Analysing Alternative Policy Response to High Oil Prices, Using an Energy Integrated CGE Microsimulation Approach for South Africa

Margaret Chitiga, Ismail Fofana and Ramos Mabugu

Working Paper Number 196

November 2010

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Margaret Chitiga[*,†], Ismael Fofana[‡], and Ramos Mabugu[§]

November 4, 2010

Abstract

An energy-focused integrated CGE microsimulation approach is used to assess the implications of differential government policy responses in South Africa, to increases in international oil prices. The first scenario assumes that increases in world oil and petroleum products are passed through to end users with no changes in government tax/subsidy instruments. The second scenario assumes that the world price increases are nullified by a full price subsidy by government in one scenario, while, in the third scenario, revenues generated from a 50 percent tax on the windfall profit of the synthetic petroleum industry, help to minimize the loss in government revenue. Overall output falls by between 2.2 and 2.5 percent, while the government deficit varies from a worsening of 12 to 22 percent under the three scenarios. Synthetic petroleum, coal, and electricity benefit under the floating price scenario, while none expands its output when a 50 percent tax is levied on the profit of the synthetic petroleum industry. Unemployment increases among medium and low-skilled workers, while skilled workers witness a substantial fall in their remuneration, particularly in rural areas. In both rural and urban areas, women are adversely affected relative to men. The poverty headcount ratio and inequality increase slightly more in the price-setting scenarios relative to the floating-price scenario. Thus, allowing the prices to be passed through to end users probably has a less adverse impact at a macroeconomic level, although there may be adverse distributional consequences.

1 Introduction

During the last few years, the oil market has witnessed substantial price volatility as well as historically high prices for crude oil and the major light products. In July 2008, oil prices struck an all-time record high above $144 a barrel, seven times higher than the $19.70 a barrel recorded in December 2001. In real terms, oil was at that time the most expensive it had ever been. Analysts have pointed out that higher oil prices are inevitable and that it is unlikely that prices will fall in the long term without major discoveries of oil or alternative energy sources. Moreover, they are unanimous that government management of the higher oil prices will have significant economic repercussions in terms of income distribution and poverty reduction. Higher oil prices will lower oil consumption in favour of other sources of energy such as coal, which are known to be more damaging for the environment. Call for the government to shield the poor and some crucial sectors are not uncommon with increasing oil prices.

[*]Human Sciences Research Council, Pretoria, South Africa
[†]Corresponding author: margaret.chitiga@gmail.com
[‡]Laval University, Québec, Canada
[§]Financial and Fiscal Commission, Midrand, South Africa.

Economists have used a variety of methods to analyse the extent and magnitude of the oil price-induced shocks, the adjustment policies and the effects of such policies on economic growth and income distribution in developing countries. Mitra (1994) explores different adjustment scenarios in oil-importing developing countries to cope with the 1973/74 and 1978/79 oil-price shocks[1]. The analysis uses three types of approaches in examining the behaviour of a number of oil-importing developing countries. A descriptive approach classifies 33 countries according to the extent of the shocks, the policies pursued and the success of the subsequent adjustment. Partial-equilibrium models for Kenya and computable general-equilibrium (CGE) models for Turkey, Thailand, Kenya and India enable counterfactual and alternative policy response experiments. The oil price increase benefited the nine oil-export developing countries while the twenty-four oil importers responded to the price shocks in various ways: via domestic resource mobilisation, reduction in domestic investment, borrowing from the international markets, and exports promotion.

Using South Africa as an example, this paper follows the approach in Mitra (1994) with some modifications to address the problem of how an oil-importing developing country can cope with oil price shocks. To account for income distribution and poverty impact analysis, a micro-simulation model is used. However, its inability to model prices and macro variables inspired us to opt for both macro- and micro- models in order to reconcile the use of macro-models (CGE) with distributional impacts analysis, a major innovation in the paper. The CGE and micro modules are linked in a top-down fashion.

The rest of this paper is divided as follows: Section 2 describes the model framework used while section 3 discusses the policy simulation and results. The last section concludes the paper.

2 The Model Framework

The CGE model used is based on the neoclassical-structuralist specification as presented in Decaluwé *et al.* (2001). The core of the constructed model is based on the neoclassical general-equilibrium theory and also builds on the energy CGE models found in the literature (Bergman, 1990; Bergman and Henrekson, 2003; Hazilla and Kopp, 1990; Manne, 1977; van der Mensbrugghe, 1994; Busollo *et al.* 2003). CGE models are widely used for evaluation of policies related to energy and carbon dioxide emission. A survey by Bergman and Henrekson (2003) highlights their usefulness in environment and resource management modelling. The rest of this section describes the model used for South Africa, its energy specificity and the microsimulation model.

2.1 Core CGE Model

The CGE model collapses a whole economy into three major parts: (i) the supply of goods and services that includes production and trade activities; (ii) the demand for goods and services by institutional units; and (iii) the macroeconomic constraints. The model then builds equations meant to capture the behaviour and interaction between the three components.

Producers maximise profit under a given technology and independent prices. Industry-specific producers are modelled as representative producers that are assumed to have a nested constant elasticity of substitution (CES) production technology. The relationship between the rest of the world and the domestic economy is determined by the substitutability between imported and domestic goods on the consumption side (*Armington assumption*), and by the substitutability between the domestic and international markets on the production side. The relative prices of foreign goods – defined by international fixed prices (*small country hypothesis*), the exchange rate, and government interventions (taxes, subsidies, and tariffs) – determine the allocation of supply and demand between domestic and international markets. Consumers maximise utility with limited budgets and given

[1] The oil price shocks were accompanied by a subsequent rise in interest rates and this is also accounted for in Mitra (1994).

market prices. Households are modelled as representative agents that are assumed to have Stone-Geary type of preferences.

Perfect competition prevails in the sense that producers and consumers take as given the relative prices that simultaneously clear all markets, that is, equalising the quantity produced for each commodity to the quantity demanded for that commodity. Households' behaviour is rational, which implies that, in the presence of complete markets, there is a separation between their production and their consumption decisions *(separability hypothesis)*.

The model specifies a number of structural features designed to reflect the characteristics of the South African economy. There is a general consensus among analysts that the labour market in South Africa is segmented. Each segment corresponds to a specific skill-level and behaves differently in terms of earnings, job opportunity, unemployment, and wage flexibility.[2] Therefore, workers and the labour market are differentiated into high-skilled (from hereon also referred to as skilled workers), medium-skilled and low-skilled categories (from hereon also referred to as unskilled workers). Each category in turn is separated by sex (male and female) and location (urban and rural areas). While education and experience are important determinants of earnings, other factors such as discrimination by race and gender and barriers to mobility (i.e. geographic location) are associated with larger differentials than usually found in studies for other countries (Fallon and Lucas, 1998)[3].

Capital demand is industry-specific. Consequently, there are as many returns to capital as there are capital-using industries in the economy. Capital supply is exogenous and institutional units are endowed with a single type of capital. Although the return to capital is industry-specific, each domestic institutional unit (urban households, rural households, firms and government)[4] receive an average return to their capital according to its distribution across industries. There is no return to capital use in general government services. Instead, the government supports the cost of using such capital.

The model explicitly treats the trade and transportation margins for commodities that enter the market sphere. A constant trade and transportation margins coefficient is added to each transaction and included in the purchasing price of commodities. Consequently, the generated revenues represent additional demands for trade, and transport services.

