



The Economy-Wide Impact of Subsidy Reform: A CGE Analysis

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The economy-wide impact of subsidy reform: A CGE analysis¹

May 2019

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Abstract

Oil prices fell from around \$US110 per barrel in 2014 to less than \$US50 per barrel at the start of 2017. This put enormous pressure on government budgets within the Gulf Cooperation Council (GCC) region. The focus of GCC economic policies quickly shifted to fiscal reform, including the removal of domestic subsidies on energy products. In this paper we use a dynamic Computable General Equilibrium (CGE) model to investigate the economic impact of the gradual removal of subsidies on refined petroleum and electricity, with specific reference to the Kingdom of Saudi Arabia (KSA).

Our study shows that removing subsidies eliminates a large distortion in the economy. This improves the efficiency of resource use, so that even though employment and capital in most years fall relative to baseline levels, real GDP rises. In addition, we show that fully-funded compensation payments offset the increases in energy prices, leaving economic welfare of the Saudi-national population little affected. Removing the energy subsidies leads to an improvement in the net volume of trade, while leading to a mixed outcome for industries.

Keywords: Computable General Equilibrium (CGE) models, Energy Subsidies, Trade

JEL Classification: C68, D58, E63, O53

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1 Introduction

The Gulf Cooperation Council (GCC) is a regional intergovernmental economic union. The union includes Bahrain, Kuwait, Oman, Qatar, the Kingdom of Saudi Arabia (KSA) and the United Arab Emirates. The members of the GCC have a number of common features. All are monarchies, all have economies that rely on the production of hydrocarbons for export, and all have fiscal structures that provide large subsidies on local consumption of energy financed from oil and gas income.

Around 90 per cent of fiscal revenue in the GCC area comes from oil and gas profits earned by state owned enterprises. Another common feature is that all of the economies are facing significant long-term pressure for structural reform due to declining hydrocarbon reserves. Currently, this pressure is exacerbated by the comparatively low price of oil. The oil price fell from around \$110 per barrel in 2014 to less than \$US50 per barrel at the start of 2017. The current price is around \$US65 per barrel.

Whether or not the price of oil will rise back to triple digits over the next decade is an open question. But what is not subject to debate is the need for the GCC economies to reform their economies. In nearly all cases, reform must start with fiscal consolidation. By this we mean reducing budget deficits that have resulted from lower oil and gas revenues, broadening the range of taxation sources, and reducing subsidies across a wide range of education, health and dwelling services and for energy.

In this paper we focus on the largest of the GCC economies, Saudi Arabia. Using a recursive dynamic CGE model for KSA, we investigate the economic impact of a gradual removal of subsidies on the use of refined petroleum and electricity. The model is called the General Equilibrium Model for Saudi Arabia (GEMSA). Its core data are calibrated to the 2010 Supply Use Tables (SUT) updated to 2015.

Why is a dynamic CGE model useful in analysing the impact of energy price reform on trade? Understanding the impact of subsidy removal on trade is a complex issue that requires a detailed model that captures (1) the economic structure of the country under consideration (e.g. the linkages between commodities, sources and users), (2) the level of economic diversification and trade exposure and (3) detailed fiscal modelling including commodity-specific tax rates. To infer the impact of higher energy prices on trade, it is important to understand how factor prices and the use of intermediate and factor inputs change when energy subsidies are removed. These changes impact the level of domestic production, domestic use of goods and services and foreign demand for domestically produced commodities. Thus, gaining insight into the impact of subsidy removal on trade would be difficult without understanding the impact on the markets and how markets adjust over time.

The rest of the paper is organised as follows. Section 2 provides background information on the current economic situation in the Saudi economy, with particular emphasis on pressures for fiscal reform.⁴ A literature review on past studies where CGE models are used to simulate the

⁴ Sommer *et al.* (2016) lists several factors, other than the low oil price, that affect oil exporting countries' fiscal balances, including (1) the conflicts in Libya, Iraq, Syria and Yemen which hold significant implications for neighbouring countries and the regional as a whole (Sommer *et al.*, 2016, 11); and (2) the slower growth in China causing downward pressure on commodity prices. Oil statistics show that the share of oil exports from the

impact of energy price reforms on different economic themes is given in Section 3. This review covers CGE studies in the MENA region and neighbouring countries where CGE models were specifically used to evaluate energy price reforms. Section 4 presents the Saudi CGE model used in this study. An overview of the data which forms the core database is given in Section 5. Section 6 describes the simulation design. Results are presented in Section 7, and concluding remarks are in Section 8.

2 Pressures for fiscal reform

2.1 Lower oil price

Responses to the recent fall in oil prices differ among oil exporting countries. Countries with a pegged exchange rate, such as the KSA, are using their reserves to absorb the initial fall in the oil price.⁵ The Saudi Arabian Monetary Authority (SAMA) noted that when the kingdom ran a budget deficit of nearly 100 billion US\$ in 2015, net foreign assets fell by 115 billion US\$ (Bloomberg 2016). Drawing on reserves is only feasible if the shock is temporary and there are enough foreign reserves.

In contrast to the KSA, most GCC countries responded to the fall in oil prices by embarking on fiscal reforms, including cutting government spending and energy subsidies. In addition to fiscal reform, GCC countries are implementing policies to improve energy efficiency, introducing stricter building guidelines and investigating the possibility of generating electricity through renewable sources in order to meet future energy demand (IMF 2015, 11).

2.2 Energy subsidies

Energy products in the GCC countries are sold at prices lower than the international price. This is justified as a means to share the rents of natural resources among the population and to protect household purchasing power, especially that of vulnerable households. Table 1 shows for 2015 and 2018 the prices of gasoline and diesel products in the GCC and the USA (IMF 2015, 5; Global Petrol Prices 2018). The data for 2015 show that the average price of gasoline and diesel products in the GCC, except the UAE, is below the US price and that the price varies between the countries. For 2015 the largest difference in the gasoline and diesel price is for Saudi Arabia where the price of gasoline and diesel is 74% and 91% lower than the USA price. Recent price reforms have reduced the price differentials in some GCC countries in 2018 (Table 1), but the differentials remain large.

KSA to Asia and the Far East increased from 27% in the 1980's to over 60% in 2015 (SAMA 2016, Oil Statistics). Slower growth in China implies lower oil exports from the KSA and a fall in oil revenues.

⁵ With the oil price set in dollar terms, any fluctuations in the exchange rate will have an impact on oil revenues if the currency is unpegged. Most GCC countries have a pegged exchange rate. Maintaining a pegged exchange rate given falling oil prices is only feasible if there are enough reserves to absorb the shock (Sommer *et al.*, 2016, 27). In light of the lower oil prices, the Caucasus and Central Asia (CCA) countries responded by depreciating their currencies. As a consequence, the loss of foreign exchange reserves has been smaller for the CCA countries than in the GCC area (Sommer *et al.*, 2016: 27-28).

