Petroleum Federation of India

Study of Macroeconomic Impact of High Oil Prices

By

NATIONAL COUNCIL OF APPLIED ECONOMIC RESEARCH

National Council of Applied Economic Research

Petroleum Federation of India

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It functions through committees from member organisations and other experts, covering all aspects of oil and gas industry, which submit recommendations on ongoing basis.

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Foreword

Fossil fuels are likely to continue to supply much of the energy world-wide despite fears of peaking oil. Given its importance in the transportation and industrial sectors, oil remains a dominant energy source. It is, however, not merely the dominance of oil and gas in the energy basket but its steadily rising price during the past few years that is a cause of concern. More so for developing economies like India.

Over 70% of India's crude oil requirements are imported and the figure may well reach 85% by the end of the decade. By 2030 India's consumption of petroleum products may quadruple. The impact of rising oil prices on the Indian economy is, therefore, a matter of grave concern. As mentioned in PetroFed publication 'Fuelling India's Growth – Vision 2030', the Indian economy has been badly singed whenever global oil prices have flared. In 1973, GDP fell by 0.3% and inflation was up at 20.2%; in 1979 the corresponding figures were 5.2% and 17.1%. The GDP grew by a meagre 1.3% in 1990, while inflation topped 14%. PetroFed has, in this backdrop, undertaken this thought leadership initiative through NCAER.

The choice facing policy makers is hard in the face of continually rising crude oil prices and our increasing reliance on crude oil imports in the forseeable future. Insulating domestic prices against such increases has adverse implications for government finances and development of the petroleum sector, according to the study. The findings have shown that in case the Government restricts the pass through of world price increase to the domestic economy, it stands a very high risk of jeopardising the fiscal position. The deteriorating fiscal deficit would lead to a contraction of the economy risking the health of the economy for future growth. A weakened petroleum sector and the industrial sector would lead to dampening of investment sentiment and this could lead to a very negative situation for a growing economy like India. If the international price rise is allowed to pass through, though there would be increase in the price level, this does not necessarily signal an unsustainable situation from an economic perspective. The more realistic energy pricing would lead to better use of resources and a market for alternative energy.

We hope this thought leadership initiative will lead to rapid progressive policy changes and help spur growth.

We welcome reader's views and comments in this regard.

August 24, 2006
New Delhi

A.K. Arora
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Preface

The sharp rise in petroleum prices internationally in the last two years has raised many concerns for policy makers around the world including India. In the Indian context, the fact that a significant part of the petroleum sector is subject to price controls makes the policy questions more significant. The trade-offs between subsidies to the consumers of the petroleum products on the one hand and alternative uses of public funds on the other hand are not easy to resolve.

In this context, objective assessment of the issues that arise from the high prices of the petroleum sector is always valuable. This study, commissioned by PetroFed, is one such attempt.

This study addresses two questions. Firstly, it examines for a few selected economies, the impact of the international crude oil prices on the domestic economy in terms of aggregate output and price. Secondly, the study also gauges the macroeconomic impact of international oil price rise on the domestic economy in greater detail for the Indian case. It captures the inter-linkages between different sectors of the economy and the oil sector more explicitly in the input-output (I-O) work. The study provides useful quantification of the impact of the high prices of the petroleum products. It also shows the implications of alternative ways of dealing with the high prices on fiscal position of the central government, inflation and GDP.

The study shows that short-term benefit in terms of lower inflation by not passing on the international price rise to the consumers would ultimately impact the fiscal position of the government adversely. The government would then be forced to borrow, increase taxes or reduce useful expenditure. None of these are helpful in sustaining a healthy economic growth.

We are thankful to PetroFed for this opportunity to contribute to policy analysis in this important area.

Suman Bery
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The most important issue in the energy scene today is one of the large and growing differential between the price of imported crude and the domestic prices of petroleum products obtained from refining crude oil. The former has increased manifold over the last couple of years, while the increase in the latter has been relatively small. This deliberate attempt, on the part of the government, to insulate domestic prices from global prices might confine the price of refined petro products to within a narrow range in the domestic market. But it also ratchets up the government's revenue deficit via higher implicit or explicit subsidy outlays, and also occasions major losses for the refining and marketing companies.

Continued rise in demand for subsidised products even after international crude prices have risen, worsens the economy's balance of payments too. Oil companies are hurt by their inability to charge the market price of the refined product and that, in turn, hurts their realization on capital employed and plans for new investments. The under-recoveries of oil companies were expected to attain a massive level of Rs 57,000 crore during 2006-07 if there were no increase in market prices and the global prices remained at the current level of $74 a barrel; that will be coming on top of the Rs 39,600 crore of under-recoveries in 2005-06. Low margins also discourage fresh investment in refining, stall the cultivation of alternative energy sources (like solid fossil fuels, nuclear power or wind), affects productivity improvement and caps employment creation in the petroleum sector. And the paradox really is that, despite everything, inflation does accelerate over the longer term, after the revenue deficit generated by oil price subsidies finds its way into the economic system.

Against this backdrop the present study addresses two questions. Firstly, it examines the impact of the international crude oil prices on the domestic economy in terms of aggregate output and price based on past data. The study provides a comparative analysis with respect to a few selected developing economies besides India. Secondly, the study also gauges the macroeconomic impact of international oil price rise on the domestic economy in greater detail for the Indian case. It captures the inter-linkages between different sectors of

the economy and the oil sector more explicitly in the framework of an input-output (I-O) framework.

Relationship between International Crude Oil Prices and the Aggregate Output and Price

The linkages between petroleum sector prices and the economy have been examined by several studies in the past. The studies point out the key role of the petroleum sector in any modern economy. For example, assessing the negative consequences of the recent oil price surge, a recent study by the International Energy Agency (IEA) reported that a sustained $10/barrel increase in oil prices, over a one-year period, would lower world GDP by at least 0.5 per cent. Developing countries would be hit particularly hard since they, on average, use twice as much oil to produce one unit of output than developed countries. In the Indian context we cite two studies where the impact of higher oil prices on the macroeconomic parameters is quantified. Sinha and Bhide (1997) show that a 10 per cent hike in the price of international oil when passed on to the domestic petroleum sector prices would lead to a 2 per cent increase in the overall domestic price level. Another study by Bhattacharya and Kar (2005) found that a 100 per cent increase in the price of imported oil would lead to a 15 per cent increase in the domestic prices, and a 3 per cent decline in industrial production. The implications of large rise in the prices of the petroleum sector are therefore quite significant.

We first examine in this study the impact of changes in the crude oil price in the international market on selected macroeconomic indicators for five selected developing countries -- India, China, Korea, Thailand and Brazil. Of these, all excepting Brazil are net importers of crude oil. The analysis in this section is carried out utilising quarterly data for the period Q1:1993 through Q4:2004 for all countries except Brazil. We have used annual data for Brazil because quarterly data were not readily available for this study. These data were used to estimate the relationship between the international oil price and the macroeconomic indicators such as industrial output, GDP and domestic price level in a 'Vector Auto Regression' (VAR) framework.

The estimated equations provide us the tool for assessing the impact of oil price changes on the domestic economy. The sample data period also provides us an opportunity to undertake a 'within sample period simulation' as it includes the period in which the oil prices rose sharply. We ask the question what could have been the impact if the international prices had not increased? We then examine the implications of a rise in the price of oil by US$ 10 /

barrel over the base year of 2005. Both the questions are similar and therefore, we report here the findings of the second set of simulations.

A US$10 increase in the price of international oil in 2005 leads to 0.15 per cent fall in India's industrial production, a short-run (over a one year horizon). But it declines more in the long run -- 0.57 per centage points[1]; manufacturing production declines even more in the long run, by 0.84 per cent. As for India's domestic price level, there is no increase in the short run, but there is a marginal increase in the long-term. In the external sector, the simulation suggests that India's imports would increase by 0.64 per cent, and its exports and trade balance decline by 0.58 per cent and 1.22, respectively, per cent in the short-run. The long-term effects are greater.

In the case of China also we find industrial production declining at a higher, 0.22 per cent, rate in the long-run, compared to 0.05 per cent in the short run. China's import bill grows higher and its trade surplus drops in the year of the oil shock.

We find that the increase by US$10 in the price of international oil in 2005 leads to uneven short- and long-term declines in the output of the other sample economies. In the case of Korea and Thailand, we see the former's output falling by almost equal amounts in the short- and long-run (0.82 per cent and a smaller 0.76 per cent respectively); but the latter's output declines by higher a percentage in the long-run (0.25 per cent) when compared to the short-run (0.01 per cent). Also, an oil price increase of US$10 would increase Korea's imports by 1.01 per cent and Thailand's by 0.93 per cent in the short run. So, an oil price rise would not only increase import bill for them, it would also reduce export earnings by 0.81 per cent for Korea and by 0.15 per cent for Thailand. As a result, their trade balance would also deteriorate.

Impact on the Indian Economy: A Detailed Analysis

We first specified the inter-linkages between the petroleum sector and the other sectors of the economy using the Input-Output table available from the CSO. The 115 sector tableau was aggregated to 27 sectors to keep the analysis manageable for a wider analysis. We carried out a preliminary analysis first to examine the strength of the inter-linkages. This initial analysis, which does not take into account any substitution between energy sources or

[1] IEA (2004) finds that US$ 10 per barrel increase of oil price results in India's real GDP decline by 0.8 percent. In this study we find that with the same amount of oil price increase, the industrial production of India declines by 0.6 percent. These two results are more or less similar because industrial production does not wholly represent India's output, hence reflects only a partial impact on GDP.

the impact of higher prices on demand, shows that a 55 per cent increase in the price of crude (taking the case of US$28 per/bbl in 2003-04 to about US$45 per/bbl in 2004-05)[2], if passed on to the domestic economy fully, would translate into a 38 per cent rise in petroleum product prices and a 5 per cent increase in the overall price level (an equivalent of WPI). This implies that a 10.0 per cent rise in crude price, if transmitted fully to the domestic economy, would lead to 6.9 per cent rise in POL price and about 1 per cent rise in WPI. Clearly, the POL sector has significant impact on the prices in the economy.

We then examined the impact of this 38 per cent POL sector's price rise on the macro variables of India's economy through NCAER's macro CGE model. The analysis was carried out under three alternative simulations.

The first scenario is considered as the 'base scenario'. Here, we let the world price of crude increase by 55 per cent but prevent it from 'passing through' to domestic POL prices; that reflects present system of administered POL prices in India. Our results show that, with unchanged domestic POL prices, the imbalances are reflected in the bulging fiscal deficit and the current account deficit. While the overall GDP growth is maintained at 8.1 percent, the average annual rate of inflation is 4.5 percent. But the real weaknesses are reflected in the large trade and fiscal deficits, something that could be unsustainable.

How can the large fiscal deficits be managed? One option is to reduce expenditures. In the next simulation, Simulation 2, we reduce government expenditure in order to lower the fiscal deficit to the approximate level of the pre-oil price increase scenario. But we also reduce the customs and excise rates on POL by 2.5 per cent along with 'full-pass through' of oil price. These, we find, adversely affect industrial growth and hence GDP. The overall GDP falls marginally, as the fiscal deficit is reduced relative to the base-line scenario. In scenario 3 custom and excise duties are not reduced, so prices remain high. The benefit is seen only in reigning in the fiscal deficit. Obviously, a balance between fiscal prudence and inflation is necessary. In this scenario, where fiscal deficit is in acceptable range, inflation is too high. So, simulation 2 which allows a pass-through, deters inflationary tendencies by lower taxes and this seems to be a more balanced case.

Clearly the impact on fiscal deficit can not be managed by simply reducing government expenditure. Revenues must be improved. In the third simulation, together with the reduced government expenditure as in simulation 2, we let the increase in world oil price

[2] The increase in oil price from a past experience is taken to fix a range of plausible changes; a different set of

pass through to the domestic POL sector and also restore the tax rates to the original levels as in the scenario 1. Now, as prices in the POL sector are raised by 38 per cent (as explained above), the overall price rises by 3.0 percentage points over its base level. What that means is, had average price inflation been reigning at 5.0 per cent without any pass through, then the 38 per cent POL price rise would lead to the overall price rise of 8.0 per cent after the shock. The overall domestic price rise would impact industrial growth and GDP adversely, but both trade and fiscal deficits would be under control in this scenario. Although this scenario does produce a sharper oil price impact on domestic prices and reduces economic growth in the short-run, it is less damaging in the longer run because a full pass-through keeps both the fiscal deficit and the trade deficit under check.

The choice facing the policy makers is hard in the face of a sharp increase in the international price of petroleum crude. Reliance on imported crude will remain significant in the foreseeable future. It would be difficult to argue that domestic prices should be fully insulated against such increases. Implications of such a move are adverse for the government finances and for the development of the petroleum sector in the economy. The simulations carried out in this analysis point to the worsening of fiscal deficit and trade deficit when domestic prices are insulated from international prices based on government's absorption of the price-gap in its own budget. Attempts to reduce the fiscal and trade deficit by reducing other expenditures of the government would also reduce overall output of the economy. It may also have more difficult long-term implications depending on which government expenditures are cut.

This study has highlighted the need for a careful examination of the policy of administered prices of the petroleum sector in the context of rising international prices. The study points to the need for understanding the wider implications of short-term measures, which consider only the price or output impact in the short-term.

A Study of the Macroeconomic Impact of High Oil Prices

I. Introduction

I.1 Background

The unprecedented rise in the price of international crude since the late 1990s requires closer examination of its macroeconomic consequences -- particularly for developing countries

changes can also be simulated using the model.

which are net importers of crude and petro products. The rise reversed the sequel to the 1974 and 1979 oil shocks. Their aftermath had been significant decline in the international price of crude, and prices remained stable until 1998 (Figure I.1). But they took a different turn thereafter -- rising continuously, and at a faster rate.

Figure I.1: Crude Oil Prices in the International Markets: 1976 to 2004(at current price)

One fallout was the 40 per cent-plus rise in the price of India's imported crude oil basket during 2002-03 to 2004-05 (see Table I.1). Product wise, petrol price rose by 57.74 per cent, and diesel by 53.75 per cent during 2002-03 to 2004-05. Although the domestic price of petrol and diesel in India's big-four metropolitan cities do show an increasing trend, they rose less than international prices (Table I.1).

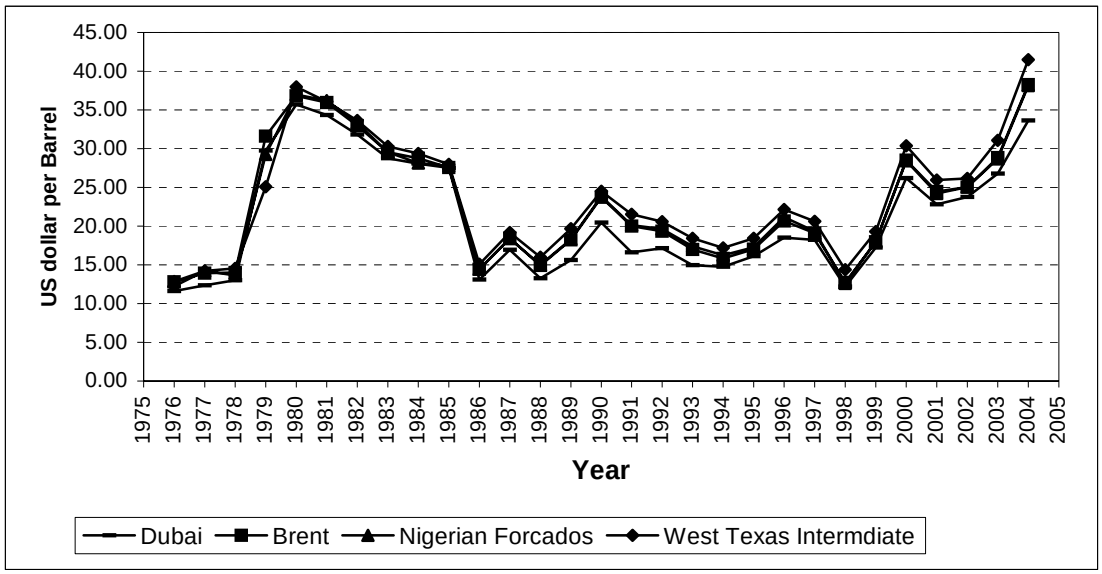


Table I.1: Trends in Domestic and International Prices of Major Petroleum Products

Retail Selling Prices of Selected Petroleum Products in Metropolitan Cities								
	Mumbai		Kolkata		Delhi		Chennai	
	MS-87	HSDO	MS-87	HSDO	MS-87	HSDO	MS-87	HSDO
	Rs./Litre	Rs./KL	Rs./Litre	Rs./KL	Rs./Litre	Rs./KL	Rs./Litre	Rs./KL
As on 1.4.2002	30.78	21.1	26.99	28.49	26.54	16.6	28.49	18.1
As on 1.4.2004	38.83	27.43	36.61	33.71	33.71	21.74	33.71	21.74
1.4.2004 over 1.4.2002 (In per cent change))	26.15	30.00	35.64	18.32	27.02	30.96	18.32	20.11

International Prices of Crude Oil and Major Petroleum Products				
Period	Exchange Rate (Rs./US$)	Crude Oil (Indian Basket)	Petrol	Diesel
		$/bbl		
2002-2003	48.39	26.66	30.15	28.93
Average 2004-2005	44.92	37.44	47.56	44.48
2004-05 over 2002-03 (In per cent change)	-7.17	40.44	57.74	53.75

Sources: www.indiastat.com

The forces behind the current oil price rise differ from those of the 1970s. While, the oil price rise was supply driven then, today it is mostly demand driven. Accordingly, despite several OPEC interventions on oil supply in recent years, there can be little doubt that it is the growing demand for oil imports (represented by growing GDP in developing countries), that is driving up prices (Table I. 2).

Table I.2: Real GDP Growth (Annual percentage change)

	2000	2001	2002	2003	2004	2005
Euro Area	3.5	1.6	0.8	0.5	2.2	2.2
US	3.7	0.8	1.9	3.0	4.3	3.5
China	6.7	5.5	6.6	7.7	7.6	6.9
India	5.4	3.9	5.5	7.2	6.4	6.7
Developing Asia	6.7	5.5	6.6	7.7	7.6	6.9

Source: World Economic Outlook, 2005, *IMF*

During the seven years (1998 to 2004), price of Dubai crude went up by 175.51 per cent, Brent crude by 200.86 per cent, Nigerian Forcados by 202.14 per cent and West Texas Intermediate by 188.33 per cent. More alarmingly, after one of the biggest hurricanes in US history churned through the Gulf of Mexico (home to a quarter of US oil production)

international crude prices surged to a record high of above $70/ bbl on August 30, 2005. (Appendix I.1 provides data on spot prices for crude oil in international markets.)

Assessing the negative consequences of the recent oil price surge, the International Energy Agency (IEA) reported that sustained $10/ bbl increase in the price of oil would lower world GDP by at least 0.5 per cent in a year. Further, this study states that developing countries in particular would be hit since, on average, they use twice as much oil to produce an unit of output as compared to developed countries.

Numerous studies have examined the macroeconomic effects of oil price shocks. The findings have been ambivalent. Examining the causes of recession in the US during the 1970s, a major study found oil price rise to be the crucial factor triggering a recession by forcing a downswing in output and employment growth. But these findings do not hold if the sample period is extended[3]. Another study found that oil price increases did impact real output negatively, but price declines did not influence output[4]. There is, thus, no clear evidence on how changes in oil price affect the course of the economy. On a similar note a couple of other studies[5] also observe that oil prices typically fail to 'cause' or 'precede' the macro variables when the data sample is extended upto the mid-1980s.

An examination of the macroeconomic impact of high oil prices in the OECD's context also point to three fundamental points. First, the 1980s' and 1990s' experiences provide no valid basis for dismissing the risk that persistent oil-price increases would pass-through into core inflation. Secondly, delays in responding to persistent oil-price increases could exact high macroeconomic costs if they eroded the credibility of monetary policy[6]. And thirdly, given significant uncertainties about behavioural relationships, the makers of monetary policy should interpret the data in a way that, other things being equal, errs in the direction of more aggressive policy responses to oil-price increases.

One may argue that it was the exchange rate and not monetary policy that had been responsible for creating a negative relationship between oil shocks and economic activities in the 1970s. But, exchange rates then being relatively 'fixed' meant the automatic transfer of international oil price increases to domestic price levels. Moreover, countries that were unable to follow independent monetary policies could not control inflation by tightening

[3] Hamlton (1983)
[4] Hamilton and Mork (1989)
[5] Lee, Ni and Ratti, 1995; Hooker, 1996
[6] Benjamin Hunt and Isard (2001)

money supply. Since the early 1980s most comprises have been following either a managed, or a freely flexible, exchange rate system - something that has led to a sharing of the shock between commodity prices and the exchange rate.

Several studies have examined the above issue for developed economies, but far less work of this sort exists for developing countries -- particularly ones experiencing high growth rates and high oil consumption. Two such studies in the Indian context have examined the macroeconomic impact of oil shocks[7]. The findings of the first reveal that a 10 per cent hike in the international price of oil would lead to a 2 per cent increase in overall domestic prices. The second finds that a 100 per cent rise in the price index of oil imports would lead to a 15 per cent increase in the rate of domestic inflation, and a 3 per cent fall in industrial production.

I.2 Objective of the Study

The current situation of high international prices have posed serious challenges in the Indian context because of their implications to basic needs of domestic heating and cooking, transportation and energy. Attempts to insulate the domestic economy from volatility in international markets can be sustained only for short periods of time. Extended periods of high prices in one market make such strategies to maintain lower prices elsewhere unviable. It is in this context that we provide an analysis of various implications of high prices of petroleum crude and products to the economy.

Our study attempts to assess the impact of high oil prices on certain selected macroeconomic parameters of the Indian economy. It is done in three parts. First we examine the implications of the international oil price rise for India's economy and compare the results with four other developing economies. They are China, Korea, Thailand and Brazil and, of these five, all excepting Brazil are net importers of crude. They therefore represent diverse developing economy situations, permitting a comparative analysis between oil importing and exporting countries. The analysis is carried out on the basis of quarterly data of the concerned variables, and on annual data wherever quarterly figures are unavailable.

In the second part of the study, we examine the Input-Output (I-O) linkages of the petroleum sector in the Indian economy. That helps us to understand the impact of a rise in price of crude on the prices of various major petro products.

[7] Sinha & Bhide (1997) and Bhattacharya.& Kar (2005)

Finally, using a short-term macroeconomic model for India, the third part examines the impact of the rise in the prices of crude and of petroleum products on India's macroeconomic parameters.

I.3. Conceptual Framework

An oil price increase can influence the economy through two important channels. First, international price hikes pass on to domestic oil prices, ratcheting up domestic price levels. In India's WPI, for instance, the weight of mineral oils (comprising POL prices mainly) is 7 per cent. Higher oil prices would raise firm's variable costs, especially for units that depend heavily on oil, or POL products. Hence firms would seek to raise their own product prices to protect profit margins.

Oil prices can also impact many other sectors besides manufacturing. Prices of products and services would also tend to rise due to higher transportation cost. Then the second-round effects of inflation kick in when workers try to compensate for losses in real income through wage bargaining. These second-round effects would be more likely to materialise if first-round effects on the overall price level are relatively large. Higher inflation also implies real income losses unless nominal wages rise with consumer prices.

But this is a vicious circle because firms seek to pass on higher labour costs to consumers when workers successfully bargain for higher wages to compensate for losses in real income. The worst case scenario would be a wage-price spiral resulting in accelerating inflation -- something that could cause the embedding of inflationary expectations in the economy's wage bargaining processes. A permanently higher rate of inflation, compared to the situation earlier, would result.

Secondly, higher oil prices would also impact balance of payments significantly. The most obvious impact would stem from the deterioration in the terms-of-trade. An oil price increase occasions a shift in terms-of-trade between net-importing and net-exporting economies favouring the latter. That essentially implies a transfer of real income from consuming to producing countries. Shrinking real incomes in countries facing larger oil bills would, in turn, leave less to spend on other products -- something that would shrink domestic demand, unless it is offset by lowered savings and/or higher exports. The evidence, meanwhile, suggests that oil-exporters have a lower propensity to consume out of current income than oil-importing economies. Higher oil prices generate a current account surplus for oil-exporters and a deficit for importers. The choice facing policy makers, therefore, is either

to control the impact of a rising current account deficit on the exchange rate via sales of foreign exchange reserves, or to keep domestic demand from falling through a monetised deficit -- or higher external borrowings. Large increases of the revenue-, and fiscal-deficit could endanger the economy's rate of growth because an increase of the former would most likely lower private investment, and, hence, overall growth.

Given the complex inter linkages between the petroleum sector and the overall economy, we assess the impact of the rise in the price of oil in the international market at three different levels. First we examine the impact of oil price rise on the macroeconomic output variables in the framework of Vector Autoregression (VAR). This approach captures the entire gamut of inter-relationship between the petroleum sector and the overall economy as reflected in the past data on such variables. We apply this framework to the experience of five developing economies, viz- India, China, Thailand, South Korea and Brazil. The results for different economies illustrate the differences and commonalties in the nature of interlinkages between the petroleum sector and the overall economy across the countries.

