SUMMARY

The main objectives of our proposed study are:

1. To analyze how the consumption pattern of various oil products is changing in different regions of India. To estimate the future oil & oil products demand we first need to calculate the growth rates of consumption of oil and individual oil products. In the present study we examine the growth rates and structural changes, which occurred in consumption of petroleum products in the entire nation and 19 major states during the implementation of various plans before and after liberalization.

2. In the partial equilibrium framework to estimate:
   The various determinants of oil product demand in general and how this is influenced by price and GDP, by evaluating the price and income elasticities.

3. In the general equilibrium framework to forecast the likely impact of oil market shocks on:
   a) Different sectors of the economy (namely agriculture, industrial, construction, services etc) and economy as a whole. The major emphasis being on important macro economic indicators viz. wages, prices, output, and employment.
   b) BOP of our country and also to forecast the possibility of export led growth to solve the likely BOP problem.

4. To suggest:
   a) A suitable consumption pattern of oil to have a sustainable and a relatively pollution free growth.
   b) A suitable policy to deal with disasters arising out of oil shocks (price and quantity). The idea is planners shall be ready with
an alternative to deal with such crisis so as to reduce the suffering, adjustment cost etc.

The details of the methodology are provided in this chapter, as it would be useful to present a broad picture of the type of methodology that is attempted. Growth of oil consumption have been calculated in chapter 4, by regression of consumption of oil and individual petroleum products consumed by nation and major states of nation on time and then using a measure of structural change in consumption, growth rates in consumption before and after liberalization have been analyzed. We have tried to find the interdecade comparison of oil in consumption. To capture the effects of structural changes in the consumption pattern, dummy variables were introduced in the simple regression model, both in additive and multiplicative forms for the amount of total oil consumption and total consumption of individual petroleum products in the entire nation and 19 major states.

For calculation of growth rates, semi - log model or what is also known as log – line has been used. This is explained as below:

Let \( Y = ab^t = a(1+r)^t \)

\[ \log Y = \log(ab)^t = \log a + \log b \cdot t \]

Or \( \log y = l + B_1 \cdot t \) (Here \( \log a = L, \log b = B_1 \))

Or \( \log Y_e = L + B_1 \cdot t + u \) (\( E = 1, 2 - - -, n \))

Here \( Y \), which in our case is the consumption of total oil or individual oil products in nation and in, States for which growth rate is required.

\( \log Y/t = \text{natural logarithm of} \ Y_t \), i.e. In \( Y_t \)

\( t \) = Time variable taking \( n \) values 1, 2, - - - \( n \), and in this study \( n \) takes 25 values for nation from 1980-81 to 2004-05 and 25 values for States from 1980-81 to 2004-05
\( \gamma \) = a random disturbance (or error) term satisfying the usual assumption of ordinary least square.

\( \gamma \) = compound annual rate of growth (CAGR)

\( B_1 \) = Constant percentage (instantaneous) rate of growth if \( B_1 > 0 \) and rate of decay if \( B_1 < 0 \).

To test, for structural change in the two time period before and after liberalization, dummy variable both in the additive and multiplicative forms has been used as below:

\[
\text{Log } Y_t = L + B_1 t + D_1 + D_2 + u
\]

Where \( D \)
- \( = 0 \) before liberalization till 1990
- \( = 1 \) after the liberalization

On the basis of estimated equation we have also forecasted the total consumption of petroleum products in 2020.

In chapter 5, we have analyzed the relationships and changes over time for income, population, and oil demand. We then focus on 8 major petroleum products—liquefied petroleum gases (LPG), Motor Gasoline, Jet Fuel, Kerosene, HSDO, LDO, Furnace oil, Lubricants and LPG—and analyze some important phenomena that explain many of the changes in demand for these products. Income and price elasticities are calculated for total oil demand and for each of the eight major oil products in the nation.

The time period taken for estimating growth rates in chapter 4 is from 1980-81 to 2004-05 and the time period taken for estimating elasticities in chapter 5 of different oil products is from 1981-82 to 2005-06. This is because until the early 1950’s coal was the principal source of commercial energy in India. Since then, the direct use of coal as a fuel has been declining in importance in relation to other fuels. In 1953-54, coal accounted for 47.8 per cent of the total commercial energy consumption (in terms of coal replacement) in the country. In 1974-75, the relevant ratio was about
24 per cent. On the other hand, the share of oil went up from 39.6 per cent to about 50 per cent during the same period. This shift in the pattern of energy consumption coincided with a sharp increase in domestic production of crude oil. Between 1960 and 1986, the domestic production of crude oil increased from 4,51,000 tonnes to 3,1157000 tonnes. The growth in domestic consumption of petroleum products was, however, much faster, and as a result a significant increase took place in imports of crude oil and petroleum products. The total consumption of petroleum products between 1970 and 1987 increased substantially from 18.73 million tones to 48.16 million tones. It is interesting to note that gross imports of petroleum products increased sharply between 1970 and 1973, from 0.97 million tones to 3.74 million tones. In the subsequent period, 1973 to 1987, imports of petroleum products fluctuated from year to year, but there was no noticeable upward trend. It is also interesting to note that in 1980’s and again in 1984, there were marked increases in imports of petroleum products. In 1990-91, liberalization process and removal of licence raj and lowering of duties, there was a sharp upsurge and growth in the industry as a whole. The automotive sector also took off. To keep pace there was lot of investment in the refining capacity. Transport infrastructure has expanded considerably and its energy-intensity has grown gradually. Rapid urbanization along with the conglomeration of industrial and commercial activities has consequently increased the transport demand. Uncontrolled expansion of cities coupled with inadequate public transport has contributed to a phenomenal growth in the number of mechanized energy-intensive private modes. In the domestic sector also rapid urbanization and diverse urban growth patterns involved many basic structural changes in the economy that have important ramifications for energy use. The growing demand for modern household fuels such as LPG and kerosene adds greatly to the already burden on scarce resources of capital and foreign exchange. Oil and gas accounted for nearly 54 percent of the total final
commercial energy consumption in 1996-97. The share of the four oil products LPG, SKO, MS, and Diesel has increased from 54.9 per cent in 1970-71 to 70.4 in 1996-97. Therefore, the economy is progressively becoming oil intensive in view of the increasing share of natural gas and petroleum products in the final commercial energy use especially after liberalization process. Due to these changes in the pattern of consumption of energy over time as well as in the fuel wise elasticities and also due to the easy availability of the data the study has chosen this period.