CGE models differ primarily in the choices of closure rules which equilibrate commodity, factor and foreign exchange markets. They also differ in rules specified to reconcile the government budget constraint and in the mechanism used to equilibrate savings and investment levels in the economy. In this model, all commodity markets follow the neoclassical market-clearing price system, in which jointly determined producer and consumer prices vary only by given tax, subsidy and margins rates. The labour market is assumed to be fully segmented. Workers are immobile between urban and rural areas according to the short-term perspective of the analysis and the absence of explicit treatment of migration between the two areas. Skilled workers do not compete for unskilled jobs and unskilled workers similarly do not compete for skilled jobs. As a result, high-skilled, medium-skilled and low-skilled male and female workers in both urban and rural areas participate in different labour markets. Each category of labour is assumed to be perfectly mobile across industries. A single wage index prevails for each market. Skilled workers are fully employed in the economy, although low rates of frictional unemployment[5] are observed in urban and rural areas for this category. The skilled

[2] The country faces at the same time a shortage of skilled workers and a high unemployment rate among unskilled workers.

[3] The model does not explicitly treat the rural-urban migration issue, though. Furthermore, men and women tend to work in different sectors, some sectors are male-oriented (i.e. mining, food, beverage and tobacco, heavy manufacturing and construction), while others are female-oriented (i.e. textile, privates services). Fofana *et al.* (2007) further discuss the gender segmentation of the labour market in South Africa. We consider that racial discrimination is minor and individuals with identical education and work experience have the same opportunity to be hired regardless of the population group to which they belong.

[4] The non-resident agents do not own capital; instead they receive property transfer income (dividend, interest, etc.) from the resident agents.

[5] Frictional unemployment exists because both jobs and workers are heterogeneous. A mismatch related to skills, payment, worktime, location, attitude and tastes can result between the supply and the demand of labor.

labour market is assumed to be perfectly competitive, so that the prevailing wage rates equalise exogenous supplies and endogenous demands for high-skilled workers in both urban and rural areas. In contrast, there is imperfect competition in the unskilled labour markets, where the total demand does not equal the total supply. There is an excess supply of labour, which remains unemployed. The wage rate paid to unskilled male and female workers is fixed in real terms in both urban and rural areas.

According to the characteristics of the labour market in South Africa and the short-term perspective of the study, we assume that the employment decisions in general public administration are exogenously determined as government hiring possibilities are limited. Therefore, fixed and indexed wage rates prevail in the general government services, while other industries take the market wage rates as given. The supply of each category of labour is exogenous[6]. Household labour supply specification takes into account the existence of unemployment for low-skilled labour categories. We assume that low-skilled employment is rationed on the demand side and workers have the same opportunity (probability) to be hired regardless of the household to which they belong.

The foreign exchange market equilibrates via adjustments of the real exchange rate. The current account balance is therefore exogenous and pre-specified at the base-year level. Hence, with fixed foreign borrowing and transfers from abroad, higher imports of some goods will require lower imports and/or higher exports of other goods in order to keep the current account balanced. Pressures to change export or import quantities (and hence, demand and supply of foreign currency) are therefore equilibrated by adjustments in the real exchange rate.

Government is passive in the sense that it does not optimise any objective function. Its role is limited to that of regulating economic activity. Its earnings comprise revenues raised from indirect taxes, direct taxes, trade taxes and net foreign borrowing. Its expenses consist of subsidies, current expenditures on the services provided by the public sector, investment and transfers to households and firms. The simulations are performed under a rigidity of government current expenditures. This closure rule is motivated by the absence of explicit modelling of the macro and distributional effects of changes in government spending. The government deficit is covered by borrowing on the domestic credit market.

Private savings are investment driven, i.e. investment is fixed at its base-year level and adjustment is forced into the savings account. In a comparative-static context, this means that the costs of the oil price increases and government interventions are not passed onto the future. In a context where private savings are endogenously determined - by exogenous constant rates for households and by residual for firms - government is forced to adjust its deficit. Thus, a compensatory lump-sum tax/subsidy on household incomes and welfares is integrated to maintain government expenditures unchanged and to adjust its deficit in order to keep constant the volume of investment. The lump-sum tax/subsidy has to be interpreted as the current cost/benefit of maintaining unchanged the future welfare effects of government expenses and of investment, i.e. there is no inter-temporal free lunch situation.

The model is homogenous of degree one in all prices and nominal values. The "numeraire" is the nominal exchange rate – however the real exchange rate remains endogenous through flexible domestic prices. All nominal values are thus measured relative to the price of internationally traded goods. The model solves for one-period equilibrium and results have to be interpreted in comparative-static terms.

[6]Allowing the supply of labour to be endogenously determined by households is not relevant in our study as long as we claim a short-term perspective of the analysis. Thus, new educated labour or/and skilled labour migrants will not play an important role in the model. With the presence of unemployment rationed on the demand side, high (low) employment will lead to low (high) participation to economic activity and will not necessary impact on the unskilled wage rates assumed fixed in real terms.

2.2 Energy Specificities of the CGE Model

The model differs from standard CGE models in two other main aspects: the energy supply and demand specification on the one hand, and the price setting method in the domestic oil market, on the other hand. The model has four types of energy, namely crude fuel, refined fuel products, coal, and electricity (including gas and renewable energy).

An industry j's technology is presented as a nested CES function (Figure 1). The gross output consists of a Leontief function of the composite value added-energy and the non-energy input consumption. Leontief technology also determines the demand for non-energy commodities in the total non-energy input consumption. A CES function aggregates unskilled labour and the bundle of capital-energy and skilled labour in the value added-energy composite, with a high elasticity of substitution. The bundle of capital-energy and skilled labour is also a CES aggregation of capital-energy and skilled labour. However, the latter has a low elasticity of substitution. Each unskilled and skilled labour category is a fixed proportional (Leontief) relationship between urban and rural labour categories. A unitary elasticity of substitution (Cobb-Douglas) aggregates low- and medium-skilled male and female workers on the one hand, and high-skilled male and female workers, on the other hand. A CES function with a low elasticity demonstrates that capital and energy imperfectly substitute for each other (quasi-complementary) in the composite capital-energy.

Energy inputs are divided into four types, which are imperfect substitutes for each other (Figure 2). Composite fuels and electricity are combined in a CES function with a relatively low elasticity of substitution, i.e. it is not easy for industries to adopt a better energy efficiency technology according to the short-run perspective of the study. The former is defined as a CES-aggregate of coal and oil fuels, also with a relatively low elasticity of substitution between them. Finally, crude oil and refined oil products are assumed to be complements in the oil bundle. The demand for each energy commodity is shared between imports and domestically produced goods, depending on their relative prices and assuming a high degree of substitutability between them.

The goods and services consumed by households are grouped by purpose, i.e. food, personal care, housing, etc. A single commodity category (e.g., petroleum product) enters into one or several groups of consumption by purpose (e.g. household fuel and transport). Representative urban and rural households maximise unitary utility functions over the group of consumption by purpose, subject to the constraint of their income. Thus, households' expenditure on commodities combine a Linear Expenditure System (LES) function over various groups of consumption by purpose, and a Cobb-Douglas (CD) function over commodity categories for each group of consumption by purpose.

2.3 Micro-simulation Model

The CGE model described up to now accounts for only two representative household categories, that is, urban and rural, whereas indicators used for the analysis of poverty and inequality generally use household or individual-level data. This high aggregation limits its usefulness for the income distribution and poverty impact analysis of oil crisis. Therefore, micro-simulation modelling is essential in analysis of the distributional impacts of the macro shocks in order to reconcile the use of macro-models with distributional impacts analysis.