Table 1. Prices for gasoline and diesel products: GCC and the USA (US\$ per litre)

Country	Gasoline		Diesel	
	2015 a	2018 b	2015 a	2018 c
Bahrain	0.27	0.53	0.27	0.42
Kuwait	0.24	0.35	0.39	0.38
Oman	0.31	0.58	0.38	0.64
Qatar	0.27	0.56	0.27	0.56
Saudi Arabia	0.14	0.54	0.06	0.13
UAE	0.59	0.67	0.56	0.72
GCC Average	0.30	0.54	0.32	0.48
GCC Maximum	0.59	0.65	0.56	0.64
USA	0.53	0.83	0.64	0.83

^a IMF, 2015. Table 1 page 5

^b http://www.globalpetrolprices.com/gasoline_prices/. Price on 20 August 2018

^c http://www.globalpetrolprices.com/diesel_prices/. Price on 20 August 2018

2.3 The case of Saudi Arabia

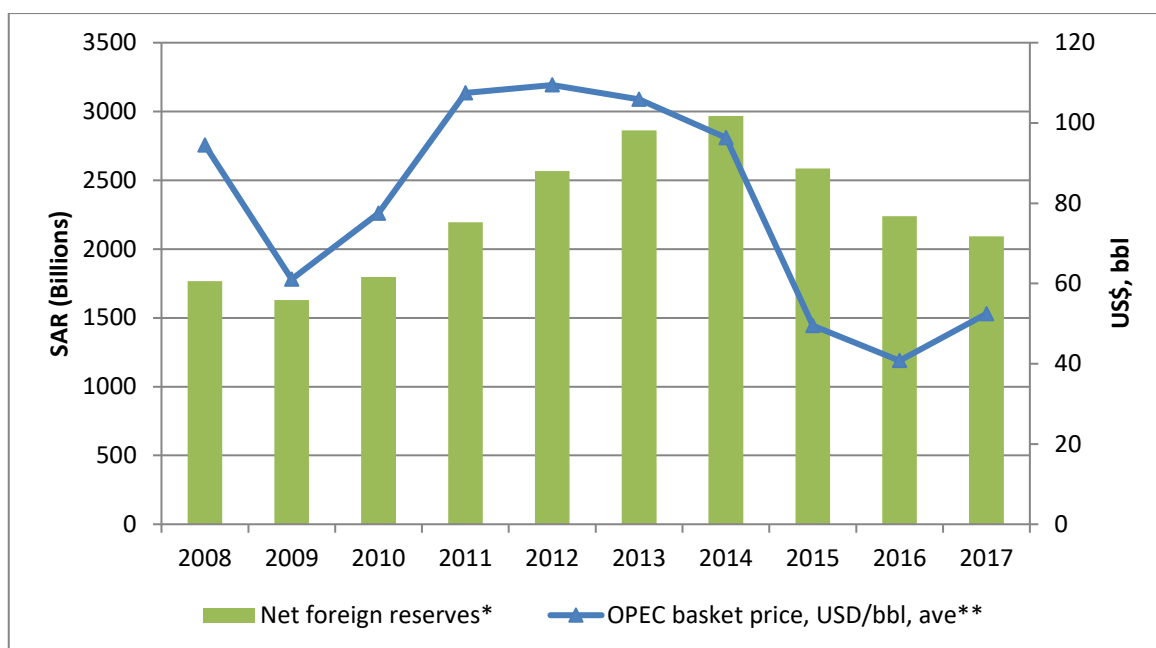
The focus of this paper is to investigate the economic and trade impact of removing energy subsidies in the KSA. The KSA has 18 per cent of the world's proven petroleum reserves and is the largest exporter of petroleum (OPEC 2016). The KSA economy is highly dependent on oil and gas exports in terms of budget revenue, growth in GDP and overall economic stability. For the foreseeable future oil sales remain a key driver of economic growth in the KSA and therefore, any change in the oil price has an impact on the governments' ability to finance its expenditure.

Figure 1 shows net foreign reserves in the KSA and the price of oil per barrel. Figure 2 shows, for the KSA, the government budget balance, the economy's current account balance, the government budget as a ratio to GDP (GovBalance/GDP) and the balance on the current account as a ratio to GDP (CA/GDP). The information for 2008 to 2017 is historical data from the Saudi Arabian Monetary Authority (SAMA).

These figures show a correlation between high (low) oil prices, government budget surplus (deficit), current account surplus (deficit) and an increase (decrease) in net foreign reserves. Figure 1 shows the oil price and net foreign reserves for 2008 to 2017. Figure 2 shows the Riyal value of the current account and the government budget for 2008 to 2017. The general trend is that if the oil price is high (lower) the current account and government balance improves (worsens). Net foreign liabilities follow the same trend. The surplus (deficit) to GDP ratios⁶ fall (increase), corresponding to lower surpluses and increased deficits.

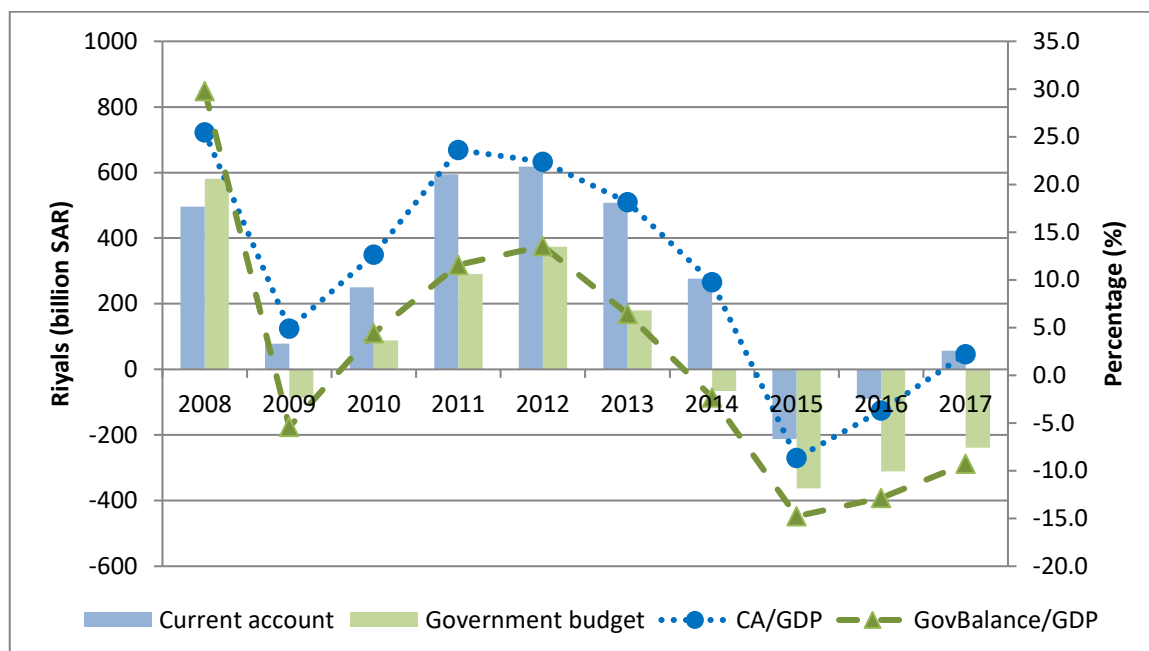
⁶ A positive ratio implies a surplus to GDP ratio whereas a negative ratio implies a deficit to GDP ratio.

Figure 1. Net foreign reserves and the oil price



Source: * Saudi Arabian Monetary Authority
 ** OPEC website

Figure 2. Government budget, current account budget (billion SAR) as well as their share to GDP (%)



Source: Saudi Arabian Monetary Authority

The implication of the lower oil price implies growing budget deficits where expenditure targets exceed lower government revenue. Currently, deficits are financed via foreign reserves, which is not sustainable in the long run. What is clear is that there is scope for energy price reform especially given the uncertainty regarding the oil price. *Ceteris paribus*, removing energy subsidies would certainly improve the government budget balance, but it would have an impact on domestic production and use (including exports) of goods and services. As we explain in Sections 3, CGE models are a useful tool in evaluating the impact of price reforms. We mention some of these studies and highlight important outcomes. Our model is rich in detail and includes specific representation of various price and tax (subsidy) variables. Although we do not present the model equations in detail, we explain in Section 4 key equations and mechanisms through which price reforms impact the Saudi economy.