In a partial equilibrium framework we thus have estimated the various determinants of oil product demand in general and have analyzed how this is influenced by price and GDP by estimating the price and income elasticity of oil demand by using autoregressive distributed lag model (ARDL) model. An Econometric Analysis of demand for total oil and eight major oil products has been made.

Given the heterogeneity of oil demand response to change in income and prices, both across countries and oil products, it is necessary to examine several specifications of the demand equation. There are two general types of specifications for which result are given. In each case, the demand and income variables are measured in per-capital terms, and logarithms of all variables are used.

\[ C_t \] logarithm of per-capita oil demand
\[ GDP_t \] logarithm of per-capita real income
\[ P_t \] logarithm of the real international price of crude oil.

The two specifications are the following:

1) Demand as a function of income only, with no price variable; demand responds symmetrically to income increases and decreases. We assume that demand is a Koyck-lag function of income, that is, there is geometrically declining weights on past levels of income.
\[ D_t = a + \gamma (\text{GDP}_t + \lambda \text{GDP}_{t-1} + \lambda^2 \text{GDP}_{t-2} + \lambda^3 \text{GDP}_{t-3} + \ldots + \lambda^1 \text{GDP}_{t-i} + \ldots) \]

We expect \( 0 < \lambda < 1 \)

The function actually estimated is the standard Koyck-lag specification:
\[ D_t = c + \gamma \text{GDP}_t + \lambda D_{t-1} \]

2) Demand as a function of income (symmetric for income increases and decreases) and price (symmetric for price increases and decreases). Following Dargay-Gately (1995a) and Johnston (1984), we assume geometrically declining lagged weights, that are separately estimated for income (\( 0 < \phi < 1 \)) and for price (\( 0 < \phi P < 1 \)):
\[ D_t = a + \beta \sum \phi P_{t-i} + \gamma \sum \phi P_{t-i} + \gamma \text{GDP}_t \]

The actual demand equation estimated is:
\[ D_t = a (1-\phi) (1-\phi P) + (\phi P + \phi P) D_{t-1} - (\phi P \phi P) D_{t-2} + \beta P_{t-1} \phi \beta P_{t-1} + \gamma \text{GDP}_t \]

There are two special cases of this specification
2a) Koyck-lag specification, in which the income and price lag coefficients are assumed to be equal:
\( \phi = \phi P \)

The specification can be simplified to its standard form:
\[ D_t = a + \beta P_t + \gamma \text{GDP}_t + \lambda D_{t-1} \]

2b) Specification with no income lag: \( \phi = 0 \) (i.e., instantaneous adjustments of demand to income changes):
\[ D_t = a + \beta \sum = 0 = \phi P_1 P_{t-1} + \gamma \text{GDP}_t \]

3) Demand as a function of price and income without Koyck specification.

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After estimating the price and income elasticites of total oil and oil product demand we have felt that within this framework, econometric modeling is useful for analyzing the factors that influence domestic demand for petroleum products. The way we model domestic demand in our chapter 5, we allow for interfuel substitution. Also, the model enables us to examine the impact of trucks, buses & cars, industrial production, pre capital Income, Power generation, etc. on domestic demand for different petroleum products. However, a serious estimation problem arises because data is available not on domestic demand but on domestic consumption. Taking domestic consumption as a proxy for domestic demand does not solve the problem, since it reduces the above functional relationship to an identity devoid of any economic interest.

Thus, to estimate the above functional relationship, one requires some estimates of domestic demand for petroleum products. This can be obtained by estimating a demand function for petroleum products at the aggregate level as Ghosh, Lahiri and Wadhwa (1986) do. Alternatively, demand functions may be estimated for different petroleum products, and the estimated demand for the products, computed on the basis of the estimated demand functions and values of explanatory variables may be aggregated to yield an estimate of D. This is what we attempt in this chapter.

