.in/

The public sector oil companies were selling these bonds in the secondary market to raise cash.[4] The liability of the government remained off-budget, even though the government would have to repay with interest the holder of the security in future. With the discontinuation of this practice, all expenditures/subsidies on oil by the government are reflected in the budget. This makes the volume of oil subsidies more transparent. The move towards greater transparency

[4] See http://wiki.answers.com/Q/How_do_oil_bonds_work

could be taken a step further by reflecting the entire annual and cumulative volume of under-recoveries on oil transactions, prudently estimated, on the government's books. This is discussed further below in section III.

Turning now to the revenue side, substantial revenues flow from the petroleum sector to the central and the state exchequers. Customs and excise duties on petroleum, oil and lubricant (POL) products are the main contributors to the central exchequer, along with cess on crude oil, royalty on crude oil/gas, service tax and dividends to government, income/corporate taxes. States' revenues from the sector comprise mainly of sales tax/ VAT on POL products, in addition to their royalty on crude oil/gas, octroi, duties including electricity duty, entry tax and dividend to government. The latest tax rates (as on 1st October 2012) for two of the major petroleum products, petrol and diesel, are shown in table 2.

Table 2: Indirect Tax Rate on Petrol and Diesel

	Customs Duty	Specific Excise Duty	Sales Tax (% of town rate before VAT) at Delhi	Retail Selling Price
Petrol	2.50%	Rs. 9.48/ltr	19% (or Rs. 10.94/ltr)	Rs 68.47/ltr
Diesel	2.50% (or Rs.1.18/ltr)	Rs. 3.56/ltr	13.29% (or Rs. 5.47/ltr)	Rs. 46.95/ltr

Source: Compiled from price buildup of sensitive products, www.ppac.org.in/

While excise taxes (including countervailing duty) on petroleum products are levied as specific duties, the basic customs duty and sales taxes on petroleum products are levied as ad valorem taxes, with the sales tax rates varying across states. Consequently, excise and countervailing duty collections are expected to rise only with a rise in consumption of petroleum products not its price. On the other hand, basic customs duty and sales tax collections rise with a rise in consumption as well as in the domestic price of petroleum product.

The share of the center in total revenue the petroleum sector averaged 60 percent for the period 2006-7 to 2011-12 (Table 3). In the latest year 2011-12 it has fallen to 51 percent due to both the lowering of customs duty and excise tax rates by the center as well as the higher sales tax collections by states.[5] Also, in 2011-12, total revenue from the petroleum sector as a percentage of GDP was the lowest in the last six years (Table 3). With increasing international price of oil,

[5]Collection of customs duty on POL products has declined in 2011-12 mainly due to elimination of customs duty on crude oil and reduction in customs duty on Petroleum products by 5% effective 25thJune 2011.Collection of excise duty on POL products has declined due to reduction in excise duty by Rs. 2.68/ Litre (including education cess) on Diesel effective 25thJune 2011. (Source: PPAC http://ppac.org.in/writereaddata/RS_5_Cont_to_Exch.pdf)

there has been pressure on the central and State governments to provide relief through a reduction in the burden of taxation.

Table 3: Combined Government Revenue & Expenditure and PSU Profit from Petroleum Sector (In Rs. Crores)

	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Total revenue from Petroleum Sector	**157219 (3.79%)**	**171731 (3.47%)**	**161798 (2.90%)**	**183860 (2.85%)**	**225494 (2.94%)**	**232769 (2.59%)**
Contribution to the Central Exchequer	97264 (2.35%)	108286 (2.19%)	93512 (1.68%)	111779 (1.73%)	136497 (1.78%)	119850 (1.33%)
Of which: Customs and Excise Duties	61965	67387	60416	67043	92176	71967
Contribution to the State Exchequer	59955 (1.45%)	63445 (1.28%)	68285 (1.22%)	72081 (1.12%)	88997 (1.16%)	112919 (1.26%)
Of which: Sales tax	53949	56445	63349	64999	78689	96945
Under-recoveries of the Oil Marketing Companies[1]	**51937 (1.25%)**	**79793 (1.61%)**	**106002 (1.90%)**	**48841 (0.76%)**	**81120 (1.06%)**	**141561 (1.58%)**
Of which: Total Revenue Expenditure by Central Government on Oil [2]	**26877 (0.65%)**	**23377 (0.47%)**	**78833 (1.41%)**	**25297 (0.39%)**	**38477 (0.50%)**	**68481 (0.76%)**
Petroleum Bonds	50734 (1.22%)	71288 (1.44%)	133887 (2.40%)	10306 (0.16%)	-	-
Oil PSUs Profit after Tax	33204	29041	26730	37319	38395	

Source: Total Revenue Expenditure by government obtained from Finance Accounts; and PPAC website for all the rest.
Notes: Figures in parentheses are as a percentage of GDP.
1 Includes fiscal subsidy by the government.
2 Revised Estimates: 2011-12

