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Keywords: Natural Gas, Price Reforms, General Equilibrium Modelling

JEL Code: C68, N75, Q41, Q48

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Natural gas as a source of clean fuel is important in many economies. With the increase of trade in gas led by LNG trade, market integration as occurred in other sectors is been promoted in various regions of the world. However, in India, the objective to address distributional concerns and domestic economic growth superseded the reform agenda with India adopting the market intervention approach of controlling energy prices. The policies were greatly focused towards the allocation of natural gas to priority sectors like fertiliser, city gas distribution, power, etc. at affordable prices as the output prices of these sectors are subsidised. The interlocking of subsidies of the demanding sector and ad-hoc pricing procedure adopted for gas pricing has resulted in a distorted market. As a result, natural gas share in primary energy consumption in India is about 8 percent as compared World average of 24 percent (2013).

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1 Introduction

Natural gas as a source of clean fuel is important in many economies. With the increase in prices of conventional fuels and growing concern for environmental regulations, natural gas is considered as the most preferred fuel to address the concerns for transition to a low-carbon economy. The last decade (2009-2019) saw the global demand for natural gas growing at an average rate of 2.9% per annum, with the natural gas share in primary energy consumption being about 24.2% in 2019 (BP, 2020). During the same period, natural gas consumption in India has remained stagnant at 59 BCM per annum with a share in the primary energy mix of about 6.3% in 2019. India's natural gas consumption is expected to grow at 5-6 % per annum during the next two decades[1]. The driving forces are economic growth, increased use of gas by fertiliser, power plants, industry and city gas distribution. The increased demand is expected to be met both by domestic production from New blocks under Hydrocarbon Exploration and Licencing Policy (HELP) and liquefied natural gas (LNG) imports through expansion of existing capacities and new investments.

To have a secured supply of gas and stability in prices, market integration is necessary for economies of scale. However, many gas markets in the world including India are either underdeveloped or fragmented. With the increase in gas trade led by LNG, market integration is being promoted in various regions of the world[2]. As a result, natural gas prices are also becoming increasingly integrated. Further, to promote the development of the upstream sector, various initiatives have been taken by both the developed and developing economies to create national markets which equalise demand and supply and allow market forces to determine the wellhead prices. Similarly, in the downstream sector, initiatives like unbundling of sales of gas and transportation, open access to transportation have allowed gas users to make direct arrangement with producers for their supplies. As a result, natural gas companies in most economies have now transformed from vertically integrated monopolies to more competitive structures. Similar models were also introduced in developing economies with completely different structures, like an embryonic market, limited and fragmented transportation network, in the belief that results would be similar to those achieved by reforms in UK and US.

In India, market integration was constrained due to (a) the absence of gas pipeline networks to facilitate distribution and substitution of energy sources, and (b) the prevalence of energy subsidies either at producer level or at consumption level or both. Since the 1990s, the government has initiated various market-oriented measures for reforms. However, the objective

[1] @ 5.3% per annum (BP, 2019) and @ 6.5% per annum (IEA, PNGRB, 2013).
[2] In 2019, LNG accounted for 38% of the total gas traded (BP, 2020).

to address distributional concerns and domestic economic growth superseded the reform agenda with India adopting the market intervention approach of controlling energy prices. The controlled regime has resulted in energy subsidies either at the producer level or at consumption level or both. In the case of natural gas, the prices for supply to certain sectors (eg. fertiliser, power, city gas distribution and petrochemical sectors) are controlled using the administrative price mechanism[3]. Further, these consuming sectors too are under a controlled regime with subsidised and controlled end-user output prices. Thus, the interlocking of subsidies of the demanding sector and ad-hoc pricing procedure adopted for gas pricing has resulted in a distorted market. As the result, though the natural gas sector is growing it suffers from issues related to pricing, demand-side growth and supply-side constraints.

With resilient inter-linking with its downstream consuming industries, any policy changes in the natural gas sector are likely to affect their energy input prices thereby increasing their production cost. With controlled output prices, there would be increased losses and additional fiscal burden, where the government is directly supporting the subsidy[4]. As a fallout of such measures, there are increased inefficiencies, wastages and technical losses in these consuming sectors[5]. Further, such low natural gas prices are not only a disincentive for investments in the upstream sector, but they also discourage investment in energy efficiency on the demand side. In the case of the fertiliser sector, because of inefficiency and imbalance in the use of fertiliser, the basic objective of self-sufficiency for which the prioritised allocations at the subsidised price were made is lost. Consequently, a rise in the price of natural gas as a subsidy reduction measure undertaken by the government would directly impact the energy cost of several sectors such as fertilizer, chemicals, electricity, and construction sectors. The change in the cost structure of these sectors is likely to affect the production level and price of the output, exports and imports of these sectors, with attendant impacts on the users of these products. The cumulative impact on the costs, output and prices of various sectors are also likely to affect household income, with its attendant consequences for household consumption and savings. Besides, changes in the price of several commodities too would have an impact on household consumption patterns. Alongside these sectoral and household level impacts, the fiscal position too is likely to be affected – directly because the rate of subsidy on these two fuels is sought to be reduced, and indirectly because the changes in sectoral output, household income and consumption, are likely to impact both direct

[3] With major gas producing and transporting companies being state owned enterprises, government could influence the prices indirectly.

[4] The focus to achieve distributional objectives by providing electricity to certain set of consumers has led to distortion through the presence of direct subsidy and cross-subsidisation between industrial consumers and agricultural consumers.

[5] Even after the reforms initiated in the power sector the electricity prices are some of the highest in the world even in public private partnership mode. For details refer to Report of the Expert Committee on Integrated Energy Policy, Chapter 5.2, Planning Commission, GOI, 2006.

and indirect tax collection. The changes in the fiscal position, in turn, would have macro-level impacts affecting savings, investment and hence the overall level of activity in the economy. The changes in the sectoral trade flows in turn would affect the balance of payments and exchange rate.

Given the historical context and distributional concerns at the consuming sectors, it is unlikely for the government to consider simultaneous reforms in the allocation as well as pricing[6]. This study, therefore, examines the plausible impacts of introductions of price reforms in the natural gas sector. In particular, it attempts to quantify the impacts of sequencing the pricing reforms under the following scenarios (i) introduce upstream price reform without introducing quantity reforms for the consuming sectors, (ii) introduce quantity reform by removing the prioritised gas allocation policy and allowing consuming sectors to pass the increase in energy price to the end-users and (iii) introduce full (i.e. price and quantity) reforms in the natural gas sector. Since the impacts of the price reforms in the natural gas sector are likely to be felt across several sectors, households, government and at the macro level, it is important that the analytical framework capture the various inter-sectoral, inter-agent linkages in the economy in a consistent manner. One such analytical framework that can capture these linkages is the computable general equilibrium (CGE) modelling framework. The study makes use of the general equilibrium model developed for the Indian economy by Harak and Ganesh-Kumar (Forthcoming).

The rest of the paper is organised as follows: Section 2 provides a brief review of literature on the natural gas sector in India and thus setting the background and context of the paper. The methodology and the database used for the study are described in Section 3. Section 4 describes the BASE case scenario and the framework for policy analysis. The results are presented in Section 5 and the paper ends with concluding remarks in Section 6.

2 Literature Review

The output of the natural gas sector is consumed by the sensitive segment of the economy and hence historically the natural gas segment has been the most contested sector. The sector, therefore, suffers from the interventions by the government and political system with the objective to ensure lower energy prices. The current policy approach is derived from the fact that India is relatively short of gas and the available gas is being allocated through quantitative restrictions with consequent under-pricing. Though the issues arising out of government interventions have been deliberated extensively at the industry level over the years both by producing and consuming sectors, there exists very limited literature on the subject and that too

[6] Reference to debate on the distributional issues raised by fertilizer and power.

from the perspective of the consuming sectors. The review, therefore, is primarily based on the Indian literature wherein we discuss the consequences and impact of interventions/subsidy but where relevant International literature is referred to especially from the methodological standpoint if it is an important issue.

Regulations: Studies like Corbeau, 2010; Agarwal, 2010, Ebinger and Avasarala, 2013; Joshi and Jung, 2008; and Kelkar, 2009; among many others have raised concerns on the interventions both with respect to pricing and quantitative allocation as these not only affected the development of the natural gas sector but also caused further distortion in the economy due to strong inter-sectoral linkages. Corbeau, (2010) in her study concludes that the existence of the dual pricing system had indeed proven its shortcomings with the domestic APM gas volumes and its share in total natural gas supplies diminished. Further, the low gas prices not only dis-incentivized the upstream investment but also discouraged investments in energy efficiency on the demand side. Similar findings were reported by Agarwal, (2010) in his study indicating that the existing pricing policy for natural gas has constrained growth of the sector leading to a large unmet demand in the power and the fertilizer sector. While Ebinger and Avasarala, (2013) in their study highlight the complex pricing structure of gas allocation in India with nearly twenty-five different prices of natural gas in 2012 based on who produces, where it is produced, and where it is sold. Allocation and pricing control enabled gas to become a cheap source of energy and became an object of political lobbying by states for allocation to the fertilizer and power sector. As a result, the pricing controls have inadvertently constrained domestic production and boosted consumption in the downstream sector. Kelkar, (2009) in his paper highlight the concern that the current policy approach to gas is from the mindset that India is relative "gas short" and this scarcity is attempted to be met through rationing with consequent under-pricing. Further, the gas prices are determined through a non-transparent manner. As a result, in the absence of fuel prices, this approach not only reinforces the shortage phenomenon, discourages supply but enhances demand. The distributional objectives in the natural gas sector were therefore pursued through a pricing and allocation mechanism wherein the consumers were sold gas at controlled prices and the loss was borne by the state-owned companies (Joshi and Jung, 2008).

Consuming Industries: The majority downstream consuming sectors for natural gas viz. fertilizer and power being sensitive sectors to the economy were themselves operated under a controlled price regime with subsidized output pricing. As a result, to reduce the subsidy burden of consuming sectors as well to address the distributional concerns, several studies like Goldar and Kumari, 2009; Parikh et al., 2009; Jackson, 2005; Rangarajan Committee (GoI, 2012) among others have justified the price intervention in the natural gas sector. Jackson, (2005) in his study justifies the existence of a hybrid gas market structure (public and private sector with dual pricing) as a transitional strategy so as to enable reforms in the consuming sectors viz. electricity and fertilizer sector in a phased manner. While Goldar and Kumari, (2009) in their paper conclude that the current regime of natural resource subsidy i.e. supplying subsidized natural gas to the power and fertilizer sector will help in keeping the power rates low and containing the fertilizer subsidy. Eliminating subsidised pricing of natural gas will adversely affect the competitiveness of Indian Industries. Rangarajan Committee (GoI, 2012) in their report also acknowledged that netback-based pricing from imported LNG works when the final product is freely traded. Since, the fertilizer and power sector, a major consumer of domestic natural gas are still subject to administrative price mechanism, linking domestic price to import parity pricing may not be relevant for India. Parikh et al., (2009) in their study concluded that a marginal increase in farm gate price of urea does not affect the demand for urea including the demand for natural gas. However, linking urea price to import parity prices reduces demand substantially with the corresponding drop in natural gas demand.

On the other hand, Ebinger and Avasarala, (2013) in their study have raised concerns on the overwhelming role of government in the allocation and pricing of natural gas which had resulted in misguided investment decisions in the consuming sectors. With the price of natural gas being lower than alternate petroleum fuels (naphtha, fuel oil, etc.), investment started solidifying around the existence of the policy and substantial investments were made in the downstream sectors i.e. fertilizer and power on the basis of allocation of subsidized domestic gas. In the absence of pricing reforms in consuming sectors and domestic gas shortages, many of the investments were operating below full capacity thereby raising the cost of capital for new projects. Jain and Sen, (2011) in their study also argue that the distortion in the gas-consuming sectors (fertilizer and power) have affected the development of domestic supply as well as infrastructure (pipelines). The study indicates that partial reforms often has the effect of displacing the problem (i.e. upstream to downstream or vice-versa), thereby presenting new policy challenges (distributional objectives). Hence, reforms in the natural gas sector cannot occur without addressing the issues of distributional and agricultural objectives.