The chapter 6, provides an assessment of the implications of a rise in domestic petroleum product prices on the macro economic scenario of India by examining the impact of oil shocks on five important macro variables viz. GDP, inflation as measured through WPI, employment, wages and BOP and also on different sectors of the economy using distributed lag regression model, which produces excellent inference about the values of $\alpha$ and $\beta$.

The total imports and exports discussed in chapter sixth does not reveal the compound annual growth rate of BOP deficit, which is an
important parameter to see the effect of increasing consumption, imports of oil and oil prices on our country’s BOP and foreign exchange position. Therefore in order to check the intensity of problem, the growth rates of imports of crude and petroleum products for the period 1970-71 to 2005-06 have been estimated in this chapter. The method adopted for estimating is statistical method. The method is a semi-log model or what is also known as log-linear model. This is explained as below:

Let \( y = ab^t = a (1 + r)^t \)

\[
\log y = \log (ab) t = \log a + \log b.t
\]

\[
\log y = \alpha + \beta t \quad \text{(here } \log a = \alpha, \log b = \beta)\]

\[
\log y_t = a + \beta t + \mu t \quad \text{(} t = 1, 2 \ldots \ldots \ldots \ldots \text{n)}
\]

Here \( y_t = t^{th} \) observation on the dependent variable.

\( Y \) in our 1st case is the imports of crude for which growth rate is required.

\( Y \) in our 2nd case is the imports of petroleum products for which growth rate has been estimated.

The growth of import demand, which we would estimate, will get translated into our BOP deficit.

\[
\log Y_t = \text{natural logarithm of } Y_t \text{ i.e. } \ln y_t
\]

\( t \) = time variable taking n values 1, 2 \ldots \ldots \ldots \ldots n.

In this study n takes thirty-six values from 1970-71 to 2002-03.

\( \mu \) = A random disturbance (or error) terms satisfying the usual assumption of ordinary least square.

\( \gamma \) = compound annual growth rate (CAGR)

\( \beta \) = constant % (instantaneous) rate of growth if \( \beta > 0 \) and rate of decay if \( \beta < 0 \).
Based on the growth rates; we have estimated the value of import demand of crude and petroleum products for the year 2020. For achieving a sustainable economic growth and development in any society, it is necessary to design a master plan for oil production and utilization. To design such an appropriate plan, requires adequate data. Therefore we have estimated the future domestic oil production for the year 2020. For this the data about the past production pattern have been collected. In order to estimate the domestic oil production in the year 2020, we have calculated the growth rates of domestic production of crude and petroleum products by the same log-linear approach for the period 1970-71 to 2005-06.

\[
\text{Log } y = \text{Log } a + t \text{ Log } b
\]

\[
\text{Log } y = \alpha + \beta_1 t
\]

\[
\text{Log } y_\mu = \alpha + \beta_1 t + \mu
\]

Here \(\text{log } y\) in 3rd case is the domestic production of crude oil for which growth rate has been estimated.

In the 4th case \(\text{log } y\) is domestic production used for the growth rate of petroleum products.

The purpose of this study thus has been to analyze and evaluate empirically as well as critically the consumption pattern of oil in India, the determinants of oil product demand and the impact of oil price shocks on the macro economic variables and main sectors of the country.

A brief summary of the main findings and policy implications emerging from the foregoing analysis has been presented in this chapter.

The results according to chapter 4 indicate the compound annual rate of growth (CAGR) of total consumption of petroleum products during the 25-year period from 1980-81 to 2004-05 has been 5.51 per cent.

The total consumption of petroleum products rolled by 32,261'000 tonnes to 57,745'000 tonnes i.e. an increase of 25%million tones from 1980-81 to 1990-91 and the growth rate for this period, of total oil consumption as estimated in chapter 4, was slightly above 6%. After 1991,
consumption of petroleum products rose by 57,745,000 tonnes to 100,074,000 tonnes in 2000-01 in 10 years, which is an increase of about 42.5 million tonnes over the same period of 10 years. After 2000-01 to 2004-05, the increase in consumption is about 12 million tonnes. Even though there is a slight drop in the percentage increase and CAGR of total oil consumption in nation after liberalization from 6.29% to 5.24%, there is a significant increase in consumption in absolute terms. This is also in spite of slow down in the economy from 1999-2000 to 2002-03 after which the economy started looking up.

Comparing the CAGR of total consumption of petroleum products in States with nation, taking the growth rate in nation of total oil consumption as a base for comparison, in nation the growth rate for total oil consumption during the entire period from 1980-81 to 2004-05 was 5.51%, the CAGR of total oil consumption in states for the period 1980-81 to 2004-05, show that the States like J&K, HP, Haryana, UP, Rajasthan, Orissa, AP, Karnataka, Kerala, have a CAGR higher than or equal to 5.51%. Among these States, J&K, HP, Rajasthan, can be placed above having growth rate higher than 7% whereas States like Punjab, Delhi, Bihar, West Bengal, Assam, Gujarat, Maharashtra, Goa, MP and Tamil Nadu have moderate compound growth rates of consumption, having CAGR of less than 5.51%. Among these states only Bihar have a CAGR of even less than 3%.