3 Using CGE models to analyse the impact of energy price reform

The literature covering various methodologies used to investigate the economic impact of energy price reform is extensive. For general literature reviews related to energy price reform, see Jamash *et al.* (2014), Arze del Granado and Coady (2012), Bacon *et al.* (2010) and Ellis (2010). The disaggregated nature of CGE models makes it a valuable tool for analysing the highly distortive impact of energy price reforms on the economy as a whole, industries or focusing on specific themes.

A large number of studies focus on issues such as household welfare and poverty (Akkemik and Li 2015; Solaymani *et al.*, 2014; Naranpanawa and Bandara 2012), regional development (Lin and Li 2012; Aronsson *et al.*, 2010), environmental issues (Al-Amin *et al.*, 2009), energy markets (Yusoff and Bekhet 2016; Lin and Jiang, 2011; He *et al.*, 2010), non-energy market (Maipita *et al.*, 2012; Gohin and Chantret 2010) and the labour market (Kuster *et al.*, 2007; Welsch 1996) for countries such as China, Indonesia and Malaysia.

Several studies focus on the MENA region, using CGE models to investigate the impact of subsidy reform. Gharibnavaz and Waschik (2015), Jensen and Tarr (2003), Karami *et al.* (2012) and Manzoor *et al.* (2012) look at the effects of food and energy subsidy reform in Iran. These studies conclude that targeted compensation can lead to large welfare increases, especially for lower income households. Energy subsidy reform leads to larger welfare improvements than food subsidies reform because initial energy subsidies are much larger than food subsidies. Other studies for Iran include AlShehabi (2013) who models the removal of fuel and crude oil subsidies and assess the impact on the labour market and Hosseini-Yekani (2011) developed a model to analyse the impact of the removal of targeted subsidies on agricultural sector.

Cockburn *et al.* (2014) links a dynamic CGE model with a micro model to simulate the impact of the removal of energy subsidy accompanied by transfers to children living in poverty for Egypt and Jordan. The results for both countries suggest that the removal of energy subsidies and the subsequent improvement in economic performance is not sufficient to offset potential poverty impacts. This result is driven by an increase in consumer prices which offsets the increase in wages and profits. They further show that if a percentage of the savings on fuel subsidies are transferred to households, child poverty falls relative to the baseline.

Adams and Roos (2014) used a dynamic CGE model for Jordan to evaluate the impact of the removal of subsidies on food, gas cylinder, water, electricity, education and health. Their results show that employment falls in the short-run due to an increase in the real cost of labour.

The real cost of labour increases because removing the subsidy on electricity causes the price of spending to rise relative to the price of production. As a consequence, producers substitute away from labour and towards cheaper alternatives such as capital. In their study, all of the benefit of the efficiency improvements returns to private consumers as increased real income. Accordingly, real private consumption increases even after making allowance for the increase in price paid for electricity by households.

Abouleinein *et al.* (2009) assess the short- and medium-run impact of phasing out of subsidies on energy products in Egypt. Their results show that if there are no transfers to households, total private consumption and real GDP falls. The main driver of this result is the increase in energy prices which spills over to consumption and production prices. All household groups show a decline in welfare with the richer quintiles showing the strongest response. This is because the richer households consume a larger share of the subsidised energy products than poorer households. The net result from cutting subsidies combined with targeted cash transfers favour the poor more than the rich, leading to an improvement in income distribution measures.

Breisinger *et al.* (2011) uses a CGE model for Yemen to evaluate the elimination of subsidies combined with alternative uses of the savings from the subsidy. Their results show that if all the subsidies are removed within one year, growth declines sharply and poverty increases. With this approach, pressure on the fiscal balance is reduced which allows the government to compensate vulnerable households. The authors prefer the gradual phasing out of subsidies because the impact on growth and poverty levels is less drastic. The drawback from the gradual approach is that it comes with a higher fiscal expense.

In general, these studies highlight three crucial issues. Firstly, the value of subsidies on energy products is substantial and removing these subsidies reduces the size of the distortion in the economy. Secondly, the price of energy commodities increase, increasing production costs. Ultimately, consumer prices increase effecting household welfare. Thirdly, compensation payments to those most affected by the removal of subsidies help mitigate the increase in costs of living and improve welfare.

Our aim with this paper is to contribute to the literature on energy price reform, by using a dynamic CGE model for Saudi Arabia to inform on the impact of energy subsidy removal on factor- and goods markets as well as trade. Several CGE models have been constructed for Saudi Arabia. Al-Thumairi (2012) uses a dynamic CGE model to evaluate the impact of changes in oil and petroleum price on the economy, foreign savings and the real exchange rate. Chemingui and Lofgren (2004) use a CGE model for Saudi Arabia to evaluate the impact of introducing an alternative tax structure. De Santis (2003) uses a static model for Saudi Arabia to evaluate the short run and long run effects of shocks to the crude oil market while the Research Department of Statistics Norway (Cappelen *et al.* 1998) constructed a CGE model for Saudi Arabia to evaluate the consequences of Saudi Arabian membership in the World Trade Organisation. Though all these studies are credible, they are now dated and based on data sets that are relatively aggregated. Our model, GEMSA is the latest and most up to date CGE model developed for KSA. It's database is detailed and contains all of the key salient features of the current KSA economy.

4 The model

GEMSA models production of 57 commodities by 57 industries. Figure 3 illustrates the production structure. Each industry in GEMSA produce (supply) output using as inputs intermediate commodities from domestic or imported sources, capital, land and labour distinguished by 9 occupational types. The production specification is managed by a series of separability assumptions illustrated by the nesting structure in Figure 3. Each nest includes demand equations derived from solving optimisation problems. For example, the bottom right hand corner of Figure 3 shows the labour nest. This nest include equations, which determine industry's occupation-specific labour demand that minimise total labour cost subject to a constant elasticity of substitution (CES) production function. Nests for the demand for primary factors and composite intermediate commodities represent a similar optimisation problem.

In creating capital, investors choose inputs that are cost minimising combinations of Saudi and foreign commodities. We assume that domestic and imported varieties of commodities are imperfect substitutes for each other, using constant elasticity of substitution (CES) functions. GEMSA has one representative household. This household optimisation problem is solved in two nests. In the first nest, we assume that the household choose a combination of composite commodities to maximise utility subject to their budget. In the second nest, the household chooses commodities from domestic or imported sources to minimise costs subject to a CES function.