Reform Alternatives: The literature on gas pricing distinguishes between the concept of the price level and price formation and attributes the dilemmas faced by developing countries to set the price of gas with the focus on the level of price rather than the formation mechanism (Rogers and Stern, 2014; Stern, 2012). Though the literature argues that to achieve the distributional objective, the prices are allowed to set through a price formations mechanism and providing a subsidy to eligible consumers. However, the gas price reforms/price revisions in the Indian natural gas have only focussed on managing the price level rather than market-based pricing. Given the underlying aspect of price levels, most of the studies on price reforms have primarily focussed on the distributional aspects of price reforms on the consuming sectors rather than the effects of price formation on the natural gas sector. GAIL, (2010) in their study has recommended a price pooling approach through the formation of a sectoral pool focused on major consumers like fertilizer and power sector where gas at pooled prices (say a weighted average of domestic and import gas) is supplied to identified customers. The objective was that a single benchmarked price of natural gas in India would be in the larger interest of the consumer and also benefit the market development of the natural gas industry. The Inter-ministerial Committee (GoI, 2011) suggested that 'price discovery' for new domestic gas should reflect opportunity costs, the incentive for exploration and production and fairness to consumers. They further recommended that domestic price may be linked to reference price arrived as the simple average between Henry Hub (HH) and the Asia Pacific imported LNG price.

While the Kelkar Committee, (GoI, 2014) in their report has stated that fair and rational pricing of gas is needed for the development of the sector. To substantiate their claim for market-driven prices, they have raised the issue of intergenerational equity in the natural gas resource. The report recommends a phased approach for linking natural gas prices to market prices and discontinuance of the gas allocation mechanism. Sen, (2015) while reviewing the price reform in the natural gas market concludes that a reorientation of policy towards the longer-term role of gas in the Indian economy relative to coal and crude oil is required so that the price reforms should reflect the dynamics of Indian gas market, rather than focussing on regional dynamics of other gas markets and managing price levels. Jackson, (2005) in his study also argues that the reform process of the natural gas sector becomes the process of constantly redrawing the boundary between these markets to switch consumers from public/domestic to private/imported market. Citing varied constraints in the natural gas and consuming sectors, these studies fail to provide a clear roadmap for reforms in the domestic natural gas market.

Reform Impact: Internationally very few studies have explored the impact of price reforms in the regulated domestic market. Heyndrickx et al., (2012) while analysing the impact of deregulating the domestic natural gas price in Russia using a CGE model conclude that if prices are gradually increased for consumers and industry then deregulation would result in energy efficiency and reduced CO_2 emissions. To simulate price increase, they increase taxes on final and intermediate consumption of gas (i.e. consumers and industry pay alike) in a phased manner. At the macroeconomic level, price deregulation leads to increased investment and thereby increased growth. Orlov, (2015) using the multi-sector CGE model for Russia also derives a similar conclusion. In addition, the study also concludes that the energy-intensive sectors are adversely affected by price rise but the labour and capital-intensive sectors become competitive due to decreased factor cost and depreciation in currency thereby shifting the economy to non-energy intensive sectors. Furthermore, the increase in domestic gas price leads to an overall reduction in carbon emissions and welfare gains. Paltsev and Zhang, (2015) while reviewing the reforms in China's natural gas market conclude that gas prices linked to a weighted average of international fuel oil and liquid petroleum gas prices falls short of establishing a truly market pricing system. Further, the lack of transparency in pricing in terms of duration affects the growth of the sector. With price reform focused primarily on producers and importer while the residential and some industrial sector continue to be subsidized thereby ignoring the demand-side dynamics fails to achieve government objective to increase the contribution of natural gas in China's energy mix.

The impact of pricing and quantitative controls on the natural gas sector and on the end users, by and large, has not been analyzed. Indeed, many of the existing studies/government committee reports have largely taken for granted the need for such controls. Sen, (2015) in her study on review of price reforms in the natural gas sector find that increase in gas price has a universally negative impact on the power sector due to the absence of carbon pricing (to displace coal) and in fertilizer, the sector increased tax revenue due to price rise is not sufficient to meet additional fertilizer subsidy. However, with reference to the upstream sector, the study concludes that an increase in domestic price could lead to additional investment and thereby additional supplies but these effects are contingent on the implementation of reforms to the fiscal regime for exploration. Ganesh-Kumar and Harak, (2015) in their study using a multi-sector CGE model for India find that increase in natural gas prices lead to the substitution of natural gas by cheaper petroleum fuels in the consuming sectors thereby resulting in contraction of the natural sector. However, the substitution into cheaper petroleum fuels (subsidized) seriously comprises the objective of improving the fiscal situation due to the increase in the petroleum subsidy.

Some open questions: Earlier studies have highlighted the severe implications of domestic natural gas price reforms (i.e. gas-to-gas competition) as the reforms in the downstream (consuming) sectors are pending and the presence of high international fossil crude oil prices would increase the stress of the fiscal. With the completion of price reform in the petroleum sector (motor spirit and diesel deregulation) and the prevailing comparatively low international crude oil price opens up a window of opportunity for carrying out reforms in the natural gas sector with the possibility that adverse impacts, if any, may not be large. Against this background some of the open questions are as follows: What are the fallouts of domestic price reforms on the downstream consuming sectors? Does the relatively low international crude oil Scenario provide an opportune window for the government to consider the implementation of price reform in the gas market? However, as seen earlier, only mere price reforms of the natural gas sector would be incomplete if the quantitative allocation mechanism under the GUP remains untouched. In this context, whether price pooling or elimination of quantitative allocation mechanism help? If so, what will be the magnitude of inter-fuel substitutions? These are some of the open questions which the existing literature have dealt upon partially but a complete assessment of the plausible impact of price reform in the natural gas sector is missing. We address some of these open questions in this study.

3 Methodology and Data

As seen above, the domestic natural gas prices are administratively controlled by the government thereby resulting in implicit subsidy to the domestic natural gas consuming sectors. Further, the preferential allocation of domestic natural gas only to the certain protected sector in the economy further distorts the market resulting dual price mechanism. The development of the natural gas sector and the consuming sectors, therefore, depends upon how the government approaches the introduction of potential reform to these interventions. Further, the impacts of the price reforms in the natural gas sector are likely to be felt across several sectors, households, government and at the macro level. Given this, it is important that the analytical framework should be able to capture the various inter-sectoral, inter-agent linkages in the economy in a consistent manner. One such analytical framework that can capture such linkages is the computable general equilibrium (CGE) modeling framework. This study uses the computable general equilibrium (CGE) model of the Indian economy developed by Harak and Ganesh-Kumar (Forthcoming). The model used is a static CGE model built around a Social Accounting Matrix (SAM) for the year 2011-12 that distinguishes 13 activities and 19 commodities, and 6 household expenditure classes, 3 each in rural and urban areas. A description of all the features of the model is provided in the Appendix. Here, some of the specific features of the model in the context of the present study such as the incorporation of 'gas utilisation policy' and specification and accounting of subsidy are discussed.

Gas Utilisation Policy (GUP): The model incorporates the GUP framework for natural gas commodity through sector-specific natural gas price ($PNAT_a$). Under the GUP, the government allocates domestically produced natural gas (XD_a) to certain "priority" or "strategic" sectors viz. city gas distribution, fertilizer, power, and refinery at administered domestic prices (PD_{ng}). Other non-priority sectors like the chemical industry and manufacturing are allocated domestic gas after meeting the committed quantity to the strategic sectors, stocking requirement ($\mathrm{cstkq_{ng}}$), household consumption ($\mathrm{HC_{ng}}$) and government consumption ($\mathrm{g_{ng}}$). The quantity allocation mechanism is shown in Equation 1, where the protected sectors are represented by a sub-set of activities (a_1) and the non-protected sectors are clubbed under activities sub-set (a_2). The administered domestic gas price ($\mathrm{PD_{ng}}$) is a subsidised price and the priority sector consumes the allocated quantity ($\mathrm{QXDA_a}$) at the subsidised price. In case the demand for the sector is more than the allocated quantity, then the marginal demand for the sector is met through imports ($\mathrm{QNGIM_a}$). Equation (2) is the marginal demand equation for the sectors in the economy. The non-priority sectors demand for natural gas is met only through imports for which the sector pays import parity price ($\mathrm{PM_{ng}}$). The import parity price of natural gas ($\mathrm{PM_{ng}}$) in the base year is more than double of the subsidised domestic price ($\mathrm{PD_{ng}}$). As a result, the protected sectors benefit from the lower domestic natural gas price thereby receiving an implicit subsidy on their consumption. In the model, the producers consume commodities for their intermediate use at the composite price ($\mathrm{PQ_c}$)[7]. However, in the case of natural gas, the model allows for consumption of natural gas commodity at dual prices when the GUP policy is in place viz. protected sectors and city gas distribution at a subsidised price ($\mathrm{PD_{ng}}$) and the non-protected sector at import prices ($\mathrm{PM_{ng}}$). With the dismantling of the GUP and in absence of domestic price reform, the sectors and agents would consume natural gas commodity at the composite or pooled price ($\mathrm{PQ_{ng}}$). In the model, the GUP regime promoting dual pricing can be operated through a parameter (GUPswitch), which assumes the value '1', when the gas utilisation policy is in place and assumes value '0' when the gas utilisation policy is removed. Equation (3) represents the natural gas sector revenue cost in the presence of GUPswitch.

1. $\mathrm{QXDA_a} = \mathrm{QNAT_a} \qquad \forall\, a \in a_1$

$$= \max\left(0.0, \beta_a^{ng}.\left(\mathrm{XD}_{ng} - \textstyle\sum_{a\in a_1} \mathrm{QXDA_a} - \mathrm{cstkq_{ng}} - \mathrm{HC_{ng}} - \mathrm{g_{ng}}\right)\right) \qquad \forall\, a \in a_2$$

$$= 0 \qquad \forall\, a \notin a_1, a_2$$

2. $\mathrm{QNGIM_a} = \mathrm{QNAT_a} - \mathrm{QXDA_a}$

3. $\mathrm{PNAT_a}.\mathrm{QNAT_a} = \mathrm{GUPswitch}.\left(\mathrm{QXDA_a}.\mathrm{PD_{ng}} + \mathrm{PM_{ng}}.\mathrm{QNGIM_a}\right) + (1 - \mathrm{GUPswitch}).\left(\mathrm{QNAT_a}.\mathrm{PQ_{ng}}\right)$

4. $\mathrm{GUPswitch} = 1$ if GUP is in operation

$= 0$ if GUP is removed

[7] We define composite price of a commodity ($\mathrm{PQ_c}$) as the market price paid by the domestic commodity demander, which is a weighted sum of domestic price ($\mathrm{PD_c}$) and import price ($\mathrm{PM_{cm}}$) with corresponding shares in total absorption ($\mathrm{Q_c}$) as weights.

Subsidy Accounting: In line with the empirical reality in the country, the subsidy bill for the petroleum and natural gas sectors is not fully borne by the government as an "expenditure" item in its accounts. The model allows the subsidy bill to be shared between the government (as a direct fiscal subsidy) and the sectors. In the model, the domestic price (PD_c) is derived from the producer's price (PDS_c) after adding the given indirect tax (tq_c) / subsidy rates (ts_c) (Equation 5). The implicit subsidy ("TSUBNATG") is captured as the difference between the administered domestic prices and imported LNG prices. The price difference is captured through an implicit variable tax rate ($VTX_{c'}$) that supports the controlled domestic price ($\overline{PD}_c$) (Equation 6). The subsidy sharing between the government i.e. the direct fiscal support provided by the government and the sector (i.e. upstream oil companies) is defined through the parameter theta 3 (θ_3^{ng}). The sharing of subsidy burden by the sector affects its profitability thereby reducing the return of factor capital to the petroleum and natural gas sector. As a result, the factor income suffers which indirectly leads to loss of dividend payment to the factor owners. Given the fact that the government is itself the major owner of the sector, a major part of the subsidy bill is thus ultimately borne by the government as a loss in dividend income i.e. dividend loss from natural gas (GDVDNG). Theta 4 (θ_4^{ng}) represents ownership share of government in the natural gas sector and Equation (7) captures the loss of dividend on account of sharing of natural gas subsidy by the sector. Similarly, household who are the minority shareholders in the sector also suffer a loss of dividend income to the extent of their ownership ($ownref_h$) in the sector i.e. dividend loss from natural gas (HDVDNG). Equation (8) captures the loss of dividend by the household on account of subsidy sharing by the sector. Since this loss of dividend affects the return to factor capital for the household, the household income includes the loss of dividend on factor capital (Equation 9).

5. $PD_c = PDS_c.(1+tq_c + ts_c)$
6. $TSUBNATG = -(VTX_c + ts_c).PDS_c.XD_c$
7. $GDVDNG = (\theta_3^{ng}).(\theta_4^{ng}).TSUBNATG$
8. $HDVDNG_h = \{ownref_h * (\theta_3^{ng}).(1 - \theta_4^{ng}).TSUBNATG\}$
9. $YH_h = \sum_f YF_f.endwsh_{h,f} + \sum_f endwshxd_{h,f}.fincinw_f.ER + trans_h.\sum wq_c.PQ_c + remw_h.ER - HDVDPT_h - HDVDNG_h$

The full mathematical specification of the model including the SAM is available in Harak and Ganesh-Kumar (Forthcoming).