As the second stage, we examine the relationship between the petroleum sector and the economy at a more disaggregated level using the framework of input-output (I-O) analysis. This analysis is applied only to Indian case. Here, we examine the impact of an increase in the price of various petroleum products on the cost of production of various other products. We also examine the distribution of petroleum products across different user in the Indian economy based on the input-output linkages. This helps us understand the significance of petroleum sector to the other sectors of the economy.

At the third level, we assess the impact of the rise in the price of petroleum crude in the international markets on the Indian economy by capturing all the key interlinkages in an explicit macroeconomic model. The model captures the short-term impact and not the long-term impact such as the influence of various changes on the conservation of energy use or on new exploration of oil sources. But, it does capture the impact of alternative oil price management policies on government finances, consumption demand and investment demand.

The three levels of analysis, thus, capture the impact of increase in oil prices on the Indian economy. The analysis also provides a comparative picture across other selected economies.

II: Analysing the Impact of Oil Price Shock on Developing Economies

Our analysis is an abstraction from other influences on the economy and is an important pointer to the consequences of high oil prices. Developing countries need to be careful in taking appropriate policy decisions in the face of an oil price shock. The increase of price of international crude since 1998 has posed a challenge to price-management in these countries. Given that, it would be also important to see empirically how the oil price increase influenced their macro economic variables during the last decade. But we first examine the structure of domestic production, oil consumption, trends in international oil price and the major economic variables of different countries before undertaking an econometric analysis of the relationship between surges in oil price and macro variables.

II.1 Oil Imports and Structure of Oil Consumption and Production of Selected Developing Countries

Asia (excluding OPEC) accounts for roughly 80 per cent of all developing economy oil imports and is also the region with the highest oil import/GDP ratio. The main reason for that is the industrial deepening of East and South Asian countries. In 2003, the oil import/GDP share was 5 per cent, or more, in Singapore, Korea, Thailand, Taiwan and the Philippines; it was 4 per cent in Pakistan and Sri Lanka. India, which is relatively less advanced in industrialisation than most other countries of the region, has a ratio of 3.8 per cent.

India: India ranks amongst the top 10 oil-consuming countries. Oil accounts for about 30 per cent of its total energy consumption, daily total oil consumption is about 2.2 m bbl and it imports about 70 per cent of total oil consumption. It faces a large supply deficit, as domestic production lags domestic demand (India produces only 0.8 m bbl per day.) Its total reserves (about 5.4 bn bbl) are primarily in Mumbai High, Upper Assam, Cambay, Krishna-Godavari and Cauvery basins. Table II.1.1 shows the growth rate of oil production of different countries since 1970 and it shows India's growth rate to be extremely low - less than China's or Thailand's. Only during 1980-89 had the growth rate of oil production been appreciable, averaging an annual 12.8 per cent.

Table II.1.1: Growth Rate of Oil Production in Thousand Barrels per day*

Countries	1970-79**	1980-89***	1990-99	2000	2001	2002	2003	2004
Brazil	-0.18	14.2	6.5	11.9	5.4	12.1	3.7	-0.8
China	17.63	2.7	1.5	1.2	1.6	1.2	1.6	2.6
India	6.84	12.8	1.0	-1.0	0.0	2.7	0.0	2.4
Thailand	-	-	10.3	24.5	5.8	10.1	16.5	-2.0
TOTAL WORLD	4.3	-0.2	1.2	3.6	-0.2	-0.5	3.5	4.2
Of which OECD	2.4	1.3	1.2	2.0	-1.0	0.6	-1.2	-2.0
OPEC	4.4	-2.5	2.7	5.2	-2.3	-5.8	6.3	7.3
Non-OPEC £	3.6	2.3	2.0	1.8	-0.1	1.5	-0.5	0.1
Former Soviet Union	6.1	0.4	-4.6	6.1	8.1	10.1	10.1	8.7

Source: Original data from BP Statistical Review of World Energy June 2005

* Includes crude oil, shale oil, oil sands and NGLs (natural gas liquids - the liquid content of natural gas where this is recovered separately). Excludes liquid fuels from other sources such as coal derivatives.

** average of annual growth rate for the period 1970-79, 1980-89 and 1990-99.

*** For Thailand, the average has been calculated from 1982 to 1989

£ Excludes Former Soviet Union

India's consumption and production of oil have been regulated by administered pricing and via public sector oil companies. The oil PSUs are present in exploration, development, refining, marketing and in imports of crude and products. Only in recent years private sectors has been given a role in exploration and marketing. In this system subsidies are inevitable since the oil companies supply domestic markets at regulated prices which do not cover costs.

The pricing of crude, and products, used to be based on 'import parity' until the 1973 oil shock. Until then domestic producers were allowed to price their products in line with prices prevailing in international markets. But that ceased after the 1973 oil shock. Domestic producers were disallowed from charging prices equivalent to (increased) international prices thereafter. Hence was born the 'oil pool' price, one that pooled the costs of imported and indigenous crude. Accordingly, with petroleum prices being 'administered' until 2002, the gap between the international and domestic price of oil was quite substantial. The result of that had been to hike the deficit in the oil pool account; it reached Rs 130 bn on July 31, 2001.[8] And, apart from petrol and diesel products, nationalised oil majors have also been losing heavily on LPG and kerosene (Rs. 4, 992 crore). Total revenue losses, including petrol and diesel, were put at Rs 13,250 crore for fiscal 2004-05[9]

Although the government abolished the oil pool account in 2003-04, introduced petroleum subsidies and proposed customs duty reductions on crude from 10 per cent to 5 per

[8] Alexander's Oil and Gas connections – News and Trend in E and SE Asia, Vol.2, November 7, 2001

[9] .The Economic Times, October 15, 2004

cent[10] the oil companies are still losing profitability. The introduction of subsidies on various petro products in the annual budget may have been a welcome step in terms of compensating oil majors for the loss of profits, but Table II.1.3 shows, petro product subsidies have been experiencing a continuous decline since 2000-01.

Table II.1.2: Growth Rate of Oil Consumption (per cent change in thousand barrels per day*)

Countries	1970-79**	1980-89	1990-99	2000	2001	2002	2003	2004
Brazil	9.9	0.9	3.8	-1.3	2.2	-2.3	-3.7	2.5
China	16.9	2.2	7.0	12.9	0.9	6.9	7.7	15.4
India	4.9	6.3	6.3	5.6	1.3	3.9	1.9	5.6
South Korea	14.1	6.1	10.3	2.3	0.3	2.1	0.8	-0.9
Thailand	10.1	5.1	7.6	-1.3	-3.3	9.2	9.2	8.7
TOTAL WORLD	4.3	0.1	1.4	1.2	0.7	1.0	1.6	3.1
Of which European Union 25#	3.1	-1.3	1.0	-0.9	1.0	-0.7	0.6	0.7
OECD	3.4	-0.7	1.5	0.3	0.1	-0.1	1.3	1.0
Former Soviet Union	6.1	0.2	-7.8	-3.7	-0.7	0.3	3.0	4.8
Other EMEs	7.0	2.7	4.2	3.7	1.9	3.2	2.1	6.8

Source: Original data from BP Statistical Review of World Energy June 2005
***** Inland demand plus international aviation and marine bunkers and refinery fuel and loss.
****** average of annual growth rate for the period 1970-79, 1980-89 and 1990-99.
# Excludes Estonia, Latvia and Lithuania prior to 1985 and Slovenia prior to 1991

Table II.1.3: Subsidies on Major Petroleum Products (Rs. crore)

Kerosene (domestic use)	1993/94	1996/97	1999/00	2000/01	2001/02	2002/03	2003/04[a]	2004/05[a]
High-speed diesel	3773	6540	8151	7522	5310	3018	0	0
LPG (domestic use)	575	8090	5070	8845	-	-	2783	1465
Total subsidies on petroleum oil and lubricant products[b]	6596	18600	17714	23091	11140	6709	4801	2417
Total central government subsidies	12682	16125	24487	26838	31207	44618	44709	43517
Total subsidies	19278	26020	42201	49933	42347	51327	49510	45934
Petroleum, oil, and lubricants subsidy as a percentage of total subsidy	34.22	53.56	41.98	46.25	26.31	13.07	9.70	5.26

Source: Basic Statistics of Indian Petroleum and Natural Gas, New Delhi, Government of India.
[a] revised figures
[b] these do not form part of the government budget

It is reported that Indian Oil Corporation, Hindustan Petroleum, Bharat Petroleum and IBP together lost about Rs 14,700 crore in revenues on fuel sale this fiscal and their total revenue loss may touch a whopping Rs 40,000 crore by 2005-06-end. State-owned Indian Oil Corporation, the country's largest oil firm, is reportedly losing Rs 52 crore every day on the sale of petrol, diesel, cooking gas and kerosene at prices below the cost at which it procures

[10] Lahiri Committee recommendations

the products. That is because the government has not allowed higher prices in tune with international crude oil prices. (Talking to The Times of India in September 01, 2005, the Chairman of Indian Oil said that "the firm is selling petrol at a discount of Rs 7.45 a litre and diesel at Rs 5.15. Cooking gas was being sold at a loss of Rs 96 per cylinder and kerosene at Rs 12.85 a litre. The company's accumulated losses this fiscal have mounted to Rs 7,350 crore so far".)

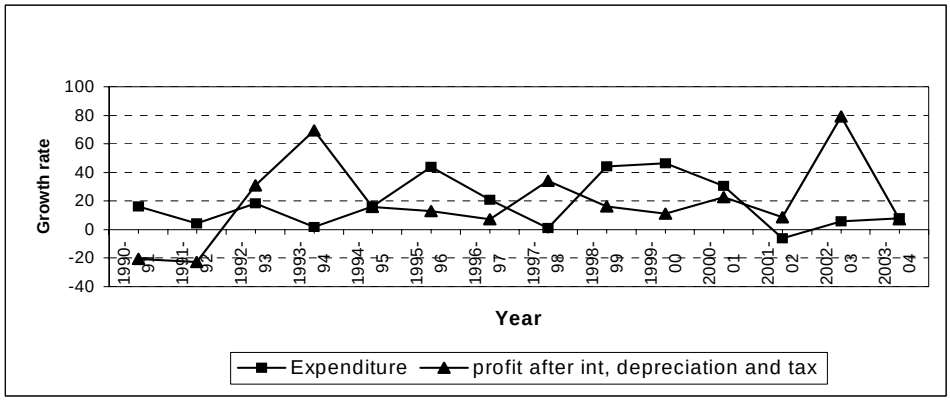
Table II.1.4 shows the annual average growth rate of some variables relating to the performance of the petroleum industry. While expenditure has gone up over the last couple of years, investment and income have declined. The growth rate of net profit touched a record low in 2003-04. The trend of all these items from 1990-91 to 2003-04 are depicted in Figures II.1.1 and II.1.2.

Table II.1.4: Annual Growth Rate (per cent) of Major Financial Indicators of Petroleum Industry

Items	1990-91 to 1994-95	1995-96 to 1999-00	2000-01	2001-02	2002-03	2003-04
Investment	-5.9	21.5	14.3	143.8	22.5	14.9
Income	11.5	28.8	29.2	-4.8	10.5	8.0
Expenditure	11.4	31.2	30.5	-6.1	5.8	8.0
Profit after interest and depreciation	-16.8	20.1	27.5	17.4	70.8	7.4
Profit after interest, depreciation and tax	14.5	16.3	22.5	8.4	79.2	7.0

Source: Ministry of Petroleum and Natural Gas, India, 2004-05.

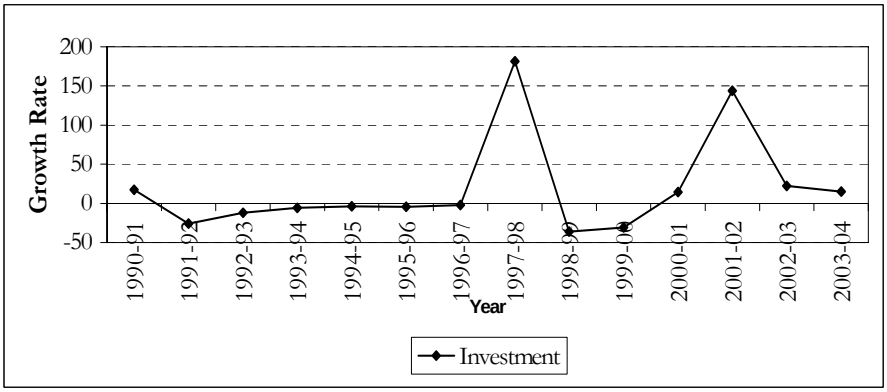
Figure II.1.1: Growth rate of Expenditure and Profits of Petroleum Industry (In per cent per year)



In the Annual report 2004-05, RBI warned that if the government does not increase domestic oil prices and domestic prices are not allowed to keep pace with the international price line, the fiscal burden of the government could increase and also hurt investors of public sector oil companies. Thereafter, given increasing pressures from various quarters to hike domestic

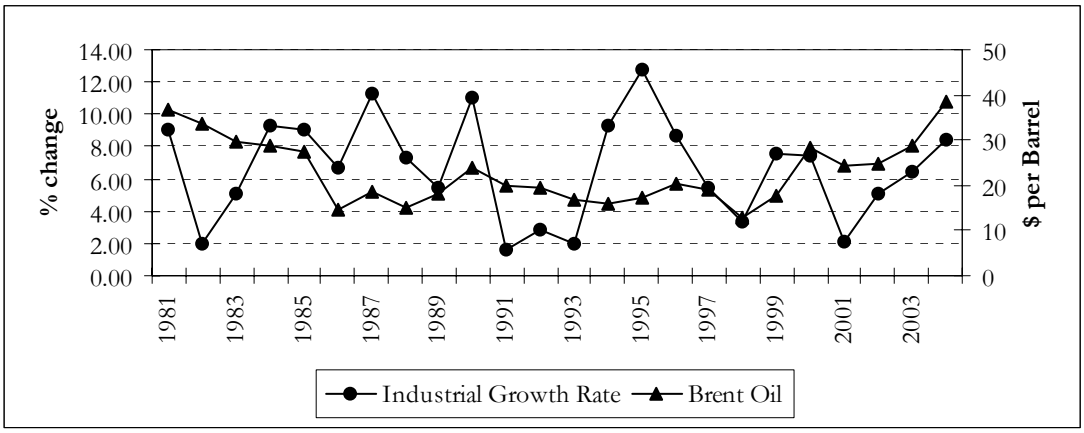
petro product prices, the government at last announced a Rs 3 per litre petrol price hike and a Rs 2 per litre hike for diesel in September 6, 2005.

Figure II.1.2: Growth rate of Investment of Petroleum Industry (In per cent per year)



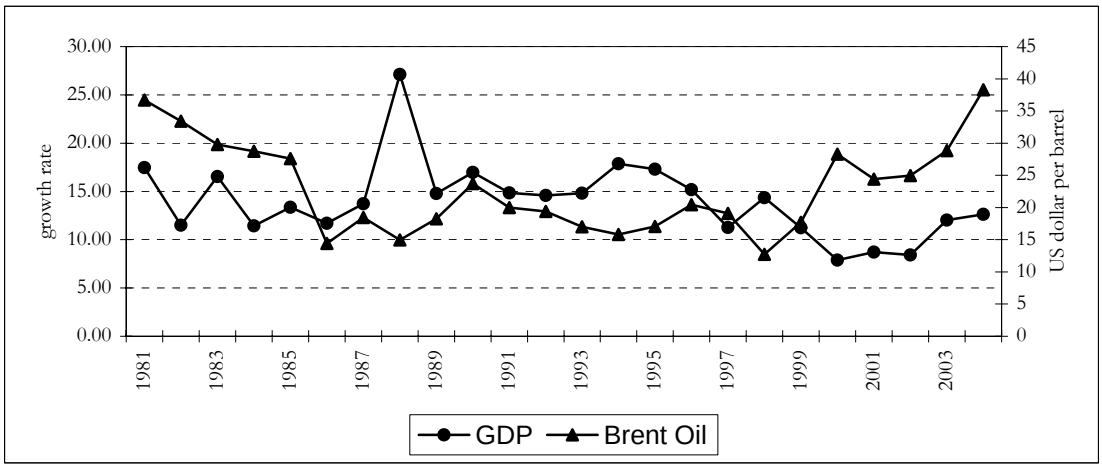
Still, the price of domestic petro products has been increasing very slowly relative to the international price. The pattern of Brent crude price in Figure II.1.3 shows spikes in 1990 and 1999, and these oil shocks impacted India's economic output very adversely (taking the IIP as a proxy for output).

Figure II.1.3: Brent Oil Price and Growth Rate of Industrial Production



Industrial production declined in 1991 and also in 1999. Besides these two years in the 1990s, it is interesting to observe that both series moved upwards in most years, especially since 2002.

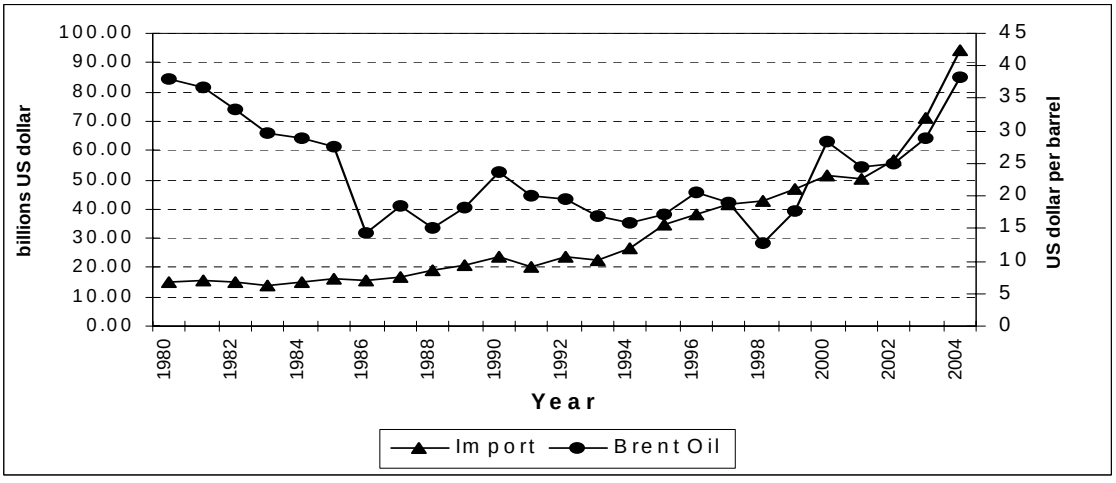
Figure II.1.4: Brent Oil Price and Growth Rate of GDP (current prices)



Similar to the industrial growth rate, the overall rate of economic growth (measured in terms of the GDP growth rate) also declined in the early 1990s due to the oil price shock (Figure II.1.4). The rate of GDP growth also fell in 1999. But it still seems that, in the short-run, an international oil price shock only has a limited impact on the India's economic growth. Still, the growing revenue deficit that is fuelled by oil subsidies could be a potential danger to long-run growth.

As for the external sector, imports have increased steadily since 1980; but at the beginning of the twentieth first century imports increased at a higher rate -- due, in part, to a rise in the value of oil imports (Figure II.1.5).

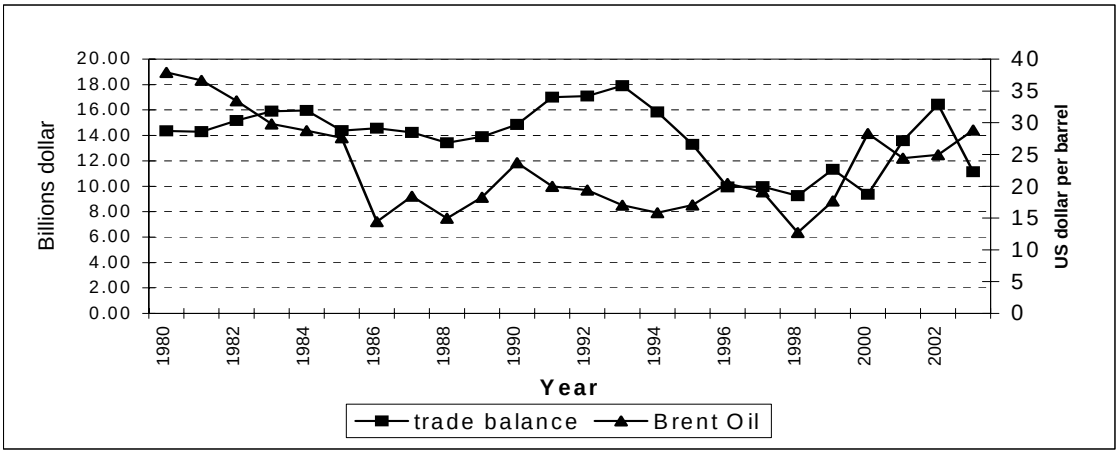
Figure II.1.5: Brent Oil Price and Value of Merchandise Imports



Most importantly, the movement of import value exactly matches the increase of oil prices since 2002. However, the pattern of trade balance (Figure II.1.6) does not follow a trend seen

in the case of imports. The reason for that is, the value of India' exports also went up in most years during the 1990s. Although India's overall trade balance experienced a rising deficit in all the years due to its imports exceeding exports, the deterioration is not uniform.

Figure II.1.6: Brent Oil Price and Trade Balance



Note: values of trade balance in the above figure could be read as deficit

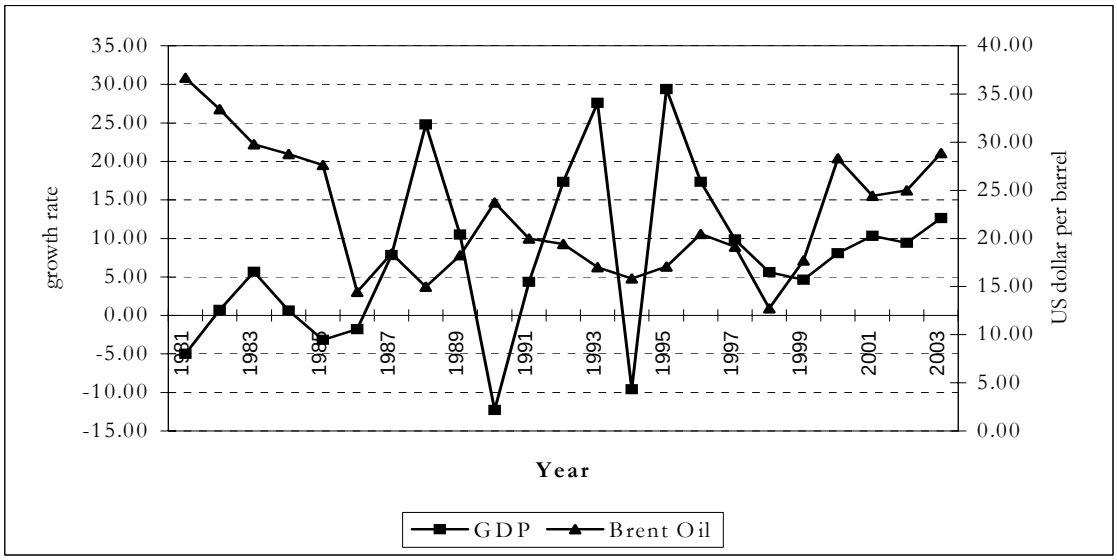
China: China is the world's second-largest oil consumer after the United States, having surpassed Japan for the first time in 2003. It has a total demand of 6.5 m barrels per day (bbl/d). China's oil demand is projected by EIA to reach 14.2 million bbl/d by 2025, with net imports of 10.9 million bbl/d. The oil import has witnessed a continuous expansion and the import of oil products has become the biggest foreign exchange user in China.

As shown in Table II.1.1, China's average growth rate of oil production during 1970-79 was much higher than other countries and more than the world average. Since the early 1980s, oil production in China has declined significantly from 2.7 per cent during 1980-89 to 1.2 per cent in 2002. During the last two years, however the growth rate of oil production has gone up but at a very mild pace from 1.2 per cent in 2002 to 1.6 per cent in 2003 and to 2.6 per cent in 2004. In contrast to oil production, China's oil consumption has gone up at a faster rate fuelled by the growing economy.

The growth rate of China's oil consumption went up from a mere 0.9 per cent in 2001 to 7.7 per cent in 2003 and further to 15.4 per cent in 2004, higher than any other country in the South and East Asian region (Table II.1.2). Transportation is a major driver pushing China's oil demand. Vehicle usage in China currently stands at 40 million, but is expected to rise to 140 million by 2020.

Despite higher oil demand, the Chinese economy has not shown signs of slowing down on account of the increase in the international oil prices. Figure II.1.7 illustrates the trends in Brent oil price and the growth rate of GDP for China. In 1988, we observe some upward spike in economic growth rate coinciding with the lower international oil prices. After that, both have been moving in the same direction. It suggests that the Chinese economy is resilient enough to absorb the oil shock due to its strong economic growth and spectacular performance in attracting capital and pushing exports.

Figure II.1.7: Brent Oil Price and China's GDP Growth (current prices)



The Chinese imports have gone up significantly since 1998 partly due to the increase in the international oil prices (Figure II.1.8). In the case of trade balance, the 1998-99 oil price shock seems to have some impact on trade balance as the trade surplus declined (Figure II.1.9). There was another factor, which contributed to lower trade surplus and that is the East Asian financial crisis. But after 2000, the trade surplus of China has gone up despite higher international oil prices.