Most of the states have a significant increase in consumption in absolute terms but the growth in CAGR of total oil consumption after liberalization has slowed down. Bihar is the only state, which shows negative growth rate after liberalization because of political instability and poor industrial climate. Some of the states like H.P., J&K, have a very high growth rate in the entire period because the initial consumption was low and a significant increase in consumption has caused the growth rate to be high.
For the individual products under study, there was a significant consumption rate of LPG during the period 1980-81 to 1990-91. The CAGR of LPG in nation after 1990 has declined from 20.67% to 11.46%. The main reason behind decline in growth rate after liberalization is that before liberalization the total consumption was very low and any increase in consumption indicated a higher growth rate. After liberalization the total consumption has gone high and therefore the percentage growth rate indicated is low. The other reason is that the government imposed restrictions on use of LPG in the industrial sector barring confectionary, bakery products and hotels and also removed subsidy where permitted but there has been a steep increase in consumption in the domestic sector because LPG is still partly subsidized by the government and because of growth in salaries. The demand in domestic sector is still growing after partial removal of subsidy on LPG. In absolute terms the consumption in 1980-81 was 405'000 tonnes. In 1984-85 it was 953'000 tonnes. In 1990-91 it went to 2415'000 tonnes. In 1995-96 it was 3922'000 tonnes, in 1999-2000 it was 6421'000 tonnes. In 2002-03 consumption was 8351'000 tonnes and was 10203'000 tonnes in 2004-05. Hence even though there is lower growth rate after liberalization, in absolute terms there is a tremendous increase in consumption. The consumption rate of HSDO was also significant in the 1st period but during the 2nd period decreased. This is explained by the fact that the subsidy on the diesel is being slowly phased out. The cost of diesel between 1990-2006 has more than doubled. Introduction of alternative fuels like CNG for buses and cars, which is relatively, a cheap fuel and replacement of HSDO by LDO, LSHS and Furnace oil for industrial use has also resulted in tapering down the growth because of the cost factor. The consumption between 2000 and 2003 went down steeply because of recession in the market, which led to lower growth rate after liberalization. Though there was a decline in consumption from 2000 to 2003 but the consumption of HSDO is increasing tremendously in
absolute terms in the entire period and also after 2003-04. The overall consumption in Naphtha has shown a significant increase in the growth rate after liberalization. This is because of increase in the capacity of the fertilizer plants to meet the agricultural demand and also because of setting up of number of Petrochemical units, which depend on Naphtha as a raw material input. The demand for Motor Spirit has grown fast as a result of rapid growth in population of personal transport vehicles but the growth rate has slightly decreased after liberalization. This can be related to the fact that the fuel efficiency of vehicles has vastly improved and the subsidy on petrol has been lowered down to a large extent. The substitution of gasoline and HSDO by CNG in private cars and public transport has also contributed to controlling the growth rate. Kerosene has been known to be a poor man fuel. The consumption of Kerosene in absolute volume is high as compared to most of the other products but the CAGR in the consumption has been going down rapidly after liberalization because of easy and subsidized availability of LPG, which is a preferred fuel. The growth rate of total consumption of LDO has gone down from 3.7% to 1.6% after liberalization. The overall growth rate is also low over the entire period. The consumption is going down in absolute terms also. This is because most of the D.G sets in the country depend on HSDO and therefore growth rate in the LDO is going down after liberalization. The availability of CNG for furnaces has also affected growth rate. The consumption pattern in absolute terms and the growth rate of consumption of Furnace oil shows an upward trend especially after 1990 because of an upswing in the industry and a high growth rate in the manufacturing sector. Overall LPG, gasoline, Naphtha, HSDO were consumed at a higher rate during the entire period of study from 1980-81 to 2004-05.

Chapter five makes some generalizations about important phenomena for understanding the determinants of oil product demand in our country. The chapter focuses on the importance of income and
population growth, and the lesser importance of changes in oil prices. It also describes some interesting asymmetries in the response of oil demand to increases and decreases in income. Finally, the importance of indigenous energy resources, domestic energy policies and the impact of the transition to modern fuels from traditional fuels such as fuelwood are discussed.

For total oil consumption and each of the products, the study has examined several alternative equation specifications of per-capita oil demand as a function of per-capita real income and WPI of crude oil and natural gas and petroleum products.

As the results depict per capita consumption of total oil has increased at a steady rate with increase in income. The income is more important explanatory variable with elasticity of .330. Price has an effect but statistically has been less significant than income effect. The price elasticity calculated is negative i.e. - .0213. Our total oil consumption per capita declined in response to peak in oil prices, but the response to oil price increases was very less and not prolonged. This shows that total oil demand responds to price increases in oil but the response is very meager. The effect of demand lag of one year is found to be most profound with value of 1.157, which is significant (at 1 percent and 5 percent levels), which suggest that last year demand effect is the most on current demand for total oil.

In case of petrol, the results according to Koycks lag specification- 3 came out to be better & statistically more significant with adjusted R Square of .997. Current income effect has come out to be .400 statistically significant at 10% level. The impact of previous years income has came out to be statistically insignificant. Changes in price of petrol have come out to be statistically significant determinant of petrol demand. The coefficient of price elasticity is -.395. Previous year demand i.e. D_{t-1} also has a strong impact on current demand for petrol. According to the estimated elasticity's,
income does matter more but change in price also have an effect on current demand of petrol. Overall the consumption of petrol in absolute terms is increasing more or less at a steady rate with the increase in income but the percentage increase and the growth rate in consumption has declined or the slope changed after liberalization with the rise in price of petrol.