For the period 2006-7 to 2011-12, the average contribution of the petroleum sector to the combined exchequer of both Central and State governments combined amounted to 3.09 percent of GDP. Compared to this, average government subsidy to the petroleum sector over the same period was 0.7% of GDP. Even if the entire under-recovery, including the portion borne by the oil companies, is taken into account as the appropriate measure of subsidization, the subsidy works out to 1.36% of GDP on average over the same period. If we include the issue of oil bonds in lieu of subsidies to the oil marketing companies, the revenue contribution of the sector still turns out to be larger than the sum total of revenue expenditure on petroleum and the petroleum bonds in most years. Thus, in the flow of funds between the private sector (firms plus households) and the government (centre plus States) there is a net revenue to the government and no net subsidy flowing to the private sector. However, a large part of this net revenue accrues to the State governments while the subsidy is entirely paid by the central

government. This is an aspect that has so far not been factored into the policy debate on oil subsidies.

The impact of an oil price change on the revenue and expenditure transactions discussed above flows through the **fiscal channel**, which in turn impacts the macroeconomy. This is shown in Flowchart 1. Revenue from oil is a function of the tax rates and the oil import quantity and/or price depending on the type of indirect tax. The impact of domestic oil price change on sales tax collection would be much more direct and would be depend on both the quantity and prices of imported oil. On the other hand, a change in domestic oil prices will not directly affect the revenue generated from excise duty because it is a quantity linked specific duty. The impact on excise revenues would be indirectly mediated via the impact on the level of demand for oil. The revenue expenditure on oil depends upon the level at which the domestic price of oil is administered, given the international prices, i.e. the pass-through ratio. Higher the pass-through ratio, lower would be the revenue expenditure and fiscal deficit, *ceteris paribus*. Oil price reforms to raise domestic prices in line with international prices are intended to reduce the revenue expenditure of the government and under-recoveries of the oil companies.

II.3 Import Channel

The third main channel through which a change in international oil prices impacts the domestic macroeconomy is the import channel. More than 80 percent of India's mineral oil requirements are being met through import of crude oil and import of petroleum products. Table 4 shows the growth in value of net oil imports over the years. The unprecedented jumps in 2008-9 and in 2011-12 are attributable to major international oil price shocks and in part to exchange rate depreciation. A significant component of our gross imported crude is refined and exported. The ratio of exports to imports has been rising over the years. Thus, net rather than gross oil imports is the proper measure of the contribution of oil to leakage from domestic demand to India's foreign exchange liabilities. Net oil imports has grown steadily, to about 5.3 percent of GDP. It constitutes about 80 percent of India's trade deficit, defined broadly to include both merchandise and service trade.

Table 4: Net Oil Imports of India

	Net Oil Imports (in Rupees Crores)	Net Oil Import growth (%)	Oil Export as Percentage of Oil Imports (%)	Net oil Imports as Percentage of GDP (%)
2000-01	62955	15.56	11.95	2.99
2001-02	56663	-9.99	15.14	2.49
2002-03	72898	28.65	14.61	2.97
2003-04	78123	7.17	17.35	2.84
2004-05	102690	31.45	23.42	3.26
2005-06	143107	39.36	26.48	4.00
2006-07	174052	21.62	32.69	4.20
2007-08	206463	18.62	35.61	4.17
2008-09	296570	43.64	29.38	5.31
2009-10	278750	-6.01	32.28	4.32
2010-11	293503	5.29	39.14	3.82
2011-12	476945	62.50	35.79	5.31

Source: Calculated using data from Table 128 and Table 141, Handbook of Statistics on the Indian Economy, RBI. GDP is nominal GDP at market price.

The **import channel** links the international price of oil to the trade and current account balance, and therefore nominal GDP (see Flow chart 1). If the demand for oil is inelastic in prices as in India, a rise in the international price of oil will increase the import bill for oil for the net oil imports. This will cause the trade balance to worsen.[6] The larger leakage from aggregate domestic demand will translate to lower growth in nominal output. The slowdown in economic growth will compress the growth in demand for import, and this in turn will partially mitigate the adverse impact of high international oil prices on the trade balance.