4 Scenario Specification

The first step towards analysing the impacts of reforms measures aimed at reducing the subsidy on diesel and natural gas is to construct a "BASE" or reference scenario that captures the current set of policies prevailing in the economy during 2011-12. That is, the BASE scenario reflects the structure of India economy for 2011-12.

4.1 BASE Scenario

In the BASE scenario, the exogenous parameters are calibrated to replicate the actual structure of the economy in FY 2011-12. Further, the pricing regime applicable to various commodities is specified as per the prevailing government policies.

In the refinery sector, the diesel pricing is deregulated and the new reality of the lower international crude oil price with limited pass-through in diesel price is considered[8]. The domestic price of LPG and kerosene continues to be administratively fixed and subsidized in the model as is the case in reality for subsidised consumption. The amount of subsidy on kerosene and LPG enters as a direct benefit transfer payment to households. The natural gas sector also continues to be regulated both in terms of price controls and quantitative controls, which is also the current reality. The domestic natural gas price is administratively fixed by the government and is lower than the import parity price of imported natural gas (i.e. liquefied natural gas) thereby resulting in implicit subsidy to the downstream consuming sectors. Whereas, the quantitative controls are exercised by the government through the gas utilisation policy (GUP) whereby the subsidised domestic natural gas is preferentially allocated to certain protected sectors (fertilizer, power, city gas distribution, etc) thereby providing implicit subsidy only to these sectors in the economy. Hence, the protected sectors continue to pay a lower price for their natural gas consumption (i.e. subsidised price) while the unprotected sectors (manufacturing, transportation, chemicals, etc.) pay a higher price (i.e. import parity price) for their natural gas consumption requirement. Amongst the other commodities, fertilizer and electricity are also subject to administrative pricing mechanism along with an endogenously determined per-unit subsidy rate. All the remaining sectors/commodities are specified to have market-determined prices that include an ad valorem tax (e.g., manufacturing, transportation, etc.) or subsidy (e.g., food crops, fertilizer, etc.) at a rate implicit in the SAM.

4.2 Policy Scenarios

Though reforms are primarily important for the development of the sector, how the reforms are implemented will define the direction of the growth of natural gas and the consuming sectors. We

[8] Pricing controls were in place for MS also till 2009-10, but were deregulated in May 2010.

study the impact of two alternate policy reforms options viz. Price Reforms and Quantity Reforms both intending to ultimately link the domestic natural gas price for producing and consuming sectors to International parity price. Finally, we consider the case of assessing the implications of introducing full reforms in the natural gas sector whereby both the price controls and the quantitative controls existing in the natural gas sector are eliminated. Hence, reforms on both accounts i.e. price and quantity are needed in the natural gas sector, we are looking at the options of sequencing of these reforms representing different policy choices.

4.2.1 Scenario 1: Price Reforms Only

In this Scenario, we consider introducing partial reforms in the sector wherein the domestic price of natural gas is linked to the import parity price. That is the implicit price subsidy burden on domestic natural gas is reduced by 100 per cent. However, the quantitative allocation mechanism under the GUP continues with the preferential allocation of natural gas to the protected sectors. This increase in the domestic natural gas price is then passed on by the downstream consumers to the extent of ad valorem subsidy to the government and balance to the consuming sectors. As a result, the protected sectors will have to pay more price than the price in BASE whereas the non-protected sectors will continue to pay the market price as in BASE. This Scenario, therefore, helps in assessing the implications of dismantling the administered price regime for the natural gas sector and integrating the domestic market with the global natural gas market. No other change is made in the pricing regime of any other petroleum products, all of which are as in BASE. It may be noted that this Scenario corresponds to the policy option (A) suggested in the literature, in particular, the Kelkar Committee (GoI, 2014).

4.2.2 Scenario 2: Quantity Reforms Only

In this scenario, we consider introducing partial reforms or only quantitative reforms that essentially involve the removal of the GUP without any change in the natural gas pricing structure. Thus, in this Scenario, the price of domestically produced natural gas continues to be subsidised at the rate in BASE. Dismantling the GUP policy essentially means that prioritised allocation of natural gas to the protected sectors in the economy is removed and price pooling (i.e. composite price) of the natural gas is introduced. That is there is only one uniform price of natural gas in the market and all the agents in the economy can consume natural gas at this single composite price. As a result of price pooling, the protected sectors in the economy will have to pay more than the BASE domestic price for their natural gas requirements while the other non-protected sectors would have to pay less than the BASE import price. The pricing regime for all other fuels remains as in BASE as do all other tax/subsidy rates, behavioural parameters and closure rules. It may be noted that this Scenario corresponds to the policy option (B) contained in GAIL, (2010).

4.2.3 Scenario 3: Price and Quantity Reforms

In this Scenario, we consider the case of assessing the implications of introducing full reforms in the natural gas sector whereby both the price controls and the quantitative controls existing in the natural gas sector are eliminated. Thus, in this Scenario, (i) the domestic price of natural gas is linked to the import parity price, i.e. 100 per cent reduction in the implicit subsidy burden (as seen in Scenario 1) and (ii) the quantitative restrictions imposed by the GUP are also removed (as seen in Scenario 2). Consequently, the distinction between protected and unprotected sectors is eliminated, and all sectors pay international parity price. The full price and quantity reform in the natural gas sector are therefore expected to have a substantial impact on the downstream consuming sectors where the output price of the protected sectors itself is regulated through ad valorem subsidy thereby affecting the returns to the downstream sectors and consequent re-allocation of the factors of production. To capture these impacts of reallocation of factors of production, we relax the full employment condition in the model by allowing excess supply or unemployment of the factors of production. The pricing regime for all other fuels remains as in BASE as do all other tax/subsidy rates and behavioural parameters.

The marginal effect of the above policy changes is assessed by comparing the model outcome of these "policy Scenarios" with BASE, which considers the following (a) price reforms already carried out in the diesel sector, (b) existence of the prevailing low international price in the fossil fuel sectors (i.e. of crude oil, natural gas, coal and lignite) and (c) limited pass-through of low price in the petroleum sector (i.e. diesel and motor spirit). The variables of interest are commodity price, consumption, output, trade flows, sectoral impacts for the consuming sectors and natural gas sector, various macroeconomic aggregates such as the GDP, savings, investment, exchange rate, and household real income per capita. The results of these three policy Scenarios are discussed in turn in the next section.

5 Simulation Results

5.1 Scenario 1: Price Reforms Only

As stated above, in this scenario subsidy on domestic gas is removed, but the quantitative allocation mechanism under GUP continues. Consequently, the protected sectors pay a higher price than in BASE whereas the non-protected sectors continue to pay the market price as in BASE. The impacts under this scenario are as follows:

Natural Gas: Within the sector itself, the elimination of price subsidy on domestic gas production results in an increase of domestic natural gas price by 0.38 per cent over the BASE. With the increase in the price, the total demand for natural gas falls by 0.03 per cent. In the case of households, with the continuation of subsidy on LPG and kerosene, the increase in natural gas prices causes a shift in the consumption away from natural gas thereby resulting in a fall of 0.73 per cent in household consumption (Table 1). As will be seen later, the exchange rate depreciates as compared to the BASE, which also affects the trade flows at the commodity level. The combination of a fall in the domestic demand due to a rise in the domestic price of natural gas and the depreciation of the currency makes exports relatively competitive in the international market. As a result, exports of natural gas increase by 35.71 per cent (albeit from a low base) resulting in a minor expansion of the output by 0.04 per cent (Table 1). To clear the market, an increase in domestic output of natural gas is accompanied by a decrease in imports by 0.03 per cent.

Table 1: Commodity-wise Impacts – Scenario 1 (% change over BASE)

Commodity	Domestic Price	Domestic Demand			Exports	Domestic Output	Imports
		Raw Material	Household	Total Demand			
Energy Aggregate							
Coal and Lignite	0.33	0.11	-0.09	0.14	0.04	0.14	0.07
Natural Gas	0.38	0.03	-0.73	-0.03	35.71	0.04	-0.03
High Speed Diesel	0.28	0.14	0.00	0.13	0.04	0.11	0.06
Naphtha	0.31	0.10	0.00	0.11	0.06	0.09	0.03
Substitute Fuels	0.35	0.07	0.00	0.06	0.06	0.06	0.02
Electricity	0.33	0.11	-0.40	0.03	0.00	0.03	0.00
Consuming Sectors							
Agriculture & Allied	-0.99	0.16	-0.36	-0.08	0.42	-0.05	-1.60
Fertilizers	0.39	-0.01	0.00	-0.01	0.00	-0.01	-0.01
Chemicals	0.42	0.13	-0.24	0.06	0.00	0.05	0.13
Manufacturing	0.27	0.23	-0.16	0.20	0.07	0.18	-0.01
Construction	0.16	0.39	0.00	0.58	0.00	0.58	0.17
Transport Service	0.22	0.16	0.00	0.14	0.08	0.14	-0.05

Source: Model results

Inter-fuel Substitution: The results also show the play of inter-fuel substitution following natural gas price reforms. Each producing activity has a nested production structure which allows substitution possibilities amongst different fuels used to produce energy and or feedstock aggregate so as to maximize the profits. With the rise in domestic natural gas price, natural gas becomes relatively costlier as compared with coal and petroleum aggregate, the two other major sources of non-electrical energy. This results in a shift in demand in favour of petroleum fuels and coal as a substitute for natural gas. As a result, the use of natural gas is down ranging between 0.02 per cent in the case of the fertilizer sector and 0.13 per cent in the agriculture and allied sector (Table 2). On the other hand, as a result of substitution, there is an increase in the intermediate use of naphtha substitute fuels, naphtha and diesel up to 0.60 per cent depending upon the input mix as per the nested structure of the sector. Similarly, the usage of coal and lignite as intermediate input increases in the range of 0.02 per cent to 0.54 per cent across the major consuming sectors.

Table 2: Intermediate Demand for Select Energy Commodities – Scenario 1 (% change over BASE)

Commodity	Major Consuming Sectors							Total All Sectors
	I	II	III	IV	V	VI	VII	
Coal and Lignite	-0.10	-0.04	0.04	0.17	0.02	0.54	0.08	0.14
Natural Gas	-0.13	-0.02	0.02	0.11	0.03	0.51	0.05	-0.03
High Speed Diesel	-0.04	0.02	0.10	0.23	0.07	0.60	0.15	0.13
Naphtha	0.00	-0.01	0.05	0.20	0.05	0.00	0.00	0.11
Substitute Fuels	-0.09	-0.04	0.04	0.17	0.02	0.55	0.09	0.06
Electricity	-0.08	-0.02	0.07	0.19	0.04	0.56	0.11	0.03

Note - Numerals denote the following sectors: I - Agriculture & Allied, II - Fertilizer, III - Chemicals, IV - Manufacturing, V - Electricity, VI - Construction and VII - Transportation

Source: Model results

Other Sectors: Since, there is limited substitution amongst the energy fuels, the rise in the price of natural gas increases the energy cost of the consuming sectors. As seen earlier, the priority consuming sectors that benefited from subsidised domestic gas (i.e. fertilizer, chemical, etc.) also see an increase in their domestic prices, thereby resulting in contraction of output. In the case of the fertilizer sector, the increase in domestic natural gas price by 0.39 per cent translates to an increase in fertilizer price by 0.39 per cent only (Table 1). It may be seen from Table 2, the increase in natural gas prices promotes the substitution of natural gas by cheaper petroleum fuels. As a result, though natural gas forms important raw material in the production process, the increase in natural gas prices causes to shift the demand in favour of cheaper diesel fuel. Consequently, the impact of price rise in the natural gas sector has been contained due to inter-fuel substitution thereby limiting the fall in demand for fertilizer marginally by 0.01 per cent. This, in turn, triggers a marginal contraction of output by 0.01 per cent and to clear the market, imports fall by 0.01 per cent. However, in the case of the transportation sector, the substitution of natural gas by relatively cheaper diesel and electricity make it relatively competitive in the domestic market thereby seeing an increase in total demand and therefore an increase in domestic output and lower imports.

On the other hand, the agriculture sector price falls by 0.99 per cent on account of price rise in the natural gas sector (Table 1). With the fall in the agriculture price, the demand for intermediate requirement increases by 0.16 per cent. However, the increase in intermediate demand does not translate into increased output due to a fall in household consumption by 0.36 per cent. As will be seen later in the study, an increase in natural gas prices results in a loss in household income and thereby a fall in household demand. Further, as a result of depreciation in the currency, exports become competitive leading to an increase in exports by 0.42 per cent. To clear the market, imports fall by 1.60 per cent in this Scenario.