Figure II.1.8: Brent Oil Prices and Value of China's Merchandise Imports

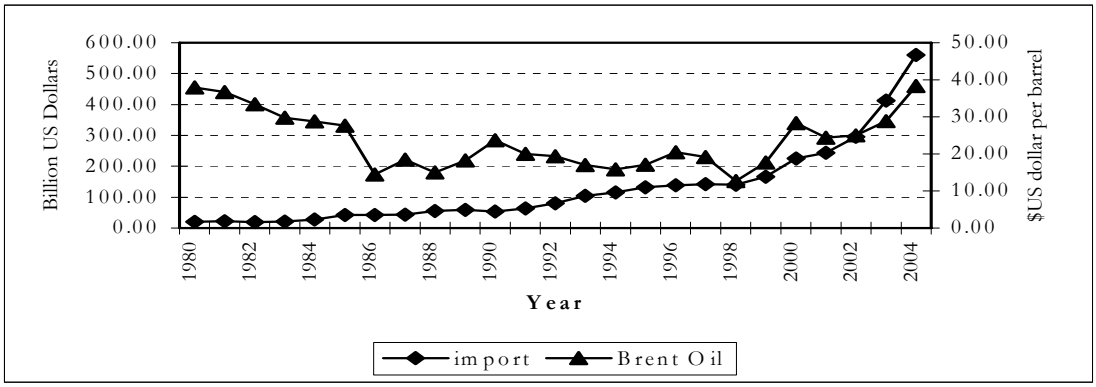
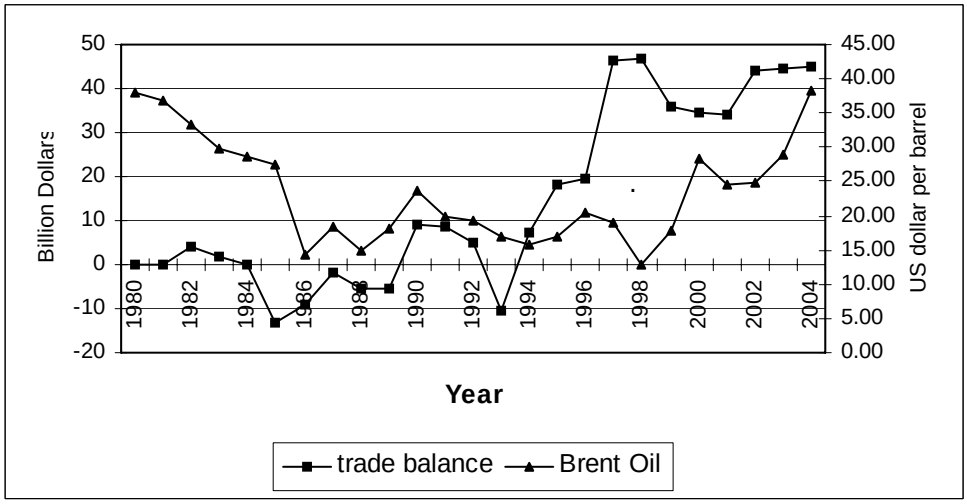


Figure II.1.9: Brent Oil Price and China's Trade Balance

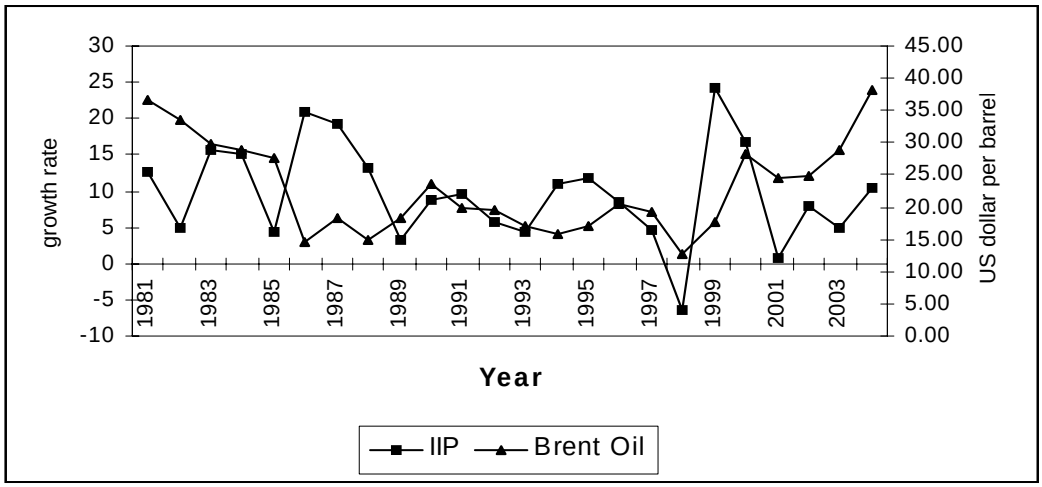


South Korea: With no domestic oil reserves, South Korea imports all its crude oil to meet domestic demand. Oil makes up the largest share of South Korea's total energy consumption, though its share has been gradually declining. Petroleum accounted for 54 per cent of South Korea's primary energy consumption in 2002. In 2004, the country consumed around 2.14 m bbl/d, down from a high of nearly 2.3 m bbl/d in 1997, all of it imported. Demand has fluctuated very little since 2000. South Korea is the seventh largest oil consumer and fifth largest net oil importer in the world. Most of South Korea's oil imports come from the Persian Gulf region, with Saudi Arabia supplying about a third in 2004. The growth rate of oil consumption of South Korea increased from 6.1 per cent in 1980-89 to 10.3 per cent in 1990-99. However, it has declined significantly in the last couple of years.

Figure II.1.10 illustrates the trend of Brent oil price and growth rate of industrial production from 1981 to 2004. The growth rate of industrial production declined in 1998 largely due to the financial crisis that gripped South Korea and its neighbouring countries.

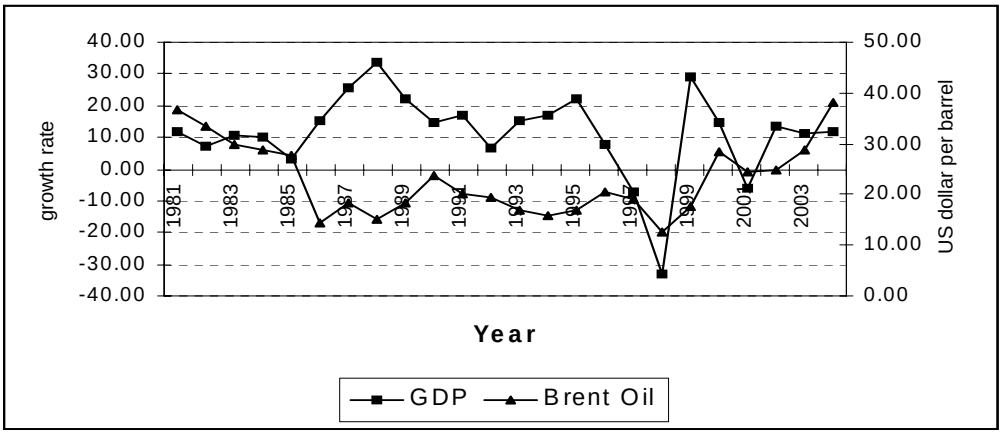
However, a second spike visible in 2000-01 appears to be due to higher international oil prices.

Figure II.1.10: Brent Oil Price and Growth Rate of Korea's Industrial Production



As in the case of industrial growth rate, the overall growth rate depicted in Figure II.1.11 also declined quite substantially in 1998 and 2001.

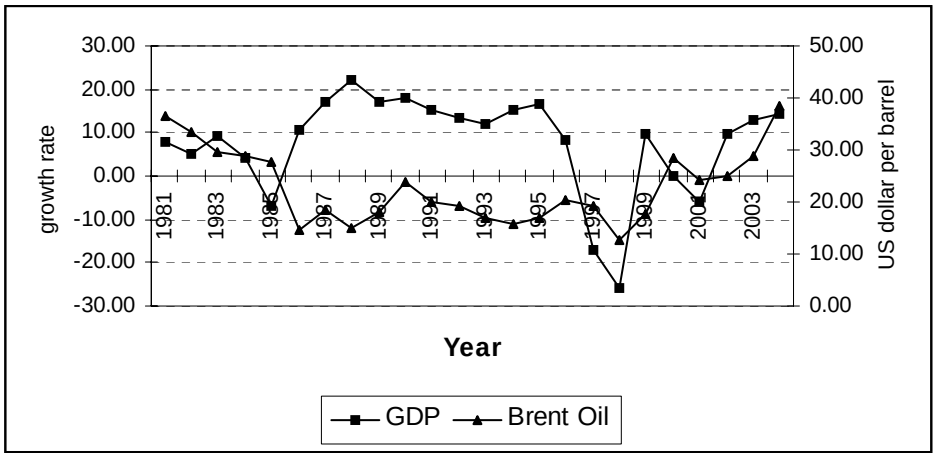
Figure II.1.11: Brent Oil Price and Growth Rate of Korea's GDP (current prices)



Thailand: Thailand is a significant net oil importer. Its energy consumption is growing rapidly as a result of strong economic growth. Thailand also has an estimated 583 million barrels of proven oil reserves. In 2003, Thailand produced 259,000 barrels per day (bbl/d) of oil, an increase of about 49,000 bbl/d over the previous year. But only about 96,000 bbl/d of that was crude oil. Oil consumption in 2003 was 851,000 bbl/d, up from 843,000 bbl/d in 2002. Demand growth in Thailand has slowed somewhat since 2002, largely as a result of increasing substitution of natural gas in electricity generation and the increased use of ethanol in motor fuels.

With regard to the impact of oil prices on economic growth, Figure II.1.12 reveals that Thailand's GDP growth rate declined in 1998 and 2001. As mentioned in the case of Korea, all East Asian countries had a negative economic growth rate in 1998 due to a major financial crisis that hit these countries. The declining growth rate in 2001 was due partly to global recession, insecurity following the terrorist attack on America and a surge in global oil prices.

Figure II.1.12: Brent Oil Price and Growth Rate of Thailand's GDP (current prices)



Brazil: is the third-largest oil producer in Latin America and possesses the second largest oil reserves in the region. Brazil's oil imports have dropped substantially since the 1970s due to intensified oil exploration, the development of the offshore Campos basin north of Rio de Janeiro, and falling domestic consumption. Total oil production (including crude, natural gas liquids, ethanol and refinery gain) has been rising steadily since the early 1990s, with an average of 1.88 Million Barrels per day (MMBD) in 2003. The offshore Campos Basin, north of Rio de Janeiro, is the country's most prolific oil producing area and has underpinned Brazil's recent increases in crude oil output. Oil consumption in Brazil also increased in the 1990s as compared to 1980s. But it declined significantly from 3.8 in 1990-99 to -2.3 per cent in 2002 and -3.7 per cent in 2003 before hovering around 2.5 per cent in 2004. But except in 2002, the growth rate of oil production shows a negative trend from the year 2000. So, although it is a major oil producer and exporter, Brazil still needs to import crude to meet domestic demand. These imports are mostly of lighter crudes; domestic refiners mix them with Brazil's predominantly heavy crude.

In 2003, according to Petrobras, 63.7 per cent of Brazil's oil imports came from Africa, 30.9 per cent from the Middle East, 3.1 per cent from South America, 1.4 per cent

from Europe and 0.9 per cent Oceania. Brazil exports petroleum products, as well as heavier crude oil which the country's domestic refineries are unable to refine. China, for example, imports Brazilian heavy crude on a spot sale basis. In respect to impact of oil prices on exports and imports, Figure II.1.13 shows that the value of Brazil's exports has gone up since 2002 due to higher oil prices. As Brazil is a net exporter of oil, it gains in export value as international oil prices go up. In contrast to other countries discussed above, the value of imports in fact lags behind that of exports for Brazil. An increase in the value of exports compared to that of imports has helped Brazil to achieve a surplus in her trade balance. Figure II.1.14 shows that its trade surplus has continued to increase since 2001.

Figure II.1.13: Brazil's Exports, Imports and WTI Oil Price

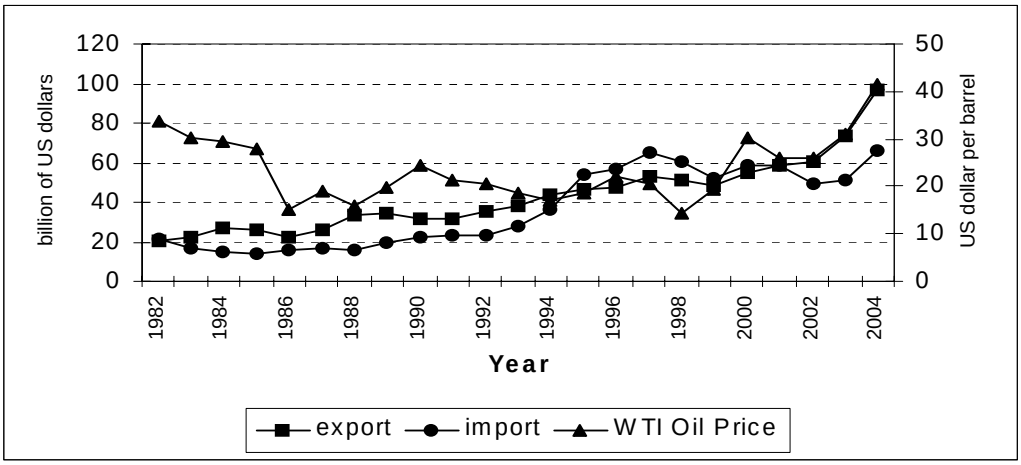
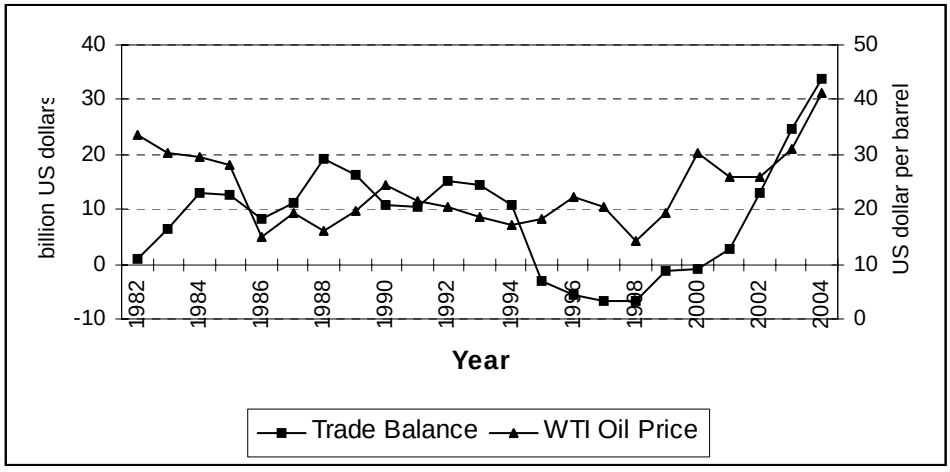


Figure II.1.14: Brent Oil Price and Brazil's Trade Balance



The above analysis reflects that except Brazil all the other four countries are heavily dependent on international oil imports because of their higher domestic consumption relative to domestic production. Hence, these countries are highly vulnerable to surges in the international price of oil. They, for instance, experienced negative economic growth in 1999 due, in part, to higher international oil prices.

Given this background, in the following section, we present our empirical findings on the impact of international oil price shock on various macro variables of the selected countries.

II.2 Linkages between International Oil Price Shocks and Macroeconomic Variables

There are diverse linkages between the international price of oil and the overall economic conditions of the five economies under review. These links arise from the central role of oil (and oil products) within the production structures of an economy. And, barring Brazil, they all import oil, or oil products, as inputs at some stage. Oil products also provide energy for cooking, heating or lighting, meaning that they also enter consumption. Finally, exogenous changes in the price of international oil may trigger changes in domestic economic policy, making oil a crucial element in the policy process too. In sum, oil price changes affect several domestic economic variables, occasion 'economy-wide' effects and are a politically sensitive issue.

Our attempt is to quantify just how deep, and immediate, is the fallout of the linkages between the economic performance of oil importing countries and changes in the price of oil. These widely disseminated effects are captured two different approaches to assess the magnitude of the link between certain, select, macroeconomic variables and the price of international oil.

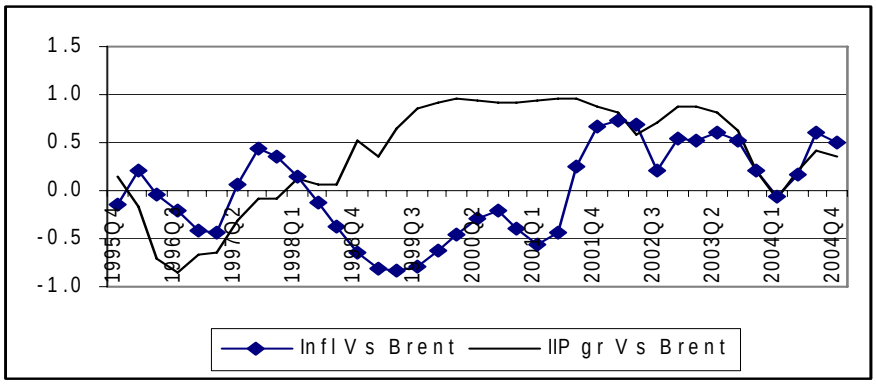
One of the two approaches adopted here in that of Vector Autoregressive (VAR) and the other in based on a macroeconomic model. VAR allows us to sequester the effects of changes in the price of oil on a selected set of macro variables. VAR is useful since it does not need the investigator to assume any a priori structure about the economy. Instead, it allows inferences to be drawn about the dynamic econometric structure of the economy

The VAR equations estimated here use the international price of oil, along with one of the macro output variables, plus others with plausible links to both. The VAR is estimated after carrying out the standard statistical tests needed for the analysis. (The basic framework of the VAR method used in this paper is outlined in Appendix II.1.)

We briefly note here some strengths and vulnerability of the five economies with respect to oil price hikes. India, for instance, differs from the other four in that changes in the international price of oil are not immediately passed on to the domestic economy. That is because the prices of a large proportion of petroleum products are either directly, or indirectly 'administered' -- occasioning sticky short-term price adjustments, even if prices are allowed to rise towards international benchmarks over the longer term. The other four selected economies allow domestic energy prices to either adjust faster, or immediately. (We were able to use VAR for all but Brazil due to data inadequacy in the case of Brazil).

We note that the interlinkages are so diverse and intertwined that we observe only the final outcome of a combination of factors. Figure II.2.1 illustrates this point. It shows that there has been a recent, positive, correlation between the (year-on-year) growth rate of Brent crude prices and WPI-based inflation in India. But it has not been so across all years. Secondly, the correlation between changes in the price of Brent crude and the growth rate of industrial production in India has been positive, not negative, during much of the 1996-2004 period.

Figure II.2.1: Correlation between Changes in Crude Oil Price and Inflation Rate and Industrial Output in India



We can therefore say, based on the period Q3:2001 onwards, that higher crude prices had been accompanied by higher domestic inflation -- but also higher growth rates of industrial production. This association turned negative in Q1: 2004, but the overall lesson has been that higher crude prices need not decelerate growth unless there are some additional factors too. We have, for instance, already reviewed some earlier studies which point to the importance of factors like monetary policy in influencing the impact of oil prices on the economy. The speed of the oil price increase, and the length of time for which they stay up, would also be important.

Plainly, therefore, the reaction of economic variables to changes in the price of international crude depends on the expectations and policy-experience of economic agents, their ability to restructure for greater competitiveness, and even their long-term assessment of official economic policy. The government may, for instance, seek to reassure business by reining in inflation and block either all, or much of the pass-through of higher crude prices. But that fact that this cannot but raise the budgetary deficit will also give pause to rational economic agents! They know the futility of arresting fuel price rises in the short term, only to have above-trend deficit induced inflationary spillovers over the longer term.

That leads us to a discussion of the estimated linkages between changes in the price of crude and economic performance in India, China, Korea, Thailand and Brazil. The central theme is the nature of the empirical relationship between international crude prices and these economies' key macroeconomic variables. The impact of international oil price changes is quantified thereafter, using these equations in the simulations presented in the subsequent section. The estimated VAR equations for India, China, Korea, Thailand, and Brazil's OLS results, are in Appendix II.2.

(i) India

We first examine the impact on industrial production of the price of international crude. Apart from the price of Brent crude, we have added two other important macro variables -- real money supply and imports -- to the VAR's set of variables. (All these variables, including industrial production, have been modeled as being endogenous in the VAR model.)

The results of the simulation show that industrial production is negatively associated with the price of Brent crude and real money supply; but its association with imports is positive (Appendix II.2.1). In short, a rise in the price of Brent crude occasions a 0.045 per cent fall in industrial production in the next quarter. But imports and real money supply have a relatively greater impact on industrial production. As for imports, a price rise in Brent crude increases the value of imports significantly (by 0.247 per cent) in the quarter that follows.

Manufacturing production is negatively affected by increases in the price of international crude -- something that is in accordance with the effect of oil price increases on overall industrial production. Thus, a 1 per cent increase in the price of oil in the previous quarter occasions a 0.012 per cent drop in manufacturing production in the current quarter (Appendix II.2.2). And numbers relating to the price level (see Appendix II.3.3) show that increase in price of international crude has a lagged positive impact on domestic prices.

Accordingly, it is just as we had noted in the previous section: India's petroleum sector prices are 'administered', and may not immediately increase following international oil price shocks. But the general price level does go up in subsequent periods, due either to domestic petro-price increases or thanks to other effects like a rise in the government's budgetary deficit. The irony of that of course is that the government's budgetary incontinence results precisely from its efforts to insulate the domestic economy from international price shocks!

Also, part from a negative, lagged, impact on domestic output, increases in international prices also affect the external sector -- the value of imports and the trade balance of oil importing countries in particular. Results flowing from the export equation in Appendix II.3.4 also show that increases in the price of oil have a positive association with exports. But as the coefficient of Brent crude is not statistically significant, the association between oil prices and exports is weak. In short, oil price increase may not impact exports significantly -- but imports present a contrast. An increase in the international price of crude has a significant impact on imports (Appendix II.3.5). That shows India’s outgo on imports is highly sensitive to international prices of oil; that owes to its large volume of oil imports.

The impact of oil price changes on the balance of trade is also obvious from the previous discussion which says that even though exports are relatively unaffected by oil prices, imports are positively related to them. The results of the "Trade Balance Equation" (Appendix II.3.6) further corroborate these findings. Thus the price of Brent crude is an important factor contributing to India's higher trade deficit.

(ii) Other countries

China, the world's leading growth engine, is second ranked in terms of oil consumption per day, and yet remains relatively less vulnerable to oil price shocks. The VAR results of the industrial output equation in Appendix II.3.7 suggest that the Chinese coefficient of international oil price (lagged by one period) is positive (0.104). That says an increase in the price of oil results in a rise in industrial production. That could be because China's economy is more resilient to oil shocks due to the export-orientation of its economy. That could be outweighing the negative impact of oil shocks. Further, it may also be that China's economic growth is impervious to oil shocks thanks to the higher productivity growth of Chinese manufacturing industries.[11]

The growth of China's exports growth were also unaffected by a rise in oil prices. The regression results in Appendix II.3.8 demonstrate that. And it may be that Chinese producers may have been helped by their (bigger) scales of production, productivity improvements, and the targeting of exports to demand driven destinations -- which may have helped producers to absorb the additional costs that were generated through higher oil prices. As for imports, China's might be expected to rise owing to increases in the international price of oil. But, even there, our results in Appendix II.3.9 do not provide enough evidence of any very strong links between the price of oil and the value of imports. This relative imperviousness to the price of international crude may partly be due to an increase in China's domestic oil production. Recently the economy has been exploring its own hydrocarbon reserves to raise domestic oil production. Meanwhile, the relative insensitivity to oil prices of China's exports and imports has meant that its trade balance is unaffected by oil prices too. Indeed, Appendix II.3.10 shows that the coefficient of Brent oil is positive (1.013). That seems to imply that higher oil prices may actually have led China to further raise the quantum of its trade surplus. Overall then, we find that that China's economy is resilient enough to absorb oil price shocks despite its high dependency on oil imports.

[11] Swaminathan S. A. Aiyar, Times of India, September 18, 2005

Korea too resembles China in that it too has been maintaining higher than average economic and export growth over the last two decades. It has been doing so even though it does not produce any oil and depends entirely on imports. It may thus be importing oil to meet domestic demand, but Korea has also quite successfully absorbed international oil price shocks. It too does not experience any reduction in current quarter domestic output despite increases in the price of oil which may have taken place in the preceding quarter. That is plain from the output results which are available in Appendix II.3.11. What becomes obvious too is that most East Asian countries have hiked their rates of economic growth by concentrating on export promotion. Our results show, too, that increases in the price of Brent crude hardly impact Korea's exports, or its output (Appendix II.3.13). About the only embarrassment it suffers is an erosion in its trade surplus. That happens because international oil price increases affect Korea's imports -- which are up by roughly 0.13 per cent for every 1 per cent increase in the price of oil (Appendix II.3.14). That finds an echo in Korea's trade balance too: every 1 per cent increase in the price of oil reduces Korea's trade surplus by 0.621 per cent (Appendix II.3.15).