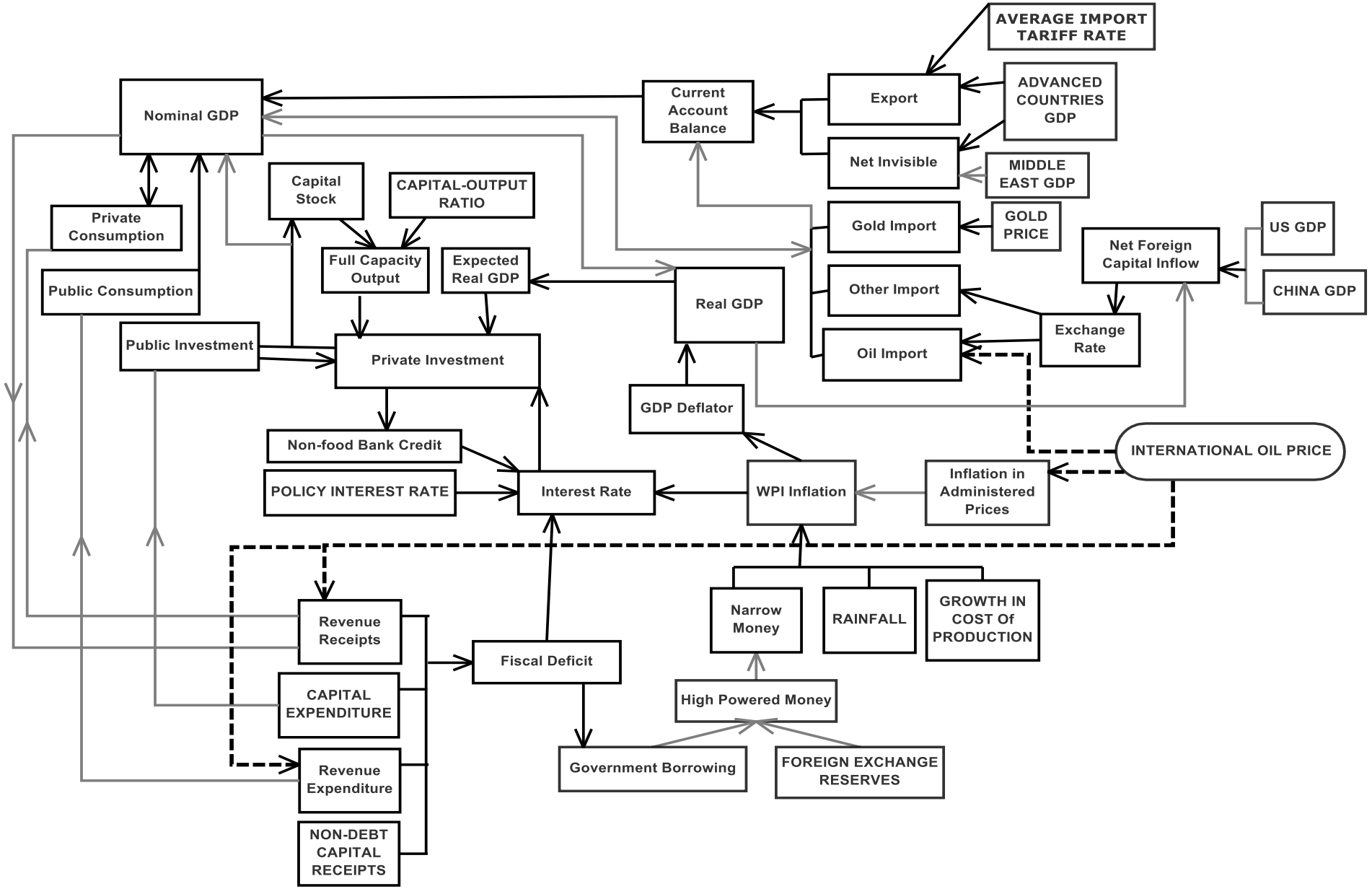
Note, however, that the outcome would also depend on the pass through ratio, a policy decision, and the resultant domestic price of oil. If a rise in international oil price is passed through to domestic oil prices, this will moderate the growth in demand for oil. This will also temporarily trigger higher inflation, which will imply a lower growth in real GDP, and further moderate the growth in demand for oil. If the pass-through ratio falls because the government decides to absorb the international price increase and not pass it on to domestic consumers, the higher revenue expenditure by the government will partly or fully offset the larger leakage of

[6] The impact of oil price shock working through the terms of trade on trade balance and aggregate demand is presented in Rakshit (2005).

aggregate demand. Domestic inflation will remain the same, but the fiscal deficit will increase. Finally, the change in import price of oil could in principle also effect the exchange rate via its impact on the trade balance. However, a stylized fact of the Indian economy which we have discussed earlier (Mundle et.al 2011), is that the exchange rate in India is largely determined by flows on the capital account rather than the trade balance or the current account.