A two-layered integrated CGE-microsimulation technique is used to analyse the income distribution and poverty impacts of the alternative policy responses. The micro-simulation model developed follows Ravallion and Lokshin (2004) and Ganuza *et al.* (2002) in accounting for both prices and reallocation effects of shocks. As inputs, it takes CGE results on the employment and unemployment variables and on the return to factors. For each of the twelve segments of the labour market, the changes in employment or unemployment variables obtained from the CGE model are imposed onto the individuals in the survey. Unemployed individuals are randomly selected to join the pool of employees in a situation where employment increases. In the opposite case, we randomly select individuals remaining employed when retrenchment occurs. The selection process is repeated a large number of times to allow for the determination of confidence intervals of poverty and inequality indicators. Finally, the changes in wage rates are applied to salary and wage workers; the latter are aggregated to the real households-level. Business and transfer earnings are also adjusted by the changes in the return to capital and in the average economy-wide price, respectively, from the CGE model. Households' earnings, that is wage, profit, and transfer, are computed and used for the measurement of the counterfactual income poverty and inequality indicators.

A standard Mincerian wage regression imputes wages to unemployed and inactive individuals. Log wages are regressed on education and age (proxy for experience), controlling for gender, employment status (full or part time), marital status, and finally, the presence of children under seven years old.

3 Experiments and Results

3.1 The scenarios

The study experiments with a sustained increase of import and export prices of crude oil and refined petroleum products under alternative government policy responses. It simulates a US $10 increase in import prices of crude oil. The shock translates into a 50 percent increase of the cost of crude oil as compared to its (average) level in 2000. A simultaneous increase - but in a smaller amount of 25 percent - of the import and export prices of refined petroleum products is also simulated. The analysis should be taken as giving a short-term perspective of the impact of recent oil price shocks.

Altogether three scenarios are run. The first scenario assumes that the increase of the prices of crude oil and petroleum products imported by South Africa is fully transmitted to end-users through an increase of the purchasing prices. This is the current intervention of the government in the oil market which we assume is maintained. This scenario is referred to as the "floating-price scenario". The alternative scenarios suppose that the government is willing to intervene and compensate for the increase of the consumption prices of petroleum products in order to protect consumers and producers. Thus, it decides to compensate fully the increase through the price-subsidy mechanism. The purchasing prices of petroleum products are kept exogenous and the government fully compensates for an increase in their prices in the *sub-scenario 1.* The price-subsidy mechanism is combined with a 50 percent tax on the profits of the synthetic petroleum industry in the *sub-scenario 2.* These scenarios are referred to as the "price-setting scenarios".

To implement its oil price support policy, the government guarantees a selling price to oil consumers. In a market-clearing context, there is zero excess supply so that the equilibrium price adjusts supply and demand. Therefore, the government provides a price policy support to oil consumers, but it is still willing to let the market adjust to the market-clearing price. In that case, the price paid by oil consumers may be exogenous, whereas the level of government subsidy is endogenously determined, depending on the fluctuation of the international oil prices[7]. The government will then have to arrange some method of financing the implied extra expenses.

The modelled scenarios are policy relevant. For instance, the idea of a windfall tax was first floated in South Africa in the October 2005 medium-term budget policy statement by the then Finance Minister Trevor Manuel. Of course the calls for a windfall tax were somewhat dampened when the oil price spike took a dive and the related windfall profits took a correlating downturn. But over recent months there has been a growing body of evidence that could suggest a windfall tax may be back on the cards. Oil prices peaked at almost $150, then tumbled to under $40 a barrel and recently jumped to around $73, bringing back to the forefront the windfall debate. With conventional tax sources battered by the global economic recession, windfall taxes could produce a marked revenue enhancement that government desperately needs. Further impetus has been provided by the proposed Australian tax on windfall mining profits, referred to as the Resources

[7] Alternatively, the level of the subsidy can be made exogenous and the consumer price then becomes endogenous instead. In that case, the government supports the difference between the market-clearing price and the selling price through a subsidy scheme.

Super Profit Tax, which is hoped to help government there recover from the global financial crisis. The IMF has expressed support for the proposal arguing that resource rent taxes give mineral-rich countries brighter prospects of repairing crisis-battered budget balance sheets. The issue of subsidies as modelled is another policy option – the whole host of social grants transfer making as much as $3\frac{1}{2}$ percent of GDP in the country does suggest that there is a huge appetite for cushioning households from negative exogenous shocks to the economy.

3.2 Findings and discussion

The scenarios have differential impacts on industries' output, modify the entire price structure and, consequently, factor reallocation. The impact on households depends on their factor endowments and their consumption patterns. The following sections trace in detail the impacts of the price shock as they channel through changes in macroeconomic variables and the government budget, in activities' outputs, factor uses and prices, consumer prices, and the well-being and poverty status of households.

3.2.1 *Macroeconomic effects*

Under the floating-price scenario, the increase of the prices of crude oil (by 50%) and petroleum products (by 25%) increases the cost of imported crude. The crude oil import bill increases as its demand falls less (10.2%) than the increase in its prices (50.0%), i.e. the demand is inelastic with respect to the price. Assuming that the economy faces a foreign-reserve constraint in the sense that there are no spare reserves to spend and that it faces constraints on external borrowing[8], the increase in the import bill puts upward pressure on the real exchange rate[9]. Under the small-country assumption, i.e. fixed international prices, and a downward-sloping export demand[10], an exogenous increase of the international prices of exported petroleum products boosts their exports by 4.9% and causes a depreciation of the real exchange rate. However, the increase of petroleum exports appears insufficient to compensate for the rise in the oil import bill. As a consequence, the real exchange rate increases in order to rebalance the external current account. With a fixed nominal exchange rate chosen as the numeraire of the model, the increase in the real exchange rate has been permitted by a fall in the average domestic prices by 2.6%. Thus, total imports drop by 4.6% and total exports increase by 0.6%. The fall in domestic prices reduces business profits and wages and increases unemployment. As a consequence, incomes and real gross domestic product (GDP) fall by 1.4% and 2.2%, respectively (Table 1).

The increase of imported crude oil prices in a context of constant domestic petroleum prices (price-setting scenarios) puts more pressure on the real exchange rate appreciation discussed earlier in the floating-price scenario, as oil imports increase relatively more (fall less in absolute terms). Thus, the changes in economic variables under the price-setting scenarios relative to the floating-price scenario are mainly driven by the substantial fall in the domestic prices, i.e. increase of the real exchange (Table 1). As a consequence, GDP falls slightly more (2.4% and 2.5%) in the price-setting scenarios compared to the floating price scenario (2.2%). Thus, the economic performance deteriorates when the government taxes the windfall profit of the synthetic fuel industry, as this transforms private savings into consumption, thereby contributing to deterioration in the trade balance.

The fall in the GDP induced by high oil prices reduces government fiscal revenue by 3.9% in the floating-price scenario. Under rigid government current expenditures, a compensatory tax on household incomes enables government spending and the economy-wide volume of investment to remain unchanged. Thus, revenue gathered from direct tax increases by 11.5%, and government

[8] This assumption is translated by a fixed current account balance and a flexible real exchange rate in the model.

[9] The real exchange rate is defined as the ratio of foreign average price (converted in local currency by the exchange rate) to domestic average price. The rise in the real exchange rate corresponds to the devaluation of the local currency.

[10] The low bound values estimated by Behar and Edwards (2004) are chosen for the elasticity of export demand.

revenue by 7.6%. As a consequence, the government deficit falls by 29.3%. Government tax receipts fall more in the price-setting scenarios (Table 2). The fall in government revenue is essentially induced by the drop in taxes and levies on domestic commodities. Of lesser importance is the contribution of taxes on imported goods to this decline. A full subsidy of an oil price increase accentuates government expenses; the latter combined with its revenue lost lead to a doubling of the public deficit from 12 to 22 percent. Thus, households continue to pay a higher cost (increase in the lump sum tax) in maintaining the public expenditure and global investment remains unchanged (Table 1).