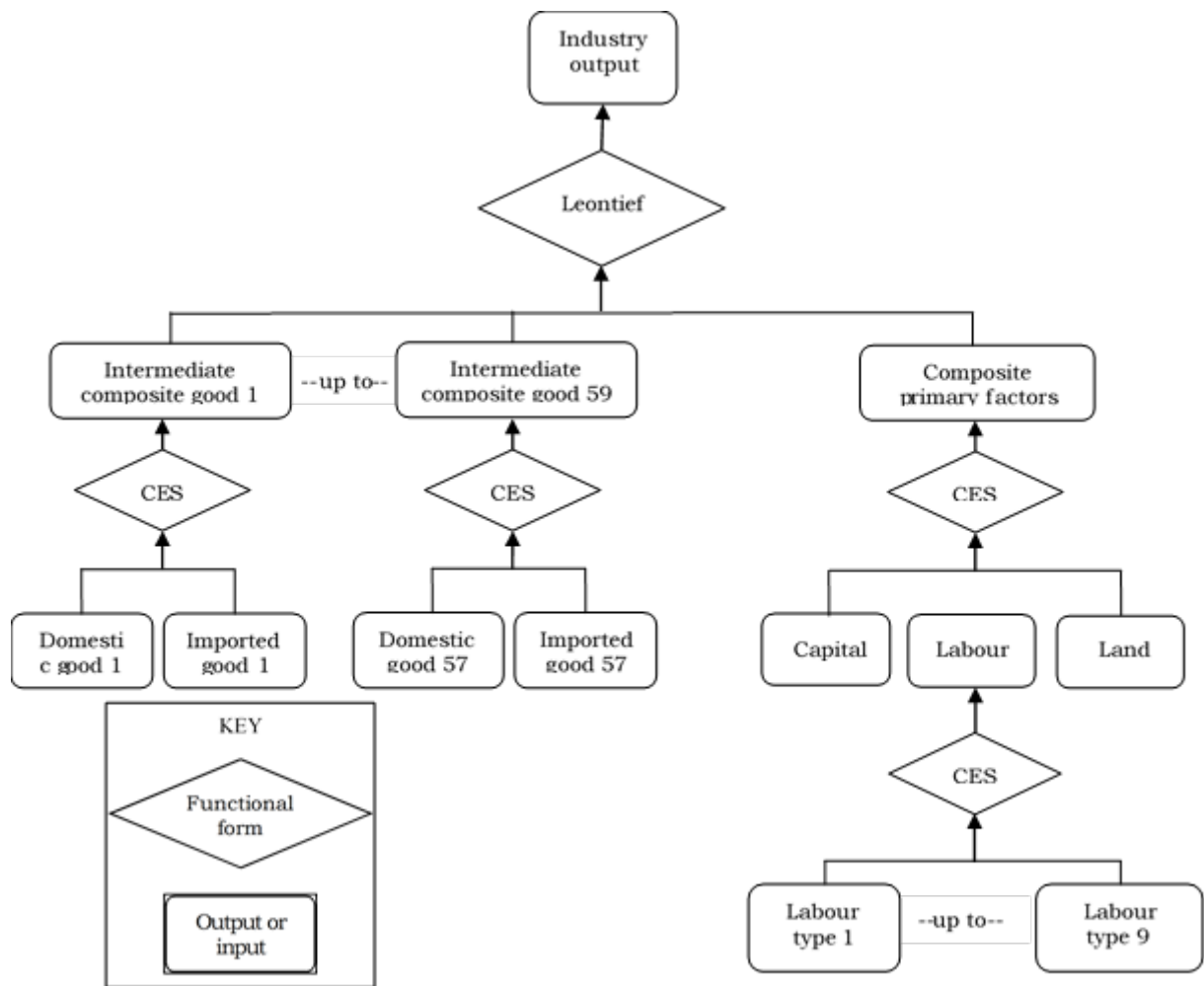
The export demand equations for Saudi commodities relate export volume inversely to foreign-currency price.⁷

GEMSA has one central government and includes equations determining the consumption of source-specific commodities by government as well as direct and indirect taxes. Government demand is either determined exogenously or can be linked to aggregate household consumption. All sectors are competitive and all commodity markets clear.

GEMSA recognises three main types of dynamic adjustment: capital accumulation, a lagged adjustment mechanism in the labour market and net foreign liability accumulation. Each industry accumulates capital, which links to industry-specific net investment. Changes in industry-specific investment are linked to changes in industry-specific rates of return. Annual changes in the net liability position of the economy are related to the annual current account balance. GEMSA includes a mechanism that guides the labour market from a typical short-run scenario (employment adjusts while the real wage remains unchanged from the baseline) to a long-run scenario (real wage adjusts while employment remains unchanged from the baseline). Typically, a positive (negative) labour market outcome manifests in the short-run as an increase (decrease) in employment away from the baseline, while real wages remain sluggish. In the long run, a positive (negative) outcome manifests as an increase (decrease) in the real wage away from the baseline while employment moves toward the baseline.

⁷ In GEMSA, we model the export demand for any given Saudi commodity as inversely related to its foreign-currency price, with the foreign-currency price determined through the interaction of demand with supply. As our model is for Saudi Arabia only, we do not have a view about changes in the position of export demand schedules, so those positions are naturally exogenous to the model. Saudi Arabia clearly has market power in the production of crude oil. We account for this market power by setting the export demand elasticity for crude oil to a relatively small number (-0.9), while export elasticities for other KSA exports are set to values averaging around -4.

Figure 3. Structure of production



Source: Horridge, 2013: 18

In this paper we are interested in the removal of subsidies on petroleum and electricity commodities used as intermediate input by industries or as a final commodity by the household. GEMSA includes three paths through which changes in commodity-specific subsidies are accounted for.

1. Subsidies are accounted for in the purchasers' price of commodities⁸ and any change in energy prices have direct and indirect impacts. The direct impact of price reform is the increase in the price of energy commodities. Indirect impacts refer to the knock-on effect of an increase in the price of energy commodities, which are used as intermediate inputs in the production of other commodities. Overall, when energy subsidies are cut,

⁸ GEMSA allows for the modelling of various commodity prices. For example, basic prices are prices before taxes on products are added and subsidies on products are subtracted. They do not include the value of margin services on the flow of commodities. Basic prices are the prices received by producers (for domestic goods) or by importers (for imported goods). Sales taxes and margins are excluded but import duties are included (Dixon *et al.*, 1982, 108-115).

Purchasers' price includes margin costs and sales taxes. It is the amount paid by the users of commodities and reflects the actual costs to users (United Nations 2009, 22). Of interest in this paper is the change in the purchasers' price of petroleum and electricity.

the cost of production raises which ultimately increases consumer prices. For example, electricity and petroleum products are used as intermediate inputs in the production of other goods. As subsidies are removed, the prices of these energy products will increase, causing the cost of production of other goods to increase. Ultimately, if the price of domestically produced commodities increases relative to the average price of the commodity, users will demand less of the domestic commodity and more from the cheaper imported alternative.

2. Price reforms are accounted for through changes in government revenue and ultimately the government budget balance. *Ceteris paribus*, removing subsidies will improve the balance on the government account.
3. Improved government revenue allows for greater government spending immediately or in the future. Part of the saved expenditure may be transferred back to vulnerable groups, such as strategic industries or households, in an attempt to alleviate the impact of an increase in prices.

5 The GEMSA Database

The core database is calibrated to a set of 2010 Supply-Use Tables (SUT) updated to 2015 National accounts data (GAS, 2015). The initial database for a CGE model is important because: (1) it contains information regarding the structure of the Saudi economy in the base year; (2) it is useful in the interpretation of results; and (3) in a Johansen-style CGE model, it is the initial solution to the CGE model (Roos *et al.*, 2015). The SUT is not in the required format of the CGE database and therefore a number of steps were taken to convert the published data into the format required by GEMSA. We highlight the following characteristics of the core database.

The model requires a core database with separate matrices for basic, tax and margin flows for both domestic and imported sources of commodities sold to domestic and foreign users, as well as matrices for the factors of production, namely labour, capital and land. Commodities can be used as intermediate inputs by domestic industries, investors, a representative household, foreigners, the government or held as inventory. GEMSA includes a detailed treatment of margins. For each commodity valued at basic prices we have a corresponding margin matrix, showing the cost of margin services used to facilitate the flow of commodities from all sources to the users of these commodities.