The foregoing discussion summarizes the institutional and policy context of the three main channels through which a change in oil prices impacts the Indian economy, i.e., the price channel, the fiscal channel, and the import channel. To trace how these channels interact with one another and the rest of the economy, and to quantify the impact of an oil price shock on the Indian economy, mediated through these channels, it is necessary to build these channels into a quantitative model of the economy. The three channels have accordingly been integrated into an existing macroeconomic policy simulation model that has been used for various policy assessment exercises in the past, starting with a fiscal consolidation program prepared for the Thirteenth Finance Commission (Mundle et.al. 2011). A flow chart indicating how these channels have been integrated into a model of the larger macroeconomic system is shown in Flowchart 2. The analytical model integrating the three channels of transmission into the broader structure of the macro-model to study the impact of oil price shocks is presented in the Appendix for technically oriented readers, who may be interested in the details of the model structure. An earlier version of this expanded model was presented in Bhanumurthy et. al.(2012).

Flowchart 2: Schematic Diagram of the Model



Note: Upper case denotes exogenous / policy determined variables. The dashed lines indicate the three channels price channels, fiscal channel and import channel.

Here, it is sufficient to say that the basic model is a somewhat eclectic simultaneous equations model in the Tinbergen - Klein tradition, which combines features of a Keynesian macroeconomic model with elements of other theoretical paradigms as appropriate for the realities of the Indian economy. To illustrate, the inflation function in the model combines a demand-supply based price formation component with a cost plus mark-up pricing component, where markets are cleared through quantity rather than price adjustments, as well as an administrative price formation component because we believe all three price formation rules apply in different segments of the Indian economy. Similar hybrid features are also reflected in the investment function and other components of the model. The three core principles that have been followed in developing the basic model is that it should be applicable on the basis of available data, that it should be flexible and easily adaptable to analyze different policy questions, and that it should be simple and transparent enough to enable even non specialist readers to follow the chains of cause-effect linkages that work their way through the model.

All the behavioral equations in the macro model have been estimated individually using annual data for the period 1991-92 to 2009-10, taking care of time series properties . 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 to validate the model for in-sample behaviour. With some assumptions on exogenous variables (discussed in the next section), including policy variables, the full model is solved for the future period up to 2016-17, which is the last year of the 12th Five Year Plan period.

The model has been used in this exercise to analyze two broad scenarios, i.e., (i) a policy shock on domestic oil prices, more specifically a sudden, sharp increase in the pass through ratio and (ii) an international oil price shock, a sharp increase in global oil prices. Based on these two scenarios, an attempt is made to analyse various policy options and their corresponding outcomes. These results are discussed in the next two sections.

III Impact of Oil Subsidy Elimination With and Without a Global Price Shock

This section analyzes the impact of an oil subsidy policy shock on major macroeconomic outcomes under different scenarios for the 12th Five year Plan period i.e. 2012-13 to 2016-17. If the government decides to eliminate existing distortions and establish parity between domestic and international oil prices, it can adopt two alternative approaches. One approach is to reduce the gap between the two prices in one go. Alternatively, it may choose to align domestic prices

with international prices gradually, say, by the end of 2016-17 or the final year of the 12th Five Year Plan. The model described earlier has been used to analyse the impact of these two approaches on a range of macroeconomic outcomes by first estimating three scenarios: the baseline scenario, scenario-1 with a one shot full pass-through, and scenario-2 with gradual enhancement of the pass-through to achieve full pass through in five years. These simulations are then supplemented by a further set of scenarios to capture the effect of an international oil price shock with no change in domestic oil subsidy policy (Scenario 3), a one shot elimination of the subsidy with full pass through of the international oil price increase (Scenario 4), and a gradual elimination of the subsidy with full pass through over a five year period (Scenario 5).

Baseline Scenario:

The business-as-usual or baseline outcomes for the 2012-13 to 2016-2017 period are estimated based on the following assumptions about 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% per year. Administered non-oil prices are assumed to rise at the rate of 10% every year throughout the reference period. Rainfall is assumed to be normal during the reference period, where 'normal' is defined as the average rainfall over the last five years.

2. In the monetary field, the policy (repo) rate has been held constant at 6.25%. Foreign exchange reserve of the government are assumed to increase by 10% 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 a major sources of remittances, are also assumed to grow at the rate forecast by the IMF. Import weighted average tariffs are assumed to remain at the same level as at present, i.e., 9%.

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 in the oil sector) remains unchanged at its medium term level of 1.225. On the expenditure side, capital expenditure of the Government (center plus States) is assumed to gradually increase to 6% of GDP by 2014-15, and to 6.5% of GDP by 2016-17. The

effective rate of excise and customs duty have been assumed to remain the same during the 12th Plan period as in 2009-10. It is also assumed that there will be no off-budget '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 are assumed to be 1 per cent of GDP every year up to 2016-17.

5. Finally, the baseline scenario assumes that international oil prices will remain at the same level as in 2010-11 during 12th plan period. At the same time the pass-through ratio for oil prices is assumed to remain constant at the 2010-2011 level throughout the plan period.