3.2.2 *Output effects*

High oil and oil products prices modify the entire price structure and, consequently, commodity prices and factor returns. The differential impacts on activity production depend primarily on their oil-input intensity, which was measured as oil and oil products input cost per unit of value added. An industry with high oil intensity is more likely to be affected adversely by higher oil prices. The structure of the demand also contributes to the distributional impacts of oil price shocks among industries. Indeed, high-traded industries benefit more from an appreciation of the real exchange rate. Furthermore, the compensatory lump-sum tax on household income and wealth that keeps unchanged the government expenditures as well as the volume of investment is not sector neutral. The tax-induced reduction of household income is less of a benefit to those industries producing for final consumption relative to investment goods-oriented industries. The detailed results and influence of the economic structure on these results are given in Appendix 2 and here we only discuss the main trends.

In the floating-price scenario, the oil price shock benefits disproportionately the alternative sources of energy that are close substitutes to oil and oil products. The price increase of imported crude oil reduces its imports as demand shifts in favour of locally produced petroleum, in particular the *synthetic petroleum* industry. As both products are close substitutes in the composite petroleum products, a $10 increase in the crude oil price boosts the output of the *synthetic petroleum* industry by 4.7% (Table 3). Its production uses coal and natural gas as input; hence, the increase of its output is more likely to have positive effects on the demand for coal (to a limited extent other mining industry). Furthermore, coal and electricity are close substitutes for petroleum products, the rise in the imported and exported petroleum price substantially increases the price of oil products and this diverts demand from these products towards alternative energy sources, namely coal and electricity. The demand for coal and electricity increases by 3.1% and 1.7%, respectively (Table 3). A number of investment- and export- oriented industries, in particular mining and heavy manufacturing industries, also experience a relatively high output level. The *transport services* also benefit from a sustained demand from expanding sectors and exports.

On the other hand, the petroleum industry with high oil-input intensity relative to its value added witnesses a substantial fall in its output (11.9%). Final consumption-oriented industries ("*Household appliances*", "*Handbags*", "*Animal feeds*", "*Soap*", "*Activities services*", "*Bakeries*", "*Knitting mills*", "*Wearing apparel*", etc.) also contract due to a drop in their final demand. Furthermore, low input demand from the latter industries affects significantly the output of many other industries (e.g. "*Textiles articles*").

In aggregate, the mining industry also benefits from the increases of its exports as the real exchange rate rises while the heavy manufacturing industry is least affected by the oil price shock. The severity of the impact is more pronounced on agriculture, light manufacturing (including food manufacturing), and private services.

The changes in sectoral output in the price-setting scenarios relative to the floating-price scenarios are mainly driven by the real exchange rate effects. Domestic prices and incomes fall more, induced by rising pressures on the real exchange rate. As a consequence, domestic demand falls, driving a relatively lower output for most of the activities (Table 3). In contrast, outputs in oil and synthetic fuel industries are relatively strong, as well as outputs in export-oriented industries (Table 3). They benefit from relatively low purchasing prices and a higher real exchange rate. However, the 50 percent tax on the synthetic petroleum profit lowered their output (Table 3). Synthetic petroleum is still the biggest winner of the oil price shock in the second scenario. Its output almost doubles when the government subsidises the domestic fuel prices. The output of coal and electricity, which are petroleum substitutes, declines compared to the first scenario; petroleum production has become less expensive. The output of electricity falls because it is the sector with the least intermediate demand from the manufacturing industries, while coal still benefits from increasing demand from the synthetic petroleum industry.

3.2.3 *Factor effects*

The discussion now focuses on how the output effects of an oil price shock influences factor prices and unemployment rates in South Africa under the three scenarios. Factor prices are driven primarily by value-added prices. While value-added price variations generally reflect those of output prices, their evolution is more positive when input costs rise less than output prices (see Annexure 2 for detailed results).

Under the floating-price scenario, value added prices generally fall the most among the highly intensive oil-input sectors, whereas they increase among sectors with low oil-input use. It is noteworthy that alternative energy industries are among the sectors with the strongest increases in value-added prices – "*synthetic petroleum*", "*electricity*" and "*coal*". This result indicates that, beyond the modest increase in their output prices, these sectors benefit relatively more from lower input costs. On the other hand, the higher input costs of the "*refined oil*" reduce the value-added price despite an increase of the output price in this industry. Value-added relative prices fall for most of the industries except the refined petroleum sector, which witnesses a substantial increase under the second scenario (Annexure 2). However, it falls in the third scenario when government levies a 50 percent tax on the profit realised in the synthetic petroleum industries.

Whereas general government service workers are sector-specific with indexed wage rates, all private sector workers are mobile between sectors with wage rates that equalise across all sectors for high-skilled workers and employment opportunities that change for medium and low-skilled workers. Under the floating price scenario, the increase of oil prices has negative effects on the real wage and unemployment rates in both rural and urban areas (Table 4). Wage rates fall in both urban and rural areas. In rural areas, male and female skilled workers witness a significant fall in their wage rates (29.5% and 31.5%); this fall is nearly ten times higher than that of their urban counterparts (3.3% and 3.8%). The increase in oil prices hits more female than male skilled workers. Unemployment rates also rise in both urban and rural areas (Table 4). The rise in percentage points is more among low than medium-skilled workers, and female than male workers. These results show that significant wage and employment distributional impacts of an oil price shock are less harmful to urban and high-skilled male workers. Rural workers are penalised by their lower involvement in energy activities for which value-added prices have increased and the high dependency in agriculture, which records a significant drop in output and value added. The other urban workers suffer more because of their higher dependency ratio on food and light non-food manufacturing activities whose output and prices also fall substantially. Wage and unemployment rates deteriorate in the price-setting scenarios (Table 4) and the urban-rural gap rises significantly as well as the gender gap (but to a limited extent).

Capital is assumed to be sector-specific because of the short-term perspective of the analysis. As a result, variations in the rates of return to capital closely follow changes in the value-added prices of their respective sectors. These rates fall most in the oil-input intensive industries and increase in the close oil-substitute energy sectors (Annexure 3). Under the floating-price scenario, the increase in the return to capital is particularly important for the "*Synthetic petroleum*" industry, at 31.2%. The "*Electricity*" and the "*Coal*" industries also witness a rise in their return to capital by 5.6% and 5.0%, respectively. Few other industries - "*Other transport manufacturing*", "*Mining machinery*", "*Machine-tools*", "*General machinery*", "*Other chemicals*", "*Special machinery*" and "*Structural metal*" - benefit from a fall in their input costs and sustained investment and export demand (Annexure 3). The above industries are the winners of the oil price shock. In contrast, "*refined petroleum*" industry records a significant fall in the return to capital by 34.6%. It is joined by many other industries that have been affected by a fall in the final and intermediate demands, among others, "*Soap*" and "*Fertilizer*", "*Animal feeds*", "*Household appliances*", "*Grain mills*", "*Pharmaceuticals*", "*Activities/services*", "*Textile articles*", "*Handbags*", "*Tyres*", "*Health and social work*", "*Meat*", "*Knitting mills*". The average return to capital falls less from the first to the second scenarios and more in the third scenario. Synthetic petroleum is still the big winner while the effect is ambiguous for other industries when comparing the simulation scenarios (Annexure 3).

3.2.4 *Price effects*

In addition to its factor effects, the oil price shock influences household welfare by changing consumer prices (see Annexure 4 for detailed price results). The prices of commodities purchased by households is a weighted average of domestic and import prices, where the weight is the share of domestic-produced and imported commodities in the total demand. While non-oil import prices are kept constant, domestic prices fall for most of the products, in particular for low import-substituting commodities. In contrast, purchasers' prices increase for energy products and high-intensive energy input use products (Table 5). Private services, food manufacturing and agriculture products experience the highest fall in the consumption prices attributed to their lowest import penetration rates. They are followed by light and heavy manufactured goods and mining products (Table 5).