Government: The impact of the reduction in subsidy on natural gas and the government's support to petroleum and natural gas sectors is given in Table 3. It is seen that the impact of a 100 per cent reduction in subsidy on natural gas reduces the government's subsidy bill for the natural gas sector by 100 per cent and the fall in loss of dividend from the natural gas sector is also a similar percentage. However, the continuing of subsidy on LPG and kerosene, causes the government's petroleum subsidy burden to reduce marginally by 0.04 per cent. The net outcome of these changes and the continuance of limited pass through in diesel and motor spirit prices, the total support provided by the government to the two sectors together goes down by 188.17 per cent in this Scenario (Table 3).

Table 3: Government Support to Petroleum and Natural Gas Sectors (% change over BASE)

Variable	Scenario 1	Scenario 2	Scenario 3
Total Refinery Subsidy	-0.04	-4.85	6.03
Total Natural Gas Subsidy	-100.00	5.83	-100
Government Account			
Subsidy - Refinery	-0.04	-4.85	6.03
Subsidy - Natural Gas	-100.00	5.83	-100
Dividend Loss - Refinery	-0.04	-4.85	6.03
Dividend Loss - Natural Gas	-100.00	5.83	-100
Total Support Oil & Natural Gas	-188.17	17.80	-219.13
Subsidy- Others	0.37	1.82	0.86
Total Subsidy	0.43	4.02	-0.84
Government Savings	4.48	-5.94	8.42

Source: Model results

Household: With partial pass-through of lower international crude oil prices and elimination of subsidy on domestic diesel and natural gas, the sectors no longer suffer from loss of income on account of subsidy sharing thereby increasing the returns to factors of production. As a result of increased factor prices, there is a fall in the agricultural domestic output which in turns results in lowers income to households as compared to BASE (Table 4). Though there is a marginal improvement in the industrial and service sector in this Scenario as compared to the BASE, the overall rise in fuel prices has a higher impact on the income of urban households. The impact is more prominent across the higher-income households, who are also the owners of the factor capital. As a result, the overall consumption of households falls by 0.18 per cent over the BASE. With the fall in household income, the total household savings fall by about 0.16 per cent over the BASE**.** From the welfare perspective also, the change in equivalent income[9] from the BASE is calculated and presented in Table 4 for this Scenario. Since the reforms increase the energy prices which in turn results in an increase in domestic prices for consuming sectors, there is a fall in consumption and thereby a fall in equivalent income. It can be seen that the equivalent income falls for all the households in the current Scenario also as compared to the BASE. The impact is more prominent in the case of higher-income households as seen in the case of per capita income of households.

Macroeconomic: The above sectoral changes also have macro-level impacts. With increased energy prices, there is an increase in the imports of energy fuels viz. coal and lignite, diesel, naphtha, substitute fuels, etc. which form a major part of the import bill. As a result, the currency depreciates marginally by 0.14 per cent over BASE rendering exports competitive and imports costlier. However, the elimination of petroleum and natural gas subsidy results in an overall increase in prices of energy-intensive commodities causing the total consumption to fall. Consequently, the total imports and exports increase marginally by 0.04 and 0.04 per cent respectively as compared to BASE (Table 4).

The government's dis-savings decline further by 4.48 per cent following the reduction in the support to the natural gas sector. The decline in government dis-savings more than compensate the fall in household saving resulting in an overall 0.55 per cent increase in total savings / total investment in this Scenario as compared to the BASE. The net impact of the above changes in sectoral output is that aggregate GDP expands marginally in this Scenario. Total GDP expands by 0.07 per cent, with industrial and services GDP increasing by 0.14 per cent and 0.09 per cent which is offset by a fall in agricultural GDP by 0.05 per cent.

[9]The equivalent income measure for a particular policy scenario is the income required to obtain at the base prices (i.e. 2011-12 prices) a consumption basket that provides the same utility as provided by the current basket of consumption.

Table 4: Impacts on Macro Aggregates and Household per Capita Income

(% change over BASE)

Variable	Scenario 1	Scenario 2	Scenario 3
GDP-Total	0.07	0.0002	-0.05
GDP-Agriculture	-0.05	-0.04	0.04
GDP-Industry	0.14	-0.02	-0.76
GDP-Services	0.09	0.02	0.14
Total Export real value (USD)	0.04	-0.52	-1.43
Total Import real value (USD)	0.04	-2.47	-0.87
Total household consumption (₹)	-0.18	-0.10	-0.61
Total Household savings	-0.16	-0.07	-0.57
Total investment (₹)	0.55	-0.49	-0.03
Exchange rate	0.14	1.72	0.63
Household per capita income			
Rural 1: 0 to 10%	-0.04	-0.26	-0.36
Rural 2: 10% to 30%	-0.06	-0.25	-0.35
Rural 3: 30% to 50%	-0.09	-0.22	-0.46
Rural 4: 50% to 70%	-0.11	-0.18	-0.52
Rural 5: 70% to 90%	-0.06	-0.14	-0.54
Rural 6: 90% to 100%	-0.06	-0.08	-0.82
Urban 1: 0 to 10%	-0.13	-0.22	-0.39
Urban 2: 10% to 30%	-0.18	-0.17	-0.51
Urban 3: 30% to 50%	-0.23	-0.11	-0.73
Urban 4: 50% to 70%	-0.28	-0.06	-0.80
Urban 5: 70% to 90%	-0.17	-0.06	-0.72
Urban 6: 90% to 100%	-0.25	-0.01	-0.85
Household per capita equivalent income			
Rural 1: 0 to 10%	-0.10	-0.25	-0.36
Rural 2: 10% to 30%	-0.14	-0.21	-0.31
Rural 3: 30% to 50%	-0.20	-0.20	-0.42
Rural 4: 50% to 70%	-0.25	-0.15	-0.42
Rural 5: 70% to 90%	-0.27	-0.10	-0.46
Rural 6: 90% to 100%	-0.36	-0.09	-0.72
Urban 1: 0 to 10%	-0.39	-0.22	-0.43
Urban 2: 10% to 30%	-0.40	-0.16	-0.49
Urban 3: 30% to 50%	-0.49	-0.11	-0.70
Urban 4: 50% to 70%	-0.58	-0.04	-0.68
Urban 5: 70% to 90%	-0.55	-0.05	-0.65
Urban 6: 90% to 100%	-0.54	-0.01	-1.08

Source: Model results

5.2 Scenario 2: Quantity Reforms Only

As stated above, in this scenario the quantitative allocation mechanism under GUP is removed, without any change in the natural gas pricing structure. Dismantling of GUP essentially results in price pooling of natural gas, and all users pay the composite price (weighted average of subsidised domestic price and import price). Thus, here too the protected sectors pay a higher price than under BASE, whereas the unprotected sectors would pay a lower price than under BASE due to price pooling. The impacts under this scenario are as follows:

Natural Gas: Within the sector itself, the price pooling results in a single composite price in the economy which results in an increase of domestic natural gas price by 5.75 per cent over the BASE. As seen earlier, the non-protected sector has to meet their natural gas requirement through imported natural gas which was more than double the price of the domestic price of gas in 2011-12. With the composite price of natural gas being lower than the imported price, there is an increase in household demand for natural gas mostly under the city gas distribution to meet the cooking and transportation demand of households thereby resulting in an increase in demand by 113.61 per cent. As seen later, the protected sectors which are already operating under a controlled/subsidised pricing regime suffer an increase in the price of natural gas leading to a contraction in intermediate demand by 2.79 per cent (Table 5). As a result, there is a marginal increase of 0.07 per cent in total demand for natural gas causing expansion of the output by 0.07 per cent (Table 5). To clear the demand-supply market, the exports of natural gas falls by 2.86 per cent while import increased by 2.0 per cent.

Inter-fuel Substitution: As seen earlier in the Chapter, with the increase in the price of the commodity in the energy aggregate, producers respond to the increased price by allowing for the possibility of inter-fuel substitution within the nested structure of the activity. With the increase in natural gas prices, the price of other energy commodities viz. coal and lignite, substitute fuel and electricity also increase between 1.26 per cent to 25.49 per cent (Table 5). As a result, natural gas and coal become relatively costlier compared with petroleum aggregate, the major sources of non-electrical energy. This results in a shift in demand in favour of petroleum fuels and coal (in some sectors) as a substitute for natural gas. Across some of the major sectors, the use of natural gas is down ranging between 7.87 per cent and 30.16 per cent (Table 6). However, in the case of the transportation sector, with the increase in the price of electricity by 2.34 per cent, there is a substitution in favour of natural gas and a reduction in electricity and substitute fuels. As a result, the intermediate consumption of substitute fuels in the petroleum aggregates falls between 11.39 to 19.04 per cent in the major sectors of the economy. The prices of substitute fuels increase by 25.49 per cent causing a contraction in its demand. To clear the demand-supply market, exports of substitute fuels fall by 25.83 per cent while imports increase by 8.51 per cent. On the other hand, as a result of substitution, there is an increase in the intermediate of naphtha and diesel up to 28.26 per cent depending upon the input mix as per the nested structure of the sector.

Table 5: Commodity-wise Impacts – Scenario 2 (% change over BASE)

Commodity	Domestic Price	Domestic Demand			Exports	Domestic Output	Imports
		Raw Material	Household	Total Demand			
Energy Aggregate							
Coal and Lignite	1.26	-0.21	-0.15	0.06	0.16	0.06	-0.54
Natural Gas	5.75	-2.79	113.61	0.07	-2.86	0.07	2.00
High Speed Diesel	-5.05	2.42	0.00	2.26	1.80	2.16	-2.12
Naphtha	-22.12	10.52	0.00	14.70	17.37	15.67	-12.94
Substitute Fuels	25.49	-15.06	0.00	-13.87	-25.83	-15.36	8.51
Electricity	2.34	-2.04	1.12	-1.52	0.00	-1.52	0.00
Consuming Sectors							
Agriculture & Allied	-0.15	-0.08	-0.15	-0.08	0.59	-0.04	-2.15
Fertilizers	1.90	0.03	0.00	-0.07	-0.06	-0.07	0.18
Chemicals	-0.43	0.30	-0.25	1.26	0.91	1.22	-2.73
Manufacturing	0.34	-0.08	-0.04	0.34	-2.85	-0.09	-2.23
Construction	0.10	-0.15	0.00	-0.26	0.00	-0.26	-3.24
Transport Service	-0.80	-0.03	0.00	0.24	0.02	0.22	-2.85

Source: Model results

Table 6: Intermediate Demand for Select Energy Commodities –Scenario 2 (% change over BASE)

Commodity	Major Consuming Sectors							Total All Sectors
	I	II	III	IV	V	VI	VII	
Coal and Lignite	-3.57	-0.27	7.80	-2.27	3.57	1.01	-4.74	0.06
Natural Gas	-33.33	-10.28	-7.87	15.86	-14.68	-30.16	46.67	0.07
High Speed Diesel	2.61	5.30	10.58	4.55	6.64	6.46	1.37	2.26
Naphtha	0.00	28.76	1.66	19.06	21.43	0.00	0.00	14.70
Substitute Fuels	-18.04	-15.79	-11.39	-16.43	-14.75	-14.82	-19.04	-13.87
Electricity	-4.33	-1.06	6.95	-3.05	2.75	0.21	-5.49	-1.52

Note- Numerals denote the following sectors: I - Agriculture & Allied, II - Fertilizer, III - Chemicals, IV - Manufacturing, V - Electricity, VI - Construction and VII - Transportation

Source: Model results

Other Sectors: As seen earlier, the availability of subsidised natural gas had resulted in the creation of excess demand through the creation of surplus capacity in the consuming sectors. The protected sectors (viz. electricity, fertilizer, construction, etc.) which benefited from the prioritized allocation of subsidised domestic natural gas see an increase of their domestic prices due to price pooling thereby resulting in contraction of output. However, in the case of the chemicals sector, the substitution of natural gas by relatively cheaper naphtha, coal and diesel fuels make it relatively competitive. As a result, the total demand for the chemical sector increases by 1.26 per cent and therefore causing an increase in the domestic output by 1.22 per cent. With depreciation in the currency as seen later in the Chapter, the decrease in domestic prices leads to an increase in chemical exports by 0.91 per cent. To clear the market, imports fall by 2.73 per cent in this Scenario as compared to BASE (Table 6). In the case of the fertilizer sector, an increase in natural gas prices shifts the demand in favour of naphtha which is relatively less costly for meeting its feedstock requirement. Due to substitution possibility between the two fuels, consumption of naphtha increases by 28.76 per cent while natural gas requirement falls by 10.28 per cent (Table 6). As a result, though there has been a sharp increase in natural gas price by 5.75 per cent, the fertilizer price increased only by 1.90 per cent thereby reducing the negative impact of the price rise in natural gas thereby resulting in a minor contraction of 0.07 per cent in output (Table 5).