Policy Shock Scenarios

Two policy shock scenarios are analyzed. Scenario-1 depicts a case where the government decides to fully align domestic oil price with international oil prices in one shot. In this scenario, the oil subsidy is completely eliminated in one year. As discussed earlier, the total oil subsidy has two components. It includes the oil subsidy provided for in the Union Budget as well as the under recoveries of the oil marketing companies, which is in effect an off-budget form of oil subsidy from the oil companies to households and firms in the private sector(see the discussion of Fiscal channel in Section II above). Policy Shock Scenario 1 simulates a situation where the government raises prices sufficiently in one shot to fully eliminate both components of the oil subsidy.

The total oil subsidy burden is estimated to be roughly 1.5 per cent of GDP at present. A one time administered price increase to fully cover this amount entails a large macroeconomic shock, with consequent effects for short term inflation and other macroeconomic outcomes. An alternative policy shock scenario, Scenario 2, is one where the total subsidy is eliminated over a five year period, with more gradual increases in the administered price of oil, which yields a much more stable macroeconomic path. The results comparing the three scenarios are presented in Table-5. It should be mentioned that, according to one view, the under- recoveries of oil companies are highly over estimated compared to what might be a true market price in a competitive environment. If true, a complete deregulation of oil prices in one shot could actually lower oil prices for the consumer and eliminate all oil subsidies at the same time. We have not considered this counterfactual scenario in this paper. Our simulations are all based on the official estimates of under-recoveries.

TABLE 5 Impact of an Oil Price Policy Shock

Year	GDP Growth			Inflation			Revenue Deficit			Fiscal deficit			Debt/GDP		
	Baseline	**Scen-1**	**Scen-2**	**Baseline**	**Scen-1**	**Scen-2**	**Baseline**	**Scen-1**	**Scen-2**	**Baseline**	**Scen-1**	**Scen-2**	**Baseline**	**Scen-1**	**Scen-2**
2012-13	6.8	1.4	5.6	6.8	12.9	8.1	4.9	4.2	4.8	9.7	9.0	9.6	74.2	74.3	74.2
2013-14	7.5	7.8	6.3	5.3	3.6	6.3	4.4	3.0	3.4	9.5	8.1	8.5	74.8	73.6	74.6
2014-15	7.6	7.9	6.5	4.6	4.6	5.6	4.1	2.9	3.0	9.5	8.3	8.4	76.0	74.5	75.4
2015-16	8.3	8.0	7.1	4.9	5.1	5.9	3.5	2.5	2.4	9.2	8.2	8.1	76.0	74.2	75.1
2016-17	8.3	8.1	7.1	5.0	5.2	6.0	3.1	2.1	1.9	9.1	8.1	7.9	76.1	74.1	74.7

Scenarios for Policy Shock

Baseline	Existing pass-through (present scheme of partial subsidization) continues
Secnario-1	Full pass-through
Scenario-2	Gradual pass-through or phased reduction in subsidy

In the baseline case, where there is no change in the pass-through policy and no change in the international oil prices, the model predicts an increase in the growth rate from around 6.8% in 2012-13 to 8.3% by 2016-17, with an average growth of 7.7 per cent In Scenario 1 after a sharp initial drop in the growth rate to only 1.4% in 2012-13, the growth rate quickly returns to around 8%, comparable to the base case.. In the gradual price increase case of Scenario 2 the initial dip in growth more moderate at 5.6%, but the growth in subsequent years remains at around 7%, about 1% lower than in the other two cases. On the inflation front, as expected the one shot price increase case shows a sharp increase of the inflation rate to nearly13% in 2012-13. But it then quickly subsides to 4% to 5%, quite comparable with inflation rates in the base case. In the gradual price increase case of Scenario 2, the initial inflation spurt is moderate at just over 8%. However, inflation during the subsequent years remains more elevated at around 6%.

The fiscal deficit is brought down in both the price shock cases to about 8% by 2016-17 as compared to over 9% in the base case. However, as intended, the adjustment is more gradual in Scenario 2. Note that fiscal deficit in this exercise has been defined to include the under-recoveries of oil companies, which are off-budget liabilities of the government. The public debt/GDP ratio remains at around 74% and 76% in all cases.

In summary, while the initial impact of the shock on both growth and inflation is very severe in Scenario 1, the medium term outcomes are very similar between the two administered price adjustment cases, and also compared to the base case. Of course, the fiscal deficit is lower when there is a price adjustment, which is of course the purpose of the adjustment. Given these outcomes from the model simulations, it would appear that the more gradual adjustment scenario depicted in Scenario 2 may be the preferred policy option. It yields the same medium term fiscal consolidation outcome, but is much less volatile in terms of growth and inflation in the initial year of the shock. It is interesting to note that at the time of writing this paper (November 2012), the government has indeed initiated a policy of gradual price adjustment, and the actual growth and inflation outlook looks very similar to that depicted in scenario 2. Finally, it has to pointed out that in both the price adjustment scenarios, while the revenue deficit is compressed, there is gradual increase in capital expenditure, which also has a much stronger multiplier effect on growth. This is why it is possible to have fiscal consolidation without much sacrifice in terms of growth (Mundle et.el. 2011). This is another crucial policy lesson for any fiscal consolidation exercise, which was much emphasized by the 13th Finance Commission, which Dr. Kelkar Chaired (Report of the Thirteenth Finance Commission, 2010)