Of special interest in this paper is the modelling of taxes and subsidies. For each commodity valued at basic prices we have tax matrices showing the indirect taxes paid on the use of commodities from all sources by various users. Consistent with the published national accounts, the elements in the tax matrices in the core database are set to zero, reflecting the fact that there are no indirect taxes or subsidies on the use of commodities. There are import duties, which are explicitly accounted for in the database via a satellite matrix, and are also included in the flow of imported commodities valued at basic price. This allows for the calculation of ad valorem rates as the ratio between tax revenues and the relevant basic flows of commodities on which the taxes are levied.

The database includes matrices showing the value of primary factors used by industries in current production. These matrices include inputs of three factors of production: occupation specific labour payments by industry, capital rentals by industry and natural resources by

industries. Natural resource use is restricted to agricultural and mining industries. Only industries pay production taxes. The database shows that labour, capital, natural resource and production taxes are only used in current production. The database includes a multi-product matrix showing the basic value of commodities produced by the various industries or stated differently, it shows the value of industry output. See Appendix 1 for a summary of the cost and sales structures captured in the database.

The data suggests that the economy is largely based on, and driven by one sector namely crude oil and gas. As an industry, crude oil and gas contributes the most in terms of value added followed by the service industries. Manufacturing industries contribute the least. The economy therefore lacks diversification in terms of production, especially in manufacturing.

In terms of industries producing traded goods⁹ the data suggests that exports are dominated by crude oil and gas, with 85 per cent of total exports earning coming from the sale of crude oil and gas to foreign markets. Other commodities that are exported includes chemicals and refine petroleum, but they contribute very little in terms of export earnings.

In terms of imports, the data suggests large import shares of commodities used by all domestic users. Import shares are high for food and beverages, textiles and clothing, basic metals and machinery with nearly all of metal ores, tobacco, motor vehicles, radio and communication equipment used in KSA sourced from outside the local market. The data further suggests that imports of manufactured commodities is much higher than for the services sectors. In summary, production is largely concentrated on crude oil and gas, which is also the mainly exported. Commodities used mainly by households, investors and as intermediate inputs are mostly imported.

6 Simulation design

To conduct policy simulations with GEMSA, we run two simulations. The first simulation is the baseline forecast simulation. This models the growth of the economy over time in the absence of the policy change under consideration. In this study, the baseline incorporates macro forecast data from the IMF's World Economic Outlook Database (IMF 2018). Specifically we adopt forecasts for GDP, employment and population growth. It is also in the baseline simulation that we incorporate the subsidy on petroleum and electricity.

The second simulation is the policy simulation. The policy simulation generates a second forecast that incorporates all of the exogenous features of the baseline forecast, plus policy-related shocks reflecting the removal of subsidies. The results of the policy simulation are typically reported as percentage deviations away from the baseline forecast. We solve the model using GEMPACK (Harrison *et al.*, 2014; Harrison and Pearson 1996).

We report results for three policy simulations. In all policy simulations, subsidies are removed gradually from 2018 to 2025. The difference between the policy simulations are the level of support (incentives) provided to industries and households.¹⁰

⁹ Industries produce traded commodities when a large share of their output is sold on foreign markets and/or which compete in domestic markets with imports.

¹⁰ Whether and how subsidies are reflected in the official government budgetary process will depend on who incurs them and how they are financed. For example, the cost of pre-tax consumer subsidies may be incurred by state-owned enterprises (SOEs) that sell electricity or petroleum products at a price below supply costs. If the government fully finances these losses with a transfer, the consumer subsidy will be reflected in the budget as

Sim 1 – no incentives for industries and no lump sum payment to households: The revenue saved by the government by removing the energy subsidies improves the government budget balance. In other words, we assume that no support or incentives are given to any industries to offset the increased price of energy.

Sim 2 – incentives provided to the directly affected industries and lump sum payment to households: The revenue generated by the government is partly returned to those industries that are directly affected to ensure that investments planned from 2018 onwards are not affected by the reduction in demand as subsidies are removed. These industries produce petroleum products and electricity. The remainder is handed to households as a non-distorting lump sum payment.

Sim 3 – incentives provided to all manufacturing industries and lump sum payment to households: Same as Sim 2, but monies are returned to all manufacturing industries to ensure that investments from 2018 onwards are not affected. The remainder is handed back to households as a lump sum payment.

Our strategy is to explain the results for Sim 1 and then compare Sim 2 and Sim3 to the outcomes of Sim 1.

6.1 Closure and simulation assumptions

In each policy simulation the labour market is characterised by short-run stickiness of the real wage with flexible employment adjustment. The labour market transitions from this short-run environment to a long-run environment in which real wages adjust and employment moves to its long run baseline level. Therefore in the policy simulations, employment can deviate from its baseline level initially, but thereafter, real wage adjustment steadily eliminate the short-run employment consequences. In the long run, the benefits of policy outcomes are realised almost entirely as an increase in the real wage rate, rather than as an increase in national employment. This labour-market assumption reflects the idea that in the long run national employment is determined by demographic factors and immigration policy, which we have assumed are unaffected by the policy.

Subject to the economy-wide average propensity to consume (APC), private consumption expenditure is determined as a fixed proportion of disposable income. In all three policy simulations, the economy-wide APC is an endogenous variable that moves to ensure that the balance of trade (BOT) remains at its baseline level (see below).

Capital and investment are specific to each industry. GEMSA allows for short-run deviations in expected rates of return from their baseline levels. These cause deviations in investment and hence capital stocks that gradually erode the initial deviations in rates of return. Provided there are no further shocks, rates of return revert to their baseline levels in the long run.

expenditure. Alternatively, the cost of consumer subsidies could be offset by subsidized access to energy inputs, the cost of which would again fall on the government.

For our modelling we are passive about how the subsidies are imposed. All that we assume is that when removed, the final prices of petroleum and electricity will rise (significantly) and that the money saved will be given, partly as compensation, back to the private sector of the economy as a non-distorting lump sum.

Real public spending is forced to remain on its baseline path in each of the policy simulations.

In Sim 1, the government budget balance is allowed to move given the increase in government revenue due to the removal of subsidies. However, in the alternative policy simulations, we assume that the monies saved from the removal of these subsidies are returned partly to the directly affected industries (Sim 2), or to all manufacturing industries (Sim 3) as to ensure that investments planned from 2018 onwards are not affected by the reduction in demand as the subsidies are removed. The remainder is handed to households as a non-distorting lump sum payment.

The Balance Of Trade (BOT) is exogenously held at its baseline path via model-determined (endogenous) movements in the economy-wide average propensity to consume (APC). The justification for this closure choice is that Saudi-Arabia's net stock of foreign assets should not be allowed to accumulate to unsustainable levels. A stable asset-to-GDP ratio requires the current account balance to be stable as a proportion of GDP. In GEMSA the balance on current account is approximated in the long-run by the BOT.

GEMSA contains many variables to allow for shifts in technology and household preferences. In the policy scenarios, most of these variables are exogenous and have the same values as in the baseline projection.

6.2 Modelling petroleum and electricity subsidies

As mentioned in Section 5, the core database reports no initial indirect tax or subsidy data. To simulate the removal of subsidies in the policy simulation, we introduce subsidies in the baseline simulation. The baseline results therefore include subsidies on petroleum and electricity whereas the policy run simulates the removal of these subsidies.

6.2.1 Subsidies in the baseline

Based on Jadwa Investment (2015) and historical IMF (2013) information, we calculated that in 2015 the subsidy cost on petroleum products and electricity was approximately 221 billion riyal, which is equivalent in value to 9.1 per cent of GDP in 2015.¹¹ We introduce these subsidies gradually over the period 2016 to 2018. By 2018, all subsidies on petroleum and electricity are accounted for in the baseline simulation. We assume that these levels of support are maintained through the simulation period.