While the unprotected sectors such as the manufacturing and transport sector benefit from the price pooling as the pooled price is lower than the import price of gas. As a result, the transportation sector increases the consumption of natural gas by 46.67 per cent and reduce the consumption of electricity and substitute fuels (Table 6). As a result, the domestic price of the transportation sector falls by 0.80 per cent thereby leading to an increase in demand of 0.24 per cent. This, in turn, causes an expansion in output by 0.22 per cent. To clear the market, import fall by 2.85 per cent while exports increased by 0.02 per cent. In the case of coal and lignite, the increase in domestic price is 1.26 per cent which is relatively lower as compared to natural gas prices in the non-petroleum aggregate leading to the substitution of natural gas by coal (Table 5). As a result, the total demand for coal increased by 0.06 per cent with a similar expansion in output. To clear the market, imports decrease by 0.54 per cent while exports increase by 0.16 per cent.

Government: Due to the implementation of only quantitative reforms in the natural gas sector, there is no change in the subsidy provisioning of domestic natural gas in this Scenario. Since, the composite price of natural gas being lower, there is an increase in total demand of natural and also its output, which results in an increase in natural gas subsidy by 5.83 per cent over the BASE (Table 3). In the case of the refinery, the decrease in total demand for LPG and kerosene, there is a reduction of petroleum subsidy by 4.85 per cent. The net outcome of these changes is that the total support provided by the government to the two sectors increases by 17.80 per cent in this Scenario (Table 3). With the continuing of the controlled output regime in the consuming sector where the per-unit subsidy is fixed (e.g. fertilizer sector), the increase in the natural gas prices, therefore, leads to an increase in subsidy in the consuming sectors to that extent. As a result, the total subsidy provided by the government increases by 4.02 per cent in this Scenario as compared to the BASE.

Household: With the implementation of quantitative reforms in the natural gas sector, the composite price of natural gas is now lower than the imported price of natural gas causing an increase in demand and therefore increased production (Table 5). Since the domestic price still continues to be subsidised, the increase in consumption of natural gas leads to an increased subsidy to be borne by the sector. The increase in natural gas subsidy, therefore, reduces returns to the factors of production. As a result, there is a decrease in factor prices, which in turns results in lowers income to households as compared to BASE (Table 4). The loss in per capita income is more prominent in the case of the lower-income households in rural areas. The middle class also suffer a moderate fall in their income. From the welfare perspective, equivalent income falls for all the households in the current Scenario also as compared to the BASE. The welfare loss for the rural household due to natural gas price reform is due to the fall in the agriculture income triggered by a fall in the agricultural prices due to a contraction in the agriculture GDP. This worsening income distribution again serves as a pointer towards the differential impact of subsidy reforms on the household and a need to introduce some kind of income transfers that serve as a safety net for the affected low-income households. As a result, the overall consumption of households falls by 0.10 per cent over the BASE with a consequent fall in the savings of about 0.07 per cent over the BASE**.**

Macroeconomic: The above sectoral changes also have macro-level impacts. As seen earlier, with increased energy prices, there is a fall in the domestic output leading to the depreciation of the currency. The depreciating currency causes imports to be costlier and exports to be more competitive. However, as a result of the elimination of petroleum subsidy and price pooling of natural gas, there is an overall increase in prices of energy commodities and also that of the energy-intensive commodities causing the total consumption to fall marginally by 0.10 per cent (Table 4). As a result, the total imports fall by 2.47 per cent as compared to the BASE, while the exports fall relatively less to 0.52 per cent due to the depreciating currency. The government's dis-savings increases further by 5.94 per cent following the increase in subsidy to the natural gas sector. Further, household savings also fall due to a fall in household income resulting in an overall 0.49 per cent fall in total savings / total investment in this Scenario.

Though there is a marginal increase in the total investment in this Scenario as compared to the BASE, the increase in the energy prices restricts the growth in the domestic output thereby resulting in a very marginal expansion of the economy in this Scenario. The net impact is that the aggregate GDP expands marginally by 0.002 per cent, with services GDP increasing by 0.018 per cent offset by a fall in agriculture and industrial GDP by 0.042 per cent and 0.022 per cent respectively.

5.3 Scenario 3: Price and Quantity Reforms

In this Scenario, both the subsidy on domestic natural gas as well as the quantitative allocation under GUP are removed. Consequently, all users pay the composite price. Unlike in Scenario 2, the composite price here is a weighted average of unsubsidised domestic price and import price and would be higher than under Scenario 2. For the protected sector this price would be higher than under BASE, while for the unprotected sector it would be lower than BASE and Scenario 1, but somewhat higher than under Scenario 2. The impacts of this scenario are as under:

Natural Gas: Within the sector itself, the elimination of price subsidy on domestic gas production results in an increase of domestic natural gas price by 0.95 per cent over the BASE. However, even with the increase in the price, the total demand for natural gas increases marginally by 0.08 per cent resulting in expansion of the output by 0.84 per cent (Table 7). The increase in intermediate demand by 0.58 per cent is on account of increased consumption by the chemicals and fertilizer sectors. While the increase in demand by household is 7.31 per cent on account of transportation and city gas distribution. Since, the domestic gas is at import parity price, to clear the demand-supply market; an increase in domestic prices of natural gas is accompanied by an increase in its export of 35.94 per cent. With the depreciation of the currency, exports become more competitive as compared to international trade flows while imports are relatively costlier. Therefore, to clear the market, the exports of natural gas increase by 35.94 per cent while imports increased marginally by 0.08 per cent (Table 7).

Table 7: Commodity-wise Impacts – Scenario 3 (% change over BASE)

Commodity	Domestic Price	Domestic Demand			Exports	Domestic Output	Imports
		Raw Material	Household	Total Demand			
Energy Aggregate							
Coal and Lignite	-2.84	-0.30	0.70	1.86	1.55	1.86	-2.84
Natural Gas	0.95	0.58	7.31	0.80	35.94	0.84	0.80
High Speed Diesel	4.69	-2.13	0.00	-1.97	-1.03	-1.75	0.31
Naphtha	14.80	-5.45	0.00	-7.17	-7.65	-7.34	6.06
Substitute Fuels	-12.31	9.49	0.00	8.93	16.91	9.96	-5.87
Electricity	-0.66	0.54	0.95	0.56	0.00	0.56	0.00
Consuming Sectors							
Agriculture & Allied	0.12	-0.76	0.70	0.03	0.27	0.04	-0.89
Fertilizers	1.23	-0.16	0.00	-0.36	-0.15	-0.36	0.13
Chemicals	0.68	-0.64	1.71	-0.18	0.06	-0.15	-0.69
Manufacturing	0.43	-1.06	-3.98	-1.45	-3.41	-1.72	-2.40
Construction	0.19	-0.11	0.00	0.08	0.00	0.08	-1.32
Transport Service	0.64	-0.69	0.00	-0.41	0.03	-0.37	-0.79

Source: Model results

Inter-fuel Substitution: With the removal of subsidy on natural gas prices and dismantling the GUP, the increase in natural gas price was marginal 0.95 per cent. However, within the petroleum aggregate, substitute fuel is relatively cheaper than naphtha and diesel which results in a shift in demand in favour of substitute fuels. Across some of the major sectors, the use of naphtha and diesel is down ranging between 0.43 per cent to 11.33 per cent and 1.64 per cent to 6.06 per cent respectively (Table 8). With naphtha being relatively costlier, the demand for naphtha falls in fertilizer and chemical sectors while that of natural gas increases by 1.99 per cent and 6.05 per cent respectively. In other sectors agriculture, transportation and construction, the increased petroleum and natural gas cost shifts demand in favour of coal.

Table 8: Intermediate Demand for Select Energy Commodities –Scenario 3 (% change over BASE)

Commodity	Major Consuming Sectors							Total All Sectors
	I	II	III	IV	V	VI	VII	
Coal and Lignite	3.76	0.74	-3.05	-0.37	-0.23	1.46	3.79	1.86
Natural Gas	1.71	1.99	6.05	-1.35	-0.68	-0.54	1.58	0.80
High Speed Diesel	-1.67	-4.11	-6.06	-5.77	-3.54	-3.32	-1.64	-1.97
Naphtha	0.00	-5.42	-0.43	-11.33	-9.22	0.00	0.00	-7.17
Substitute Fuels	12.31	9.52	7.29	7.62	10.18	10.43	12.34	8.93
Electricity	3.28	0.27	-3.50	-0.83	-0.69	0.99	3.31	0.56

Note- Numerals denote the following sectors: I - Agriculture & Allied, II - Fertilizer, III - Chemicals, IV - Manufacturing, V - Electricity, VI - Construction and VII - Transportation

Source: Model results

Other Sectors: Due to the introduction of price and quantitative reforms in the natural gas sector, coal and lignite suffer fall in domestic by 2.84 per cent. As a result, there is an increase in total demand for the sector by 1.86 per cent leading to the expansion of the sector by a similar per cent (Table 7). As seen later in the Chapter, the depreciation of the currency makes exports relatively competitive in the international market leading to an increase in exports. To clear the market, imports fall by 2.84 per cent while exports increase by 1.55 per cent.

In the case of the fertilizer sector, the increase in the price of natural gas (0.95 per cent) is relatively less as compared to naphtha (14.80 per cent), there is a shift in demand in favour of natural gas for the feedstock requirement leading to an increase in natural gas consumption by 1.99 per cent and fall in naphtha consumption by 5.42 per cent. For the energy requirement, within the petroleum aggregate, a fall in the price of substitute fuels leads to substitution in its favour by 9.52 per cent while there is a fall in diesel requirement by 4.11 per cent. As a result of the substitution, the fertilizer price increases by only 1.23 per cent thereby leading to a fall in demand and contraction of output by 0.36 per cent. To clear the market, imports increase by 0.13 per cent while exports fall by 0.15 per cent (Table 7).

As seen in Table 7, in the case of the electricity sector, which had been benefited from the prioritized allocation of subsidised domestic gas, the increase in natural gas prices do not translate into an increase in the domestic price of electricity due to the substitution effect. With substitute by relatively cheaper substitute fuels, the domestic price of electricity is cheaper by 0.66 per cent causing an increase in domestic demand by 0.56 per cent with a consequent increase in output by 0.56 per cent. While manufacturing, construction, transportation and chemicals sectors see an increase in their domestic prices as a result of reforms in the natural gas price, thereby resulting in the contraction of their output (Table 7).

Government: The implementation of price reforms along with quantitative reforms in the natural gas sector does reduce the government's subsidy bill by 100 per cent for the natural gas sector as compared to BASE (Table 3). The fall in the loss in dividend from natural gas is also a similar percentage. However, due to the increase in natural gas prices, the demand for LPG and kerosene rise causing the government's petroleum subsidy burden to increase by 6.03 per cent as a result of the substitution of natural gas by petroleum-based fuels. As seen earlier in the Chapter, with the continuing of the controlled output regime in the natural gas-consuming sector where the per-unit subsidy is fixed (e.g. fertilizer sector), the increase in the natural gas prices, therefore, lead to an increase in subsidy in the consuming sectors by 0.86 per cent. However, the total savings on account of natural gas subsidy and limited pass-through of diesel and motor spirit prices, the total support provided by the government to the two sectors together goes down by 219.13 per cent in this Scenario (Table 3).

Household: With partial pass-through of lower international crude oil prices and elimination of subsidy on domestic diesel and natural gas, the sectors no longer suffer from loss of income on account of subsidy sharing thereby increasing the returns to factors of production. As a result of increased factor prices, there is a fall in the industrial domestic output which in turns results in lowers income to households as compared to BASE (Table 4). The impact is more prominent in the higher-income households in urban and rural areas as these households are also the owners of the factor capital. The middle class also suffer a moderate fall in their income. As a result, the overall consumption of households falls by 0.61 per cent over the BASE as the higher income group in urban areas suffers a larger loss of income. With the fall in household income, the total household savings fall by about 0.57 per cent over the BASE**.** From the welfare perspective, it can be seen that the equivalent income falls for all the households in the current Scenario also as compared to the BASE. The impact is more prominent in the case of higher-income households as seen in the case of per capita income of households as is seen in the case of per capita income.

Macroeconomic: As seen earlier, the above sectoral changes also have macro-level impacts. With the increase in the natural gas prices, the prices of petroleum commodities increase leading to a contraction in their output and an increase in their imports. As a result, the currency depreciates marginally by 0.63 per cent thereby rendering imports costlier and exports competitive as compared to BASE (Table 4). However, with the elimination of petroleum (diesel) and natural gas subsidy, there is an overall increase in prices of energy-intensive commodities causing a fall in their demand and therefore the total consumption falls by 0.61 per cent in this Scenario. As a result, the total imports and exports also fell by 0.87 per cent and 1.43 per cent respectively as compared to the BASE. As seen earlier, the increase in natural gas prices causes an increase in subsidy in the consuming sector thereby causing an increase in other subsidies by 0.86 per cent. As a result, governments savings increase further by 8.42 per cent. With the increase in government dis-savings and fall in household savings, the total savings/investment in the economy falls by 0.03 per cent fall in this Scenario as compared to the BASE. The net impact of the above changes in sectoral output is that aggregate GDP contracts. Total GDP contracts by 0.05 per cent with industrial GDP registering a fall of 0.76 per cent, which is offset by an increase in agricultural GDP by 0.04 per cent and services GDP by 0.14 per cent.