Oil Price Shock Scenarios

In this exercise, we again compare alternative policy scenarios of a sudden and gradual increase in the pass through ratio, but with an added exogenous oil price shock, i.e., a 50 per cent rise in the international price of oil. Thus the base case or 'business as usual scenario' includes a 50% international oil price increase with no change in domestic pass through policy. (scenario 3) This is then compared with scenario 4, where there is full pass through of the international price shock in one shot, and scenario 5 where the international oil price shock is gradually passed through. The results are presented in Table-6.

TABLE 6 Impact of an International Oil Price Shock

Year	GDP Growth			Inflation			Revenue Deficit			Fiscal deficit			Debt/GDP		
	Scen-3	Scen-4	Scen-5	Scen-3	Scen-4	Scen-5	Scen-3	Scen-4	Scen-5	Scen-3	Scen-4	Scen-5	Scen-3	Scen-4	Scen-5
2012-13	5.3	-2.2	3.7	6.8	15.6	8.5	4.7	3.8	4.5	10.2	9.4	10.0	75.6	75.9	75.7
2013-14	6.7	6.8	5.1	5.4	3.3	6.7	4.2	3.3	3.8	9.6	8.4	8.9	76.4	75.0	76.2
2014-15	7.5	8.0	6.0	4.4	4.4	5.7	3.9	3.1	3.3	9.6	8.5	8.7	77.7	75.9	77.0
2015-16	8.4	8.0	6.8	4.8	5.1	6.1	3.4	2.7	2.7	9.2	8.4	8.4	77.6	75.4	76.5
2016-17	8.3	8.1	6.8	5.0	5.1	6.3	3.0	2.4	2.1	9.1	8.2	8.1	77.6	75.1	75.9

Scenarios

Exogenous oil price shock (of 50% rise in international price of oil)

Scenario-3 Business as usual case (present scheme of partial subsidization) continues with 50% international price hike

Scenario-4 Full pass-through with 50% international price hike

Scenario-5 Gradual pass-through or phased reduction in subsidy with 50% international price hike

As is to be expected, with a large international oil price shock of 50% , there will be a slowdown in growth compared to the no shock case (Table 5), even when there is no change in the domestic pass through policy (Scenario 3). Growth in this case declines to 5.3 % in 2012-13, the year of the shock. However, when this shock is compounded with a domestic price policy , shock with a full one shot pass through of the increase in international oil prices (Scenario 4), the economy goes into recession, with output declining by (-) 2.2%. With a more moderate policy of gradually passing through the global price increase, and eliminating oil subsidies, including oil company under-recoveries over five years (Scenario 5), there is still a strong growth shock, but more muted. Growth in this case slips to 3.7% in the shock year. Growth also recovers more gradually, remaining below 7% after five years in Scenario 5 compared to over 8% in both Scenarios 3 and 4.

Inflation outcomes are also very sharp and volatile in the one shot pass through case. It spikes to 15.6% in the shock year, but then quickly settles to a comfortable level of 4% to 5% by the third year. In contrast the initial spike in the gradual pass through case of Scenario 5 is quite moderate at 8.5%, but inflation remains slightly elevated at over 6% even after five years. The fiscal deficit settles at just over 8.5% under both the one shot and gradual adjustment policy options compared to over 9% when there is no increase in the pass through (Scenario 3), and the public Debt to GDP ratio is also slightly higher. We note again that the fiscal deficit is defined here to include the deficits of the central government, the State governments, and also the under-recoveries of the oil companies.

IV. A Concluding Remark

The main objective in this paper was to measure the immediate and medium term impact of an oil price policy shock or a global oil price shock on macroeconomic outcomes such as growth, inflation and the fiscal deficit. Towards this end, the paper first identified and described the working of the key channels through which these shocks impact macroeconomic outcomes, i.e., the price channel, the fiscal channel, and the import channel. The channels were then integrated into an empirically estimated macroeconomic model, and the model was used to simulate the macroeconomic outcomes under different shock scenarios.