Thailand, in turn, produces a quantity of oil that meets a part of its total demand for oil. Even then it is a net importer of oil and, like most other oil importing East Asian economies, has experienced spectacular growth over the last couple of decades. It is thus because, despite being a net importer of oil, Thailand has single-mindedly implemented export promotion policies right from the start. In other words, high export growth could be one of the important reasons why the Thai economy remains steady in the face of high oil prices. About the only black mark is that the relationship between Thai domestic output and the price of international oil show that energy prices are negatively associated with economic growth. The linkage is such that a 1 per cent rise in the price of international oil lowers Thailand's GDP by 0.049 per cent (Appendix II.3.16).

But Thailand also exports some oil, which may account for why its exports are linked positively to increases in the price of crude. In Appendix II.3.18 we find that the coefficient of oil price in the export equation is statistically significant and positive (0.128. And exports, like imports, have a positive association with oil prices too (Appendix II.3.19). As a result, the combined effect of the impact of the price of oil on exports and imports is that Thailand's trade surplus declines following a rise in the price of international oil. But our results suggest that Thailand's overall economic performance has remained relatively unaffected by price surges in internationally traded oil.

In terms of oil production, Brazil is quite unlike any other country in our sample. It is one of the leading oil producers in the Latin American region, meaning that increases in the price of internationally traded crude have a positive influence on its economic growth. Also, oil export is a major contributor Brazil's GDP. So, even though we do not have enough observations to use VAR, our analysis of the relationship of oil price with other macro variables (using OLS) shows that there is a significant, and positive, impact on domestic output of the price of oil (Appendix II.3.21). Moreover, exports are one of the critical determinants of output and the result show that it is statistically significant. As for domestic prices, the results of Appendix II.3.22 show that the impact of the price of international oil on the Brazilian economy is insignificant. That clearly arises from the fact that Brazil imports no oil, and is a net exporter instead. Indeed, its imports are unaffected by oil prices due to the dominance of non-oil commodities in the import basket. As for exports, the coefficient of oil price is highly significant at the 1 per cent level (Appendix II.3.23), which clearly implies that higher oil prices benefited Brazil. And, given that its exports are highly influenced by oil prices, Brazil's trade balance too is influenced by surges in the price of oil (Appendix II.3.25).

II.3. A Simulation Analysis

The aim of the exercise is to see how higher global oil prices affect domestic economic variables. It is done, firstly, by 'within sample' simulation of the scenario that might have materialised had there been no oil price hike in 1999; secondly, by carrying out the 'out of sample' simulations we estimate the likely effects of a rise in international oil prices, starting 2005-06. The idea is to see how the economy's growth momentum could modify the impact of a rise in the global price of oil.

We employ statistical relationships estimated in Section II.2. A simplistic assumption made by us is that international oil price changes affect domestic economic indicators, but changes in the latter do not influence global oil prices.

II.3.1. Model Evaluation

Tables II.3.1 and II.3.2 depict historical annual averages, plus baseline scenarios thrown up in simulations for the seven key, macro variables. The simulations span the interval Q1:1994 to Q4:2004, and there is evidently a very close fit between the actual data and the (simulated) baseline figures. Just how close the correspondence is may be seen from Figures II.3.1 to II.3.5. That is also a vindication of the specified model.

Table II.3.1: Actual and Base Line Simulation Values of Output (Annual averages from 1994Q1 to 2004Q4)

	Gross domestic product		Industrial production		Manufacturing production	
	Actual	Baseline	Actual	Baseline	Actual	Baseline
India	-	-	94.98	95.07	159.35	159.20
China	-	-	15.64	15.46	-	-
Korea	122.45	122.52	-	-	-	-
Thailand	35.39	35.44	-	-	-	-

Note: industrial production and manufacturing production are indices with base 2001-02=100 and gross domestic product in billion of US dollars

Table II.3.2: Actual and Base Line Simulation Values of Price, Imports and Trade Balance (Annual averages from 1994Q1 to 2004Q4)

	Price		Imports		Exports		Trade balance	
	Actual	Baseline	Actual	Baseline	Actual	Baseline	Actual	Baseline
India	96.57	97.74	13.07	13.07	10.70	10.72	-2.36	-2.35
China	-	-	60.74	60.56	68.006	68.014	7.26	7.41
Korea	93.30	93.34	36.42	36.50	38.54	38.19	2.12	1.69
Thailand	97.69	97.68	16.23	16.24	16.07	16.14	-0.16	-0.10

Note: Except price index, all other variables (imports, exports and trade balance) are in billion of US dollars

Figure II.3.1: Baseline and Historical Values of India's IIP from 1994Q1 to 2004Q4

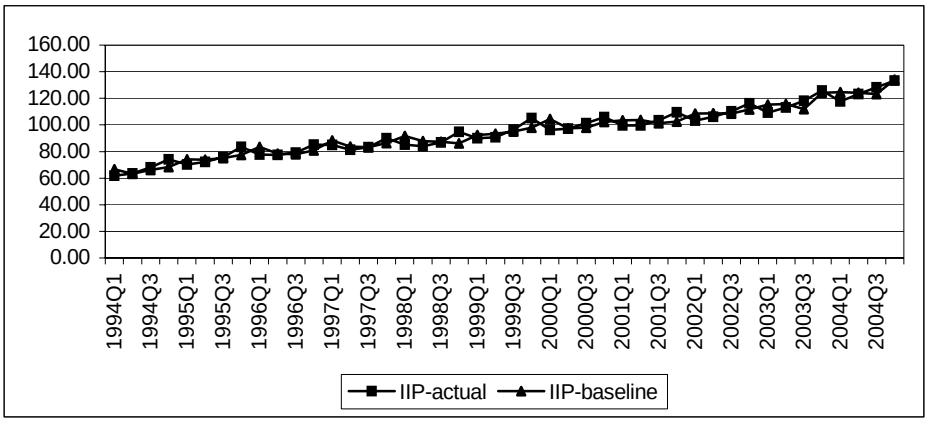


Figure II.3.2: Baseline and Historical Values of India's WPI from 1994Q1 to 2004Q4

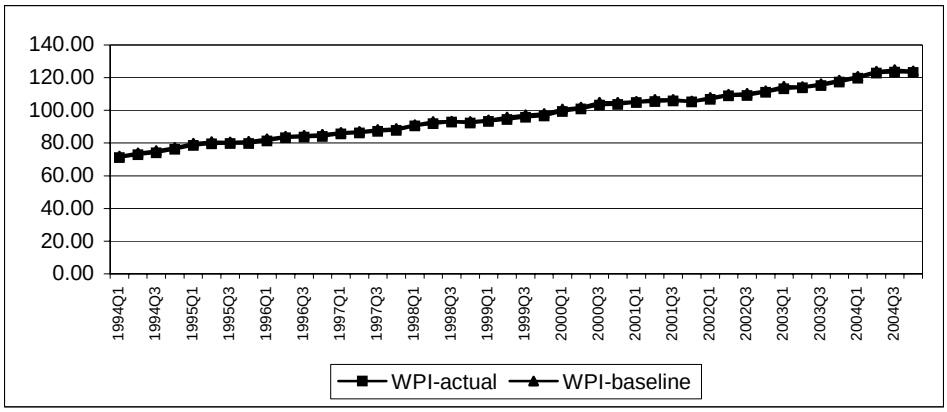


Figure II.3.3: Baseline and Historical Values of China's IIP from 1994Q1 to 2004Q4

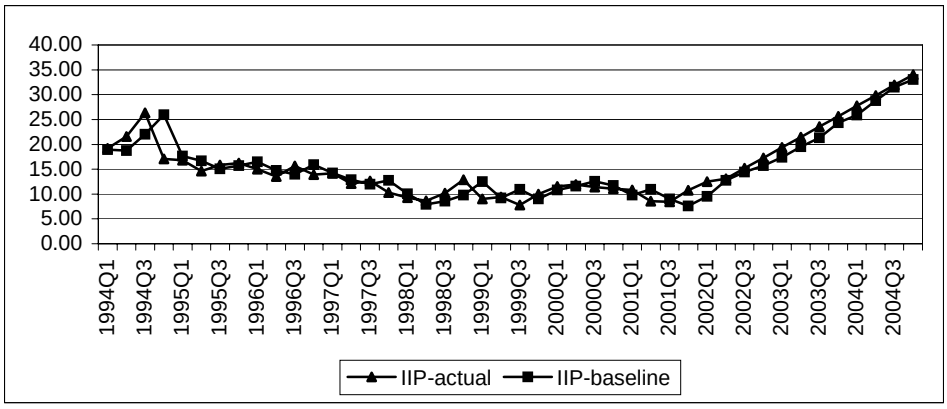


Figure II.3.4: Baseline and Historical Values of Korea's GDP (in billions of US dollars) from 1994Q1 to 2004Q4

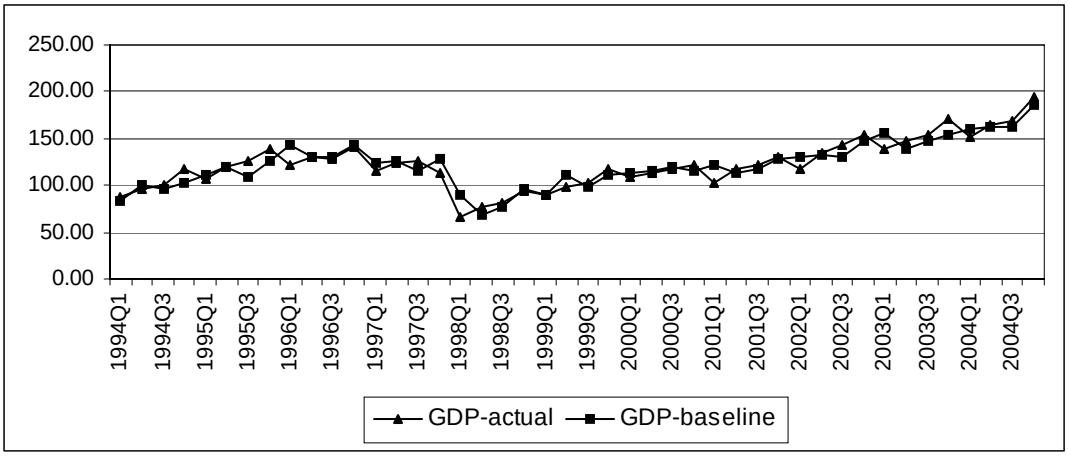
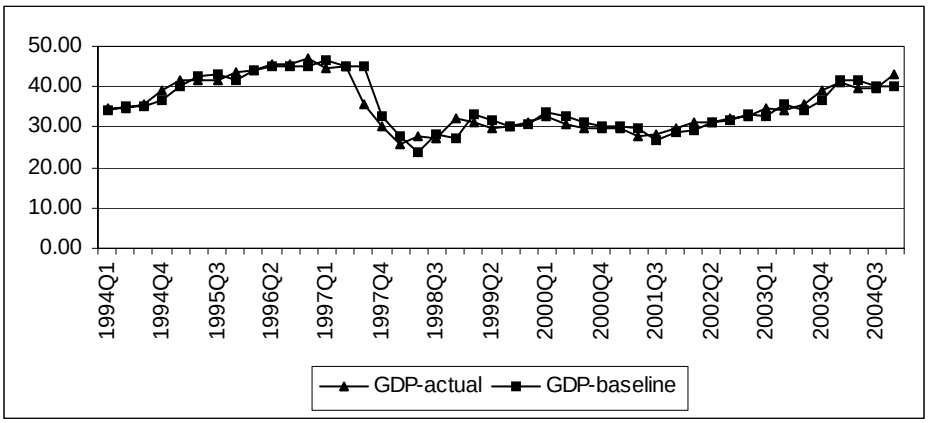


Figure II.3.5: Baseline and Historical Values of Thailand's GDP (billions of US dollars) from 1994Q1 to 2004Q4



II.3.2. Impact of the Oil Price Shock-India (within Sample Analysis)

We use the validated model to capture the impact of crude prices on the specified macro variables -- first in India and then in the other sample economies.

In India's case, the short-term effect of a $10/ bbl decrease in Brent crude in 1999 (over 1998) is to raise industrial and manufacturing production in 1999 by 1.08 per cent and 0.64 per cent respectively. But decrease in the price of crude generate a much higher positive impact on the long-run values of industrial and manufacturing output. Therefore, it can be inferred that the $10/ bbl rise in the price of international crude lowers growth rates of industrial and manufacturing production. Similarly, the impact of the higher price of imported crude would be felt more in the long-run than in the immediate after math of the price rise.

The impact on domestic inflation of the drop in the price of international crude-yields follow similar reasoning as above. They decline marginally by 0.32 per cent in 1999 despite the drop in the international price of crude by $10 per bbl in the short term, but they decline further over a longer period (Q1:1999-Q4:2004).

The increase (decrease) in crude prices also impact India's external sector adversely (favourably). The value of imports rises by 0.959 per cent in the same year (short-run impact), and then by an average of 1.706 per cent over the Q1:1999 to Q4:2001 interval. Exports, on the other hand, declined in value by 0.379 per cent in the short-run and 0.525 per cent over the longer term. India's trade balance also worsened owing to this rise in imports and decline in exports. Our simulations show a 1.338 per cent deterioration in the trade balance in the short- run and 2.231 per cent in the long-run.

Table II.3.3: Within Sample Simulation for Major Macro Variables of India & China*: Impact of an Increase in the Price of Oil

Variables	India		China	
(Percentage change)	**Short run‡**	**Long run**	**Short run**	**Long run**
Industrial production	1.080	1.780	0.451	0.652
Manufacturing production	0.638	0.989	-	-
Overall Price Level	0.318	-0.109	-	-
Imports ($ value)	-0.959	-1.706	-1.518	-0.528
Exports ($ value)	0.379	0.525	0.455	0.147
Trade Balance$^{\perp}$ ($ value)	1.338	2.231	1.973	0.675

Note: Units of variables are defined in Table 4

A positive value implies simulated value is higher than the baseline value and *vice-versa* for a negative value.

* In case of within sample simulation, Brent oil price in 1999 has been reduced by $10, maintained at 1998 level. Percentage of variables has been derived from between simulated value and base line value

‡ Short run and long run are defined as one year (1999Q1 to 1999Q4) and three years (1999Q1 to 2001Q4) respectively

$^{\perp}$Trade balance has been calculated as the difference between simulated exports and imports values

Out-of-sample analysis: Next we project the likely outcomes of a $10/ bbl rise in the international price of crude in 2005. And there too we find domestic output and prices responding to the price rise with a lag. Table II.3.4 depicts the lagged nature of the impact of the increase in the price of crude on output and price levels. So, whereas projected manufacturing output falls by 0.147 per cent in the short run, there is a 0.621 per cent decline in the long run. Likewise, manufacturing output also falls by only 0.007 per cent in 2005 (the shock year) but plummets by 0.838 per cent in the long run.

The balance of trade suffers too: the 2005 price hike in crude leads to higher imports in the short-run (0.641 per cent), and even more in the long-run (1.24 per cent). The value of exports too declines by 0.580 per cent in the short-run. The result is a decline in the trade balance -- by 1.22 per cent in the short-run, and 0.60 per cent in the long-run.

The only (relatively) dampened reaction is that of the domestic price level; official controls on the price of oil restrict its rise to no more than 0.059 per cent in the long-run.

Table II. 3.4: Out of Sample Simulation for Major Macro Variables of India and China* : Impact of an Increase in the Price of Oil

Variables	India		China	
(Percentage change)	Short run‡	Long run	Short run	Long run
Industrial production	-0.147	-0.621	-0.045	-0.217
Manufacturing production	-0.007	-0.838	-	
Price	-0.246	0.059	-	
Imports	0.641	1.242	0.372	0.295
Exports	-0.580	0.640	-0.939	-0.136
Trade Balance⊥	-1.221	-0.602	-1.311	-0.431

Note: Units of variables are defined in Table 4
A positive value implies simulated value is higher than the baseline value and *vice-versa* for a negative value.
* Out of sample simulation has been carried out with increasing Brent oil price by $10 in 2005
Percentage of variables has been derived from between simulated value and base line value
‡ Short run and long run are defined as one year (2005Q1 to 2005Q4) and three years (2005Q1 to 2007Q4) respectively
⊥Trade balance has been calculated as the difference between simulated exports and imports values

We see from the foregoing that India's trade balance and imports are both immediately impacted by a rise in the price of international crude, while output and prices respond with a lag. But the stickiness of the price index owes mainly to price controls; it is accordingly crucial to have an understanding the fallout of the lag in price adjustment under India's oil pricing regime.

Price adjustments occur with a lag, thanks to official subsidies on petroleum -- first introduced in Budget 2003-04. But the subventions have aggravated the government's fiscal imbalance too; and that is what pressurizes domestic price and output levels. The burden of this on the exchequer will be unsustainable in the long-run.

II. 3.3. Impact of the Oil Shock - Other Countries (within Sample Analysis)

Within-sample simulation results for the other economies (China, Korea, Malaysia and Thailand) show that they too are hit harder over the long-run than the short (Tables II.3.3 to II.3.6). Estimates suggest that the $10 bbl rise in the price of international crude leads China to lose 0.45 per cent in industrial output over the short-run, and 0.65 per cent in the long-run[12]. Others to witness decline output in the short-run are Korea (by 1.45 per cent) and Thailand (by 1.05 per cent). Their long-run declines are larger -- Korea (by 1.76 per cent) and Thailand (by 1.46 per cent).

The 1999 oil shock hikes the value of imports too. China's imports rise by 1.52 per cent that very year, and by 0.53 per cent over the longer run. Others who import more in the

[12] The simulations here were carried out using decrease in the international price of crude. However, in the discussion we use the findings to describe the impact of a rise in price.

short run are Korea (1.484 per cent) and Thailand (0.92 per cent). Simply put, each one of these economies has to combat a modicum of pressure of rising import bill.

Table II.3.5: Within Sample Simulation for Major Macro Variables of Korea and Thailand* : Impact of an Increase in the Price of Oil

Variables	Korea		Thailand	
(Percentage change)	***Short run‡***	***Long run***	***Short run***	***Long run***
Gross domestic product	1.448	1.755	1.052	1.457
Price	0.403	-0.021	0.616	-0.104
Imports	-1.484	-1.127	-0.919	-0.770
Exports	0.591	0.297	0.389	0.627
Trade Balance$^{\perp}$	2.075	1.427	1.308	1.397

Note: Units of variables are defined in Table 4
A positive value implies simulated value is higher than the baseline value and *vice-versa* for a negative value.
* In case of within sample simulation, Brent oil price in 1999 has been reduced by $10, maintained at 1998 level.
Percentage of variables has been derived from between simulated value and base line value
‡ Short run and long run are defined as one year (1999Q1 to 1999Q4) and three years (1999Q1 to 2001Q4) respectively
$^{\perp}$Trade balance has been calculated as the difference between simulated exports and imports values

Table II.3.6: Out of Sample Simulation for Major Macro Variables of Korea and Thailand*: Impact of an Increase in the Price of Oil

Variables	Korea		Thailand	
(Percentage change)	***Short run‡***	***Long run***	***Short run***	***Long run***
Gross domestic product	-0.822	-0.763	-0.008	-0.250
Price	-0.053	0.032	-0.111	0.038
Imports	1.014	0.706	0.926	1.228
Exports	-0.811	-0.245	-0.150	0.177
Trade Balance$^{\perp}$	-1.825	-0.951	-1.076	-1.051

Note: Units of variables are defined in Table 4
A positive value implies simulated value is higher than the baseline value and *vice-versa* for a negative value.
* Out of sample simulation has been carried out with increasing Brent oil price by $10 in 2005
Percentage of variables has been derived from between simulated value and base line value
‡ Short run and long run are defined as one year (2005Q1 to 2005Q4) and three years (2005Q1 to 2007Q4) respectively
$^{\perp}$Trade balance has been calculated as the difference between simulated exports and imports values

Exports of these countries, however, show a sustained rise. China's exports increase by 0.46 per cent in the short-run and by 0.15 per cent over the long-run. Korea and Thailand export more as well -- by 0.59 per cent and 0.39 per cent respectively. A decline in the price of crude by $10/ bbl leads to an improvement in the trade balances of these economies. Netting out imports and exports in our simulation, we find China's trade balance improves by 1.97 per cent and 0.68 per cent in the short-, and long-term respectively. Korea's improves by 2.08 per cent and 1.43 per cent -- and Thailand's improve by 1.31 per cent and 1.40 per cent in the respective periods.

Out-of-sample analysis

The out of sample simulations reported in Tables II.3.4 and Table II.3.6 reflect the same trends as the within-sample findings (as represented in Table II.3.3. and Table II.3.5.). China's industrial production would fall by 0.05 per cent in the short run, but by 0.22 per cent in the long run (Q1:1999 to Q4:2001). Its value of imports tends to increase by 0.37 per cent in the shock year and by 0.295 per cent in long run. But the oil price hike reduces the value of China's exports by 1.31 per cent in the short run -- resulting in a like 1.31 per cent decline in its trade balance from Q1:2005 to Q4:2005, and by 0.43 per cent in the long run. For Korea and Thailand, our results show their GDP declining by 0.822 per cent (0.763 per cent) and 0.008 per cent (0.250 per cent) in the short-run (long-run) respectively. A simulated hike by $10/ bbl in the price of international crude in 2005 would drive up long run domestic price levels in Korea and Thailand by 0.03 per cent and 0.04 per cent respectively. The results also show that the value of imports tends to increase by 1.01 per cent in the short-run, and 0.71 per cent in the long run. Similarly, the value of Thai imports tends to increase by 0.93 per cent in the short run and 1.23 per cent in the long run. The value of these countries' export would, however, decline over the short term -- by 0.81 per cent for Korea and 0.15 per cent for Thailand. Their trade balance declines, both in the short-, as well as the long-run. Table II.3.6 shows Korea's and Thailand's trade balance tends to decline by 1.83 per cent and 1.08 per cent respectively in short-run.

These findings suggest that the trade balance of all these economies declines following an increase in the international price of crude; it also builds pressure on their balance of payments (BoP). That in turn impacts the prospects of long run sustained growth in these countries.

II.4 A Summary

We analysed the macroeconomic impact of high oil prices for five developing economies including India. The period covered is the most recent one spanning the years 1993 till 2004-- one characterized by high oil prices. The analysis has used quarterly data for India, China, Korea and Thailand. We were constrained to use annual data for Brazil.

VAR was applied to assess the inter-linkages across variables used for all countries, and to estimate the impact, on different macro variables, of a surge in the international price of oil. Only in the case of Brazil did data limitations compelled us to use OLS instead of VAR.

A major finding of the review of the actual performance of the economies in the recent years shows that China's is the only economy in which the increase in the price of international crude failed to occasion a decline -- either in output or in economic activity. Inflation-wise, though, the oil price rise leads to higher domestic prices in all five countries.

The external sector of all five economies were strongly impacted by the rise in the price of oil experiencing higher values of imports and an erosion in balance of trade.

Meanwhile, the simulation exercise suggests that the $10/ bbl rise in the price of international crude in 1999 leads to a fall in India's industrial and manufacturing output. The extent of the fall is larger over the long-run, while the rise in the price level only picks up in the long-run. Finally, India's trade balance takes an adverse turn; the value of exports decline while that of imports rise over the entire interval (ie, from the short- to the long-run).

As for the remaining economies, 'within sample' simulations using 1999 data suggest that the post-oil price reduction period would be better for Korea than either for China or Thailand. That could be because of the higher extent of Korea's dependence on imported oil. In case of China, industrial output fell over both the short- and the long-run due to rise in oil price. Thailand fared somewhat better; its GDP falling by 1.05 per cent in the short-run, and by 1.48 per cent in the long-run.

'Out of sample' simulations reveal a lagged impact of the rise in the price of international crude on domestic output and price level -- in India and also in the other selected oil importing countries. An increase of the price by US$10/ in 2005 would induce a decline in industrial production in the short run and in the long run. But the long-term decline would be significantly higher than that the short-run.

We also find that China's industrial production would decline at a higher rate in the long run, while (within the shock year itself) more costly crude ratchets up its import bill and

erodes its trade surplus. Output in Korea and Thailand also charts a decline; but whereas Korea's falls by roughly equal amounts in the short-, and the long-run, Thailand's falls by a higher percentage in the long-run. As for trade, a US$10 bbl increase in the price of crude increases the value of Korea's imports by 1.014 per cent, and Thailand's by 0.926 per cent, in the short-run. The price increase also reduces the value of Korean and Thai exports value by 0.811 per cent and 0.150 per cent. As a result, their trade balance would decline if oil prices continue growing by US$10 in 2005.

Overall, therefore, we find that an increase in the international price of crude would hit these developing countries more because of their high dependency on imported oil. Also, India's policy of oil price management appears to differ somewhat from that of the other three. There may be controls on the pricing of domestic oil, but our findings suggest that once the domestic price level begins moving upward over the longer term, the economy does suffer.

III. A Structural Analysis of the Impact of High Oil Prices on the Economy

Changes in the price of crude impact the aggregate economy via inter-linked, across-the-board use of petro products. These inter-sectoral linkages can be modeled as a macroeconomic construct. We combine Input-Output (I-O) price analysis with a computable general equilibrium (CGE) model to analyse the macroeconomic impact of increases in the international price of oil on major economic variables in India.