6.2.2 Subsidies in the policy simulation

Saudi Arabia is extending the timeline to remove subsidies. The government aims to increase domestic energy price levels gradually between 2018 and 2025 (compared to a previous target of 2020) (Nereim, 2017). Therefore, in the policy simulations we reduce the petroleum and electricity subsidy on the use of these products gradually from 2018 to 2025. GEMSA then determines the adjustment in regulated prices. Figure 4 shows that the removal of subsidies commence in 2018 and by 2025 all subsidies are removed.

¹¹ Jadwa estimates that energy subsidies cost the Saudi government approximately \$61 billion dollars in 2015 (9.3per cent of GDP) (Jadwa Investment, 2015).

IMF data suggests a subsidy rate of 7.4 per cent and 2.4 per cent of GDP for petroleum and electricity respectively (IMF 2013: 151).

7 Results

In this section, we present the macro-economic and industry-specific results of the gradual removal of energy subsidies under three alternative scenarios. The removal of the subsidies is interpreted as a change to a (negative) tax on the use of energy inputs and to a (negative) tax on energy used in household consumption.

GEMSA is a large, complex model. To gain a better understanding of the main macroeconomic features of GEMSA, we develop a stylised back-of-the-envelope (BOTE) model. Specifically, the BOTE focuses on how subsidies impact the marginal product of capital and labour.

The BOTE model is configured along the lines described in Dixon and Rimmer (1999, Section 3.3). The BOTE equations are explained in Section 7.1. Sections 7.2 and 7.3 contain our explanation of Sim 1. Results for Sim 2 and Sim 3 are examined in Section 7.4.

7.1 Back-of-the-envelope (BOTE) model

The BOTE model contains eight equations. It is assumed that the economy produces and exports one commodity (dom) and imports one commodity (imp). Both these commodities are consumed domestically and used to create capital. The domestic good is produced via a constant-returns-to-scale production function of labour (L) and capital (K).

$$Y = A * F(K, L) \tag{B.1}$$

where

Y is the output of the domestic commodity;

A is a technology variable, with an improvement in technology shown as an increase in A;

K and L are the factors of production, namely capital and labour; and

F is a constant-returns-to-scale production function.

Note that in our discussion below, we omit A as there are no productivity shocks in the GEMSA simulations.

Units of consumption and investment are created as Cobb-Douglas (CD) functions of the domestic and imported commodities leading to CD cost functions.¹² We further assume that the cost per unit of employing capital and labour is equal to the value to the employer of their marginal products.

$$W = \frac{P_{\text{dom}}}{T_g} * MPL \tag{B.2}$$

$$Q = \frac{P_{\text{dom}}}{T_g} * MPK \tag{B.3}$$

where

W is the wage rate;

Q is the rental price of capital;

P_{dom} is the price of the domestic commodity;

T_g is the power (1 + rate) of the production tax; and

MPL and MPK is the marginal product of labour and capital.

¹² In GEMSA the production theory is based on a nested constant-returns-to-scale CES and Leontief production functions. In the BOTE model, CD is a simplification of this structure.

Below we define the price deflators for consumption and investment.

$$P_c = P_{dom}^\gamma * P_{imp}^{(1-\gamma)} * T_c \quad (B.4)$$

$$P_i = P_{dom}^\delta * P_{imp}^{(1-\delta)} \quad (B.5)$$

where

P_c and P_i is the purchasers' price of a unit of consumption and a unit of investment;

P_{dom} and P_{imp} is the basic price of the domestic commodity and the c.i.f price of the imported commodity;

T_c is the power of the consumption tax (1+ rate); and

γ and δ are positive parameters reflecting the share of the domestic commodity in consumption and investment.

From (B.2) – (B.5) we can define the real consumer wage and the rate of return as:

$$W_r = \frac{W}{P_c} = \frac{P_{dom}}{P_{dom}^\gamma * P_{imp}^{(1-\gamma)}} * \frac{1}{T_g} * \frac{1}{T_c} * MPL \quad (B.6)$$

$$RoR = \frac{Q}{P_i} = \frac{P_{dom}}{P_{dom}^\delta * P_{imp}^{(1-\delta)}} * \frac{1}{T_g} * MPK \quad (B.7)$$

where

W_r is the real consumer wage defined as the ratio of the wage and the consumer price; and

RoR is the rate of return defined as the ratio of the rental price of capital (Q) and the asset price of capital (P_i).

From these equations, we find that:

$$MPL \left(\frac{K}{L} \right) = \frac{W}{P_c} * \left(\frac{P_{imp}}{P_{dom}} \right)^{(1-\gamma)} * T_c * T_g \quad (B.8)$$

$$MPK \left(\frac{K}{L} \right) = \frac{Q}{P_i} * \left(\frac{P_{imp}}{P_{dom}} \right)^{(1-\delta)} * T_g \quad (B.9)$$

Equations (B.8) and (B.9) emphasise that the MPL is an increasing function of the K/L ratio while the MPK is a decreasing function of the K/L ratio. In (B.8) and (B.9) the price ratio

$\frac{P_{imp}}{P_{dom}}$ is a function of the terms of trade. In terms of our BOTE model, we can think of the removal of subsidies as an increase in the T_c and T_g .

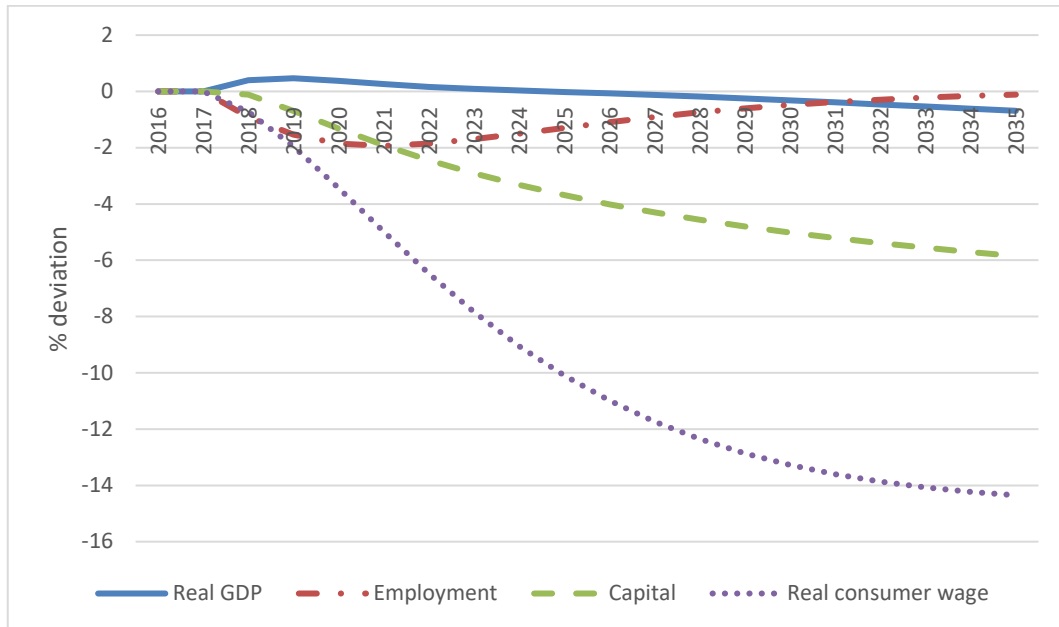
7.2 Results for macroeconomic variables – Sim 1

We use (B.8) and (B.9) of the BOTE model to explain the simulated outcomes for national capital and labour in the short and long run. In the short-run, the real wage (W_r) and capital stock (K) are sticky (i.e., slow to respond to the subsidy removal). Holding the price ratio¹³ unchanged, (B.8) shows that the increase in T_c and T_g cause the marginal product of labour

¹³ Changes in this price ratio is viewed as second round outcomes due to changes in labour and capital, which in turn is directly impacted by the increase in T_c and T_g .