According to specification 3(a) with the highest adjusted R Square among all specifications the income elasticity of kerosene is .07 statistically significant at 10 percent level and the price elasticity is -.098 statistically significant at 1 percent level. This shows the adverse impact of price is slightly more than income. The impact of one-year lag in demand is most profound with coefficient of .8 statistically significant at one percent level. Kerosene is the product for which per-capita demand kept increasing till 1998-1999 but has been slowly and continuously declining since 1999-2000. There is a steep decline in per capita consumption and consumption in absolute terms after 2003-04. The growth rate of consumption of kerosene has declined steeply after liberalization; much of this decline in growth rate is attributable to the price of kerosene which has steeply increased after liberalization due to the reduction in subsidy on the price of kerosene and the rapid growth of LPG, which is being substituted for kerosene in cooking.

In the case of ATF, the results with Koyck specification 3 are the best with highest Adjusted R2 value, with income elasticity & price elasticity both found to be statistically insignificant. The results of price elasticity had come out to be insignificant in all cases. The growth rate of consumption of ATF has declined after liberalization as estimated in chapter 4, but consumption of ATF has been increasing in absolute terms. There is evidence of the profound positive impact of previous year’s demand (D_{t-1}) on current demand with coefficient greater than unity. The estimate of D_{t-2} is -.89 statistically significant at 1 percent but showing a strong adverse impact on current demand of ATF. The results without Koyck specification i.e.
according to simple regression model shows, income has the expected positive coefficient of .392 and statistically significant at 1 percent level, and price elasticity is not statistically significant. There is very less or no evidence of the impact of price on the per capita consumption of ATF.

The econometric results for HSDO were better or relatively good than both Gasoline and ATF with nearly all the specifications. In specification 3(a), income elasticity is found to be with strong and positive coefficient of .4 and statistically significant at 1 percent level. Price elasticity effect came out to be statistically significant with coefficient of -.25. The impact of price according to specification 3 also, came out to be statistically significant with coefficient of -.4. But the income elasticity coefficient came out to be statistically insignificant. The impact of last year GDP growth is most strong and positive on the current demand of HSDO with coefficient of .879, statistically significant at 5 percent level. Overall the estimates show that income growth mattered more in the case of demand for HSDO.

The econometric results of LDO have been fairly bad. The Koyck specification 3, gives better results as compared to others. The value of adjusted R Square is .613. The income elasticity is -2.968, which is considered as a wrong sign or statistically insignificant and the results depict price elasticity to be negative and stronger and more statistically significant than income elasticity. The coefficient of price elasticity is -.981. There is evidence of a strong effect of last year demand i.e. Dt-1 (with coefficient of .8) on the current demand of LDO. There is very profound one-year lag impact of GDP with coefficient of 3.296 statistically significant at 1 percent level. According to the next best result with specification 3(a) with adjusted R Square of .429, income elasticity is .286 or approximately .3 and price elasticity is -.35. Here again there is a strong impact of last year demand on current demand. Overall the changes in prices or the adverse impact of price and previous year’s income growth i.e. GDPt-1, both have strong impact on the demand for LDO. The CAGR of consumption of LDO
declined significantly after liberalization. This can be correlated to the fact that there is a maximum price rise in the case of LDO as compared to other products.

In case of FO, According to Koyck specification -3a) with the best results among others, the price elasticity came out to be insignificant and income elasticity came out to be .135, statistically significant at 5 percent level. There is a positive impact of last year demand on the current demand of FO with coefficient of .51. Thus overall the results depicted that income mattered more as a determinant of FO demand. The consumption of FO is increasing after liberalization at a positive and higher growth rate. There is complete absence of a price effect on demand of FO.

The results for lubricants were best provided by specification 3(a). According to this specification with highest adjusted R square, price and income both were equally important determinants for demand of lubricants. The income elasticity estimated came out to be 1.068 i.e. more than unity and price elasticity estimated is −1.008 (both significant at 1 percent and 5 percent levels), which shows strong adverse effect of prices and strong positive impact of income on demand of lubricants. The strong impact of income and price is felt in other specifications also but the impact of income is slightly more than the impact of price on demand of Lubricants. Thus the consumption of lubricants responds more to changes in income. The consumption of lubricants is increasing significantly in absolute terms. With increase in income, per capita consumption has gone up due to increase in affordability to buy 2-wheeler and 4-wheeler. The growth rate of consumption of lubricants has slightly gone down after liberalization due to increase in price of lubricants and also because initially the consumption in absolute terms was very low which led to higher growth rate before liberalization.