Such an analysis helps also in explaining the possible inflationary effects of various policy changes. CGE models have the added advantage that they are economy-wide, multi-agent, multi-commodity constructs; they can thus capture the response to energy price shocks while fulfilling the conditions of (a) optimality in agent behaviour, (b) technological feasibility and (c) resource constraints. Finally, policies very often must address the immediate (short-run) fallout of sudden energy price hikes; that is why the focus of our augmented CGE model is on short-run developments.

The model adopted for analysis here accounts for output, and price implications via I-O linkages, components of aggregate demand and the fiscal response to high prices of oil in the context of the Indian economy. It uses the framework of NCAER's short-term macro model of the Indian economy -- augmented to reflect the main features of the petroleum sector's linkages with the economy. But whereas the current NCAER model has 12 production sectors, the present model is based on a more disaggregated, classification of production sectors for the analysis of I-O linkages.The base data set for a CGE model is a Social Accounting Matrix (SAM). A SAM provides a detailed, and disaggregated, quantitative description of the inter-linkages of an economic system's components. The interdependence amongst the different sectors of a given economic structural system is described by a set of accounting flows. And the SAM can be viewed as an augmentation of I-O table describing the flow of goods and services between different economic sectors over a given period of time, generally a year.

III.1 Assessing the Use of Petroleum Products in the Economy: Application of the I-O Technique

We first present here a detailed description of the production side of India's economy, using I-O analysis. The 115-sector I-O matrix the CSO published for 1998-99 is re-structured to 27 sectors (Appendix III.1) with data from the CSO, National Accounts Statistics, and

Indian Natural Gas & Petroleum Statistics. That is in line with our endeavour to re-construct the production side of the economy on the basis of the 12 sectors in the NCAER model noted below.

1. Agriculture Food Crops
2. Agriculture Other Crops
3. Livestock, Forestry & Other Allied Activities
4. Fertilizers
5. Petroleum, Oil and Lubricants (POL)
6. Other Intermediate Goods
7. Durable Consumer Goods
8. Non-Durable Consumer Goods
9. Capital Goods
10. Construction
11. Infrastructure
12. Services

Industry, uses inputs from two sources -- (a) Domestically produced commodities & services from various production sectors (intermediate inputs), and (b) Other inputs like imports, labour and capital.

Industrial outputs, in turn, have two broad uses, or destinations, which can be distinguished under the account heads of 'endogenous' and 'exogenous' in a SAM/I-O methodology. Some outputs are inputs for the production of these industries (intermediate, or endogenous, accounts). Others feed final demands (consumption, investment, government spending, trade, or exogenous ones.).

We build a 27-Sector I-O table for 1998-99, for which we use the 115 sector I-O Table for 1998-99 published by the CSO for the year 1998-99 to start with. We simultaneously map the sectors to the 12 sectors NCAER uses for CGE analysis. And, as CSO's I-O Table lacks detailed information on the petroleum sectors we take the required data from Indian Petroleum & Natural Gas Statistics. Then, with endogenous and exogenous accounts both specified through the I-O transactions matrix, the latter can be transformed into another (corresponding) matrix of average spending propensities. The proportions that can be obtained from exogenous accounts also show leakages or injections -- ie, some proportion of each endogenous account leaks out as expenditure, or enters into the external accounts without any feedback. Also, external accounts can be changed by exogenous shocks. Finally,

the entire, transformed, coefficient matrix is expressed as ratios where each column adds up to one.

The quantitative foundations of our study can be found in the various issues of Indian Petroleum & Natural Gas Statistics. It provides output data for 1998-99 -- a tabulation we disaggregate with the help of the 1998-99 I-O table to separate the total value of petroleum output into the output of individual petro-products. 'Petroleum Statistics' also reveals consumption patterns for every class of hydrocarbon product. Accordingly, we also inspected the I-O table to get a clearer understanding of imports of petroleum products. We calculate private final consumption expenditure on POL products based on the consumption of LPG, kerosene, and other petro-derivatives which enter domestic use.

III.1.1 Input-Output Table for the Year 2003-04

The latest data available in NAS are for the year 2003-04 and therefore the I-O table comprising 27 sectors is updated for this year (see Appendix III.2.). We start with the latest I-O Table of 115 sectors published by CSO for the year 1998-99. These 115 sectors are aggregated to the 27 sectors. In order to prepare the SAM for 2003-04, price updating is carried out for intermediate flow of 1998-99 Input-Output table using relative prices for each sector. Relative prices indicate how the prices of each sector have changed from one year to another. As a proxy to sectoral level prices, the wholesale price indices of the sectors are taken

for the years 1998-99 and 2003-04. These indices are available for agricultural and manufacturing sectors only. For services sector, we have used the GDP deflators as a proxy for prices. I-O coefficients are computed for 27 by 27 intermediate flow matrix dividing each column value by respective value of output given as a column total. Price adjusted coefficients are then computed using these I-O coefficients and relative price ratios.

Table III .1.1 Sources of Value of Output and Value Added

S.No.	Sectors	Value of Output (Rs. Crore)	Source – value of output	Value Added (Rs. Crore)	Source : Value Added
1	Food Agriculture	168467	NAS	152599	NAS
2	Other Crop	302129	NAS	273671	NAS
3	Non-Crop Agri (Livestock)	164509	NAS	149014	NAS
4	Fertlizers	28184	*	7410	*
5	POL-Crude	30824	Annual Report, Min of Petroleum. Here production is given in volume terms which is converted to value terms using oil price deflator.	4518	*
6	LPG	377	*	25	*
7	Kerosene	1170	*	76	*
8	ATF	502	*	33	*
9	Motor Gasolene	1221	*	80	*
10	HSD Oil	5852	*	381	*
11	Other Petroleum Products	5017	*	327	*
12	Mining and Quarrying	79719	*	63357	*
13	Consumer Durables	218647	*	44827	*
14	Consumer NonDurables	988127	*	161025	*
15	Iron and Steel	46998	*	9326	*
16	Intermediate	539495	*	127116	*
17	Non-Electrical Machinery	88777	*	21194	*
18	Electrical Machinery	22445	*	4142	*
19	Other Capital Goods	76435	*	12441	*
20	Construction	384087	NAS	155834	NAS
21	Railways	61695	NAS	22663	NAS
22	Road	272427	Using 1998-99 VA to Output Ratio	108931	NAS
23	Aviation	15618	Using 1998-99 VA to Output Ratio	6245	NAS
24	Shipping	45383	Using 1998-99 VA to Output Ratio	18147	NAS
25	Electricity	229260	Using 1998-99 VA to Output Ratio	43584	NAS
26	Gas and Water Supply	15515	Using 1998-99 VA to Output Ratio	10529	NAS
27	Services	1545894	Using 1998-99 VA to Output Ratio	1122293	NAS

* - For Manufacturing sectors, NAS is used, both for VA and output. Value Added is available at 2-digit level for registered and unregistered sectors. Output is available only for registered sectors. For unregistered part, registered VA to output ratio is imposed. Since data are given at 2-digit level, information can not be obtained for all the 27 sectors directly, so the proportions obtained from 1998-99 Input-Output table is used wherever necessary.

Next, value of output and value added for each of the 27 sectors are taken from the NAS. Such information is not available for all the sectors, so wherever necessary the value added to output ratio from a previous year are used for estimation purpose. The following table provides details of the 27 sectors with respect to the sources of data on value of output and value added for each of these sectors:

Thus, value of output and value added by the 27 sectors for the year 2003-04 (see Table III.1.1) are obtained. Using the price adjusted coefficients matrix and the value of

output for 2003-04, the intermediate flow matrix for the same year is constructed. Net Indirect Tax is then obtained for each sector for 2003-04 as:

Net Indirect Tax = Value of Output – Value of Inputs – Value Added

This gives net indirect tax for each of the 27 sectors. Moreover, NAS provides Net Indirect Taxes at an aggregate level. Therefore, the sectoral taxes add up to the Tax reported by NAS. There are also sectors which get subsidies and hence, taxes against them are of negative value. Total subsidies are given in NAS, and budget documents provide breakup of Central subsidies, the structure of which is applied on total subsidies. Petroleum subsidy is assigned to petroleum crude and petroleum products sectors.

For final demand components, consumption expenditure and investment follow the same structure as in 1998-99 I-O table. However, the Exports and Imports of each of the sector are taken from the DGCI&S Report on 'Foreign Trade Statistics' whereas, report on Petroleum Statistics are used for data on petroleum products.

We maintain the following equalities while building the SAM:

1. Government income = Government expenditure (GFCE) + Government Savings
2. Private Income = Private expenditure (PFCE) + Private Savings
3. Gross Savings = Investment (GFCF) + Change in Stocks (CIS)
4. Exports = Imports-foreign saving

III. 1.2. Sectoral Demand of Petroleum Products

The SAM so constructed for 2003-04 also provides a structure of the demand for petroleum products namely, HSDO, Kerosene, LPG, ATF, Petrol (i.e., motor gasoline) and Other Petroleum Product by the various sectors of the economy. The Table III.1.2.1 gives the proportion of output of a particular petroleum product going to different sectors as inputs as well as to final consumers.

The flow shows that as high as 85 per cent of demand for LPG is made by households. In case of kerosene, this percentage is higher at 93 per cent. About 58 per cent of available Petrol is used in road transportation, whereas the similar figure for HSD is lower at 44 per cent. HSD is also used in other sectors, apart from road transportation unlike petrol. High proportion of ATF is exported while only 20 per cent is used in aviation sector – the sole consumer of ATF.

Table III.1.2.1. Petroleum Products' Intermediate and Final Demand (As per cent to total availability) (Base Year 2003-04)

Sectors	Petroleum Crude and Petroleum products – Percentage distribution of their usage						
	POL-Crude	LPG	Kerosene	ATF	Petrol	HSD Oil	Other Petroleum Products
Food Agriculture	0.00	0.01	0.01	0.00	0.00	1.02	2.24
Other Crop	0.00	0.00	0.00	0.00	0.00	0.78	2.15
Non-Crop Agriculture (Livestock)	0.00	0.00	0.00	0.00	0.00	0.44	0.93
Fertlizers	1.71	0.00	0.00	0.00	0.00	0.11	0.23
POL-Crude	0.11	0.00	0.00	0.00	0.00	0.57	1.21
LPG	1.57	0.00	0.00	0.00	0.00	0.02	0.05
Kerosene	3.74	0.00	0.00	0.00	0.00	0.04	0.08
ATF	1.95	0.00	0.00	0.00	0.00	0.04	0.09
Motor Gasolene	4.66	0.00	0.00	0.00	0.00	0.12	0.25
HSD Oil	24.98	0.00	0.00	0.00	0.00	0.33	0.71
Other Petroleum Products	16.15	0.00	0.00	0.00	0.00	0.61	0.62
Mining and Quarrying	0.00	0.00	0.01	0.00	0.00	0.16	0.33
Consumer Durables	0.42	2.42	5.35	0.00	0.00	1.65	2.43
Consumer Non Durables	2.11	6.11	13.55	0.00	0.00	4.17	6.15
Iron and Steel	1.34	2.36	5.23	0.00	0.00	1.61	2.37
Intermediate	9.12	7.82	17.33	0.00	0.00	5.33	7.87
Non-Electrical Machinery	0.16	1.22	2.70	0.00	0.00	0.83	1.22
Electrical Machinery	0.04	0.22	0.50	0.00	0.00	0.15	0.23
Other Capital Goods	0.80	2.15	4.77	0.00	0.00	1.47	2.17
Construction	0.05	0.00	0.00	0.00	0.00	7.51	15.88
Railways	0.05	0.00	0.00	0.00	0.00	2.02	1.62
Road	0.00	0.01	0.02	0.00	57.81	44.14	13.52
Aviation	0.00	0.00	0.00	20.41	0.00	2.54	0.44
Shipping	0.00	0.00	0.00	0.00	1.03	6.65	5.07
Electricity	15.13	0.01	0.02	0.00	0.00	8.90	1.81
Gas and Water Supply	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Services	1.77	0.00	0.00	0.00	0.00	4.64	9.90
Total Intermediate consumption	85.87	22.33	49.48	20.41	58.84	95.86	79.63
GFCE (Gross Final Consumption Expenditure)	0.03	0.26	0.29	1.50	1.44	1.08	0.97
PFCE(Private Final Consumption Expenditure)	1.13	85.03	93.29	0.00	0.00	0.00	2.36
Indirect tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Direct Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00 per cent
GFCF (Gross Fixed Capital Formation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CIS (Change in Stock)	12.97	-7.62	-43.06	78.09	39.71	3.07	17.04
Export	0.00	0.00	0.00	76.02	57.85	10.74	8.58
less IMP	56.22	42.98	7.80	0.35	0.00	0.18	13.03
Final Demand	14.13	77.67	50.52	79.59	41.16	4.14	20.37
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note: There is marginal change in prices in decimal points when the rise is indicated as 0.00 per cent. Details available with NCAER.

III. 1.3. Assessing the Impact of Rise in Petroleum Prices on other Prices

The intermediates sub-matrix in a SAM could be treated as an I-O flow matrix. Where each row describes the flow of output of this sector to other sectors of the economy. In such a matrix, each column represents the cost of production of the output of a sector. The inter-sectoral linkage can be explained algebraically as:

$$X_{ij} = a_{ij} * X_j \quad (1)$$

where X_{ij} is the amount of sector i's output required for the production of sector j's output, Xj. The parameter aij is the relevant I-O coefficient, i.e., proportion of input of sector i required in the production of one unit output of sector j.

The output flow equation for the ith sector could be written as:

$$X_i = \sum_{j=i}^{n} a_{ij} X_j + Y_i \quad (2)$$

where Y_i is the total final demand for the ith sector's output.

This equation can be rewritten in the matrix form as:

$$(I - A) X = Y \quad (3)$$

where X is the vector of outputs, Y is the vector of final demands, A is the matrix of I-O coefficients and I is an identity matrix.

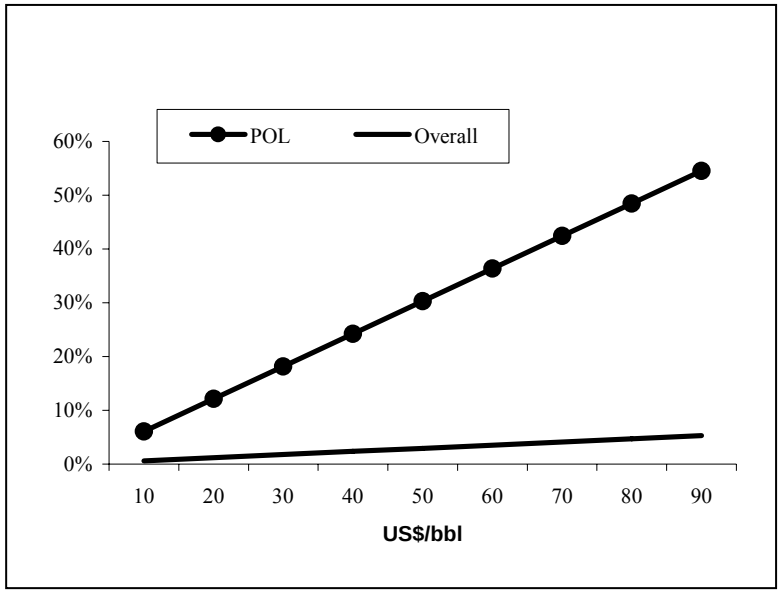
The I-O framework also provides a representation of the price formation process. In the equation above, variables and parameters are calculated from a standard I-O flow table measured in current prices. Despite the fact that it is expressed in terms of money value, equation 1 is a quantity model in that the unit of measure is the volume of output, valued in constant, base-year prices (see Duchin Faye, 1998). That is, if one assumes changes in A and computes new values for X, the percentage change in X corresponds to volume changes since prices remain unchanged.

If production of the sector j requires a_{1j} of commodity 1, a_{2j} of commodity 2 and a_{3j} of commodity 3, and prices of these three commodities are p_1, p_2, p_3 respectively, then the total cost of production of one unit of out-put in sector j, will be:

$p_j = (a_{1j} * p_1 + a_{2j} * p_2 + a_{3j} * p_3) + (VA_j / X_j + Tax_j / X_j)$ (4)

where VA_j and Tax_j are the Value Added and Indirect Taxes for the sector j.

Figure III.1.3.1: Impact of crude oil price hike on POL sector and overall inflation



In matrix form this can be expressed as p = A'p + (VA + Tax) where p is the price vector, VA is the value added coefficient vector, Tax is tax per unit of output vector and A' is the transpose of the input coefficient matrix.

This formulation now allows us to assess the impact of a change in the price of any of the 27 sectors on the resultant change in prices of the other sectors. The A' Matrix for these 27 sectors is given in Appendix III.3. The change in any input price would directly and indirectly impact the price of a commodity produced by any of the 27 sectors we have considered (See Figure.III.1.3.1. for an illustration of the impact of a change in the international crude price on the domestic prices). However, the second round feedback effect cannot be measured through this analysis. Further, the analysis assumes a full pass-through of the increase in crude prices to the consumers without affecting marketing margins or taxes.

Thus, the above a methodology allows us to examine the impact of increase in crude prices on the price of petroleum products and also on the overall price level. This impact takes into account the intersectoral demand and hence captures the indirect linkages. We present below an analysis where we assume that petroleum crude price rises from the base level of US $ 42 in 2004-05 (as shown from our available data) to US$ 65 in 2005-06. This translates into 55 per cent hike in oil price. The methodology outlined in section III.1.2. is

used to derive at the impact of this price rise on the prices of the 27 sectors of the SAM prepared for 2003-04. The procedures assumes full pass through of the increase in crude price. However, it ignores the impact of additional adjustments such as the changes in wage rates induced by the initial price increase. The sectors which experience the highest impact are clearly those which use the crude oil most intensively. Besides the petroleum products, fertilizers and electricity are the most affected sectors by the increased price of crude oil. The changes in prices experienced by these sectors are presented below in Table III.3.1.1. The table shows that at the aggregate level, the overall price index is estimated to increase by 5.2 per cent when crude oil price is increased by 55 per cent. The petroleum product prices experience increases between 29 per cent to 39 per cent. The price rise depends on the various inputs required in these sectors. As there are other inputs apart from crude as prices of these rise at a lower rate, the 55 per cent rise is not what is experienced by these petroleum sectors. An average increase of over 38 per cent in price is what is experienced by these sectors.

Table III.1.3.1: Sectoral Impact of Oil Price Hike by (Base Year 2003-04)

Sl. No.	Sectors	Price Index for the base year 2003-04	Price Index after Oil Shock	Change (per cent) in Price Index
1	Food Agriculture	1.00	1.0047	0.47
2	Other Crop	1.00	1.0035	0.35
3	Non-Crop Agri (Livestock)	1.00	1.0015	0.15
4	Fertlizers	1.00	1.0628	6.28
5	POL-Crude	1.00	1.5500	55.00
6	LPG	1.00	1.3854	38.54
7	Kerosene	1.00	1.2947	29.47
8	ATF	1.00	1.3618	36.18
9	Motor Gasolene	1.00	1.3567	35.67
10	HSD Oil	1.00	1.3326	33.26
11	Other Petroleum Products	1.00	1.3004	30.04
12	Mining and Quarrying	1.00	1.0075	0.75
13	Consumer Durables	1.00	1.0130	1.30
14	Consumer NonDurables	1.00	1.0087	0.87
15	Iron and Steel	1.00	1.0513	5.13
16	Other Intermediates	1.00	1.0272	2.72
17	Non-Electrical Machinery	1.00	1.0150	1.50
18	Electrical Machinery	1.00	1.0140	1.40
19	Other Capital Goods	1.00	1.0290	2.90
20	Construction	1.00	1.0134	1.34
21	Railways	1.00	1.0238	2.38
22	Road	1.00	1.0488	4.88
23	Aviation	1.00	1.0538	5.38
24	Shipping	1.00	1.0502	5.02
25	Electricity	1.00	1.0811	8.11

Sl. No.	Sectors	Price Index for the base year 2003-04	Price Index after Oil Shock	Change (per cent) in Price Index
26	Gas and Water Supply	1.00	1.0025	0.25
27	Services	1.00	1.0036	0.36
	Petro products	1.00	1.3838	38.38
	Overall WPI	1.00	1.0520	5.20

Note: Prices of Overall (all sectors) and Petro products are their weighted averages with weights being the their wholesale price index weights.

III.2 Assessing the Economy-wide Implications of the High Oil Price on the Indian Economy : Application of a CGE Model

The current NCAER macro CGE model is built around a Social Accounting Matrix (SAM). Such a framework is based on a structural inter-industry and inter-institutional relationship. Technology is assumed to remain constant. The model consists of a number of identities and behavioural equations. The CGE's parameters relating to the identities are computed as point estimates from the SAM. The parameters for the behavioral equations are estimated using time series data. In the model, output in non-agricultural sectors is specified as demand driven -- i.e. excess capacity is postulated. Agricultural output is supply determined. Agricultural output is determined in a sub model consisting of econometrically estimated equations. Prices are exogenous to the macro core in the case of agriculture and administered sectors. Prices of manufacturing goods, excepting for petroleum and fertilizers, are linked to world prices. For the other sectors, like services, a mark-up and a tax rate determine prices over the intermediate range; wage costs and the production process generates income.

Income and sector level prices determine sector level consumption patterns through the Linear Expenditure System. Government consumption is exogenously specified.

Equations in the trade block determine the volume and price of exports and imports. Both are specified as demand equations except in the case of agricultural sectors where exports are supply determined. Investment equations determine investment levels of major segments of the economy. In the government account current flows are endogenously determined, the capital account exogenously; and these two determine budgetary deficits. From the BOP account we get the forex reserves. Budget deficit and foreign exchange reserves determine base money, which determine broad money and thus also influence price formation. Some key features of the NCAER macro-CGE model are:

- Agricultural outputs have supply constraints and are determined through supply functions where input prices, lagged output prices, irrigation and rainfall are the major explanatory

variables. Several policy instruments and government interventions in agricultural markets are specified. Both agricultural outputs and prices influence the non-agricultural sectors but there is no reverse feed back.

- Outputs of non-agricultural sectors except those that are administered are demand driven, postulating excess demand.
- Prices of durable and non-durable consumer goods infrastructure and services non-administered sectors are formulated by mark-up over cost rules. Prices of intermediates and capital goods are determined by imposing tariff and sales tax on world prices. Prices of administered and agricultural sectors are exogenously given.
- Income accrues to three income classes, viz. agricultural wage income earners, non-agricultural wage income earners and non-agricultural non-wage (profit) income earners. In agriculture, non-wage or profit income is not differentiated from wage earnings as agriculture is dominated by 'self-employed' category.
- Consumption and saving behavior varies between urban and rural households.
- Wages respond to changes in prices measured by current and lagged Consumer Price Index.
- There are no quantitative restrictions on imports or exports.
- The world price is taken as given and the exchange rate is fixed.
- Public investment is exogenously given and sectoral private investment responds to changes in real GDP, user cost of capital, bank credit and relative prices.

III.2.1. Impact of Crude Oil Price Changes on Major Petroleum Products

The main objective of the SAM based short-run macro CGE model presented above is to provide a framework for assessing the impact of oil price shocks and various policy changes on key macro variables of the economy such as the GDP, inflation rate, trade deficit and government budget deficit. Alternative sets of assumptions can be made and the model could be used to obtain a set of possible outcomes.

Table III.2.1.1: Crude Oil Price Impact on Petro-Products: A Price Hike of 55 Per cent

S. No.	Crude & Petro Products	WPI Weight	Base	Change (per cent)
1	Crude	1.7529	100	55.0 per cent
2	LPG	1.8373	100	37.9 per cent
3	Kerosene	0.6893	100	29.1 per cent
4	ATF	0.1695	100	35.4 per cent
5	Motor Gasolene	0.8882	100	34.7 per cent
6	HSD Oil	2.0203	100	32.6 per cent
7	Other Petroleum Products	0.1602	100	29.3 per cent
	Total POL Sector (CGE model)	7.5177	100	38.2 per cent

We carry out the following procedure to study the impact of oil price rise on the economy. We can now see how the price rise in crude actually translates into a price rise in the POL sector of the model. We thus an analyse the impact of an increase in the world price of oil on to the economy first by translating this crude price rise to the POL sector of the CGE model, which is a combination of the 7 sectors as presented in Table III.2.1.1. The table shows that the price hike of 55 per cent translates to 38 per cent price rise in the POL sector (as explained in section III.2.1). We use this initial calculation and increase the POL price by 38 per cent to study the impact of this change on the macro aggregates of the economy through the NCAER model. We carry out this exercise under three different simulations scenarios.

In the first simulation, we let the world price of crude increase by 55 per cent but do not let this pass through to the domestic POL price. However, this is a situation that leads to a very large increase in trade deficit and fiscal deficit as the government does not allow the hiked cost of crude oil to pass through but absorbs the highs cost in the budget.(see Table III.2.1.2).

In the next simulation the government is forced to reduce its deficit to maintain the targets of Fiscal Responsibility Bill (FRB) through a reduction in government expenditure.

The fall in government expenditure reduces deficit but leads to a major contraction in industrial growth and hence in GDP. The overall GDP falls drastically by 2.2 per cent. This is a direct outcome of not letting the deficits rise.