While the consumption prices of petroleum goods are kept constant, the reduction in consumption prices is more pronounced for other commodities. The increasing pressure on the real exchange rate via the factor prices and the revenues, and ultimately domestic demand, has essentially driven the fall in consumption prices (Table 5). However, the relative changes in the purchasers' prices are less drastic compared to those of the wage and unemployment rates.

3.2.5 *Poverty and inequality effects*

These macroeconomic effects, output effects, factor effects and price effects discussed up to now are important determinants of income distribution and, ultimately, the changes in poverty and inequality measures in South Africa. Table 6 shows the FGT and the Gini results of the oil price shock using the low bound poverty line (Rands 322 per month) provided by Hoogeveen and Ozler (2004). The overall poverty headcount index increases by 1.2% (Table 6). Further, the amount of money needed to bring poor people to the poverty line has also increased, as seen in the poverty gap index. The poverty severity also increases more by 1.6%, i.e., the poorest suffer the most. These results are reflected when the group is disaggregated by region or by race. Poverty increases more in urban than rural areas. Although the oil price shock adversely affects more wages and employment in rural areas, the poverty indices fall less in this area because of the high reliance of the rural middle-income class on transfer incomes - which values are kept fixed in real terms - and on high-skilled labour income as compared to its counterpart in urban areas. In terms of racial groups, the poverty indices increase more among Coloured and African household groups. These two racial groups have the highest concentration of medium and low-skilled workers, who were shown to suffer more from the oil price shock in South Africa. In addition, the Coloured groups are generally more concentrated in urban than rural areas, hence they are worse off than their African counterparts.

Using the Gini coefficient, inequality increases by 0.7% with the floating prices scenario in all of South Africa (Table 6). Upon decomposition, this inequality is attributed to the urban areas with a fall in rural areas by 0.5%. The greater dependency of rural poor households on transfer incomes compared to their urban counterparts appears to be the main explanation for the fall in inequality in rural areas. Coloured and Asian households have the higher Gini coefficients, signifying greater inequality increases among these groups.

Poverty also increases in the price-setting scenarios (Table 6) and the changes in poverty gap and severity are similar to the results of the floating-price case, although slightly higher. Indeed, incomes fall by more under the price-setting scenario relative to the floating-price scenarios. Furthermore, in the case of a tax on windfall profits, the poverty results are worsened and the urban-rural gap increases once again. Coloured and African households are worst affected due to a substantial increase in the unemployment of medium and low-skilled workers. Inequality increases more under the price-setting scenario than under the floating-price scenarios. In terms of rural and urban inequality, the Gini coefficient increases in the urban areas but falls in the rural areas. Inequality increases most among Coloured and Asian household groups respectively.

4 Conclusion

Using an energy-focused computable general-equilibrium model linked to a micro-simulation household model of South Africa, this paper quantifies the effects of three scenarios corresponding to different government policy responses to the oil price shock. The first scenario assumes that increases in world oil and petroleum products are passed through to end users with no changes in government tax/subsidy instruments. The two other scenarios assume that the world price increases are nullified by a full price subsidy by government in one scenario, while revenues generated from a 50 percent tax on the windfall profit of the synthetic petroleum industry contributes to minimise the loss in government revenue in the other scenario.

Starting with the macroeconomic effects, the model predicts that GDP would fall by between 2.2 and 2.5 percent under the three scenarios. A key driver of these results is the exchange rate effect. The impact on the government deficit varies widely among the scenarios, ranging from a worsening of 12 to 22 percent in the floating-price and the price-setting scenarios, respectively. The meso-economic effects show that synthetic petroleum, coal and electricity, which are alternative sources of energy to oil petroleum, benefit under the floating-price scenario. Electricity does not benefit from high oil prices under the price-setting scenario, as refined petroleum products become less expensive and less substituted with the alternative source of energy compared to the floating-price scenario. None of the energy industries expands its output when a 50 percent tax is levied on the profit of the synthetic petroleum industry. Except the mining sector that benefits from the exchange rate depreciation (appreciation of the real exchange rate), all other industries experience a fall of their production, but with different magnitudes. Agriculture, food and light manufacturing and private services are the big losers of the high oil price shock, being directly affected by a fall in the final demand.

There is a significant increase in the wage gap between urban and rural high-skilled workers, which is worsened under the price-setting scenario. Employment increases most among medium and low skilled in urban than rural area, accentuated when government subsidises the oil price increase. In both areas, women are adversely affected relative to men by high oil prices. They are more intensively used in contracting industries (agriculture, food and light manufacturing and private services) and less in expanding industries (energy related activities and mining). There is no significant difference in male and female wages and employment opportunities among the three scenarios.

Finally, the poverty headcount ratio increases by 1 percent when the imported crude oil and oil products prices rise by 50 and 25 percent with respect to their base-year levels respectively. The poorest households are most adversely affected by the increase of oil prices. Although employment and wages drop more in rural areas, households in that area observe a lower increase in the poverty indices because of their relatively lower dependency on factor revenues compared to their counterparts in urban areas. African and Coloured household categories record the highest increase in the poverty indices as they rely heavily on low and medium-skilled labour incomes. Inequality increases in urban areas while it falls in rural areas. Poverty and inequality increase slightly more in the price-setting scenarios relative to the floating price scenario.

5 Acknowledgements

We gratefully acknowledge the financial contribution of the Financial and Fiscal Commission (FFC) and thank participants in seminars held at the FFC, University of Pretoria as well as conference participants at the South Africa Tax Symposium organized by National Treasury in March 2008. Bernard Decaluwé and John Cockburn are gratefully acknowledged for development of models and data approaches used in this paper. The views expressed in this paper are those of the authors and do not necessarily represent those of the institutions that they are involved with.

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Annexure 1: Data assembly procedures

This section presents an overview of the procedures followed in building the data used to run the models developed in this paper. The procedure involves linking a standard SAM first with an energy module to get an integrated energy SAM and then linking this to disaggregated household surveys to enable the analysis of poverty. The detailed procedures can be made available from the authors upon request.

The standard SAM brings together the supply and use tables (SU-tables) and the integrated economic accounts (IEA), both for the year 2000 in a single framework. It presents one aggregate account of "petroleum products" and fails to distinguish them either by origin (that is, synthetic fuel or refined oil) or by type (that is, petrol, LPG, diesel, paraffin, etc). Furthermore, crude oil activity (production and import) is neither highlighted in the SU-tables nor in the standard SAM. The procedure of building an energy-focused SAM is presented in three steps and again the details are available upon request. First, the supply of "crude oil" is extracted from "other mining and quarrying". As there is no domestic production of "crude oil", the total supply is essentially satisfied by imports. Second, the petroleum industry is decomposed into synthetic fuel industry and refined oil industry. South Africa has large endowments of coal which have been converted into close substitutes of refined oil products by the well-developed synthetic fuel industry. Third, most SAM households' consumption are presented by product-category. As a result, the Energy-SAM rearranged the households' consumption by purpose for all the additional accounts.

The resulting Energy-SAM for the year 2000 is a detailed database that brings together in a single framework, information on the South African economy from various sources. The SAM's industries and commodities are kept as disaggregated as possible in order to better track the multiple channels by which the economy might be impacted by oil price shocks. The Energy-SAM presents 6 institutional accounts consisting of 2 representative household categories (urban and rural), 2 representative corporation categories (financial and non financial), government, and the rest of the world. Its also has 16 productive factors, 12 types of labour and 4 capital categories. Three criteria are used to distinguish workers, namely, the residential area (urban and rural) and the skill category (high, medium and low skilled) and the sex of individuals (male and female). The capital factor is separated into public capital which is the capital endowed by the government and private capital endowed by other domestic institutional units. The latter is also distinguished by urban, rural and corporations' capital. There are 5 taxes and transfer accounts, mainly the taxes on revenue and wealth, the tax on production less subsidies, the import duties, the value added tax, and the other taxes on product less subsidies. The SAM accounts for 95 activities including 1 aggregate agriculture activity, 4 mining activities (including one crude oil represented by a domestic production of synthetic fuel), 80 industries (with one aggregate petroleum industry that combines synthetic fuel and refined oil industries) and 10 services (including one aggregate general government service). The commodity account presents the same decomposition.