5.4 Comparison of Scenario Result

As mentioned earlier, Scenario 1 and Scenario 2 correspond closely to the policy alternatives as suggested in the Kelkar Committee (GoI, 2014) and GAIL (2010), respectively, for reforms in the Natural Gas sector. Scenario 3 while combining these two policy alternatives is nevertheless not a straightforward addition of Scenarios 1 and 2 as the price of natural gas paid by different users varies under each of these alternatives. It would thus be of interest to compare the outcomes under these policy alternatives. We do this in this section for a select set of variables of interest. Table 9 presents the comparative picture across the three scenarios, wherein an increase or decrease in a variable's value over BASE is indicated by a '+' or '-', respectively.

Table 9: Comparison of Scenario Results (change over BASE)

Variable	Scenario 1	Scenario 2	Scenario 3
Natural Gas			
Domestic Price	+	+	+
Intermediate demand	+	-	+
Household demand	-	+	+
Final demand	-	+	+
Output	+	+	+
Imports	-	+	+
Exports	+	-	+
Coal and Lignite- Total demand	+	+	+
Diesel- Total demand	+	+	-
Naphtha- Total demand	+	+	-
Transport			
Domestic Price	+	-	+
Output	+	+	-
Fertilizer			
Domestic Price	+	+	+
Output	-	-	-
Government			
Subsidy Natural gas	-	+	-
Subsidy Petroleum	-	-	+
Total Subsidy	+	+	-
Government Savings	+	-	+
Household savings	-	-	-
Total Investment	+	-	-
GDP	+	+	-

Source: Model results

As seen in Table 9, the domestic natural gas price increases in all three Scenarios. However, the increase in domestic price has a differential impact on the intermediate demand for natural gas due to the presence of quantitative controls (gas utilization policy) whereby the protected sectors receive a preferential allocation of the domestic natural gas. Therefore, in Scenario 2, dismantling the GUP exposes the protected sector to composite price (pool price) which is higher than the subsidised domestic price of natural gas thereby leading to contraction ('-') in the intermediate demand for natural gas (Table 9). However, at the same time, the household demand for natural gas increases in Scenario 2 as compared to Scenario 1, as a large part of the household's consumption[10] falls under the unprotected sector category and under Scenario 2, the household pay a lower price for the natural gas (as compared to BASE) and therefore see an increase in natural gas consumption. However, in Scenario 1, the households pay a higher price (as compared to BASE) and therefore see a fall in their consumption and consequently in household demand. As a result, the final demand in Scenario 1 falls ('-') while in the case of Scenario 2 and 3, the final demand increases ('+') as compared to the BASE. In Scenario 1, as seen earlier, the exchange rate depreciates (as compared to BASE), which affects the trade flows resulting in minor expansion of output ('+') with an increase in exports ('+') and to clear the market imports fall ('-'). While, in Scenario 2, the increase in final demand results in expansion of output ('+'), increase in imports ('+') and to clear the market there is a fall in exports ('-'). In Scenario 3, as all the sector now consume natural gas at a uniform price (i.e. import parity price), there is an increase in demand for intermediate ('+') and households ('+') and consequently leading to the expansion of output ('+'). To clear the market, there is a rise in exports ('+') followed by a marginal increase in imports ('+').

The demand for other fuels i.e. coal and lignite, diesel, naphtha, etc. in the energy aggregate of the various sectors in the economy is driven by the flexibility in the production system which allows for inter-fuel substitution. Accordingly, with the increase in natural gas price, the demand for substitute fuels increases ('+') in both Scenario 1 and Scenario 2 (Table 9). In the case of Scenario 3, with the elimination of the distortion in the natural gas sector, the demand for natural gas increase causing a substitution effect and thereby causing a fall in the demand for other petroleum aggregates. Accordingly, the demand for diesel ('-') and naphtha ('-') decreases in Scenario 3.

The reforms in the natural gas sector under policy Scenario 1 and Scenario 2 have a differential impact on the major consuming sectors of natural gas viz., fertilizer, transport, electricity etc. Since the fertilizer sector is a protected sector under the GUP and the majority of its requirement of natural gas is for feedstock purpose and therefore in all the Scenarios, it has to pay a higher price for natural gas consumption (as compared to BASE) leading to an increase in its domestic price ('+'). However, as seen earlier, the substitution effect due to the availability of naphtha as a substitute fuel for natural gas for feedstock purpose dampens the impact of price rise. An increase

[10] Only limited quantity of domestic natural gas is being allocated to city gas distribution under the GUP. Balance quantity requirement of the sector is met through imported LNG.

in domestic price consequently leads to a fall in its output across all Scenarios ('-'). Whereas in the case of the transport sector which is an unprotected sector[11] under the GUP suffers an increase in its domestic prices ('+') due to the increase in natural gas price in Scenario 1. However, the substitution of natural gas by relatively cheaper diesel and electricity make it relatively competitive in the domestic market thereby seeing an increase in total demand and therefore an increase in domestic output ('+'). In Scenario 2, the transport sector benefit from the price pooling as the composite price is lower than the import price of natural gas and therefore the domestic price of transport sector fall ('-') in this Scenario (as compared to BASE) leading to increase in demand and consequently the expansion of output ('+'). In Scenario 6, due to the substitution effect, the increase in fertilizer price ('+') is relatively lower as compared to Scenario 2 while in the case of the transport sector the increase ('+') in domestic price is higher than Scenario 1.

In Scenario 1, a 100 per cent reduction in subsidy on domestic natural gas reduces the government's subsidy bill for the natural gas sector ('-') and also for the refinery sector ('-'). However, an increase in the domestic price of natural gas causes an increase in other subsidy (fertilizer) and consequently the total subsidy increases ('+') in this Scenario. However, the reduction in the support to the natural gas sector being higher the government's savings ('+') increases further in this Scenario. The increase in government savings more than compensate the fall in household saving resulting in an increase in total savings / total investment ('+') in this Scenario and consequently aggregate GDP expands marginally ('+') in this Scenario (Table 9).

However, in Scenario 2, with only quantitative reforms and no change in the subsidy provisioning of domestic natural gas, there is an increase in total demand of natural gas and also its output, which results in an increase in natural gas subsidy ('+'). The decrease in total demand for LPG and kerosene leads to a reduction of petroleum subsidy ('-'). The increase in the domestic price of fertilizer, in turn, causes an increase in 'other' subsidy (fertilizer) and consequently the total subsidy increases ('+') in this Scenario. This, in turn, causes a further fall in the government's savings ('-') in Scenario 5. With a fall in government savings combined with a fall ('-') in household savings, the total savings/investment fall ('-') in this Scenario consequently causing minor contraction ('-') of the GDP (Table 9).

Scenario 3 has the highest gains in terms of reduction ('-') of total subsidy thereby increasing government saving ('+'). However, the fall in household savings ('-') offsets the gains from subsidy reduction thereby leading to a fall in total savings/investment ('-') in this Scenario. The net effect of these changes causes minor contraction ('-') of the GDP (Table 9).

From the above analysis, we see the introduction of partial reforms within the natural gas sector i.e. price reforms in the absence of quantitative reforms will not result in the development of the

[11] Transport sector receives far less allocation of subsidised natural gas under the GUP under city gas distribution and balance quantity requirement of the sector is met through imported LNG.

natural gas sector. It eventually leads to shifting the problem from one end (i.e. natural gas sector) to the other (i.e. consuming sector). Similarly, with the majority of downstream consuming sectors for natural gas viz. fertilizer and power being sensitive sectors of the economy, are themselves operated under a controlled price regime with subsidized output pricing, so the partial reforms, either in the form of introducing price or quantity reforms in the upstream natural gas sector without carrying out parallel reforms in the consuming sector is unlikely to aid in improving the fiscal position.

The implementation of full reforms in the natural gas sector does bring in efficiency gains as there is a net reduction ('-') in the total subsidy in Scenario 6 as compared to Scenario 1 and Scenario 2. However, the reduction in the subsidy is not sufficient to offset the fall in household income thereby leading fall in total savings/ investment. We see that even though full reforms have been carried out in the natural gas sector (as described in Scenario 3), the problems still persist causing loss of household welfare, fall in investment and consequently leading to contraction of the economy (GDP). These results, therefore, highlight the general equilibrium effects of the problems which one still has to worry about. In the case of the natural gas sector, the reforms in the upstream sector, therefore, cause the problem shifts to the downstream consuming sector, which continues to be under a controlled price regime thereby causing distortion in the economy. Our analysis, therefore, suggests that an integrated approach is required to address the problems in the natural gas sector by carrying out full reforms in the natural gas value chain, which includes introducing parallel reforms both in the upstream and downstream sector.

6 Conclusion and Policy Implications

As seen earlier, the controlled pricing regime in the natural gas sector is closely intertwined with the source of gas i.e. domestic or imported. The price of domestic gas is regulated which was nearly half of the import parity price for natural gas in the BASE year. This differential between the two prices has resulted in an implicit subsidy being provided by the natural gas sector to the gas-consuming sectors. Further, the subsidised domestic gas is allocated to certain priority sectors (fertilizer, power, etc.) within the economy using the GUP and the balance quantity was allocated to un-protected sectors (petrochemicals, manufacturing, etc.). If the priority sectors have an additional requirement, then the same is met through imported quantity. The majority downstream consuming sectors for natural gas viz. fertilizer and power being sensitive sectors to the economy were themselves operated under a controlled price regime with subsidized output pricing. Citing various distributional concerns in the consuming sector, the government has continued with the controlled pricing regime for the sector. The gas price reforms/price revisions in the Indian natural gas have only focussed on managing the price level rather than market-based pricing. This regulated regime, therefore, has affected the development of the natural gas sector.

This study examined the issue of using a CGE model for the Indian economy. This model is used to simulate three Scenarios, viz., elimination of 100 per cent subsidy on domestic natural gas in isolation without any quantitative reforms to the GUP (Scenario 1), quantitative reforms that essentially involve removal of the GUP without any pricing reforms (Scenario 2), and Scenario 3 wherein we consider the case of full price reforms by linking the domestic price system to the international import parity pricing and relaxing the full employment condition thereby allowing the factor supply to vary.

In policy Scenario 1, a 100 per cent reduction of subsidy on natural gas is accompanied by an increase in the price of natural gas. As seen earlier, the availability of subsidised natural gas had resulted in excess demand through the creation of surplus capacity in the consuming sectors (chemicals). Availability of cheaper fuel to the priority sector, therefore, had a perverse effect of the subsidy on the development of the natural gas sector. In response to subsidy elimination, there is a shift in demand in favour of petroleum fuels and coal as a substitute for natural gas. The key sectors that benefited from subsidised domestic gas (fertilizer, electricity, etc.) also see an increase in their domestic prices, thereby resulting in a minor contraction of demand. However, in the case of the transportation sector, the substitution of natural gas by relatively cheaper diesel and electricity make it relatively competitive thereby seeing an increase in total demand and therefore an increase in domestic output and lower imports. Since the output prices are moderated, the expansion in the GDP is marginally more than 0.07 per cent. Secondly, the elimination of subsidy increases government savings further by 4.48 per cent. The increase in the price of natural gas leads to a fall in household savings (0.16 per cent) which marginally offset the improvement in the fiscal situation, thereby causing the aggregate investment in the economy to improves by 0.55 per cent as compared to the BASE.

In policy Scenario 2, the elimination of quantitative restrictions imposed by the GUP results in a single composite price in the economy which causes an increase in domestic natural gas price by 5.75 per cent over the BASE. As seen earlier, the availability of subsidised natural gas had resulted in the creation of excess demand through the creation of surplus capacity in the consuming sectors. As a result, domestic gas was allocated to prioritized sectors in the economy through the GUP. In response to price pooling, one composite price is formed in the economy which is higher than the domestic price of natural gas and lower than the price of imported gas. As a result, the prioritized sectors in the economy face price increase and other sectors are benefited from the lower price. This results in a shift in demand in favour of petroleum fuels and coal. Across some of the major sectors, the use of natural gas is down ranging between 7.87 per cent and 33.33 per cent. Since the output prices are moderated, the expansion in the GDP is marginal about 0.0002 per cent. The increase in natural gas price leads to an increase in the subsidy burden by 1.82 per cent in the consuming sector (fertilizer with fixed per unit subsidy). As a result, the total subsidy burden of the government increases by 4.02 per cent leading to an increase in government dis-savings by 5.94 per cent. The increase in government subsidy burden along with a fall in the household savings (0.07 per cent) causes the aggregate investment in the economy falls by 0.49 per cent.