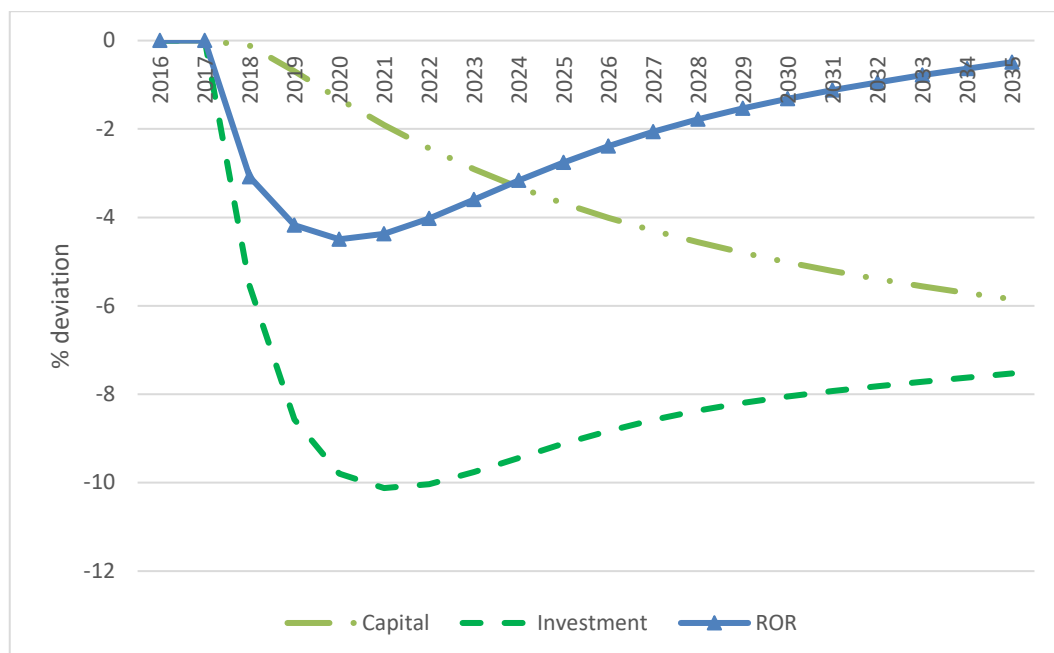
(MPL) to increase. With K sticky, this requires a fall in L. We see this short-run employment result confirmed in Figure 4.

Figure 4. National employment, capital stock, real GDP and real wage (% deviation from baseline)



Turning to (B.9), the short-run deviation in employment causes K/L ratio to increase, which requires the marginal product of capital (MPK) to fall. Assuming no change in the price ratio, the fall in the MPK requires the rate of return (RoR) to fall relative to baseline. The fall in the rates of return is reinforced, by the removal of the subsidy on intermediate use (i.e. the increase in T_g). The negative short-run deviation in the rates of return accounts for the fall in real investment in the short-run (Figure 5).

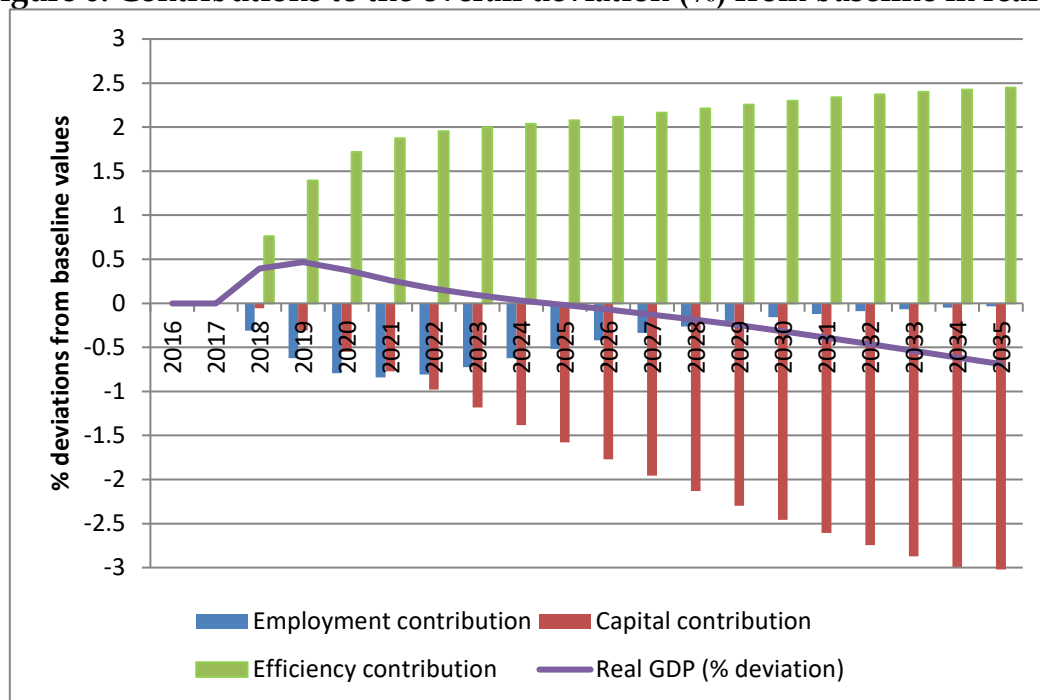
Figure 5. Investment, capital and rates of return (% deviation from baseline)



We expect that with capital unchanged in the short-run and employment below baseline, GDP would fall. However, our results show that GDP is slightly above baseline in the short-run. Removing the energy subsidies effectively eliminates a large distortion in the economy. This improves the efficiency of resource use, such that even though employment and capital in most years fall relative to baseline levels, real GDP rises. Such efficiency gains are not captured in the BOTE framework. They represent the reduction in deadweight loss associated with removing the distortions created by energy subsidies in the baseline.

The percentage change in real GDP is a share-weighted average of the percentage changes in quantities of factor inputs (labour, capital), with allowance for changes in the efficiency of resource use. Figure 6 shows, in stacked annual columns, the contribution of each component to the overall percentage deviation in real GDP.¹⁴ Increased (reduced) efficiency increases (reduces) real GDP even with unchanged levels of factor inputs.

Figure 6. Contributions to the overall deviation (%) from baseline in real GDP



As explained above, capital and labour markets adjust to a long-run environment where capital accumulated return the values of actual rates of return to required rates of return in the baseline, and the real wage adjustment returns employment to the baseline level. In (B.8) and (B.9) the long-run outcome is presented by holding employment (L) and the rates of return (RoR) exogenous while the real wage (Wr) and capital (K) is endogenous. In (B.9), with L and RoR exogenous, the increase in Tg causes the MPK to increase in the long-run. This requires capital to fall. With K below baseline and L returning to baseline, (B.8) shows that the MPL must fall, causing the real wage to fall. The negative impact on the real wage caused by the fall in K, is reinforced by the increase in taxation of intermediate (Tg) and consumption use (Tc). In the long-run we expect GDP to be above the baseline due to the efficiency improvement. However, Figure 6 shows that GDP is below base in the long-run. This is because the efficiency

¹⁴ Note that the contributions of natural resources to the real GDP deviation are zero (because in this simulation natural resource supply does not change between policy and baseline) and are not shown.

gain is not sufficient to offset the fall in capital in the long-run. This results suggests that it is important to consider alternative support (incentive) programs that can lessen the negative long-run impact on capital and GDP. We model two such incentive programs in Sim 1 and Sim 2.