Finally, the 95 commodities are then clustered into 12 groups of consumption by purpose for each urban and rural household category. The classification used by Statistics South Africa in the IES 2000 is based on consumption by purpose. Table A1 summarizes the different categories of consumption by purpose. It shows 13 groups of consumption by purpose which have been finally aggregated into 12 groups. Each consumption commodity is distributed over these 12 groups of consumption by purpose according to their distributional shares. Additional accounts are created to integrate this latter classification of consumption into the standard SAM. The latter feature presents an advantage to highlight household fuel and transport fuel items in the households' expenditures in the same way as if one were to decompose fuel products into several types (for example, petrol, LPG, diesel, etc).

Table A1: Household expenditure by purpose of consumption

<table>
<tr><th colspan="2">IES 2000 classification</th><th colspan="2">E-SAM2000 classification</th></tr>
<tr><td>1</td><td>Housing</td><td>1</td><td>Housing</td></tr>
<tr><td>2</td><td>Food and beverages</td><td>2</td><td>Food and beverages</td></tr>
<tr><td>3</td><td>Personal care</td><td>3</td><td>Household care</td></tr>
<tr><td>4</td><td>Household fuel</td><td>4</td><td>Household fuel</td></tr>
<tr><td>5</td><td>Clothing and footwear</td><td>5</td><td>Clothing and footwear</td></tr>
<tr><td>6</td><td>Household appliances and equipment</td><td>6</td><td>Household appliances and equipment</td></tr>
<tr><td>7</td><td>Transport</td><td>7</td><td>Transport</td></tr>
<tr><td>8</td><td>Education</td><td>8</td><td>Education</td></tr>
<tr><td>9</td><td>Health and social services</td><td>9</td><td>Health and social services</td></tr>
<tr><td>10</td><td>Computer and telecommunication</td><td>10</td><td>Computer and telecommunication</td></tr>
<tr><td>11</td><td>Recreation, entertainment and sport</td><td>11</td><td>Recreation, entertainment and sport</td></tr>
<tr><td>12</td><td>Miscellaneous</td><td rowspan="2">12</td><td rowspan="2">Miscellaneous</td></tr>
<tr><td>13</td><td>Household work</td></tr>
</table>

Source: compilation from the IES 2000

For the micro-simulation model, individual regular incomes are drawn from the 2000 Income and Expenditure Survey (IES) and the September 2000 Labour Force Survey (LFS) both published by Statistics South Africa. Data on individuals' (thus, household) regular income, that is, salaries and wages, profits and net incomes, and transfer receipts are generated from the IES. Time spent by individuals on market activities, that is, salary and wage work, self-employment work, and unemployment, and many other pieces of information related to the employment status of individuals are missing from the IES 2000. Therefore, the latter is completed by information from the LFS 2000. The 18 sources of income from the IES are grouped into 3 categories according to the main source of income in the CGE model. Household earnings sum up the regular incomes generated by its members. There are 389 occupational groups aggregated into 3 skill levels using the Statistics South Africa classification in the 1998 SAM.

The IES and the September LFS are based on the same sample of households interviewed but a lot of mismatches have been observed between the two databases as pointed out by many analysts who work with these databases[1]. Important differences between income and expenditures within the IES have been raised. Indeed, there has been substantial inflation in South Africa between 1995 and 2000, whereas the 2000 household survey data shows that nominal household per-capita incomes have decreased since 1995, the year of the previous household survey. The 2000 sample contains a much larger African share and a much smaller white share. This may have generated in part by the above apparent anomalies. Therefore, we re-weight the survey sample to make it consistent with the 2001 census population shares.

Estimate of trade parameters, i.e. industry-level Armington elasticities and aggregate export supply and demand elasticities, are available for South Africa. According to the short term perspective of the analysis, our study uses the short-run Armington elasticities from Gibson (2003) and the low-bound export supply and demand elasticities from Behar and Edwards (2004). Unemployment rates are drawn from the 2001 labour force survey report by Statistics South Africa (2001). To our knowledge, estimates for parameters in industries' production and households' demand are not available for South Africa. Therefore, our study borrows these values from the literature surveyed by Annabi et al. (2006), and analyses the sensitivity of the results with respect to these elasticities. In general, results are not significantly affected by "reasonable" changes in these values.

[1] Pauw (2005) have provided useful discussions on these inconsistencies.

Table 1 : Comparison of the change in macroeconomic variables (percent)

	Floating price Scenario	Setting price sub-scenario 1	Setting price sub-scenario 2
Import of crude oil	-10.2	-7.9	-6.8
Export of oil products	4.9	2.6	0.4
Average export price of oil products	16.8	20.6	24.3
Average domestic price	-2.6	-3.3	-3.4
Total import	-4.6	-4.9	-4.9
Total export	0.6	0.8	0.8
Income	-1.4	-1.5	-1.6
GDP	**-2.2**	**-2.4**	**-2.5**

Source: Compilation from the experiments.

Table 2 : Fiscal effects (percent)

	Initial share	Change in		
		Floating price scenario	Setting price sub-scenario 1	Setting price sub-scenario 2
Tax on imported goods	7.4	-4.7	-9.3	-10.2
Tax on local goods	23.4	-6.0	-16.2	-18.2
Tax on production	7.8	-6.8	-8.0	-8.3
Tax on income (uncompensated)	46.7	-3.5	-3.8	-4.0
Capital revenue (uncompensated)	8.6	0.4	0.9	0.7
In-transfer	6.1	-2.2	-2.8	-2.8
Uncompensated revenue	**100**	**-3.9**	**-6.8**	**-7.5**
Public expense	64.2	-0.9	-1.1	-1.2
Out-transfer	63.9	-2.2	-2.8	-2.8
Deficit (uncompensated)	**-28.1**	**11.8**	**21.6**	**24.0**
Tax on income (compensated)	-	11.5	14.7	15.1
Tax on windfall profit	-	-	-	0.9
Compensated revenue	**-**	**7.6**	**8.0**	**8.5**
Deficit (compensated)	**-**	**-29.3**	**-30.9**	**-33**

Source: Results from the CGE model experiments.

Table 3 : Comparison of the change in output (percent)

Aggregate products	Floating price Scenario	Setting price sub-scenario 1	Setting price sub-scenario 2
Refined petroleum	-11.9	-6.7	-4.4
Agriculture	-4.8	-5.4	-5.5
Food manufacturing	-4.6	-5.2	-5.4
Light manufacturing	-3.4	-3.7	-3.8
Services	-2.5	-2.7	-2.8
Heavy manufacturing	-0.8	-0.9	-1.0
Mining	0.4	0.6	0.6
Electricity	1.7	-0.5	-0.6
Coal	3.1	1.8	0.0
Synthetic petroleum	4.7	8.5	-1.0

Source: Results from the CGE model experiments.

Table 4 : Comparing the change in wage and unemployment rates (percent)

	Wage rate high skilled workers				Unemployment rate medium and low skilled workers							
	Urban		Rural		Urban				Rural			
					Medium skilled		Low skilled		Medium skilled		Low skilled	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Floating price Scenario	-3.3	-3.8	-29.5	-31.5	11.5	21.6	15.6	35.5	14.3	23.9	21.3	34.2
Setting price sub-scenario 1	-3.2	-3.9	-34.2	-36.6	14.4	24.6	18.9	40.9	17.8	27.0	26.3	39.3
Setting price sub-scenario 2	-3.4	-4.0	-35.4	-37.8	15.0	25.4	19.6	42.1	19.0	27.8	27.4	40.4

Source: Compilation from the CGE model experiments
Note: Percent change in the wage rates; percentage point change in the unemployment rates.