Policy Scenario 3 builds upon Scenario 2 with the removal of quantitative restrictions imposed by the GUP. As seen in the earlier section, elimination of subsidy results in an increase in natural gas prices thereby rendering it non-competitive to the other non-electrical components viz. petroleum aggregates and coal. This causes increased substitution of natural gas by petroleum aggregate, coal and electricity as compared to Scenario 2. The rise in the relative price of natural gas and petroleum increases the energy cost of the consuming sectors resulting in the rise of output prices in certain sectors. However, the governments dis-savings decline by 8.42 per cent which helps in reducing the impact on the economy and the contraction in GDP by 0.05 per cent. The households also suffer income loss as compared to Scenario 2 resulting in a fall in their savings by 0.57 per cent. The improvement in the fiscal situation is inadequate to offset the fall in household savings thereby causing the aggregate investment in the economy to fall by 0.03 per cent.

The results show that the increase in domestic natural gas prices does affect the downstream consuming sectors in all three Scenarios. However, the presence of inter-fuel substitution among the fuels in the energy aggregate dampens the impact of the rise in natural gas prices. However, at the household level, there is a fall in income in all three Scenarios. In Scenario 2, the lower-income group in rural areas suffer a higher income loss on account of a fall in agricultural and industrial GDP. From the household's welfare perspective, it is seen that all the households suffer from loss of equivalent income in all three Scenarios as compared to the BASE. To address these distributional concerns, the net savings occurring to the government as a result of natural subsidy reforms could be considered for redistribution to low-income households to improve welfare. The analysis in the paper also brings out certain other important lessons as follows:

(a) Partial reforms within the natural gas sector i.e. price reforms in the absence of quantitative reforms will not result in the development of the natural gas sector. It eventually leads to shifting the problem from one end to the other.

(b) Indeed, carrying out a complete set of both price and quantity reforms in the natural gas sector, while improving efficiency in the system, is nevertheless inadequate due to the significant general equilibrium effects that the sector has.

(c) Reforms in the natural gas sector have to be seen in a context where the main downstream consuming sectors for natural gas such as fertilizer and power, being sensitive sectors of the economy, operate under a controlled price regime with subsidized output pricing. Therefore, the introduction of partial reforms in the natural gas sector without carrying out reforms in these consuming sectors eventually leads to shifting the problem from one end to the other, without any commensurate improvement in the fiscal position. Our analysis suggests that an integrated approach, which includes introducing parallel reforms both in the upstream and downstream sector is possibly required to address the problems in the natural gas sector.

(d) There exists substantial scope for substitution amongst alternative fuels in various sectors of the economy. It is important to capture these substitution possibilities in the analytical framework used in order to arrive at a proper assessment of the impacts of changes in the pricing regime for various fuels. The fear of rising cost and increased subsidy burden in the downstream sector is therefore not warranted as long as there is flexibility in the production process.

(e) The subsidy reforms in the natural gas sector had a differential impact on the household thereby worsening the income distribution with lower-income households suffering a loss in income and consequent fall in consumption. Therefore, there is a need to introduce some kind of income transfers that can serve as a safety net for the adversely affected low-income households

(f) Another conclusion that emerges from the analysis is that sector-specific policy reforms may not be able to achieve the desired objectives of the reform process due to the general equilibrium effects on other sectors and agents in the economy. Policy formulation, therefore, has to consider these consequential impacts on other sectors and agents in the economy and develop a set of measures that complement such sectoral reforms.

(g) Scenario 1 analysis and conclusion at point (a) above evidently highlights the shortcomings of introducing partial reforms in the natural gas sector as suggested by GAIL, (2010) in their study wherein they had recommended introduction of sectoral price pooling without reforms in consuming sector. At the same time, the conclusions at point (b) and (c) above not only bring out the assessment of the impact due to introduction of full price reforms in the natural gas sector but also substantiate the concerns raised by Kelkar Committee Report (2014) wherein the Committee had suggested following a phased approach to price reform to smoothen the adjustment, integrated approach to reform and provision of adequate support including income transfer/subsidy to key industries during the transition period.

In general, the findings of the study are in line with other studies on energy price reforms in terms of directions of change. Some limitations of the study here are that the analysis is static and does not account for dynamic impacts over time. Specifically, gains in energy use efficiency are not modelled here and thus, the positive impacts noted here could be somewhat on the lower side.

Though these effects may vary in magnitude for the individual sectors, it is our conjecture that the direction of change as projected by the model is likely to remain the same. It is conceivable, that the results could be somewhat different if the subsidy on various petroleum products is completely eliminated. The government's own approach has been to reduce the subsidy in a calibrated manner, which perhaps reflects a similar concern. Follow-on work will be reflecting on some of these limitations.

References:

Agarwal, P. (2010), 'Energy Price Regulation in India: The Case of Natural Gas Sector,' USAEE-IAEE Working Paper No. 10-040. (https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1548435), Accessed on 07 July 2018.

BP Statistical Review of World Energy, (2020). (https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2020-full-report.pdf), Accessed on 10 August 2020.

Corbeau, A. S. (2010), 'Natural Gas in India,' Working Paper, International Energy Agency, Paris, France. (https://www.iea.org/publications/freepublications/publication/natural_gas_india_2010.pdf), Accessed on 07 July 2018.

Ebinger, C. and Avasarala, G. (2013), 'Natural Gas in India: Difficult Decisions,' James A. Baker III Institute for Public Policy, Rice University. (https://www.bakerinstitute.org/media/files/Research/6aa07dc6/CES-pub-GeoGasIndia-102513-3.pdf), Accessed on 07 July 2018.

GAIL, (2010), *Study on Common Pool Price Mechanism for Natural Gas in the Country*, Report by Mercados Energy Markets India Private Limited. (http://petroleum.nic.in/sites/default/files/gaspricepooling.pdf), Accessed on 07 July 2018.

Ganesh-Kumar, A. and Panda, M. (2009), 'Global Economic Shocks and Indian Policy Response: An Analysis Using a CGE Model,' in Parikh, K. S. (ed), *Macro-Modelling for the Eleventh Five Year Plan of India*, Academic Foundation.

Ganesh-Kumar, A. and Harak, N. (2015), 'Oil and Natural Gas Price Reforms and its Impacts on Indian Agriculture,' in Dev, M. S. (ed.), *India Development Report-2017*, Oxford University Press, New Delhi.

Goldar, B. and Kumari, A. (2009) "Subsidies Discipline of Natural Resource Pricing," Report submitted to UNCTAD by Institute of Economic Growth, India.

Government of India, (2006), *Report on the Expert Committee on Integrated Energy Policy,* New Delhi. (https://www.ctc-n.org/sites/www.ctc-n.org/files/resources/rep_intengy.pdf).

Government of India, (2011), *Report of the Inter-Ministerial Committee on Policy for Pooling of Natural Gas Prices and Pool Operating Guidelines,* Planning Commission, New Delhi. (http://www.indiaenvironmentportal.org.in/files/file/gaspoolingreport.pdf), Accessed on 07 July 2018.

Government of India, (2012), *Report of the Committee on the Production Sharing Contract Mechanism in Petroleum Industry*, New Delhi. (http://eac.gov.in/reports /rep_psc0201.pdf), Accessed on 07 July 2018.

Government of India, (2014), *Report of the Committee on Roadmap for Reduction in Import Dependency in Hydrocarbon Sector by 2030,* Ministry of Petroleum and Natural Gas, New Delhi. (http://petroleum.nic.in/sites/default/files/kelkar.pdf), Accessed on 07 July 2018.

Harak, N. and Ganesh-Kumar, A. (Forthcoming), 'Impact of Diesel Price Reform in India: A Review'.

Heyndrickx, C., Tourdyeva, N. and Talebi, V.A. (2012), 'Gas Price Liberalization: Impact Assessment with a Multi-sector Multi-household model of the Russian Federation,' Centre for European Economic Research, Germany.

Jackson, M. (2005), 'Natural Gas Sector Reform in India: Case Study of a Hybrid Market Design,' Working Paper No. 43, Stanford, California: Program on Energy and Sustainable Development, Stanford University. (https://pesd.fsi.stanford.edu/publications/natural_gas_sector_reform_in_india_case_study_of_a_hybrid_market_design), Accessed on 07 July 2018.

Jain, A. and Sen, A. (2011), 'Natural Gas in India: An Analysis of Policy,' Working Paper NG 50, The Oxford Institute for Energy Studies. (https://www.oxfordenergy.org/wpcms/wpcontent/uploads/2011/05/NG_50.pdf), Accessed on 07 July 2018.

Joshi, S. and Jung, N. (2008), 'Natural Gas in India,' in Stern, J (ed), *Natural Gas in Asia: The Challenges of Growth in China, India, Japan, and Korea,* Oxford: Oxford University Press.

Kelkar, V. (2009), *Towards A New Natural Gas Policy,* Rajiv Gandhi Institute of Petroleum Technology, India. (https://www.livemint.com/r/LiveMint/Period1/oldpdf/b8b1ac4d-7aa1-4a11-b3cf-0e4794f3d2ca.pdf), Accessed on 07 July 2018.

Orlov, A. (2015), 'An assessment of optimal gas pricing in Russia: A CGE Approach,' *Energy Economics*, 49 (2015), 492–506.

Paltsev, S. and Zhang, D. (2015), 'Natural Gas Pricing Reform in China: Getting Closer to a Market System?' *Energy Policy*, 86(2015), 43-56.

Panda, M. and Ganesh-Kumar, A. (2008), 'Trade Liberalization, Poverty and Food Security in India,' Indira Gandhi Institute of Development Research, Working Paper WP-2008-013.

Parikh, J., Biswas, C. R. D., Singh, C. and Singh, V. (2009) "Natural Gas Requirement by Fertilizer Sector in India," Energy, 34(2009), 954-961.

PNGRB. (2013), 'Vision 2030 Natural Gas Infrastructure in India,' Report by Industry Group for Petroleum & Natural Gas Regulatory Board, 2013.

Rogers, H. V. and Stern, J. (2014), 'Challenges to JCC Pricing in Asian LNG Markets,' The OIES Paper No. NG 81, Oxford Institute for Energy Studies. (https://www.oxfordenergy .org/wpcms/wp-content/uploads/2014/02/NG-81.pdf), Accessed on 07 July 2018.

Sen, A. (2015), 'Gas Pricing Reform in India: Implications for the Indian Gas Landscape,' OIES Paper No. NG 96, The Oxford Institute for Energy Studies. (https://www.oxfordenergy.org/wpcms/wp-content/uploads/2015/04/NG-96.pdf), Accessed on 07 July 2018.

Stern, J.P. (2012), 'International Gas Pricing: An Historical Overview,' in Stern, J. P. (ed.) *The Pricing of Internationally Traded Gas,* OIES/OUP, Oxford, 40-84.

Appendix: Features of the CGE model

This Appendix provides a brief description of the salient features of the CGE model used in this study. As mentioned earlier, we use a modified version of the static CGE model developed by Ganesh-Kumar and Panda, (2009) (referred to as G-P model) in which we have incorporated several features that are designed to address the questions of concern in this study. The G-P model is a static CGE model built around a Social Accounting Matrix (SAM) for the year 2003-04 that distinguishes 71 sectors and 10 household expenditure classes, 5 each in rural and urban areas. Five major modifications are made here for the present study. These are,

i. Specification of commodity-producing sectors and households, Joint-production structure of refinery sector, and updating of the SAM to 2011-12,

ii. Specification of production technologies for various sectors wherein petroleum and natural gas (NG) products are key intermediates,

iii. Incorporation of the "Gas Utilisation Policy" that determines how domestically produced gas is allocated to certain "protected sectors",

iv. Subsidised LPG Entitlement linked to Linear Expenditure demand System (LES) consumption function, and

v. Specification and accounting of economic subsidies for petroleum and NG products.

This Appendix first describes the main features of the G-P model and its limitations in the context of this study. The modifications carried out here to overcome the limitations of the G-P model are then described. The full mathematical specification of the equations of the CGE model used in this study is available in Harak and Ganesh-Kumar (Forthcoming).