The results of LPG according to specification2, 3, and 3(a), with same adjusted R Square, give the coefficients of price and income elasticity to be
There is a strong impact of one-year demand lag on current demand with coefficient of around unity significant at 1 percent level. The coefficient of all other variables has come out to be statistically insignificant. There is a strong and positive impact of current income on current demand of LPG according to simple regression model and also according to specification 3 (b), where the impact of \( D_{t-1} \) is not included in the regression function. There is complete absence of price effect in all the specifications. The per capita consumption of LPG is increasing at a very rapid rate in the entire period. There is no decline in the consumption of LPG. The slope of per capita consumption of LPG is showing a continuous upward trend. In absolute terms there is a tremendous increase in consumption in the entire period but the growth rate of consumption has declined in nation after liberalization. The main reason behind decline in growth rate after liberalization is that before liberalization the total consumption was very low and any increase in consumption indicated a higher growth rate. There may be some impact of price on the growth rate of LPG but there is no impact of price on LPG consumption in absolute terms or on per capita consumption.

Overall, the results indicate that in most of the products the impact of income and previous year demand is more on current demand than the price effect. The price elasticity is negative in most cases showing an adverse effect. But for those cases where the prices of oil products were statistically significant, the price elasticity was often small relative to the income elasticity.

In case of certain products like ATF, FO, LPG there is complete absence of price effect on demand.

Examining the price and income elasticites for total oil demand in states, in most cases like Punjab, Haryana, Bihar, Maharashtra, Rajasthan, Karnataka, Kerela, Andhra Pradesh, the impact of income elasticity is evident but the results of price elasticity were statistically insignificant. The
impact of previous year’s demand is most profound on current demand of total oil.

J&K has an income elasticity of .28 and price elasticity of -.33. The negative impact of price is slightly greater than positive impact of income. In Himachal Pradesh also, according to specification 3, the negative impact of price on demand is more profound on current demand. Orissa has income elasticity of .338 or between .2 & .416 and have price elasticity of around -.3 or little greater than -.3.

Tamil Nadu and UP had the worst results with negative adjusted R Square in all the cases and the t values came out to be statistically insignificant.

To the best of our knowledge, no one has so far analyzed the determinants of domestic demand for different petroleum products in India. The way we model domestic demand in our chapter / study, we allow for interfuel substitution. Also, the model enables us to examine the impact of trucks, buses & cars, pre capita Income, index of industrial production, power generation, etc. on domestic demand for different petroleum products.

The results indicate that the own price elasticity estimates are negative (as they should be) for all products except MS (but statistically insignificant) and FO and the numerical values of the own price elasticity’s are low in general and statistically significant only in one case, which indicates that domestic demand was not much responsive to price changes. Our results indicate no significant substitution possibilities between HSDO and MS and but there are significant substitution possibilities between Kerosene and coal. The coefficients of the various activity variables in the demand equations are of the correct sign & plausible magnitude. These are statistically significant in most cases. An important conclusion that may be drawn from this analysis is that one cannot hope to reduce petroleum
demand and thereby imports of petroleum products much by simply raising the domestic administered prices of petroleum products.

As international oil markets become tight, global prices would rise, and so would domestic retail prices. How do these changes in domestic prices of petroleum products influence the overall price level and hence the whole range of economic performance? Chapter 6 is an attempt to answer this question using regression model for India.

The world economy has witnessed four bouts of oil price shocks in the past thirty years, viz, 1973-74, 1979-80, 1990 and the recent one in 1999. Oil prices have been steadily rising from mid 2001. A record price of $75.35 was reached, due in part to Iran’s nuclear crisis, on April 21, 2006. This study have examined the impact of oil shocks on five important macro variables viz. GDP, inflation as measured through WPI, employment, wages and BOP using Ordinary least Squares (OLS) regression.

Overall the results on different macro variables indicate that there is clear negative lag impact of oil prices on GDP. Assuming other factors as constant, an increase of oil prices by one percent has a one-year lag impact of .10 percent. Similarly oil prices have an immediate and strong impact on inflation of around .157 to .22 percent whereas there are less or no signs of any delayed impact on inflation. Similarly the oil price has an immediate adverse impact of .5 percent on wages. But there is no indication of any impact of oil prices on employment according to our regression results. There may be an indirect impact of oil prices on employment. Employment turned negative in the 1979-80. This negative rate of decrease in employment can be due to global recession that occurred in 1979-80 due to peak in the price of oil.

Increase in oil price also impacts on agriculture sector mainly through transport costs and through impact on prices of inputs like fertilizers. Our analysis of the impact of oil price increase on the Indian economy revealed that among different sectors of the economy the only sector that had a
strong negative relationship with oil prices was the manufacturing sector. However, though the manufacturing sector is the most susceptible to oil price increase, a lag impact spread and the increase in competitiveness of this sector allows the manufacturing sector to escape the full brunt of oil price hikes and also because a sustained increase in oil prices over two to three years is very unusual. One major aspect that accentuates the negative influence of oil prices increase on industry is the excessive dependence of some industries on diesel based captive power plants for energy. Chemicals account for about 14% of India's manufacturing sector in output value terms, and 14% of exports, according to the Indian Chemical Manufacturers Association (ICMA; Bombay). India's chemical companies have been struggling to increase prices to keep pace with rising oil, naphtha, and gas costs. Meanwhile, prices of imported chemical products have skyrocketed in line with higher prices on international markets. Higher raw material prices are hitting those sectors of India's chemical industry, mainly pharmaceutical and agchem intermediates, and certain other specialty chemicals, where India has built up a formidable export position partly through outsourcing of production by multinationals. "Any sustained flare-up in prices could have an impact on the activities of export-driven sectors such as dyes and intermediates, and specialty chemicals,"