Table 5 : Comparison of the change in purchasing prices (percent)

Aggregate products	Floating price scenario	Setting price sub-scenario 1	Setting price sub-scenario 2
Coal	1.4	0.0	-1.6
Crude oil	50.0	50.0	50.0
Synthetic petroleum	11.7	0.0	0.0
Refined petroleum	11.7	0.0	0.0
Electricity	2.0	-1.5	-1.8
Agriculture	-3.0	-4.0	-4.1
Mining	-0.5	-0.7	-0.8
Food manufacturing	-3.5	-4.4	-4.6
Light manufactuing	-1.1	-1.7	-1.7
Heavy manufacturing	-0.6	-0.9	-1.0
Services	-4.3	-5.2	-5.4

Source: Compilation from the CGE model experiments.

Table 6 : Comparison of the change in poverty and inequality (percent)

	Floating price scenario				Setting price sub-scenario 1				Setting price scenario 2			
	Poverty			Inequality	Poverty			Inequality	Poverty			Inequality
	Head count	Gap	Severity	Gini coefficient	Head count	Gap	Severity	Gini coefficient	Head count	Gap	Severity	Gini coefficient
South Africa	1.2	1.5	1.6	0.7	1.1	1.6	1.8	1.2	1.2	1.7	1.8	1.1
Urban	1.3	1.6	1.7	0.7	1.2	1.9	2.0	1.3	1.4	2.0	2.1	1.2
Rural	1.1	1.3	1.4	-0.5	1.0	1.3	1.5	-0.4*	0.9	1.2	1.4	-0.7
African	1.1	1.5	1.6	0.6*	0.9	1.6	1.9	1.3	1.2	1.7	1.9	1.3
Coloured	2.6	2.1	2.0	1.4	3.2	2.5	2.2	2.1	2.5	2.4	2.2	1.8
Asian	1.8*	1.3	1.2	1.2	1.4*	1.7	1.5	1.1	-0.4*	0.9*	1.1*	0.9
White	0.6	0.6	0.6	0.6	0.8	0.9	0.8	1.2	0.8	1.0	1.0	1.1

Source: Results from the CGE model experiments. **Note:** * Value not significant at 95% degree of confidence.

Annexure 1: Change in factor prices, in percent

Industry	Floating price scenario		Setting price sub-scenario 1		Setting price sub-scenario 2	
	Output price	Value added price	Output price	Value added price	Output price	Value added price
Agriculture	-2.9	-6.2	-3.9	-6.2	-4.1	-6.4
Coal	0.7	2.8	-0.4	1.8	-1.5	-0.2
Gold	-0.6	-0.3	-0.9	0.2	-0.9	0.2
Other mining	-0.7	0.0	-1.0	0.6	-1.1	0.6
Meat	-3	-6.1	-4.0	-5.6	-4.2	-5.7
Fish	-1.6	-1.0	-2.1	-0.6	-2.2	-0.6
Fruit	-2.6	-2.7	-3.2	-2.7	-3.4	-2.8
Oils	-2.7	-5.3	-3.5	-5.5	-3.7	-5.6
Dairy	-3.1	-4.0	-3.9	-4.2	-4.0	-4.3
Grain mills	-4.5	-9.9	-5.6	-11.1	-5.9	-11.4
Animal feeds	-3.8	-10.4	-4.8	-11.7	-5.0	-12.1
Bakeries	-3.5	-4.4	-4.4	-4.2	-4.6	-4.3
Sugar	-2.3	-1.7	-3.1	-1.7	-3.2	-1.7
Confectionery	-2.9	-3.0	-3.6	-3.3	-3.7	-3.4
Other food	-2.8	-2.7	-3.4	-3.2	-3.6	-3.3
Beverages and tabacco	-4.8	-7.0	-5.7	-7.9	-5.9	-8.2
Textiles	-1.3	-1.4	-1.8	-1.3	-1.9	-1.3
Textile articles	-2.1	-3.1	-2.8	-3.3	-2.9	-3.3
Carpets	-1.6	-2.3	-2.5	-1.8	-2.6	-1.8
Other textiles	-0.9	-1.2	-1.6	-0.8	-1.7	-0.8
Knitting mills	-1.7	-2.2	-2.2	-1.7	-2.3	-1.7
Wearing apparel	-1.8	-1.5	-2.2	-1.7	-2.3	-1.7
Leather	-2	-0.9	-2.7	-0.6	-2.8	-0.6
Handbags	-3.5	-6.1	-4.3	-6.9	-4.5	-7.1
Footwear	-2.2	-3.3	-2.8	-3.5	-2.9	-3.6
Wood	-1.5	-0.5	-2.0	-0.4	-2.0	-0.4
Paper	-2.1	-1.9	-2.7	-1.7	-2.8	-1.7
Containers of paper	-1.6	-2.3	-2.2	-2.3	-2.3	-2.3
Other paper	-3.1	-6.3	-3.7	-7.0	-3.9	-7.2
Publishing	-2.7	-3.4	-3.1	-3.7	-3.2	-3.8
Recorded media	-2.2	-3.7	-3.0	-3.4	-3.2	-3.5
Coal petroleum	9.4	26.2	14.2	48.0	17.4	-14.5
Oil petroleum	9.4	-29.6	14.2	-12.5	17.4	-3.2
Basic chemicals	0.9	-4.1	-0.5	-5.2	-0.4	-4.8
Fertilizers	10	-14.2	9.0	-14.8	8.9	-14.9
Primary plastics	0.1	-5.3	-1.7	-4.1	-1.8	-4.2
Pesticides	-1.9	-5.1	-2.5	-5.4	-2.6	-5.6
Paints	-0.3	-4.0	-1.5	-3.6	-1.6	-3.9
Pharmaceuticals	-3.5	-7.1	-4.4	-7.7	-4.5	-7.9
Soap	-3.4	-9.7	-4.6	-10.2	-4.8	-10.5
Other chemicals	-0.3	-1.0	-1.5	-1.4	-1.5	-1.4
Tyres	-1.3	-4.1	-2.2	-2.6	-2.3	-2.7
Other rubber	-0.8	-0.3	-1.5	0.0	-1.6	0.0
Plastic	-0.7	-1.1	-1.4	-0.9	-1.4	-1.0
Glass	-1.4	-0.8	-1.8	-0.6	-1.9	-0.6
Non-structural ceramics	-2.9	-4.4	-3.2	-3.5	-3.5	-4.2
Structural ceramics	-1.1	-0.8	-1.5	-0.4	-1.6	-0.4
Cement	-1.3	-1.2	-1.6	-0.9	-1.7	-0.9

Source: Compilation from the experiments.