In the third and the last simulation, we let the increase in world oil price pass through to the domestic POL sector. As price of POL sector is raised by 38 per cent (as explained above), the overall average price rises by 5 percentage points over the base level. There is no contraction in government expenditures to neutralize the rise in the cost of crude and petro products as deficit has been contained because the POL price rise has been passed on to domestic prices. This means that if the average price inflation is reigning at 6 per cent without a pass through in the base year (2004-05) then the 38 per cent price rise in POL sector would lead to an overall inflation rate of 9 per cent after the shock. The price rise would also impact industrial growth and GDP, but the contraction in GDP is lower in this simulation compared to simulation 2 where the higher cost of imports is not by a reduction in government spending. The situation is also more sustainable as the fiscal deficit in this scenario remains under control and does not change from the base level. The strength of the third simulation lies in the fact that when prices are corrected then the potential for further, inflationary tendencies is curbed. Moreover, as deficits of the PSUs are reduced they would not suffer from loss of normal profit.

Table III.2.1.2: Impact of Crude Oil Price Changes on Major Macro Aggregates: A Price Hike of 55 Per cent

Major Macro Variables	Base 2005-06	Simulations		
		SIM-1	SIM-2	SIM-3
	Percentage Change over Previous Year	Change in Percentage Points over Base		
Real GDP	8.40*	0.27	-2.19	-1.59
VALUE OF OUTPUT				
Agriculture	3.90*	0.00	0.00	0.00
Industry	8.49*	0.40	-4.92	-3.46
EXPORTS (US$ Nominal)	20.63	3.09	3.09	4.79
IMPORTS (US$ Nominal)	24.54	21.55	15.22	15.06
Average Price	4.41	0.05	-0.18	3.08
	As percentage of GDP MP (1993-94 base)			
Fiscal Deficit of the Centre	4.12	5.97	4.38	4.22

* **Source:** Press Release, Central Statistical Organisation, 31st May, 2006

III.2.2. Prospects for 2006-07

As the Budget 2006-07 has been presented we carry out an analysis of the alternative pricing policies and the impact on the economy in the short run. We carry out three further

scenarios to study the impact of the pricing policies on the economy and fiscal deficit as shown in Table III.2.2.1.

Table III.2.2.1: Impact of Crude Oil Price Changes on Major Macro Aggregates in 2006-07: A Price Hike of 55 Per cent

Variables	Alternative Scenarios for 2006-07		
	Under Scenario :1	**Under Scenario 2:**	**Under Scenario 3:**
	Oil Price Control	**Complete Pass through with out Customs and Excise duties reduction**	**Complete Pass through customs and Excise duties reduced**
Real GDP	8.11	8.02	7.90
Average Price	4.50	6.20	9.91
As a Percentage of GDP mp			
Fiscal Deficit of the Centre	4.80	4.61	4.12
TD	2.69	2.53	2.25
CAD	0.17	-0.01	-0.01

We examine the impact on macro variables by assuming world oil prices (which saw an average price rise of 37 per cent in the last fiscal, reaching an yearly average of US$ 60/ bbl) go up to an annual average of US$ 73/ bbl in 2006-07. In 2006-07, we assume that excise and customs are reduced by 2.5 per cent (based on the budget announcement). Under these changed tax rates, we run scenarios 1 and 2. In Scenario 1 we first assume that petroleum price rise in restricted and only 20 per cent of the crude price rise is passed on to the petroleum products and the crude sector. The GDP rises by 8.11 per cent in this scenario and the average price rises by 4.5 per cent in line with the general expectations[13]. However, in this scenario, the fiscal deficit of the centre rises substantially to nearly 5 per cent of GDP at market price. This certainly is not a viable situation and moreover, this fiscal deficit is due to the losses incurred by the oil companies as the higher prices of crude imports are not passed on to the consumers.

In scenario 2, we assume that together with price rise in the POL sector the custom and excise duties are reduced in this sector as in all other sectors. Prices go up by 6.2 per cent compared to 4.5% as POL price rise. This reduces GDP to 8.02 per cent growth level, but more importantly the deficit under this scenario when tax rates are reduced remain at about 4.6 per cent of GDP.

However, though overall price rise is substantial it is manufacturing prices that causes this inflationary tendency; and prices in other sectors (agriculture and services) do not rise.

Next, in Scenario 3, we assume that domestic petroleum sector prices are allowed to rise in line with the rise in world price of crude. But in this scenario we do not allow custom and excise duties to be reduced as fiscal prudence is desired. Under such conditions the GDP grow at a slightly lower rate than 8 per cent. But inflation reaches 9.9 per cent. As tax rates are not reduced, the fiscal deficit is maintained at about 4 per cent of GDP.

III.3 A Summary

In this section, we have attempted to examine the impact of oil price change on different petroleum products and thus on different sectors of the economy. The SAM based CGE analysis has allowed the disaggregation of the use of various major petroleum products in the economy through which we could analyse the impact of such price change on the overall economy. The findings have shown that in case the government restricts the pass through of world price increase to the domestic economy, it stands a very high risk of jeopardizing the fiscal position. The deteriorating fiscal deficit would lead to a contraction of the economy risking the health of the economy for future growth. A weakened petroleum sector and the industrial sector would also lead to a dampening of investment sentiments and this could lead to a very negative situation for a growing economy like India. On the other hand, if the international price rise is allowed to pass through, though there is an increase in price level initially, this does not necessarily signal an unsustainable situation. The trade deficit declines and the fiscal deficit also would decline substantially under such conditions. The more realistic energy pricing could also lead to better use of resources and a market for alternative energy. With healthier government accounts, the public sector could also undertake investments expenditures that could improve their productivity.

IV. Summary and Conclusions

The unprecedented growth of international oil prices since late 1990s - partly due to OPEC supply management policy and most importantly due to additional demand from East and South Asian countries over and above OECD demand, is a matter of concern to policy makers around the world. High oil prices pose a challenge to the sustainability of strong

[13] The projections for 2006-07 presented here are not strictly our forecast for this year. They should be taken as baseline values for the simulations.

economic growth in developing countries. It is important to assess the consequences of high oil prices on the economy particularly of developing countries that are net importer of crude oil. After two major oil shocks in 1974 and 1979, the price of crude oil declined significantly and continued to remain at a sustainable level till 1998. Since then, crude oil prices have taken an upward turn rising continuously at a faster rate and now even have surpassed the pace of the increase experienced in the late 1970s. During the last seven years (1998 to 2004), Dubai oil price has increased by a total of 175.49 per cent, Brent oil price by 200.93 per cent, Nigerian Forcados by 202.07 per cent and West Texas Intermediate by 188.40 per cent.

This study has three components. We first examine the impact of oil price changes on the economy taking the case of five selected developing countries. Next we examine the impact of high oil prices to the Indian economy constructing I-O relationships across major sectors. Finally, we examine the implications of the high oil prices in a macroeconomic framework. The five countries chosen for analysis in the first phase of the study are India, China, Korea, Thailand and Brazil. Out of these five countries, except Brazil, all the others are net importers of crude oil. Our analysis has been carried out using quarterly data of concerned variables and with annual data wherever quarterly figures are not available.

We find that large increase of international oil price hits oil importing developing countries significantly because of their high dependency on international oil. India's oil price policy is different from the other four countries considered in this study. Despite the controlled nature of domestic petroleum sector prices, our findings suggest that the economy would also suffer in the long run once the domestic price level begins to absorb the stock indirectly. Hence, with short sighted perspective one may suggest that the domestic price level has to be kept insulated from the international market pressures. But this can be achieved only over a short-term period. The present oil pricing system in India though effective in controlling the inflation rate in the short run it would fail to achieve the same in the long run. The reason is that such a strategy would increase fiscal burden as not allowing the oil companies to increase the domestic oil price would divert resources from productive activities to providing subsidies. The introduction of petroleum subsidies from 2003-04 budget has aggravated the fiscal imbalances of the government. Our findings suggest that revenue deficit is very sensitive to the external sector deficit. Increase of external sector deficit due to higher oil price would produce negative repercussion on the fiscal position of the government. Sooner or later, the government would bear the extra burden generated in the external sector. Increase in fiscal burden poses significant problems in the long run as it puts

immense pressure on future domestic prices as well as output and erodes the competitiveness of the exports.

In the second part of the study, the I-O technique based analysis of the prices for 27 major sectors of the Indian economy shows that a 55 per cent increase in crude oil price would translate into 38 per cent increase in the prices of petroleum products and 5 per cent increase in overall price level. This provides us with an elasticity that allows us to analyse how much domestic petroleum prices would change to absorb, let's say, a 10 per cent change in international price of crude.

In the third part of the study, we have analysed the impact of high crude oil price on output and inflation rate specifically in the Indian case using a computable general equilibrium model. The findings reveal that if the government restricts the pass through of world price increase reaching the domestic prices and manages the impact through measures that are not sustainable in a fiscal sense, the domestic economy is bound to suffer. The high fiscal deficit then adversely affects the public sector resource position and hence the overall economy. The deteriorating fiscal deficit would require measures that in turn lead to contraction of the economy impacting the health of the economy. On the other hand, if the global price rise of oil is allowed to pass through, there would be initial dampening of output and an increase in the overall price level. However, this does not necessarily signal an unsustainable situation. The government would be able to maintain its prevailing level of expenditure and the fiscal deficit would not worsen substantially under such conditions. However, some additional spending may be needed to protect the availability of essential goods such as food grain and fuel to the poor. The more realistic market determined energy pricing may also lead to better use of resources and a market for alternative energy sources. Finally, with healthier government finances, the public sector could undertake investment expenditures including attracting investment in the oil sector. In the last set of scenarios for 2006-07 in which we allow the international crude oil prices to pass on to the domestic prices GDP growth rate is still retained at about 8 per cent though price rise is substantial for the manufacturing sectors. However, the fiscal deficit falls to the desired level at 4 per cent to GDP.

This study has highlighted the need for a careful examination of the policy of administered prices of the petroleum sector in the context of rising international prices. The

study points to the need for understanding the wider implications of short-term measures, which consider only the price or output impact in the short-term.

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Appendices

Appendix I.1. Spot Crude Prices (US dollars per Barrel)

Year	Dubai $/bbl *	Brent $/bbl +	Nigerian Forcados $/bbl	West Texas Intermediate $/bbl ++
1972	1.90	-	-	-
1973	2.83	-	-	-
1974	10.41	-	-	-
1975	10.70	-	-	-
1976	11.63	12.80	12.87	12.23
1977	12.38	13.92	14.21	14.22
1978	13.03	14.02	13.65	14.55
1979	29.75	31.61	29.25	25.08
Value of 1979 over 1978	128.42	125.46	114.29	72.37
1980	35.69	36.83	36.98	37.96
1981	34.32	35.93	36.18	36.08
1982	31.80	32.97	33.29	33.65
1983	28.78	29.55	29.54	30.30
1984	28.06	28.78	28.14	29.39
1985	27.53	27.56	27.75	27.98
1986	13.10	14.43	14.46	15.10
1987	16.95	18.44	18.39	19.18
1988	13.27	14.92	15.00	15.97
1989	15.62	18.23	18.30	19.68
1990	20.45	23.73	23.85	24.50
1991	16.63	20.00	20.11	21.54
1992	17.16	19.32	19.61	20.57
1993	14.95	16.97	17.41	18.45
1994	14.74	15.82	16.25	17.21
1995	16.10	17.02	17.26	18.42
1996	18.52	20.67	21.16	22.16
1997	18.23	19.09	19.33	20.61
1998	12.21	12.72	12.62	14.39
1999	17.25	17.97	18.00	19.31
2000	26.20	28.50	28.42	30.37
2001	22.81	24.44	24.23	25.93
2002	23.74	25.02	25.04	26.16
2003	26.78	28.83	28.66	31.07
2004	33.64	38.27	38.13	41.49
Value of 2004 over 1998	175.51	200.86	202.14	188.33

Source: BP Statistical Review of World Energy June 2005

* 1972 - 1985 Arabian Light
1986 - 2004 Dubai dated

\+ 1976 -1983 Forties
1984 -2004 Brent dated

++ 1976 -1983 Posted WTI prices
1984 -2004 Spot WTI (Cushing) prices

Appendix II.1

Data Source and Methodology

The macro variables selected and estimated in this study are: Gross Domestic product (GDP), Industrial Production (IIP), Price level (WPI/CPI), Money Supply, Exports, Imports and Trade Balance[14]. The variables and their functional form estimated for different countries are given below:

The equations estimated in this study are:

India	
Output (IIP) = f(import, real money supply, Brent oil price) . . .	(1)
Manufacturing output = f(import, real money supply Brent oil price) . . .	(2)
Price level (WPI) =f(money supply, Brent oil price) . . .	(3)
Exports = f(exchange rate, IIP, Brent oil price) . . .	(4)
Imports = f(exchange rate, IIP, Brent oil price) . . .	(5)
Trade Balance = f(IIP, exchange rate, Brent oil price). . .	(6)
China	
Output (IIP) =f (import, Brent oil price) . . .	(7)
Exports = f(exchange rate, IIP, Brent oil price) . . .	(8)
Imports = f(exchange rate, IIP, Brent oil price) . . .	(9)
Trade Balance = f(exchange rate, IIP, Brent oil price) . . .	(10)
South Korea	
Output (GDP) = f(import, real money supply, Brent oil price) . . .	(11)
Price level (CPI) = f(money supply, Brent oil price) . . .	(12)
Exports = f(exchange rate, GDP, Brent oil price) . . .	(13)
Imports = f(exchange rate, GDP, Brent oil price). . .	(14)
Trade Balance = f(exchange rate, GDP, Brent oil price) . . .	(15)
Thailand	
Output (GDP) = f(import, real money supply, Brent oil price) . . .	(16)

[14] In some countries case we have estimated either GDP or IIP depending upon the availability of data for these two variables.

Price level (CPI) = f(money supply, Brent oil price) . . .	(17)
Exports = f(exchange rate, GDP, Brent oil price). . .	(18)
Imports = f(exchange rate, GDP, Brent oil price). . .	(19)
Trade Balance = f(exchange rate, GDP, Brent oil price) . . .	(20)

Brazil	
GDP = f(export, West Texas Index) . . .	(21)
Price level (WPI) = f(money supply, West Texas Index) . . .	(22)
Exports = f(GDP, West Texas Index) . . .	(23)
Imports =f(GDP, West Texas Index). . .	(24)
Trade Balance = f(GDP, exchange rate, West Texas Index) . . .	(25)

Equations (1) to (20) have been estimated using the financial year quarterly data from 1993Q1 to 2004Q4. For equations (21) to (25), we have used annual data from1982 to 2004. Data on Brent oil price and WTI price have been taken from the *International Energy Agency*, 2005. Most of macro variables such as Exports, GDP (except for India), IIP, WPI, CPI, Money supply, imports, trade balance, exchange rate have been collected from 2004, CD-ROM, *International Financial Statistics (IFS),* IMF. In case of India, data are collected from *Handbook of Statistics, RBI.* Financial variables of petroleum industry have been taken from the report *Ministry of Petroleum and Natural Gas, India, 2004-05*.

For estimation, we have used vector autoregressive (VAR) technique[15]. In both of these two techniques, we have estimated all variables in logarithmic terms except the growth variables of petroleum industry. We have used this technique under the implicit presumption that oil shock is endogenous, where the international oil prices are determined by the demand factors. This assumption appears justified in view of the current factors of oil prices, in which increase in demand factors are playing a more decisive role.

In the VAR analysis, we examine the dynamic interrelationships among the concerned variables in a particular equation. The VAR model contains simultaneous equations in which all the variables are considered to be endogenous. Further, within this simultaneous equation

[15] In case of India, China, Korea and Thailand we have applied VAR technique and for Brazil OLS technique due to data limitations.

system, each endogenous variable is explained by its lagged or past values and the lagged values of the other endogenous variables included in the system.

For estimation of VAR equations, we got a unified ordering of the variables as: policy variable first flowed by intermediate variable(s) and then target variable. Nevertheless, it has been done after estimating all other alternative orderings with findings of no substantial change in the result. Further all variables included in the VAR equations are taken in first log difference form. The reason is that we find all variables are non-stationary at log level, however become stationary at log first difference. The maximum lag-length of variables in each estimated VAR system has been selected on the basis Akaike Information Criteria (AIC).

The reduced form of unrestricted VAR model for industrial production of India estimated in the present study is as follows[16]:

$$DLIIP_t = a_{10} + a_{11}\sum_{i=1}^{n} DLRMS_{t-i} + a_{12}\sum_{i=1}^{n} DLIMPORT_{t-i} + a_{13}\sum_{i=1}^{n} DLBOILI_{t-i} + a_{14}\sum_{i=1}^{n} DLIIP_{t-i} + \varepsilon_{1t}$$

$$DLRMS_t = b_{10} + b_{11}\sum_{i=1}^{n} DLIIP_{t-i} + b_{12}\sum_{i=1}^{n} DLIMPORT_{t-i} + b_{13}\sum_{i=1}^{n} DLBOILI_{t-i} + b_{14}\sum_{i=1}^{n} DLRMS_{t-i} + \varepsilon_{2t}$$

$$DLIMPORT_t = c_{10} + c_{11}\sum_{i=1}^{n} DLRMS_{t-i} + c_{12}\sum_{i=1}^{n} DLIMPORT_{t-i} + c_{13}\sum_{i=1}^{n} DLBOILI_{t-i} + c_{14}\sum_{i=1}^{n} DLIIP_{t-i} + \varepsilon_{3t}$$

$$DLBOIL_t = d_{10} + d_{11}\sum_{i=1}^{n} DLRMS_{t-i} + d_{12}\sum_{i=1}^{n} DLIMPORT_{t-i} + d_{13}\sum_{i=1}^{n} DLBOILI_{t-i} + d_{14}\sum_{i=1}^{n} DLIIP_{t-i} + \varepsilon_{4t}$$

[16] Functions of other variables have been estimated in the similar fashion

where, IIP_t , $IMPORT_t$, RMS_t and $BOIL_t$ are index of industrial production, import, real money supply and price of Brent oil. Subscript 't' refers to the value of a variable in the current period and 't-i' in the previous period(s). Symbol DL is first difference of logarithm value of each variable. ε_{1t} , ε_{2t} , ε_{3t} and ε_{4t} are white-noise disturbances.

Appendix II.2

Vector Autoregression (VAR) Results of India

Appendix II.3.1: Vector Autoregression Results with output (Industrial production) as an Endogenous Variable

Dependent variables/ Independent variables	**Brent oil**	**real money supply**	**Import**	**Industrial production**
	Coefficients (t-value)			
Brent oil_{t-1}	0.328 (2.213)	0.018 (0.447)	0.247 (3.604)	-0.045 (-0.720)
Real money $supply_{t-1}$	1.191 (2.026)	0.290 (1.860)	0.326 (1.201)	-0.149 (-0.597)
$Import_{t-1}$	-0.606 (-1.941)	0.119 (1.436)	-0.104 (-0.719)	0.363 (2.742)
Industrial $production_{t-1}$	0.202 (0.580)	0.074 (0.799)	-0.108 (-0.671)	-0.334 (-2.261)

Note*:* t refers to current year value and t-1 implies previous year.
All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses

Appendix II.3.2: Vector Autoregression Results of With Output (Manufacturing Production) as an Endogenous Variable

Dependent variables/ Independent variables	**Brent oil**	**Real money supply**	**Import**	**Manufacturing production**
	Coefficients (t-value)			
Brent oil_{t-1}	0.306 (2.107)	0.012 (0.309)	0.258 (3.831)	-0.012 (-0.208)
Real money $supply_{t-1}$	1.217 (2.058)	0.290 (1.853)	0.317 (1.156)	-0.131 (-0.543)
$Import_{t-1}$	-0.551 (-1.784)	0.128 (1.563)	-0.128 (-0.894)	0.254 (2.009)
Manufacturing $production_{t-1}$	-0.037 (-0.101)	0.046 (0.477)	-0.008 (-0.048)	-0.292 (-1.946)

Note: t refers to current year value and t-1 implies previous year.
All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses

Appendix II.3.3: Vector Autoregression Results with Domestic Price as an Endogenous Variable*

Dependent variables/ Independent variables	Brent oil	Money supply	Price
	Coefficients (t-value)		
Brent oil$_{t-1}$	0.222 (1.310)	0.022 (0.661)	0.017 (1.471)
Money supply$_{t-1}$	1.836 (1.906)	0.316 (1.652)	-0.067 (-1.043)
Price$_{t-1}$	-3.317 (-1.258)	-0.574 (-1.096)	-0.040 (-0.230)

Note: t refers to current year value and t-1 implies previous year.
All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
* Price level = All commodities WPI.
t-values are given in the parentheses

Appendix II.3.4: Vector Autoregression Results with Exports as an Endogenous Variable*

Dependent variables/ Independent variables	Brent oil	Exchange rate	Industrial production	Export
	Coefficients (t-value)			
Brent oil$_{t-1}$	0.236 (1.259)	-0.015 (-0.687)	0.035 (0.487)	0.153 (1.571)
Exchange rate$_{t-1}$	-1.960 (-1.416)	0.443 (2.758)	-0.069 (-0.133)	-0.951 (-1.322)
Industrial production$_{t-1}$	0.063 (0.106)	-0.098 (-1.438)	-0.165 (-0.742)	0.020 (0.064)
Export$_{t-1}$	-0.154 (-0.405)	-0.013 (-0.288)	-0.083 (-0.579)	-0.561 (-2.848)

Note: t refers to current year value and t-1 implies previous year.
All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
* Exports= Value of total exports (f.o.b) (US$).
t-values are given in the parentheses

Appendix II.3.5: Vector Autoregression Results with Imports as an Endogenous Variable*

Dependent variables/ Independent variables	Brent oil	Exchange rate	Industrial production	Import
	Coefficients (t-value)			
Brent oil$_{t-1}$	0.327 (1.731)	-0.003 (-0.123)	-0.030 (-0.427)	0.228 (2.796)
Exchange rate$_{t-1}$	-1.919 (-1.440)	0.447 (2.920)	-0.075 (-0.152)	-0.650 (-1.130)
Industrial production$_{t-1}$	0.098 (0.207)	-0.087 (-1.606)	-0.324 (-1.856)	-0.110 (-0.538)
Export$_{t-1}$	-0.624 (-1.518)	-0.078 (-1.657)	0.301 (1.988)	-0.146 (-0.824)

Note*:* t refers to current year value and t-1 implies previous year.
All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
* Imports = Value of total imports (c.i.f) (US$).
t-values are given in the parentheses

Appendix II.3.6: Vector Autoregression Results with Trade Balance as an Endogenous Variable*

Dependent variables/ Independent variables	Brent oil	Exchange rate	Industrial production	Trade balance
	Coefficients (t-value)			
Brent oil$_{t-1}$	0.223 (1.229)	-0.016 (-0.767)	0.022 (0.313)	-1.083 (-1.848)
Exchange rate$_{t-1}$	-1.994 (-1.440)	0.441 (2.738)	-0.046 (-0.088)	0.834 (0.187)
Industrial production$_{t-1}$	-0.099 (-0.207)	-0.111 (-1.991)	-0.233 (-1.280)	-1.811 (-1.171)
Trade balance$_{t-1}$	0.023 (0.475)	0.002 (0.265)	-0.007 (-0.405)	-0.606 (-3.966)

Note: t refers to current year value and t-1 implies previous year.
All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
* Trade balance = Revenue on merchandise exports (f.o.b) minus expenditure on merchandise imports (c.i.f) (US$).
t-values are given in the parentheses

Vector Autoregression (VAR) results of China

Appendix II.3.7: Vector Autoregression Results with Output (Industrial Production) as an Endogenous Variable

Dependent variables/ Independent variables	Brent oil	Import	Industrial production
	Coefficients (t-value)		
Brent oil $_{t-1}$	0.296 (1.979)	0.178 (0.804)	0.104 (0.527)
Import$_{t-1}$	-0.118 (-1.262)	-0.580 (-4.181)	-0.070 (-0.567)
Industrial production $_{t-1}$	0.096 (0.770)	-0.066 (-0.354)	-0.004 (-0.023)

Note*:* All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses

Appendix II.3.8: Vector Autoregression Results with Exports as an Endogenous Variable*

Dependent variables/ Independent variables	Brent oil	Industrial production	Export
	Coefficients (t-value)		
Brent oil $_{t-1}$	0.290 (1.927)	0.105 (0.526)	0.344 (1.715)
Industrial production $_{t-1}$	0.071 (0.587)	-0.016 (-0.099)	0.184 (1.137)
Export$_{t-1}$	0.107 (1.034)	-0.074 (-0.540)	-0.507 (-3.667)

Note: All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses
* Exports= Value of total exports (f.o.b) (US$).

Appendix II.3.9: Vector Autoregression Results with Imports as an Endogenous Variable*

Dependent variables/ Independent variables	Brent oil	Industrial production	Import
	Coefficients (t-value)		
Brent oil $_{t-1}$	0.296 (1.979)	0.104 (0.527)	0.178 (0.804)
Industrial production$_{t-1}$	0.096 (0.770)	-0.004 (-0.023)	-0.066 (-0.354)
Import$_{t-1}$	-0.118 (-1.262)	-0.070 (-0.567)	-0.580 (-4.181)

Note: All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses
* Imports = Value of total imports (c.i.f.) (US$).