Experience shows that oil price shocks have had only a marginal impact on the Indian economy, especially in the long-term perspective. In India, the episodes of increasing energy prices have been reflected in rising inflation during the two oil price shocks of 1974 and 1980 as well as 1990-91 Gulf War. The increase in oil prices in 2000-01 also resulted in higher inflation in that year. This pushed up the monthly inflation to 8 per cent in the second-half of 2000-01 compared to 6 per cent in the first. But the following year, inflation rolled back to 3.7 per cent negating all fears of a prolonged period of high inflation. Thus, the impact on inflation was short-lived despite international oil prices rising 35 per cent, from $22 to $30 a
barrel. The impact of rising fuel prices on the price of primary and manufactured products is likely to remain subdued in line with the deflationary environment worldwide and increased competitive pressures at home. We expect overall inflation to rise moderately in the near future as a result of increase in the price of oil.

Thus the direct impact on inflation as well as GDP growth rate at fraction of one percent would be indistinguishable from similar impacts from myriad other causes.

The oil consumption pattern and the abundance of non-oil energy resources have shielded the country from the effects of oil-price shocks. In India, the major energy source is coal — accounting for over 52 per cent of total commercial energy — followed by oil at 34 per cent. Such a situation is unique to India. The direct impact of oil is largely on the transport sector, which consumes over 42 per cent of the oil products. Nearly 84 per cent of the energy consumed by industry comes from coal. Similarly, in agriculture, the main energy source is power (about 90 per cent) or coal; oil accounts for a mere 10 per cent and is used mainly for operating agricultural pumps.

The overall impact of the high oil prices on the Indian economy is also restrained by factors like the comfortable balance of payment position, the large foreign exchange reserves and the access to international capital. These parameters have improved substantially in India’s favor as compared to the previous period of high oil prices. Moreover the latest numbers indicate that economic growth continues to be strong. GDP grew at an annual rate of 5.8 percent in the second quarter of 2002-03, only slightly lower than the previous quarter’s growth rate of 6.0 percent. Although agricultural growth has been flat, growth in both industry and services has been strong. The index of industrial production grew at 6.9 percent in 2003-04, up from a dismal 2.7 percent growth in 2001-02. Most encouragingly, exports grew at 15.6 percent during April to November 2002, compared to a decline of 1.2 percent in 2001.
The structure of balance of payments including current and capital accounts has undergone significant changes in the past years. A $5 per barrel rise in oil prices is expected to have an annual impact of around $4 billion on the current account, an impact that can be easily absorbed. Therefore structural changes in the past 14 years have significantly improved the Indian economy's ability to absorb the current oil-price shock without throwing it into another crisis or even dragging the domestic product growth to less than 5 percent.

But Inspite of the very healthy foreign exchange reserves and prospect of being a net exporter of refined products, in view of the spiraling oil prices and prices hovering around $100 per barrel as of in late 2007, the country will not be able cover the BOP deficit because of the huge dependence on import of crude in the near future. It is expected that the price of oil will most likely more than double than the price today, therefore our BOP would surely be adversely affected. Moreover Chemicals, which account for 15% of India’s manufacturing capacity and 6.7% of its GDP, the government says soaring oil prices are hampering the government's plans and putting pressure on the chemical industry. However, India imports almost all of its oil requirements. High oil costs have added to the challenge the government faces to satisfy the aspirations of the two-thirds of India's 1-billion population that live in relative poverty in rural areas, and of the country's growing urban middle class.

By ensuring a comprehensive energy security strategy, India can alter the economic and political landscape of the region. Lastly now the chapter will read out the policy implications.

**Issues of Knowledge and Policy Responses to Higher Oil Prices**

- India’s energy security is at stake and the country could play a leading role among developing countries to set up emergency preparedness mechanism.
• Incentive should be given like for linking electricity grids, promoting regional hydroelectric stations. Stockpiling oil on a cooperative basis and pursuing nuclear energy options.

• In the international scene the two previous oil shocks of 70’s brought out the inherent instability in the supply and price of oil. As a result the share of oil in total energy demand dropped significantly in many countries like USA, West Germany, Canda, UK, Italy, France and Japan etc. after 1979. One of the classic examples of reduction in consumption of oil and consequently its imports is that of Japan. The share of imported oil within the oil supply in Japan hovered around 90% or above most of the time. Against this background, Japan’s success in reducing its dependence on oil and imported oil in particular is a remarkable achievement. Therefore one of the major reasons for Japan’s success in coping with the high cost energy environment since 1979 has been the remarkable reduction in oil use without sacrificing growth. Panikar (1991). As against the foregoing, apparently there has been no evidence of any deliberate attempt in India to cut down oil consumption since the outbreak of the oil shocks in the 1970’s. It is true that the annual rate of increase in imports of oil has been cut to half; however the absolute volume of imports has increases substantially and steadily. Therefore the growth and stability of our economy is dependent on crude oil price, which is a major arm-twisting lever in the hands of oil cartels and can play a major role in GDP growth and progress of our country. Dependence on imported oil should be decreased through effective oil conservation programmes and inter fuel substitution. Public transport systems should be improved in every possible way to discourage energy intensive private modes of transport.
Renewable energy should be allotted a higher share of total allocation of power starting with 10% with the ninth plan and increasing appropriately from the next plans. A separate solar energy commission is to be created in line with atomic energy commission with identical terms of reference to adopt solar energy to the maximum possible extent in every sector of consumption.