Bringing together the results of Scenarios 1 to 5, presented in Tables 5 and 6, along with the base case, the comparisons of different policy outcomes point to the strong advantage of a policy of gradual administered oil price adjustment compared to a policy of eliminating all oil

subsidies and under-recoveries in one shot. Both policy options yield the same results in terms of fiscal consolidation over the medium term. However, the gradual adjustment policy generates this result without an extreme disruption of either growth or price stability in the year of the shock. This result is quite evident even when there is no international oil price policy shock. However, it comes into much sharper relief when the pass through of a 50% increase in global oil prices is simulated. In such a situation, a one shot pass through drives the economy into recession, with an output decline of over 2%, and inflation spiking up to nearly 16%. The more gradual pass through of the global price shock does not lead to this extreme outcome of stagflation.

Appendix

The Model

The empirical estimation of the impact of oil price changes is based on a structuralist simultaneous equation policy simulation model developed at NIPFP (Mundle et al 2011). 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 domestic oil price reforms and international oil price shock on various macroeconomic indicators of India. It is a fairly simple model, consisting of only 34 equations. There are 21 behavioural relationships and 13 identities.

The model is theoretically eclectic rather than purist, picking up elements from different theoretical approaches as required by the empirical realities of the Indian economy. That being said, it should be mentioned that the model is essentially Keynesian in nature since output levels are demand determined rather than supply constrained (Bhaduri, 1990). Given the persistence of high levels of involuntary unemployment, either open or disguised, we believe that this is the appropriate specification for India. Capacity constraints enter the picture only in the form of utilisation levels influencing the level of private investment demand.

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.[7]

Also, the scope of the present study 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.

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

There are four blocks in the 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, gold and non-oil non-gold), trade balance, net invisible, net capital inflow, exchange rate. The monetary block contains equations determining the change in high-powered and narrow money, the public borrowing, private borrowing and the rate of interest. Flowchart 2 presents a schematic diagram of the model.

Macroeconomic Block[8]

The model is specified below in terms of equations (1) to (34). 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

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

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, (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 ( ) is given by

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

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, $\bar{\dot{A}}_t$ is the rate of change in factor costs (wage, rent and interest costs), and $\bar{V}_t$ is the index of rainfall in period t. Within the administered prices, there are oil and non-oil

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

commodities that need to be disaggregated to analyse the oil price impact. This is disaggregated as follows.

$$\hat{\hat{p}}_t^a \equiv 0.26 \times \hat{\hat{p}}^{aO} + 0.74 \times \hat{\hat{p}}_t^{anO} \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Where $\hat{\hat{p}}_t^{aO}$ is the administered price of the oil basket and $\hat{\hat{p}}_t^{anO}$ is the price of the non-oil administered commodity basket.[9] 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:

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

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, IDBIetc.) I_t^g is government investment in period t, Z_t^e is the expected real 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.

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

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

$$K_{t-1} \equiv K_{t-2} + \frac{1}{p_{t-1}}\left(I_{t-1}^p + I_{t-1}^g\right) \quad \ldots\ldots\ldots\ldots \quad \ldots\ldots \quad \ldots. \quad (6)$$

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

$$Z_t^e \equiv Z_{t-1} + \Delta\widetilde{Z}_t \quad \ldots \quad \ldots \quad \ldots. \quad (7)$$

[9] To calculate inflation in administered commodities six broad commodity groups, viz. cereals, fertilizer, iron & steel, mineral oil, electricity and coal from the WPI basket have been considered. Prices of these commodities are significantly influenced by the government (if not controlled directly). The relative weights of oil and non-oil components are 26: 74, respectively, for the administered basket.

where Z_{t-1} is real outputin period t-1 and $\Delta\tilde{Z}_t$ is the predicted first difference of real output in period t. This is derived from equation 8.

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

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. $\Delta Z'_{t-1} > 0$ & $\Delta^2 Z'_{t-1} < 0$.

Government Block

Nominal aggregate revenue expenditure of government (E_t) is given by government subsidy on oil (E_t^O)and the rest of the revenue expenditure of government in period t, a policy variable, $\hat{E}_t^{NO}$.

$$E_t \equiv E_t^O + \hat{E}_t^{NO} \quad \ldots \quad \ldots \quad (9)$$

Equation (10) links two data sources *viz*. national accounts statistics (NAS) and Indian public finance statistics (IPFS) for consistency.

$$G_t = f(G_{t-1}, E_t) \quad \ldots \quad \ldots \quad (10)$$

Revenue expenditure on oil E_t^O is the subsidy to the oil companies, which is a function of domestic price of oil and international price of POL basket. Although the oil subsidy bill is expected to depend on the quantity of oil imports (sales), empirically it is found that oil subsidy is dependent solely on the price variables.

$$E_t^O = f(\hat{p}_t^{ao}, \bar{p}_t^o) \quad \ldots \quad \ldots \quad \ldots (11)$$

Where $\bar{p}_t^o$ is international oil price of the Indian import POL basket and $\hat{p}_t^{aO}$is the administered price of the oil basket.