Appendix II.3.10: Vector Autoregression Results with Trade Balance as an Endogenous Variable*

Dependent variables/ Independent variables	Brent oil	Industrial production	Trade balance
	Coefficients (t-value)		
Brent oil$_{t-1}$	0.255 (1.726)	0.080 (0.413)	1.013 (1.126)
Industrial production$_{t-1}$	0.050 (0.419)	-0.033 (-0.211)	-0.471 (-0.651)
Trade balance$_{t-1}$	0.018 (0.779)	0.008 (0.264)	-0.454 (-3.317)

Note: All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses
* Trade balance = Revenue on merchandise exports (f.o.b) minus expenditure on merchandise imports (c.i.f.) (US$).

Vector Autoregression (VAR) results of Korea

Appendix II.3.11: Vector Autoregression Results with Domestic Output (GDP) as an Endogenous Variable

Dependent variables/independent variables	Brent oil	Real money supply	Import	Gross domestic product
	Coefficients (t-value)			
Brent oil$_{t-1}$	0.053 (0.316)	-0.083 (-0.467)	0.073 (0.647)	0.100 (0.705)
Brent oil$_{t-2}$	-0.314 (-1.808)	0.021 (0.117)	-0.028 (-0.239)	-0.023 (-0.158)
Real money supply$_{t-1}$	0.211 (1.007)	0.3136 (1.428)	0.399 (2.866)	0.895 (5.102)
Real money supply$_{t-2}$	0.051 (0.210)	0.278 (1.089)	0.052 (0.320)	0.420 (2.060)
Import$_{t-1}$	0.275 (0.819)	-0.029 (-0.082)	-0.255 (-1.141)	-0.607 (-2.158)
Import$_{t-2}$	0.985 (2.910)	0.168 (0.473)	0.276 (1.223)	0.336 (1.183)
Gross domestic product$_{t-1}$	-0.108 (-0.375)	-0.209 (-0.691)	0.028 (0.146)	-0.669 (-2.778)
Gross domestic product$_{t-2}$	-0.450 (-1.853)	-0.515 (-2.018)	0.083 (0.512)	-0.538 (-2.636)

Note: All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses

Appendix II.3.12: Vector Autoregression Results with Domestic Price as an Endogenous Variable*

Dependent variables/independent variables	Brent oil	Money supply	Price
	Coefficients (t-value)		
Brent oil$_{t-1}$	0.208 (1.357)	0.048 (0.330)	0.005 (0.498)
Money supply$_{t-1}$	-0.125 (-0.630)	0.185 (0.986)	0.045 (3.338)
Price$_{t-1}$	-1.429 (-0.578)	-1.364 (-0.584)	-0.267 (-1.613)

Note*:* All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses
* Price level = consumer price index.

Appendix II.3.13: Vector Autoregression Results with Exports as an Endogenous Variable*

Dependent variables/ Independent variables	Brent oil	Exchange rate	Gross domestic product	Export
	Coefficients (t-value)			
Brent oil$_{t-1}$	0.188 (1.200)	0.103 (1.188)	0.023 (0.183)	0.170 (1.696)
Exchange rate $_{t-1}$	-0.711 (-1.738)	0.663 (2.942)	-1.226 (-3.741)	-0.542 (-2.070)
Gross domestic product $_{t-1}$	-0.346 (-1.156)	0.350 (2.127)	-0.585 (-2.443)	-0.332 (-1.734)
Export $_{t-1}$	0.197 (0.758)	-0.190 (-1.329)	-0.239 (-1.147)	-0.499 (-2.998)

Note: All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses
* Exports= Value of total exports (f.o.b) (US$).

Appendix II.3.14: Vector Autoregression Results with Imports as an Endogenous Variable*

Dependent variables/ Independent variables	Brent oil	Exchange rate	Gross domestic product	Import
	Coefficients (t-value)			
Brent oil$_{t-1}$	0.147 (0.845)	0.0531 (0.546)	0.187 (1.493)	0.126 (1.131)
Exchange rate$_{t-1}$	-0.478 (-1.290)	0.552 (2.661)	-1.653 (-6.172)	-0.888 (-3.739)
Gross domestic product$_{t-1}$	-0.258 (-1.151)	0.152 (1.207)	-0.546 (-3.365)	0.202 (1.402)
Import$_{t-1}$	0.267 (0.796)	0.119 (0.636)	-0.802 (-3.309)	-0.192 (-0.891)

Note: All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses
* Imports = Value of total imports (c.i.f.) (US$).

Appendix II.3.15: Vector Autoregression Results with Trade Balance as an Endogenous Variable*

Dependent variables/ Independent variables	Brent oil	Exchange rate	Gross domestic product	Trade balance
	Coefficients (t-value)			
Brent oil$_{t-1}$	0.216 (-1.377)	0.074 (-0.854)	-0.004 (-0.029)	-0.621 (-1.006)
Exchange rate$_{t-1}$	-0.594 (-1.545)	0.559 (-2.612)	-1.410 (-4.533)	-0.184 (-0.121)
Gross domestic product$_{t-1}$	-0.202 (-0.906)	0.218 (-1.753)	-0.789 (-4.373)	1.355 (1.541)
Trade balance$_{t-1}$	-0.009 (-0.255)	-0.011 (-0.563)	0.000 (-0.003)	-0.431 (-3.040)

Note: All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses
* Trade balance = Revenue on merchandise exports (f.o.b) minus expenditure on merchandise imports (c.i.f.) (US$).

Vector Autoregression (VAR) results of Thailand

Appendix II.3.16: Vector Autoregression Results with Output (GDP) as an Endogenous Variable

Dependent variables/ Independent variables	Brent oil	Real money supply	Import	Gross domestic product
	Coefficients (t-value)			
Brent oil$_{t-1}$	0.178 (1.050)	0.091 (0.690)	0.082 (1.060)	-0.049 (-0.533)
Real money supply $_{t-1}$	0.269 (0.872)	-0.049 (-0.204)	-0.106 (-0.757)	0.054 (0.325)
Import $_{t-1}$	0.216 (0.513)	0.138 (0.421)	0.291 (1.513)	0.304 (1.338)
Gross domestic product $_{t-1}$	-0.156 (-0.383)	0.507 (1.605)	0.429 (2.311)	0.103 (0.471)

Note: All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses

Appendix II.3.17: Vector Autoregression Results with Price Level as an Endogenous Variable*

Dependent variables/independent variables	Brent oil	Money supply	Price
	Coefficients (t-value)		
Brent oil_{t-1}	0.062 (0.420)	0.082 (0.653)	-0.009 (-1.065)
Brent oil_{t-2}	-0.104 (-0.750)	0.055 (0.466)	0.004 (0.511)
Money $supply_{t-1}$	0.122 (0.623)	0.147 (0.877)	0.002 (0.173)
Money $supply_{t-2}$	0.247 (1.251)	0.096 (0.569)	-0.019 (-1.668)
$Price_{t-1}$	0.526 (0.187)	-3.102 (-1.293)	0.710 (4.285)
$Price_{t-2}$	-7.361 (-2.550)	1.951 (0.791)	-0.197 (-1.156)

Note: All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses
* Price level = All commodities WPI.

Appendix II.3.18: Vector Autoregression Results with Exports as an Endogenous Variable*

Dependent variables/ Independent variables	**Brent oil**	**Exchange rate**	**Gross domestic product**	**Export**
	Coefficients (t-value)			
Brent oil_{t-1}	0.408 (2.525)	0.037 (0.444)	-0.056 (-0.633)	0.128 (1.973)
Exchange $rate_{t-1}$	-0.122 (-0.205)	0.218 (0.710)	-0.325 (-0.996)	-0.673 (-2.812)
Gross domestic $product_{t-1}$	0.234 (0.425)	-0.101 (-0.355)	0.010 (0.034)	-0.533 (-2.407)
$Export_{t-1}$	-0.769 (-1.953)	-0.010 (-0.047)	0.416 (1.927)	0.150 (0.943)

Note: All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses
* Exports Value of total exports (f.o.b) (US$).

Appendix II.3.19: Vector Autoregression Results with Imports as an Endogenous Variable*

Dependent variables/ Independent variables	Brent oil	Exchange rate	Gross domestic product	Import
	Coefficients (t-value)			
Brent oil_{t-1}	0.181 (1.060)	0.056 (0.665)	-0.048 (-0.528)	0.085 (1.101)
Exchange $rate_{t-1}$	-0.412 (-0.696)	0.197 (0.673)	-0.082 (-0.258)	-0.195 (-0.726)
Gross domestic $product_{t-1}$	-0.261 (-0.470)	-0.069 (-0.252)	0.083 (0.277)	0.202 (0.800)
$Import_{t-1}$	0.344 (0.893)	-0.094 (-0.494)	0.329 (1.593)	0.215 (1.229)

Note*:* All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses
* Imports = Value of total imports (c.i.f.) (US$).

Appendix II.3.20: Vector Autoregression Results with Trade Balance as an Endogenous Variable*

Dependent variables/independent variables	Brent oil	Exchange rate	Gross domestic product	Trade balance
	Coefficients (t-value)			
Brent oil_{t-1}	0.160 (1.081)	0.056 (0.690)	-0.036 (-0.415)	0.243 (0.901)
Brent oil_{t-2}	-0.026 (-0.173)	-0.093 (-1.147)	0.121 (1.411)	-0.308 (-1.145)
Exchange $rate_{t}$	-0.138 (-0.231)	0.258 (0.790)	-0.064 (-0.186)	-0.736 (-0.677)
Exchange $rate_{t-2}$	-0.247 (-0.426)	0.014 (0.043)	-0.677 (-2.018)	-0.233 (-0.220)
Gross domestic $product_{t-1}$	-0.263 (-0.501)	0.016 (0.055)	0.145 (0.477)	-1.523 (-1.594)
Gross domestic $product_{t-2}$	0.463 (0.868)	-0.059 (-0.204)	-0.471 (-1.527)	-0.186 (-0.191)
Trade $balance_{t-1}$	-0.095 (-0.994)	0.060 (1.147)	-0.055 (-0.992)	0.039 (0.222)
Trade $balance_{t-2}$	-0.097 (-1.015)	-0.028 (-0.530)	-0.008 (-0.136)	-0.067 (-0.385)

Note*:* All variables are estimated in log first difference.
For simplicity, we have not reported intercept values in the above table.
t-values are given in the parentheses
* Trade balance = Revenue on merchandise exports (f.o.b) minus expenditure on merchandise imports (c.i.f.) (US$).

Simple Ordinary Least Square Results of Brazil

Appendix II.3.21: Gross Domestic Product on Exports and West Texas Index

Dependent Variable: Log of gross domestic product	Coefficient	t-statistic	Prob.
Included observations: 23 after adjusting endpoints			
Constant	1.970	0.911	0.374
Log(export)	0.320	2.300	0.033
Log(West Texas Index)	0.232	2.013	0.052
$Log(GDP)_{t-1}$	0.663	5.078	0.000
R-squared	0.89	D-W statistics	1.84

Appendix II.3.22: Wholesale Price Level on Money Supply and West Texas Index

Dependent Variable: Log of Wholesale price level	Coefficient	t-statistic	Prob.
Included observations: 23 after adjusting endpoints			
Constant	-573.739	-5.580	0.000
Log(money supply)	22.582	5.680	0.000
Log(West Texas oil price index)	7.494	1.478	0.155
R-squared	0.619	D-W statistics	0.861

Appendix II.3.23: Exports on Exchange Rate and West Texas Index

Dependent Variable: log of exports	Coefficient	t-statistic	Prob.
Included observations: 23 after adjusting endpoints			
Constant	23.567	67.272	0.000
Log(exchange rate)	0.041	12.124	0.000
Log(West Texas Index)	0.366	3.268	0.004
R-squared	0.884	D-W statistics	0.794

Appendix II.3.24: Imports on Gross Domestic Product and West Texas Index

Dependent Variable: Log of imports*	Coefficient	t-statistic	Prob.
Included observations: 23 after adjusting endpoints			
Constant	191.916	0.002	0.999
Log(GDP)	0.709	5.309	0.000
Log(West Texas Index)	0.097	1.024	0.319
R-squared	0.975	D-W statistics	0.949

* Results obtained after solving first order auto correlation

Appendix II.3.25: Trade Balance on Exchange Rate, GDP and West Texas Index

Dependent Variable: Log of trade balance*	Coefficient	t-statistic	Prob.
Included observations: 22 after adjusting endpoints			
Constant	114.780	4.477	0.000
Log(exchange rate)	0.105	1.064	0.302
Log(GDP)	-3.488	-3.713	0.002
Log(West Texas Index)	0.907	1.808	0.104
R-squared	0.819	D-W statistics	1.08

* Results obtained after solving first order auto correlation

Appendix III.1. Input-Output Table for the Year 1998-99 (Rs. lakh)

1998-99		Food Agriculture	Other Crop	Non-Crop Agri (Livestock)	Fertilizers	POL-Crude	LPG	Kerosene	ATF	Motor Gasoline	HSD Oil
1	Food Agriculture	1472158	310788	275364	0	7	0	0	0	0	2
2	Other Crop	7530	251968	2667819	40	12	97	300	129	313	1502
3	Non-Crop Agri (Livestock)	624416	950821	55539	3540	9	12	37	16	39	185
4	Fertlizers	1341246	1074203	116	278896	0	0	0	0	0	0
5	POL-Crude	127	282	485	238519	9706	74845	231871	99373	241942	1159830
6	LPG	21	0	0	0	0	0	0	0	0	0
7	Kerosene	45	0	0	0	0	0	0	0	0	0
8	ATF	0	0	0	0	0	0	0	0	0	0
9	Motor Gasolene	0	0	0	0	0	0	0	0	0	0
10	HSD Oil	59022	32303	17476	3641	11768	489	1514	649	1580	7575
11	Other Petroleum Products	96395	52794	28560	5951	19233	799	2475	1061	2583	12381
12	Mining and Quarrying	16	8	176	119189	38745	22	69	30	72	346
13	Consumer Durables	1139	935	25353	2396	40171	407	1261	541	1316	6309
14	Consumer NonDurables	38252	19601	417389	82513	49709	253	783	336	818	3919
15	Iron and Steel	1	66	2392	1111	156	19	60	26	63	301
16	Intermediate	124887	250241	52091	516512	87788	1995	6180	2649	6449	30914
17	Non-Electrical Machinery	27628	19288	2573	12264	129208	133	412	177	430	2063
18	Electrical Machinery	32	82	80	41	0	4	14	6	14	68
19	Other Capital Goods	4323	3633	45088	510	10714	151	469	201	489	2345
20	Construction	101541	56558	55566	4969	27940	169	522	224	545	2611
21	Railways	56377	42652	12288	27942	16419	1557	4823	2067	5032	24124
22	Road	258692	275217	144462	71892	67442	2413	7476	3204	7801	37396
23	Aviation	18174	19335	10149	5051	4738	170	525	225	548	2627
24	Shipping	31279	33277	17467	8693	8155	292	904	387	943	4522
25	Electricity	179571	75841	5048	87184	138238	3058	9474	4060	9885	47389
26	Gas and Water Supply	63	57	263	5733	938	141	438	188	457	2190
27	Services	701055	537844	660181	277828	126738	11441	35446	15191	36986	177303
Total Inputs at Factor Cost		5143990	4007794	4495924	1754414	787836	98468	305055	130738	318306	1525904
Net Indirect Tax		-684232	-454801	11432	-20270	83313	8236	25515	10935	26623	127626
Total Inputs at Purchaser's Price		4459758	3552993	4507356	1734144	871149	106703	330570	141673	344929	1653529
Gross Value Added		12117008	18933810	12801515	729935	2905668	15819	49009	21004	51137	245144
GROSS Value of Output		16576767	22486804	17308871	2464079	3776817	122523	379578	162676	396066	1898673

Appendix III.1. Input-Output Table for the Year 1998-99(Rs. Lakh) (contd)

1998-99		Other Petroleum Products	Mining and Quarrying	Consumer Durables	Consumer NonDurables	Iron and Steel	Intermediate	Non-Electrical Machinery	Electrical Machinery	Other Capital Goods	Construction
1	Food Agriculture	2	6	1	1351510	0	6902	0	1	0	207
2	Other Crop	1288	857	116	5817753	11	677011	5	3	50	370462
3	Non-Crop Agri (Livestock)	158	17	1639	2072057	1562	119038	435	584	1056	81746
4	Fertlizers	0	0	5	16075	0	66142	1	3	1	4476
5	POL-Crude	994209	22	34749	183232	362995	634743	14524	7293	33948	6455
6	LPG	0	14	5121	13768	16534	14099	2850	1149	2380	0
7	Kerosene	0	30	10767	28947	34763	29644	5992	2416	5004	0
8	ATF	0	0	0	0	0	0	0	0	0	0
9	Motor Gasolene	0	0	0	0	0	0	0	0	0	0
10	HSD Oil	6494	4906	32195	86555	103945	88637	17916	7223	14963	226196
11	Other Petroleum Products	10613	7974	36728	98743	118582	101118	20439	8240	17070	369674
12	Mining and Quarrying	297	1	43990	62349	198241	767222	1671	808	27839	1180708
13	Consumer Durables	5408	7481	665777	167954	306021	132802	74770	27322	46581	306691
14	Consumer NonDurables	3359	1376	276412	4932376	39950	744964	105788	114914	41673	771462
15	Iron and Steel	258	16	1391277	533758	1791758	162190	901948	285407	427619	1453874
16	Intermediate	26500	27518	913211	4667780	187262	4978716	293656	603695	146034	2414329
17	Non-Electrical Machinery	1768	7476	77179	153187	23912	64338	491940	13434	11961	19300
18	Electrical Machinery	59	0	249225	34619	5455	3203	34879	209376	7359	204401
19	Other Capital Goods	2010	745	129979	69248	18695	65454	52102	12737	76589	1206
20	Construction	2238	8484	16357	103460	9653	46486	12292	5003	3620	115072
21	Railways	20679	5413	65617	136889	273644	273155	29128	10729	33913	270760
22	Road	32056	9225	155573	1445582	142548	611977	76418	34635	33824	827521
23	Aviation	2252	648	10929	101557	10014	42993	5369	2433	2376	58136
24	Shipping	3876	1115	18811	174789	17236	73995	9240	4188	4090	100057
25	Electricity	40622	27911	354915	1394492	287972	1004338	162751	88814	77016	357846
26	Gas and Water Supply	1877	124	11910	20828	4829	26968	1737	1171	1687	29648
27	Services	151985	32356	1308336	5620916	1060217	2307858	651282	367309	316583	2501913
Total Inputs at Factor Cost		1308007	143718	5810820	29288425	5015799	13043993	2967131	1808886	1333237	11672143
Net Indirect Tax		109401	13333	602076	1038830	317487	868645	285407	180332	99931	951342
Total Inputs at Purchaser's Price		1417408	157051	6412896	30327255	5333286	13912637	3252538	1989218	1433168	12623485
Gross Value Added		210138	665472	2184358	9810803	1822542	5683156	1153719	585521	650873	9312930
GROSS Value of Output		1627546	822523	8597254	40138058	7155828	19595793	4406257	2574739	2084041	21936415

Appendix III.1. Input-Output Table for the Year 1998-99(Rs. Lakh) (contd)

1998-99		Railways	Road	Aviation	Shipping	Electricity	Gas and Water Supply	Services	Total	PFCE	GFCE
1	Food Agriculture	0	28499	2002	3446	0	0	479579	3930476	12127051	45165
2	Other Crop	0	77428	5440	9362	47	39	1095523	10985104	11172310	20743
3	Non-Crop Agri (Livestock)	14	0	0	0	1	31679	421203	4365801	12248914	98155
4	Fertlizers	0	0	0	0	0	717	62731	2844613	0	0
5	POL-Crude	4116	1	0	0	1206842	26	239208	5779343	48893	8024
6	LPG	0	35	0	0	14	0	0	55985	288196	2439
7	Kerosene	0	74	0	0	30	0	0	117712	605950	5129
8	ATF	0	0	130529	0	0	0	0	130529	0	6063
9	Motor Gasolene	0	358870	0	3984	0	0	0	362853	0	15810
10	HSD Oil	39928	1148398	0	138855	169731	0	149569	2371529	0	106843
11	Other Petroleum Products	24671	350605	0	81814	26655	1145	246510	1742810	597589	72043
12	Mining and Quarrying	0	0	0	0	0	307	84931	2527038	0	0
13	Consumer Durables	4675	207143	14552	25046	15773	1247	425860	2514933	1810129	95216
14	Consumer NonDurables	4203	210935	14819	25505	68374	1151	2826928	10797762	23892855	1038681
15	Iron and Steel	131	237	17	29	1	1206	496484	7450405	0	7
16	Intermediate	4269	705208	49543	85268	66106	5699	2840345	19094845	1707797	394183
17	Non-Electrical Machinery	3849	141727	9957	17137	139656	1466	158296	1530758	97357	342776
18	Electrical Machinery	3633	86246	6059	10428	343186	335	69370	1268176	0	201
19	Other Capital Goods	321393	113291	7959	13698	141	30	226208	1179408	0	1321
20	Construction	165913	180886	12708	21871	63422	131120	1060452	2209683	0	1088973
21	Railways	7585	89035	6255	10765	476611	2347	212978	2118784	655511	73234
22	Road	11672	419886	29498	50769	295903	6728	1436622	6496432	7664158	390723
23	Aviation	820	29498	2072	3567	20788	473	100927	456394	538430	27449
24	Shipping	1411	50769	3567	6139	35778	813	173705	785498	926690	47243
25	Electricity	537584	969318	68098	117202	2894651	34019	1021640	9998939	909661	171560
26	Gas and Water Supply	106	17673	1242	2137	93984	22252	36623	285265.22	266508.76	381903.72
27	Services	411646	2814623	197736	340322	1223181	52048	9907371	31845696	38527379	16512749
Total Inputs at Factor Cost		1547618	8000385	562051	967344	7140875	294847	23773064	133246772	114085380	20946633
Net Indirect Tax		50605	1245530	87502	150600	203276	5223	1420756	6764653.7	3971268.3	456615.76
Total Inputs at Purchaser's Price		1598224	9245915	649554	1117944	7344152	300070	25193820	140011425		
Gross Value Added		1406876	6160234	432775	744848	3736008	633608	66748781	159812690		
GROSS Value of Output		3005100	15406149	1082329	1862792	11080160	933678	91942601	299824116	118056648	21403249

Appendix III.1. Input-Output Table for the Year 1998-99(Rs. Lakh) (contd)

1998-99		GFCF	CIS	EXPORT	less IMP	Total
1	Food Agriculture	0	34408	619512	179845	16576767
2	Other Crop	0	-19042	566379	238691	22486804
3	Non-Crop Agri (Livestock)	205660	121249	502500	233408	17308871
4	Fertlizers	0	-74262	3705	309977	2464079
5	POL-Crude	0	-68945	10070	2000568	3776817
6	LPG	0	-28744	0	195354	122523
7	Kerosene	0	251276	0	600488	379578
8	ATF	0	26698	0	614	162676
9	Motor Gasolene	0	46714	0	29311	396066
10	HSD Oil	0	158136	0	737834	1898673
11	Other Petroleum Products	0	-500631	35852	320117	1627546
12	Mining and Quarrying	0	-24384	148869	1829000	822523
13	Consumer Durables	4777410	-180606	918867	1338695	8597254
14	Consumer NonDurables	2122086	-312805	6347181	3747703	40138058
15	Iron and Steel	194817	-130864	240685	599221	7155828
16	Intermediate	505592	352687	3183075	5642386	19595793
17	Non-Electrical Machinery	4517072	-81511	388903	2389098	4406257
18	Electrical Machinery	1659260	180905	149644	683447	2574739
19	Other Capital Goods	968747	37222	108210	210867	2084041
20	Construction	18637759	0	0	0	21936415
21	Railways	63350	0	94222	0	3005100
22	Road	467723	0	1414930	1027817	15406149
23	Aviation	32859	0	99403	72207	1082329
24	Shipping	56553	0	171082	124276	1862792
25	Electricity	0	0	0	0	11080160
26	Gas and Water Supply	0	0	0	0	933677.7
27	Services	2142849.6	0	5035690.6	2121763	91942601
Total Inputs at Factor Cost		36351737	-212500	20038779	24632686	299824116
Net Indirect Tax		3162963.2	0	-69665.048	0	14285836
Total Inputs at Purchaser's Price						140011425
Gross Value Added						333911217
GROSS Value of Output		39514700	-212500.18	19969115	24632686	299824116

Appendix III.2. Input-Output Table for the Year 2003-04(Rs. crore)