Massive education awareness programmes for people in every walk of life for efficient utilization of energy through supply and demand management. Everybody is to be informed that energy, especially oil is a really precious commodity.

Thus the volatility of oil prices is a highly destabilizing factor for the world economy. It is more devastating for oil importing developing countries than for other countries. Given the strong cartel in the form of OPEC operating in this market, it is not possible to rule out oil price shocks of the type faced in the early 1970s, early 1980s, early 1990s and 2000 or even in the future. It is imperative for international community to create a mechanism to regulate and stabilize oil prices at a certain reasonable and sustainable level. The intervention should bring the OPEC and other oil producers to observe some international discipline. Further, there should be a special fund to moderate the impact of volatility in oil prices for the poorer developing countries. One medium term option to cushion the oil price shock is the setting up of strategic petroleum reserves. The government should set up at least a 45-day reserve at a capital cost of over Rs 4300 crore. This is a conservative target in view of reserves of 90-day net imports for OECD countries and 90-day domestic consumption for the EU countries, but from a poor
country point of view it may still be excessive. Therefore, the size of reserves should be kept at the minimum level necessary to ensure the physical supplies to meet only the urgent strategic needs.

- Need for careful targeting of the beneficiaries so that subsidies do not go to the wrong segments- or into the adulteration of petrol and diesel, thanks to the irrational pricing of products.

- Initiate measures for reducing technical losses in production, transportation and end-use of all forms of energy.

- Initiate action to reduce energy intensity of the different consuming sectors of the economy and promote conservation and demand management through appropriate organizational and fiscal measures.

- Maximize satisfaction of demand for energy from indigenous resources.

- Initiate appropriate organizational changes in the case of different energy sub-sectors consistent with the overall energy strategy.

- Promote technologies of production, transportation and end-use energy that are environmentally benign and cost effective. We have to encourage those industries, which are using more energy efficient technologies and introduce new technology at a more rapid rate than in the past. This is only possible by the proper enhancement of expenditure on Research and Development projects.

- Developments on the oil front have always been significant for a growing economy like India. However, these become highly
significant when the country is poised for an economic take-off. Restoration of the fiscal health of the nation is linked to the oil sector reforms. At present, the key problem that is currently inhibiting sustained and higher economic growth is the serious nature of the fiscal situation at both the central and state levels. Unless there is urgent and drastic action to improve the quality of the Indian fiscal, higher economic growth will be stymied. Any increase in private corporate sector investment will not sustain itself unless the fiscal health of the nation is restored.

- India’s yawning energy needs and the looming import gap has led to a reassessment of its energy strategy in recent years. Policies in the energy sector are now aimed at exploiting domestic oil and gas resources more efficiently, attracting foreign investment to finance the required infrastructure, and shifting from imported oil toward the more competitive natural gas. Government should quickly finalize the proposals of laying gas pipelines with the neighboring countries. We should also invest in finding new gas fields in our own country. The government is actually laying a gas pipeline to import Natural Gas from Iran. It is also laying a gas pipeline from Burma across Bangladesh into India. These are the two proposals, which are likely to materialize. Gas will help reduce oil imports and oil import bill as there would be no shipping costs importing from the neighboring countries, the cost will also be cheaper. Reliance and Gail have also discovered gas fields in Godavari and Cambay Basin. Thus efforts like pipelines may reduce cost but will out way due to price increase as the expectation of price increase is more at the time of exhaustion in the near future or around 2020.
The Indian government is conscious of the need to diversify its sources of supply and also to boost domestic supply of primary energy as well as final products. (LPG, Kerosene, Natural gas, Lubes, etc.) On the exploration and production front, developments are slow. They reflect in part the state of India- its oil and gas reserves, mature fields, limited reserves or costly new developments. The only bright side of the Indian petroleum scene is the increase in the refining capacity, which can play as major export item. Tackling import dependence and handling the BOP is going to be the biggest task for the government's to come. The oil companies and ONGC will need to keep stepping up domestic exploration; improving recovery factors at existing fields and acquiring overseas assets. ONGC's domestic reserves amount to 6 billion tons of oil equivalent (toe), but it plans to double this in the next 20 years through offshore exploration. Acquiring overseas assets and exporting refined products will be the mainstay in balancing our BOP strategy. India is participating in Russia and projects in Sudan, Vietnam and Iran. This will help offset and reduce the oil import bill.

On balance, it appears that the Indian economy is more resilient to shocks because of reforms. As far as counter shock policies are concerned, all major domestic and external shocks must be countered through contra-cyclical fiscal and monetary policies. In the short run, this may lead to higher inflation due to a tradeoff between growth and inflation in case of certain shocks that are stagflationary. In the long run, counter shock policy must involve higher public investment financed by the lowering of other government expenditure.
• At the very least, the current oil shock serves as a further reminder of the need for a longer term strategy involving economizing on energy utilization and intensifying for alternative energy sources.