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_t^{ECO}), sales tax revenue on oil (T_t^{STO}) and other tax and non-tax revenue of the government (T_t^N).

$$T_t \equiv T_t^{ECO} + T_t^{STO} + T_t^N \quad \ldots \quad \ldots \quad \ldots (12)$$

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

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

Revenue from excise and custom duty from oil T_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.

$$T_t^{ECO} \equiv \hat{\Phi} \times QM_t^O \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (14)$$

$$QM_t^O = f(Z_t) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (15)$$

where QM_t^O is a function of real GDP.

Sales tax revenue from oil T_t^{STO}, levied at an ad-valorem rate, is a function of administered domestic price of oiland net oil import value (import minus export of oil).Net oil import $NM_t^O$is a linear function of oil imports, M_t^O.

$$T_t^{STO} = f(\hat{p}_t^{ao}, NM_t^O) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (16)$$

$$NM_t^O = f(M_t^O) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (17)$$

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

$$I_t^g = f(\hat{S}_t^g) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (18)$$

$\hat{S}_t^g$ where, is the capital expenditure of government in period t, a policy variable.

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

$$F_t \equiv \hat{E}_t + \hat{S}_t^g \dot{-} T_t - \hat{N}_t^g \equiv D_t^g \mp \Delta \hat{O}_t^g \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (19)$$

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

$$B_t^T \equiv X_t - M_t - M_t^O - M_t^{GL} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (20)$$

where X_t is the value of exports (including services) M_t^O, M_t^{GL}, M_t are the values of oil import, gold imports and non-oil non-gold imports (including services) respectively.

The value of exports depends on the external demand conditionsand the domestic tariff rates.

$$X_t = f\left(\hat{U}_t, \overline{Y}_t^a\right) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (21)$$

where is the policy determined average tariff rate and is the *GDP* of advanced countries, an exogenous variable.

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

$$M_t = f\left(e_t, Y_t\right) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (22)$$

where is the nominal exchange rate (Rs/US$), and Y_t is nominal GDP in period t.

$$M_t^O = f(e_t, \overline{P}_t^O, Y_t) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (23)$$

where, $\overline{P}_t^O$ is the dollar price of POL imports in period t, an exogenous variable.

Import of gold is assumed to depend on the predicted price of gold and the domestic GDP. The predicted price of gold for period t, in turn,is a function of the actual price of gold in two of the preceding periods simulating an adaptive expectations path.

$$M_t^{GL} = f\left(\widetilde{P}_t^{GL}, Y_t\right) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (24)$$

$$\widetilde{P}_t^{GL} = f(P_{t-1}^{GL}, P_{t-2}^{GL}) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (25)$$

$\widetilde{P}_t^{GL}$is the predicted price of gold, and $P_{t-1}^{GL}, P_{t-2}^{GL}$are the price of gold in period t-1 and t-2, respectively.

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

$$e_t = f\left(J_t\right) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (26)$$

where is net foreign capital inflow.

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

$$J_t = f(\overline{Y}_t^{us}, \overline{Y}_t^c, Y_t) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (27)$$

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 ($\bar{Y}_t^a$) and the Middle East ($\bar{Y}_t^{me}$), these being the two major sources of remittances.

$$L_t = f(\bar{Y}_t^a + \bar{Y}_t^{me}) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (28)$$

The balance of payments identity in period t (B_t^p) is given by

$$B_t^p \equiv B_t^t + L_t + J_t + \Delta\bar{R}_t \equiv 0 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (29)$$

where $\Delta\bar{R}_t$ 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

$$\dot{M}_{1t} = f(\dot{H}_t) \quad \ldots \quad \ldots \quad \ldots \quad (30)$$

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 ($\Delta\bar{R}_t$), i.e.,

$$\frac{\dot{H}_t}{H_{t-1}} = f(D_t^g, \Delta\bar{R}_t) \quad \ldots \quad \ldots \quad \ldots \quad (31)$$

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

$$D_t^g \equiv \hat{D}_{ct}^g + \hat{D}_{mt}^g \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (32)$$

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 borrowing from the financial sector. Volume of borrowing from

the financial sector consists of volume of government borrowing from the market, the potential crowding out element and bank credit to the private sector. Hence,

$$r_t = f(\dot{p}_t, \hat{i}_t, \hat{D}^g_{mt} + BC_t) \quad \ldots \quad \ldots \quad \ldots \quad (33)$$

where $\hat{i}_t$ is the repo rate (bank rate before 2004-05) of RBI in period t, and BC_t is the credit disbursed by banks to the private sector. Private sector investment demand determines the volume of credit disbursed by banks to the private sector.

$$BC_t = f(I^P_t) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (34)$$

All these equations in the model above have been individually estimated. The estimated equations have then been used to solve the simultaneous equation system for the values of dependent variables. This has been done both in the in-sample and out-of sample period.[10]

[10] Estimated equations can be obtained from the authors, on request.

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