Annexure 1: Change in factor prices, in percent (continued)

Industry	Floating price scenario		Setting price sub-scenario 1		Setting price sub-scenario 2	
	Output price	Value added price	Output price	Value added price	Output price	Value added price
Other non-metallic	-0.9	-0.5	-1.3	-0.2	-1.4	-0.2
Iron and steel	-0.7	-1.1	-1.2	-0.4	-1.3	-0.2
Non-ferrous metals	-0.1	-1.8	-0.8	-0.5	-0.9	-0.5
Structural metal	-0.5	-0.3	-0.8	-0.2	-0.8	-0.2
Treated metals	-1.6	-2.1	-2.2	-2.1	-2.3	-2.1
General hardware	-1.3	-2.9	-1.8	-2.5	-2.0	-2.4
Fabricated metal	-0.9	-1.4	-1.4	-1.2	-1.5	-1.2
Engines	-0.9	-1.4	-1.4	-1.0	-1.5	-1.0
Pumps	-0.3	-1.4	-1.0	0.0	-1.1	0.0
Gears	-1.5	-1.0	-2.3	0.1	-2.4	0.0
Lifting equipment	-1.3	-2.0	-1.9	-1.3	-2.0	-1.3
General machinery	-0.7	-0.5	-1.1	-0.2	-1.2	-0.2
Agricultural machinery	-1.5	-1.6	-2.2	-0.9	-2.3	-0.9
Machine-tools	-1.1	-0.7	-1.5	-0.5	-1.6	-0.5
Mining machinery	-0.7	-0.7	-1.0	-0.5	-1.1	-0.6
Food machinery	-1.3	-1.4	-1.8	-0.9	-1.9	-0.9
Special machinery	-0.7	-0.9	-1.0	-0.8	-1.0	-0.9
Household appliances	-2.5	-5.9	-3.2	-6.3	-3.3	-6.5
Office machinery	-2.4	-1.4	-3.3	0.1	-3.4	0.2
Electric motors	-0.6	-1.1	-1.1	-0.4	-1.1	-0.4
Electricity apparatus	-0.5	-0.2	-1.0	-0.2	-1.0	-0.3
Wire and cable	-0.3	-0.5	-0.9	-0.7	-0.9	-0.7
Accumulators	-1.4	-0.6	-2.1	-0.6	-2.2	-0.6
Lighting equipment	-0.9	-1.6	-1.4	-1.5	-1.5	-1.5
Electrical equipment	-0.6	-1.5	-1.1	-0.9	-1.1	-0.9
Radio and television	-1.7	-3.5	-2.0	-3.6	-2.1	-3.8
Optical instruments	-1.0	-1.5	-1.4	-1.1	-1.5	-1.1
Motor vehicles	-0.5	-2.0	-0.9	-2.4	-0.9	-2.5
Motor vehicle parts	-0.5	-0.6	-0.8	-0.6	-0.9	-0.6
Other Transport	-0.9	-1.3	-1.1	-1.1	-1.2	-1.2
Furniture	-1.7	-2.8	-2.2	-2.9	-2.3	-3.0
Jewellery	-1.1	-3.7	-1.5	-3.7	-1.6	-3.9
Other manufacturing	-1.1	-1.9	-1.6	-1.3	-1.7	-1.4
Electricity	1.9	3.1	-1.5	-1.5	-1.8	-1.5
Water	-4.3	-7.2	-5.3	-7.8	-5.6	-8.1
Buildings	-0.7	-0.7	-1.1	-0.1	-1.1	-0.1
Other construction	-0.7	-0.9	-1.1	-0.1	-1.2	-0.1
Trade	-3.5	-2.9	-4.0	-2.7	-4.1	-2.7
Accommodation	-3.4	-3.5	-4.1	-3.9	-4.2	-4.0
Transport services	-1.6	-3.2	-2.7	-2.4	-2.9	-2.6
Communications	-5.5	-7.0	-6.3	-7.4	-6.5	-7.6
Insurance	-6.3	-7.0	-7.2	-7.8	-7.4	-8.1
Real estate	-8.4	-10.1	-10.2	-12.0	-10.5	-12.4
Business activities	-2.3	-1.0	-2.9	-1.0	-3.0	-1.0
General Government	-0.9	-0.7	-1.1	-0.7	-1.2	-0.7
Health and social work	-5.4	-8.2	-6.5	-8.9	-6.7	-9.2
Activities/ services	-6.0	-7.4	-7.1	-8.4	-7.4	-8.7
ALL	**-2.4**	**-3.7**	**-3.0**	**-3.7**	**-3.1**	**-4.0**

Source: Compilation from the CGE model experiments.

Figure 1: Structure of production by industry

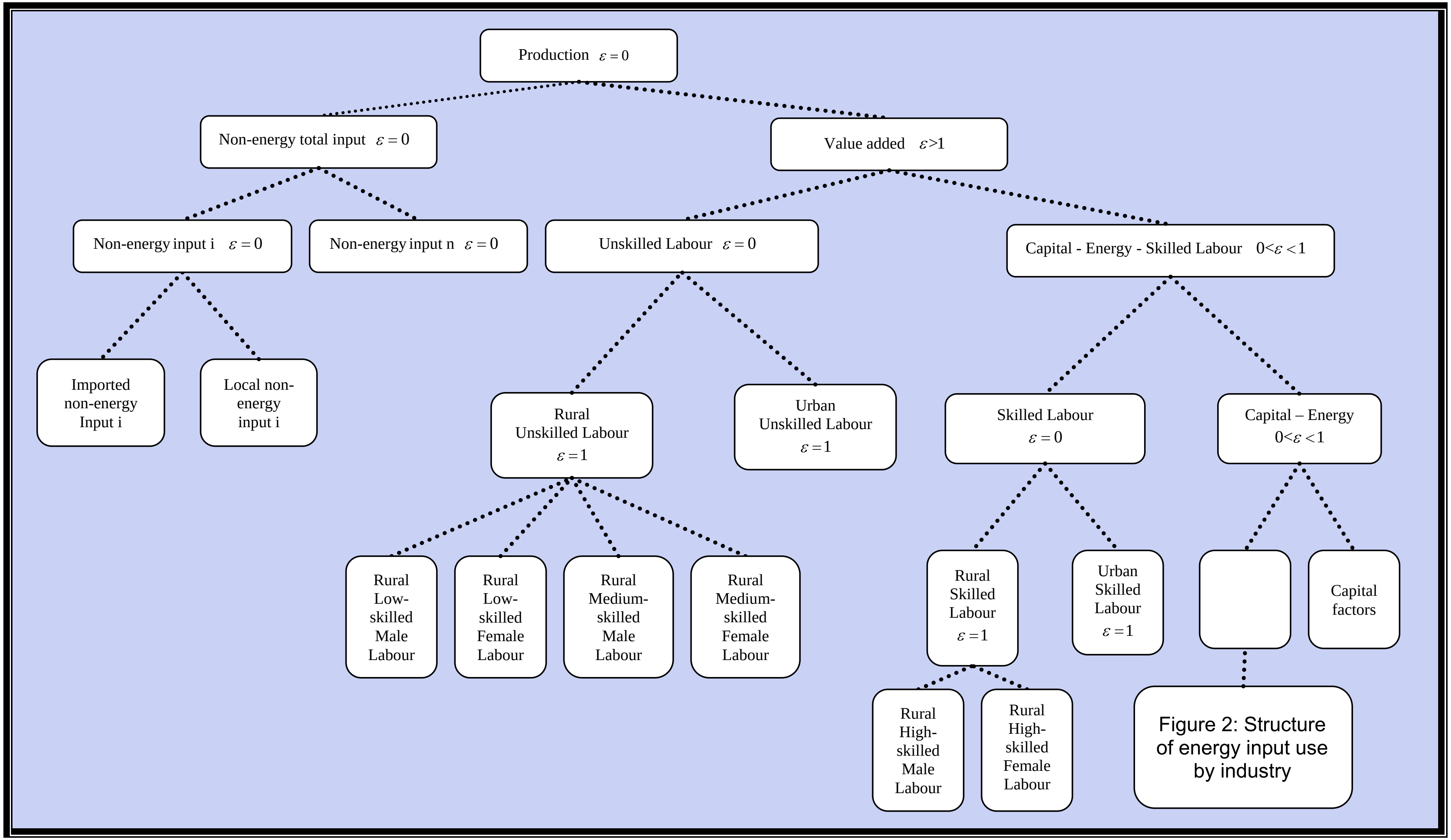

Figure 2: Structure of energy input use by industry