2003-04		Food Agriculture	Other Crop	Non-Crop Agri (Livestock)	Fertlizers	POL-Crude	LPG	Kerosene	ATF	Motor Gasolene	HSD Oil
1	Food Agriculture	5961	2934	997	0	0	0	0	0	0	0
2	Other Crop	65	1385	8479	0	0	1	2	3	7	20
3	Non-Crop Agri (Livestock)	1150	7817	528	40	0	0	0	0	1	3
4	Fertlizers	3902	10017	1	3190	0	0	0	0	0	0
5	POL-Crude	1	4	4	2536	167	2340	5555	2903	6926	37115
6	LPG	0	0	0	0	0	0	0	0	0	0
7	Kerosene	1	0	0	0	0	0	0	0	0	0
8	ATF	0	0	0	0	0	0	0	0	0	0
9	Motor Gasolene	0	0	0	0	0	0	0	0	0	0
10	HSD Oil	645	493	276	69	359	16	24	27	73	210
11	Other Petroleum Products	1056	1017	438	109	570	25	38	42	116	333
12	Mining and Quarrying	0	0	2	1975	1040	1	1	1	3	8
13	Consumer Durables	16	20	316	36	970	10	16	18	48	138
14	Consumer NonDurables	487	403	2902	1157	786	6	9	10	28	81
15	Iron and Steel	0	1	26	14	3	0	1	1	2	6
16	Intermediate	756	2870	579	5856	1888	45	68	77	311	603
17	Non-Electrical Machinery	338	369	28	160	2731	3	4	5	14	40
18	Electrical Machinery	0	1	1	1	0	0	0	0	0	1
19	Other Capital Goods	45	60	423	6	194	3	4	5	13	39
20	Construction	507	811	736	79	715	4	7	8	21	61
21	Railways	702	566	175	476	453	45	69	77	211	1104
22	Road	1320	4178	1153	1279	1943	72	611	224	441	1977
23	Aviation	234	189	117	69	105	4	6	7	18	53
24	Shipping	447	444	223	132	201	7	11	13	35	101
25	Electricity	1290	1143	62	1288	3308	76	237	131	559	3028
26	Gas and Water Supply	1	1	3	89	24	4	6	6	17	50
27	Services	2684	4033	3633	3175	2333	614	3480	794	1743	15800
Total Inputs at Factor Cost		21611	38758	21104	21735	17793	3276	10149	4350	10590	60770
Government Income		1200	2153	1172	200	122	1	2	1	2	10
Private Income		151398	271518	147841	7209	51193	330	1021	438	1065	5107
Net Indirect Tax		-5743	-10300	-5608	-961	-4066	-212	-657	-282	-686	-3288
Direct tax											
Gross Savings											
GROSS Value of Output		168467	302129	164509	28184	65042	3394	10515	4507	10972	62599

Appendix III.2. Input-Output Table for the Year 2003-04(Rs. crore) (contd)

2003-04		Other Petroleum Products	Mining and Quarrying	Consumer Durables	Consumer NonDurables	Iron and Steel	Intermediate	Non-Electrical Machinery	Electrical Machinery	Other Capital Goods	Construction
1	Food Agriculture	0	0	0	23512	0	150	0	0	0	2
2	Other Crop	18	8	2	85662	0	12451	0	0	1	3760
3	Non-Crop Agri (Livestock)	3	0	32	37775	9	2711	8	5	39	1027
4	Fertlizers	0	0	0	295	0	1519	0	0	0	57
5	POL-Crude	23997	0	631	3130	1992	13544	238	55	1182	76
6	LPG	0	0	144	364	140	466	72	13	128	0
7	Kerosene	0	1	611	1545	596	1977	307	57	544	0
8	ATF	0	0	0	0	0	0	0	0	0	0
9	Motor Gasolene	0	0	0	0	0	0	0	0	0	0
10	HSD Oil	385	100	1036	2623	1012	3355	522	96	924	4725
11	Other Petroleum Products	294	157	1147	2904	1120	3715	578	106	1023	7495
12	Mining and Quarrying	7	0	1244	1661	1696	25523	43	9	1511	21677
13	Consumer Durables	122	120	16932	4022	2353	3972	1720	287	2272	5062
14	Consumer NonDurables	71	21	6614	111120	289	20963	2290	1136	1913	11981
15	Iron and Steel	5	0	30219	10915	11768	4143	17724	2562	17815	20494
16	Intermediate	732	393	20689	99561	1283	132642	6019	5651	6346	35498
17	Non-Electrical Machinery	35	105	1719	3212	161	1685	9912	124	511	279
18	Electrical Machinery	1	0	5258	688	35	79	666	1825	298	2799
19	Other Capital Goods	34	9	2485	1247	108	1472	901	101	2809	15
20	Construction	54	144	441	2628	79	1475	300	56	187	2015
21	Railways	733	99	1909	3750	2407	9345	767	129	1892	5112
22	Road	1163	177	4723	41318	1309	21848	2099	434	1970	16305
23	Aviation	47	10	256	2239	71	1184	114	24	107	883
24	Shipping	89	18	489	4280	136	2263	217	45	204	1689
25	Electricity	1408	444	8948	33099	2195	29776	3712	925	3724	5855
26	Gas and Water Supply	44	2	315	519	39	840	42	13	86	509
27	Services	14276	578	36265	146649	8858	75257	16344	4223	16845	45012
Total Inputs at Factor Cost		43520	2387	142109	624718	37655	372354	64594	17876	62331	192327
Government Income		9	25801	1212	4352	252	3436	573	112	336	-46
Private Income		4377	-13759	43616	151122	9073	122307	20621	4030	12105	155880
Net Indirect Tax		-2818	248	31710	124067	17	23970	2989	427	1663	35926
Direct tax											
Gross Savings											
GROSS Value of Output		45088	14677	218647	904259	46998	522067	88777	22445	76435	384087

Appendix III.2. Input-Output Table for the Year 2003-04(Rs. crore) (contd)

2003-04		Railways	Road	Aviation	Shipping	Electricity	Gas and Water Supply	Services	Total	GFCE	PFCE
1	Food Agriculture	0	307	23	60	0	0	5377	39323	287	130372
2	Other Crop	0	705	52	137	1	0	10396	123158	132	170227
3	Non-Crop Agri (Livestock)	0	0	0	0	0	385	4949	56484	623	140496
4	Fertlizers	0	0	0	0	0	9	743	19732	0	0
5	POL-Crude	74	0	0	0	22472	0	2634	127576	51	1675
6	LPG	0	1	0	0	0	0	0	1329	15	5061
7	Kerosene	0	2	0	0	2	0	0	5644	33	10640
8	ATF	0	0	523	0	0	0	0	523	38	0
9	Motor Gasolene	0	4018	0	72	0	0	0	4090	100	0
10	HSD Oil	1274	27788	1600	4186	5606	0	2921	60343	678	0
11	Other Petroleum Products	764	6380	206	2394	855	22	4673	37578	457	1113
12	Mining and Quarrying	0	0	0	0	0	5	1458	57868	0	0
13	Consumer Durables	118	3068	228	597	412	20	6572	49465	604	100143
14	Consumer NonDurables	100	2940	219	572	1679	17	41047	208841	6592	484821
15	Iron and Steel	3	3	0	1	0	16	6544	122264	0	0
16	Intermediate	96	9306	692	1809	1537	81	39047	374434	3488	150401
17	Non-Electrical Machinery	85	1838	137	357	3192	20	2139	29203	2176	376
18	Electrical Machinery	76	1060	79	206	7430	4	888	21396	1	0
19	Other Capital Goods	6093	1262	94	245	3	0	2625	20295	8	0
20	Construction	4438	2842	211	553	1756	2220	17360	39707	6912	0
21	Railways	219	1509	112	293	14229	43	3760	50188	465	7385
22	Road	351	11165	552	1444	9219	128	26465	153868	1494	99773
23	Aviation	19	402	30	78	500	7	1434	8206	174	5813
24	Shipping	36	769	57	150	955	13	2742	15770	300	26860
25	Electricity	13437	14234	1058	2768	74888	538	15629	223761	1089	4411
26	Gas and Water Supply	3	273	20	53	2554	370	588	6471	2424	6621
27	Services	11352	35448	3399	8857	34836	931	166606	664025	104804	657312
Total Inputs at Factor Cost		38538	125321	9292	24830	182123	4833	366598	2521542	132945	2003500
Government Income		2657	-1078	-62	-180	4473	1081	70936			
Private Income		20006	110009	6307	18326	39111	9448	1051357		359871	
Net Indirect Tax		494	38175	81	2406	3553	154	57003	322882	82642	-48021
Direct tax											124419
Gross Savings										-9429	785849
GROSS Value of Output		61695	272427	15618	45383	229260	15515	1545894	288262	566029	2865747

Appendix III.2. Input-Output Table for the Year 2003-04(Rs. crore) (contd)

2003-04		Indirect tax	Direct Tax	GFCF	CIS	EXPORT	less IMP	Total Value of Output
1	Food Agriculture			0	-6513	7285	2287	168467
2	Other Crop			0	752	11054	3194	302129
3	Non-Crop Agri (Livestock)			3549	-44785	8232	90	164509
4	Fertlizers			0	11267	101	2916	28184
5	POL-Crude			0	19269	0	83528	65043
6	LPG			0	-454	0	2558	3394
7	Kerosene			0	-4911	0	890	10515
8	ATF			0	2003	1950	9	4506
9	Motor Gasolene			0	2760	4021	0	10972
10	HSD Oil			0	-5069	6763	116	62599
11	Other Petroleum Products			0	8043	4047	6150	45088
12	Mining and Quarrying			0	-41048	10885	13028	14677
13	Consumer Durables			82442	12190	8294	34492	218647
14	Consumer NonDurables			36620	57502	138240	28358	904259
15	Iron and Steel			1640	-81364	11775	7317	46998
16	Intermediate			8725	56567	58605	130153	522067
17	Non-Electrical Machinery			70416	690	9829	23912	88777
18	Electrical Machinery			25044	-23771	3782	4008	22445
19	Other Capital Goods			16717	45259	8988	14833	76435
20	Construction			337468	0	0	0	384087
21	Railways			1093	0	2564	0	61695
22	Road			5071	0	38502	26281	272427
23	Aviation			567	0	2705	1846	15618
24	Shipping			976	0	4655	3178	45383
25	Electricity			0	0	0	0	229260
26	Gas and Water Supply			0	0	0	0	15516
27	Services			36978	0	137028	54254	1545894
Total Inputs at Factor Cost		0	0	627307	8387	479305	443398	
Government Income		322882	124419					566029
Private Income						104819		2865747
Net Indirect Tax								322882
Direct tax								
Gross Savings						-140726		635694
GROSS Value of Output		322882	124419	627307	8387	443398	443398	

Appendix III.3. Transpose of Coefficient Matrix, A

2003-04		Food Agriculture	Other Crop	Non-Crop Agri (Livestock)	Fertlizers	POL-Crude	LPG	Kerosene	ATF	Motor Gasolene	HSD Oil
		1	2	3	4	5	6	7	8	9	10
1	Food Agriculture	0.0354	0.0004	0.0068	0.0232	0.0000	0.0000	0.0000	0.0000	0.0000	0.0038
2	Other Crop	0.0097	0.0046	0.0259	0.0332	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016
3	Non-Crop Agri (Livestock)	0.0061	0.0515	0.0032	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017
4	Fertlizers	0.0000	0.0000	0.0014	0.1132	0.0900	0.0000	0.0000	0.0000	0.0000	0.0024
5	POL-Crude	0.0000	0.0000	0.0000	0.0000	0.0026	0.0000	0.0000	0.0000	0.0000	0.0055
6	LPG	0.0000	0.0004	0.0001	0.0000	0.6894	0.0000	0.0000	0.0000	0.0000	0.0046
7	Kerosene	0.0000	0.0002	0.0000	0.0000	0.5283	0.0000	0.0000	0.0000	0.0000	0.0023
8	ATF	0.0000	0.0006	0.0001	0.0000	0.6441	0.0000	0.0000	0.0000	0.0000	0.0059
9	Motor Gasolene	0.0000	0.0006	0.0001	0.0000	0.6313	0.0000	0.0000	0.0000	0.0000	0.0067
10	HSD Oil	0.0000	0.0003	0.0000	0.0000	0.5929	0.0000	0.0000	0.0000	0.0000	0.0034
11	Other Petroleum Products	0.0000	0.0004	0.0001	0.0000	0.5322	0.0000	0.0000	0.0000	0.0000	0.0085
12	Mining and Quarrying	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0068
13	Consumer Durables	0.0000	0.0000	0.0001	0.0000	0.0029	0.0007	0.0028	0.0000	0.0000	0.0047
14	Consumer NonDurables	0.0260	0.0947	0.0418	0.0003	0.0035	0.0004	0.0017	0.0000	0.0000	0.0029
15	Iron and Steel	0.0000	0.0000	0.0002	0.0000	0.0424	0.0030	0.0127	0.0000	0.0000	0.0215
16	Intermediate	0.0003	0.0238	0.0052	0.0029	0.0259	0.0009	0.0038	0.0000	0.0000	0.0064
17	Non-Electrical Machinery	0.0000	0.0000	0.0001	0.0000	0.0027	0.0008	0.0035	0.0000	0.0000	0.0059
18	Electrical Machinery	0.0000	0.0000	0.0002	0.0000	0.0024	0.0006	0.0025	0.0000	0.0000	0.0043
19	Other Capital Goods	0.0000	0.0000	0.0005	0.0000	0.0155	0.0017	0.0071	0.0000	0.0000	0.0121
20	Construction	0.0000	0.0098	0.0027	0.0001	0.0002	0.0000	0.0000	0.0000	0.0000	0.0123
21	Railways	0.0000	0.0000	0.0000	0.0000	0.0012	0.0000	0.0000	0.0000	0.0000	0.0207
22	Road	0.0011	0.0026	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0148	0.1020
23	Aviation	0.0015	0.0034	0.0000	0.0000	0.0000	0.0000	0.0000	0.0335	0.0000	0.1025
24	Shipping	0.0013	0.0030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0922
25	Electricity	0.0000	0.0000	0.0000	0.0000	0.0980	0.0000	0.0000	0.0000	0.0000	0.0245
26	Gas and Water Supply	0.0000	0.0000	0.0248	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	Services	0.0035	0.0067	0.0032	0.0005	0.0017	0.0000	0.0000	0.0000	0.0000	0.0019

Appendix III.3. Transpose of Coefficient Matrix, A (contd)

		Other Petroleum Products	Mining and Quarrying	Consumer Durables	Consumer NonDurables	Iron and Steel	Intermediate	Non-Electrical Machinery	Electrical Machinery	Other Capital Goods	Construction
		11	12	13	14	15	16	17	18	19	20
1	Food Agriculture	0.0063	0.0000	0.0001	0.0029	0.0000	0.0045	0.0020	0.0000	0.0003	0.0030
2	Other Crop	0.0034	0.0000	0.0001	0.0013	0.0000	0.0095	0.0012	0.0000	0.0002	0.0027
3	Non-Crop Agri (Livestock)	0.0027	0.0000	0.0019	0.0176	0.0002	0.0035	0.0002	0.0000	0.0026	0.0045
4	Fertlizers	0.0039	0.0701	0.0013	0.0410	0.0005	0.2078	0.0057	0.0000	0.0002	0.0028
5	POL-Crude	0.0088	0.0160	0.0149	0.0121	0.0000	0.0290	0.0420	0.0000	0.0030	0.0110
6	LPG	0.0073	0.0002	0.0030	0.0018	0.0001	0.0131	0.0009	0.0000	0.0008	0.0013
7	Kerosene	0.0036	0.0001	0.0015	0.0009	0.0001	0.0065	0.0004	0.0000	0.0004	0.0007
8	ATF	0.0094	0.0002	0.0039	0.0023	0.0002	0.0170	0.0011	0.0000	0.0011	0.0017
9	Motor Gasolene	0.0106	0.0003	0.0044	0.0026	0.0002	0.0283	0.0013	0.0000	0.0012	0.0019
10	HSD Oil	0.0053	0.0001	0.0022	0.0013	0.0001	0.0096	0.0006	0.0000	0.0006	0.0010
11	Other Petroleum Products	0.0065	0.0002	0.0027	0.0016	0.0001	0.0162	0.0008	0.0000	0.0008	0.0012
12	Mining and Quarrying	0.0107	0.0000	0.0082	0.0014	0.0000	0.0268	0.0072	0.0000	0.0006	0.0098
13	Consumer Durables	0.0052	0.0057	0.0774	0.0303	0.1382	0.0946	0.0079	0.0240	0.0114	0.0020
14	Consumer NonDurables	0.0032	0.0018	0.0044	0.1229	0.0121	0.1101	0.0036	0.0008	0.0014	0.0029
15	Iron and Steel	0.0238	0.0361	0.0501	0.0062	0.2504	0.0273	0.0034	0.0007	0.0023	0.0017
16	Intermediate	0.0071	0.0489	0.0076	0.0402	0.0079	0.2541	0.0032	0.0002	0.0028	0.0028
17	Non-Electrical Machinery	0.0065	0.0005	0.0194	0.0258	0.1996	0.0678	0.1116	0.0075	0.0102	0.0034
18	Electrical Machinery	0.0047	0.0004	0.0128	0.0506	0.1141	0.2518	0.0055	0.0813	0.0045	0.0025
19	Other Capital Goods	0.0134	0.0198	0.0297	0.0250	0.2331	0.0830	0.0067	0.0039	0.0368	0.0025
20	Construction	0.0195	0.0564	0.0132	0.0312	0.0534	0.0924	0.0007	0.0073	0.0000	0.0052
21	Railways	0.0124	0.0000	0.0019	0.0016	0.0000	0.0016	0.0014	0.0012	0.0988	0.0719
22	Road	0.0234	0.0000	0.0113	0.0108	0.0000	0.0342	0.0067	0.0039	0.0046	0.0104
23	Aviation	0.0132	0.0000	0.0146	0.0140	0.0000	0.0443	0.0087	0.0050	0.0060	0.0135
24	Shipping	0.0528	0.0000	0.0131	0.0126	0.0000	0.0399	0.0079	0.0045	0.0054	0.0122
25	Electricity	0.0037	0.0000	0.0018	0.0073	0.0000	0.0067	0.0139	0.0324	0.0000	0.0077
26	Gas and Water Supply	0.0014	0.0004	0.0013	0.0011	0.0011	0.0052	0.0013	0.0003	0.0000	0.1431
27	Services	0.0030	0.0009	0.0043	0.0266	0.0042	0.0253	0.0014	0.0006	0.0017	0.0112

Appendix III.3. Transpose of Coefficient Matrix, A (contd)

2003-04		Railways	Road	Aviation	Shipping	Electricity	Gas and Water Supply	Services
		21	22	23	24	25	26	27
1	Food Agriculture	0.0042	0.0078	0.0014	0.0027	0.0077	0.0000	0.0159
2	Other Crop	0.0019	0.0138	0.0006	0.0015	0.0038	0.0000	0.0133
3	Non-Crop Agri (Livestock)	0.0011	0.0070	0.0007	0.0014	0.0004	0.0000	0.0221
4	Fertlizers	0.0169	0.0454	0.0025	0.0047	0.0457	0.0032	0.1127
5	POL-Crude	0.0070	0.0299	0.0016	0.0031	0.0509	0.0004	0.0359
6	LPG	0.0132	0.0213	0.0012	0.0022	0.0224	0.0011	0.1809
7	Kerosene	0.0065	0.0581	0.0006	0.0011	0.0225	0.0005	0.3309
8	ATF	0.0170	0.0498	0.0015	0.0029	0.0290	0.0014	0.1761
9	Motor Gasolene	0.0192	0.0402	0.0017	0.0032	0.0510	0.0016	0.1588
10	HSD Oil	0.0176	0.0316	0.0008	0.0016	0.0484	0.0008	0.2524
11	Other Petroleum Products	0.0163	0.0258	0.0010	0.0020	0.0312	0.0010	0.3166
12	Mining and Quarrying	0.0068	0.0120	0.0007	0.0012	0.0302	0.0001	0.0393
13	Consumer Durables	0.0087	0.0216	0.0012	0.0022	0.0409	0.0014	0.1659
14	Consumer NonDurables	0.0041	0.0457	0.0025	0.0047	0.0366	0.0006	0.1622
15	Iron and Steel	0.0512	0.0278	0.0015	0.0029	0.0467	0.0008	0.1885
16	Intermediate	0.0179	0.0418	0.0023	0.0043	0.0570	0.0016	0.1442
17	Non-Electrical Machinery	0.0086	0.0236	0.0013	0.0024	0.0418	0.0005	0.1841
18	Electrical Machinery	0.0057	0.0194	0.0010	0.0020	0.0412	0.0006	0.1882
19	Other Capital Goods	0.0248	0.0258	0.0014	0.0027	0.0487	0.0011	0.2204
20	Construction	0.0133	0.0425	0.0023	0.0044	0.0152	0.0013	0.1172
21	Railways	0.0035	0.0057	0.0003	0.0006	0.2178	0.0000	0.1840
22	Road	0.0055	0.0410	0.0015	0.0028	0.0522	0.0010	0.1301
23	Aviation	0.0072	0.0353	0.0019	0.0037	0.0677	0.0013	0.2177
24	Shipping	0.0065	0.0318	0.0017	0.0033	0.0610	0.0012	0.1952
25	Electricity	0.0621	0.0402	0.0022	0.0042	0.3267	0.0111	0.1520
26	Gas and Water Supply	0.0028	0.0083	0.0004	0.0009	0.0347	0.0238	0.0600
27	Services	0.0024	0.0171	0.0009	0.0018	0.0101	0.0004	0.1078

Appendix IV: Terms and References of the Study

1. The Backdrop and Objectives

Petroleum products are widely used in the economy as source of energy and as inputs in chemicals with wide applications. Their use is extensive and they are often called 'universal intermediates'. The changes in the price of oil products, therefore, have significant repercussions throughout the economy. Although flexibility in the production processes and energy production processes with respect to the use of petroleum products varies across usage, it is generally believed that the use of petroleum products is inelastic with respect to their prices, especially in the short-term. This feature tends to make higher oil prices a trigger for inflationary pressures in the economy.

The sharp rise in oil prices in the international markets is now a frequent phenomenon. When the price increase becomes protracted over many months, many sectors and activities in the economy are affected. There are also effects emerging from the global linkages of trade, investment and transactions.

At the macroeconomic policy level, therefore, petroleum product prices are a significant concern. Petroleum products are also an internationally traded group of commodities subject to the pulls and pressures of international markets. An understanding of how the prices are formed is necessary to design policies that aim to address issues relating to the implications of price changes of petro products.

In this study we will focus on understanding the impact of higher world oil prices to India's macro economy. The concerns range from inflationary impact, the consequent impact on economic growth, impact on fiscal position emerging from the overall impact of the oil price rise on the economy as well as specific fiscal response to oil price rise. The fiscal response may range from cuts in duties and taxes or changes in subsidies.

The key objectives of the proposed study will be to:

- examine the impact of high oil prices on some of the key aggregates of the economy in the past both for India as well as for some selected developing economies, especially large economies such as China and Brazil.

- examine the implications of the high world oil prices to the Indian economy and identify the policy responses that can sustain the growth momentum of the economy and restrain inflationary effects

2. Approach and Methodology

We will examine the past experience of the Indian economy and other selected economies using a set of macroeconomic indicators available from international data sources such as that of the World Bank and International Monetary Fund. The other country experiences will be examined by a review of past available studies as well as by an econometric analysis of the time series data on international petroleum prices and the macroeconomic indicators of the specific economies.

The second major objective noted above will be addressed using a modelling framework.
The oil price changes can have significant impact at the aggregate level because of the fact that petro products usage permeates the economy at all levels. These inter-linkages across different sectors and activities can be captured only through a macroeconomic model that specifies such linkages. With this in view, the present study will use a macroeconomic modelling framework to analyse the macroeconomic impact of world oil price increase.

The macroeconomic model that will be used in the present analysis will be structural in nature in order to capture the various linkages explicitly in the analysis. The model will also focus on short-term implications because policies are often needed to address the situation arising from high oil prices in the short run. The model will capture production and price implications through input-output linkages, aggregate demand components and fiscal and monetary responses to the high oil prices.

The study will use the framework of NCAER's short-term macroeconomic model for the Indian economy. Although the model is currently operational to examine the macroeconomic scenario in general, it will require some changes to capture the main features of the petroleum sector's linkages o the economy.

3. Time Frame and Cost of the Study

The time required for the study will be three months from the date of its commissioning. This duration of time will be needed to assemble the necessary data, estimate the parameters for

the model wherever necessary and carry out the analysis and draft the findings in a report form.

A draft report will be provided at the end of 3 months which will be finalized after a presentation at a forum identified by the sponsors.

Cost of the study inclusive of all expenses except for travel, if needed for presentation purposes, will be Rs 4.5 lakh. We request that this may be paid in 3 installments. The first would be an advance of Rs 2.7 lakh (60 per cent), the second would be Rs 1.35 lakh (30 per cent) on submission of the draft report and the final payment of Rs 45 thousand on submission of the final report.

Appendix V

List of Acronyms

ATF	Aviation Turbine Fuel
BBL	Barrel
BOIL	Brent Oil
BoP	Balance of Payment
CGE	Computable General Equilibrium
CIS	Change in Stocks
CSO	Central Statistical Organization
EIA	Energy Information Administration
FRB	Fiscal Responsibility Bill
GDP	Gross Domestic Product
GFCE	Government Final Consumption Expenditure
HSD	High Speed Diesel
HSDO	High Speed Diesel Oil
IIP	Index of Industrial Production
IEA	International Energy Agency
I-O	Input-Output
LPG	Liquified Petroleum Gas
MMBD	Million Barrels per day
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary Least Squares
OPEC	Organisation of the Petroleum Exporting Countries
PFCE	Private Final Consumption Expenditure
POL	Petroleum, Oil and Lubricant
PSUs	Public Sector Undertakings
RBI	Reserve Bank of India
RMS	Real Money Supply
SAM	Social Accounting Matrix
US	United States
VAR	Vector Auto Regression
WPI	Wholesale Price Index