Features of G-P Model

The following are the main features of the G-P model:

- The G-P model is a neo-classical CGE model in the Dervis, de Mello and Robinson (1982) tradition. A key aspect of this class of CGE models is that they allow for imperfect substitution between domestically produced and traded goods following the Armington insight.
- The model distinguishes several types of prices for each commodity, viz., imports, exports, domestic market price, and producer price. The wedge between these types of prices arises due to the government's tariffs on imports, export subsidies, and indirect taxes/subsidies for domestic goods, and also due to the imperfect substitutability between domestic and traded goods.
- Domestic market price clears domestic commodity markets.
- For certain commodities (diesel, cooking gas, kerosene and natural gas) an administered price mechanism is allowed, wherein the government sets the price at which the commodity is sold in the domestic market. For such cases, the model endogenously determines the subsidy rate that is required to clear the market.
- Factor prices clear factor markets under full employment specification. This is the default closure for the factor markets which is retained in the analysis here.[12]
- As is common to all CGE models, the G-P model solves for relative prices only, with the consumer price index being specified as the numeraire.
- The agents in the model are the 10 household types, government and the rest of the world.
- Households receive income from their factor endowment, government transfers and foreign remittances. They use this income for paying direct taxes, savings, and consumption of various commodities. Household demand for various commodities is determined through a piece-wise LES.
- Government receives revenue from taxes (direct, domestic indirect, tariffs), and from its ownership of capital. Its expenditures are towards current consumption, transfers to households and subsidies. Government's savings is residually determined.
- With regard to the balance-of-payments, commodity-wise trade flows are determined endogenously through the Armington approach. Various foreign flows – net-factor income

[12] The model allows the specification of unemployed factors to exist, in which case factor prices are fixed in real terms.

from abroad, remittances, government borrowings, and capital flows – are fixed in foreign currency units. The Exchange rate clears the forex market.[13]

- The model has a typical neo-classical savings-investment closure, wherein aggregate investment in the economy is driven by savings from 3 sources, viz., private, government and foreign savings. The stock (working capital) requirement for each commodity is fixed in real terms. Thus, it is the total fixed capital formation that adjusts to the level of savings after accounting for the value of stocks. The demand for various capital goods (which is part of the total domestic demand) is taken to be in fixed proportions as given in the SAM.

From the perspective of the present study, the G-P model has several limitations. These are primarily with regard to the common production structure specified for all sectors/commodities. The main limitations of the G-P model are as follows:

- The G-P model follows a commodity-by-commodity framework, wherein each sector produces only one commodity. This is a major limitation while modelling the petroleum refining sector, which produces more than 7 commodities as joint products, each of which has a separate pricing regime and demand structure. Further, the government intervention into the sector has been for only select individual products viz. motor-spirit, diesel, LPG and kerosene while other products were market priced. Absence of a joint production structure, therefore, limits the realistic assessment of the impact of subsidy removal on the select individual product.

- Crude oil and NG sectors are treated as a composite sector in the G-P model whereas the present study seeks to maintain the differences in their pricing and demand structure. As a result, the behavioural response to reform in subsidies by way of inter-fuel substitution is captured only in a limited sense.

- For all sectors, intermediate inputs are considered through Leontief (fixed coefficient) productions function. This does not capture the substitution possibilities across different types of fuels/energy types that exist in reality, which limits the ability of producers/agents to respond to relative prices changes as a result of profit maximising behaviour.

- In the Government expenditure account, the subsidy bill for the petroleum and NG sectors is fully borne by the government as an "expenditure" item in its accounts which is not in line with the empirical reality in the country.

[13] The model has the flexibility to switch the closure between exchange rate and capital flows.

Modifications to GP Model

To overcome the above-mentioned limitations of the G-P model, the following modifications are carried out in the model used here:

i. The SAM for 2011-12 developed by Ganesh-Kumar (2015) is modified with regard to the sector, commodity and household classifications (Appendix Table 1). Now key petroleum products, viz., Liquefied Petroleum Gas (LPG), Kerosene, Diesel, Motor Spirit, Naphtha, Substitute fuels and Non-Substitute Fuels are explicitly represented in the SAM. Further, the 10 household classes in the G-P model are mapped onto 6 households, 3 each in rural and urban areas. Harak and Ganesh-Kumar (Forthcoming) describe the process followed for updating the SAM and also report the updated SAM.

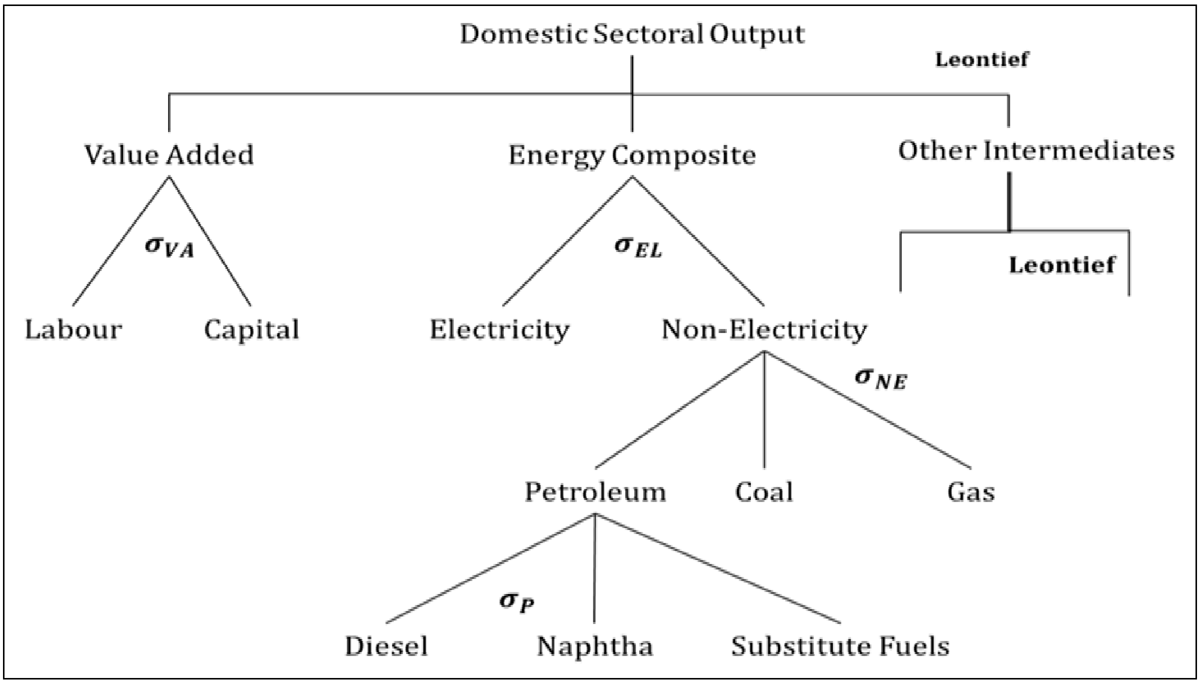
Appendix Table 1: Classifications in the SAM

Activities (13)	Commodities (19)	Factors (2)	Households (12)
Agriculture	Agriculture	Labour	Rural 1: 0% to 10%
Coal & Lignite	Coal & Lignite	Capital	Rural 2: 10% to 30%
Natural Gas	Natural Gas		Rural 3: 30% to 50%
Crude Petroleum	Crude Petroleum		Rural 4: 50% to 70%
Other Minerals	Other Minerals		Rural 5: 70% to 90%
Fertilizers	Fertilizers		Rural 6: 90% to 100%
Chemicals	Chemicals		Urban 1: 0 to 10%
Manufacturing	Other Manufacturing		Urban 2: 10% to 30%
Construction	Construction		Urban 3: 30% to 50%
Electricity	Electricity		Urban 4: 50% to 70%
Transportation Services	Transportation Serv.		Urban 5: 70% to 90%
Other services	Other services		Urban 6: 90% to 100%
Petroleum Refinery	LPG, kerosene, diesel, motor spirit, naphtha, substitute fuels and non-substitute fuels		

Source: Author's Analysis

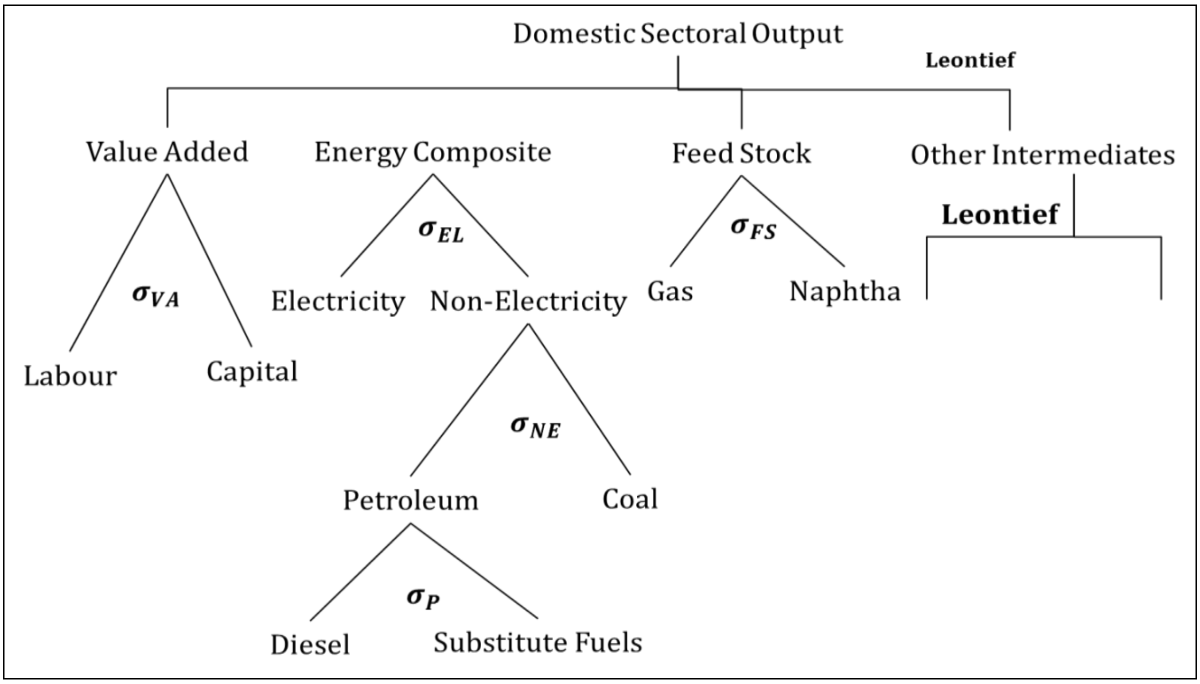
ii. For sectors other than Fertilizers and Chemicals, the production function specification in the G-P model is replaced with a nested production functions approach taking into account substitution possibilities amongst different fuels in these sectors (Appendix Figure 1). In the case of Fertilizers and Chemicals, the nested production function takes into account the use of Naphtha and Natural gas both as a fuel and also as a feedstock in these two sectors (Appendix Figure 2).

Appendix Figure 1: Nested production structure for all sectors other than Fertilizers and Chemicals



Source: Authors

Appendix Figure 2: Nested production structure for Fertilizers and Chemicals sectors



Source: Authors

In this approach at the highest level of nesting, the output is determined by a Leontief type function with the value-added, energy composite and other intermediates (and feedstock for Fertilizer and Chemicals).

At the second level of nesting, in all sectors, value added is determined using the Constant Elasticity of Substitution (CES) production function with labour and capital as factors. Energy aggregate is also a CES production function of electricity and non-electricity energy inputs. And other intermediates are considered through the Leontief type input-output coefficients derived from the I-O table in SAM. Additionally, in the case of Fertilizer and Chemicals, feedstock aggregate is also a CES production function between Naphtha and NG as inputs. The third and fourth levels of nesting determine how different fuels are combined using CES production functions to determine the non-electricity energy input used by the sectors.

iii. The model incorporates the "Gas Utilisation Policy" framework for natural gas commodity, under which the government allocates domestically produced natural gas to certain "priority" or "strategic" sectors viz., fertiliser, power and chemicals at administered domestic (subsidised) prices. The demand for natural gas by other activities is met through imports for which they pay at import parity price. This results in an implicit subsidy for the protected sectors as the imported gas prices are almost double the domestic prices. This duality in the pricing of natural gas and the GUP framework are important characteristics of the natural gas sector, which have been captured in the model.

iv. As part of the reform measures, the government has introduced a new scheme for subsidy provisioning where the household consumption is linked to their entitlement for fuels. To capture the impact of policy interventions of entitlement linked consumption (like direct benefit transfers) on household consumption, the model incorporates a modified Linear Expenditure System function which allows for the government to provide entitlement of limited quantity of a commodity at the subsidised price. Any consumption beyond the entitlement quantity happens at market price.

v. In line with the empirical reality in the country, the subsidy bill for the petroleum and NG sectors is not fully borne by the government as an "expenditure" item in its accounts. The model incorporates this aspect of burden-sharing between the two sectors and the government (as a direct fiscal subsidy). The portion of the subsidy bill borne by the two sectors, in turn, manifests as a loss of factor income to capital (i.e., loss of dividend income) to the owners of these sectors based on their ownership shares. However, given the fact that the government is itself is the majority owner of these two sectors, a substantial part of the true subsidy bill is thus ultimately borne by the government as a loss in dividend income; i.e., as a reduction in its revenue while other agents in the economy bear the balance amount to the extent of their ownership.