In our explanation thus far, we have ignored the movement in the terms of trade (TOT).¹⁵ Our results show that the TOT is below baseline throughout the simulation period (Figure 7). In terms of the BOTE model, the fall in the TOT reinforces the short-run increase in the MPL (a decrease in the TOT increases the P_{imp}/P_{dom}). Similarly, it reinforces the short-run fall in the ROR and the subsequent fall in investment and capital. In the long-run, the fall in the TOT reinforces the upward movement in the MPK and the subsequent long-run negative outcome in capital. With the MPL falling in the long-run, the increase in TOT further dampens w/P_c (Figure 4).

Figure 7. National exports, imports the terms of trade (% deviation from baseline)

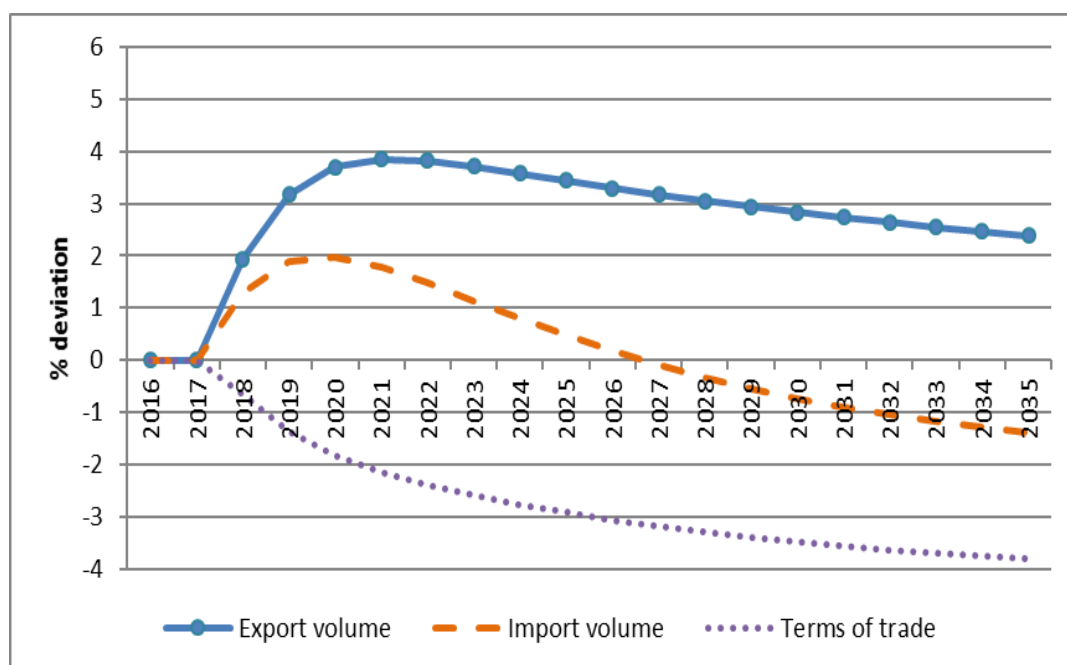


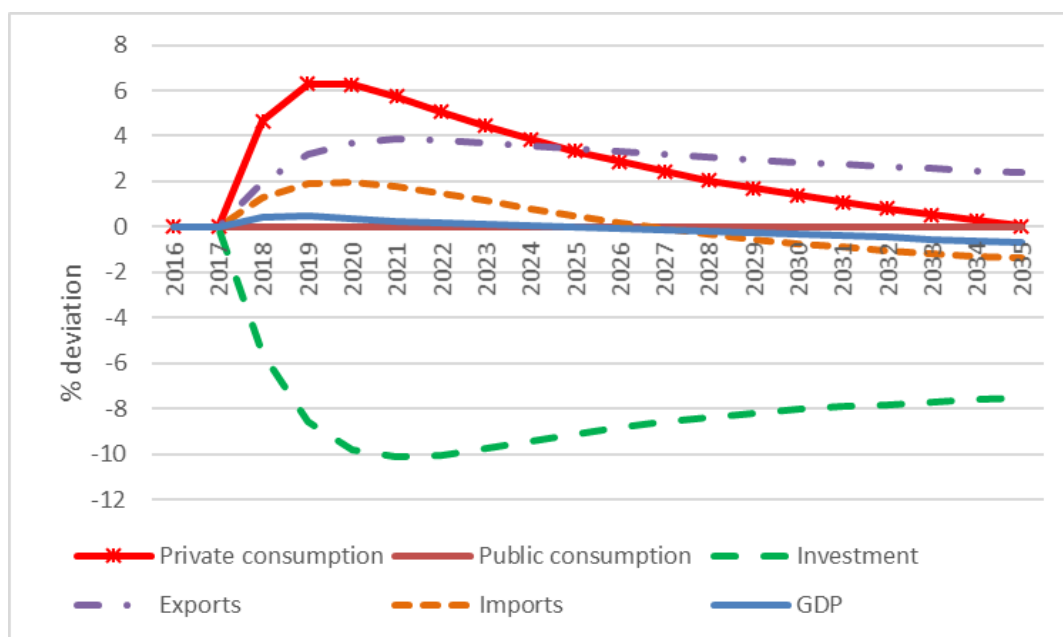
Figure 8 reports deviations in the expenditure side components of GDP. Via assumption, public spending is exogenously held at the baseline level throughout the simulation period (see Section 6.1). As seen in Figure 5, the negative deviation in the rates of return in the short run, cause investments to fall. As capital accumulates, the rates of return move towards the baseline. With capital below baseline in the long-run, investment will also be below baseline.

Via assumption we fix the BOT at its baseline level (Section 6.1). Thus, with the deterioration of the terms of trade, the net volume of trade (X-M) must improve. For the net volume of trade to improve, the deviation in real GDP (Y) must exceed the change in real GNE (C+I+G). This is allowed via a reduction in the APC. Our results shows a postive deviation in

¹⁵ The terms of trade is defined as the price ratio of a country's export prices to import prices. Holding the c.i.f import prices in foreign currency exogenous, an improvement (fall) in the TOT requires the price of exports to increase (fall).

real private consumption in the short run, which gradually erodes in the long-run as the APC falls.

Figure 8. GDP expenditure components (% deviation from baseline)



7.3 Industry results – Sim 1

This section focuses on the effect of the removal of energy subsidies on industry output, highlighting the influence of trade effects. For reporting purposes we rank the industries based on the percentage change in output for 2035. Table 2 present the results for the crude oil and gas industry (line 1), and then for the ten most adversely affected (line 2 – 11) and ten most advantaged (line 12 – 22) industries. The percentage deviation in industry output is shown in column 4. The remaining columns separate the overall change in output into contributions from three underlying market forces. The first column of numbers (*export*) shows the contribution to the change in domestic commodity output, brought about by the change in exports. The second column of numbers (*import replacement*) is the contribution due relative price changes favouring import replacement. The third column (*market effect*) shows by how much we would expect domestic-commodity production to change, if output of the domestic commodity increased in line with the change in domestic demand for the commodity, regardless of source (i.e., domestic or imported).

Table 2 shows that the output of crude oil and gas (line 1) is 1.1 per cent below baseline in 2035 (column 4). Column 3 shows that a contraction in overall size of the local market contributes 4.9 percentage points to the fall in total production. This is expected because although most of the crude oil and gas is exported, domestic industries such as petroleum, chemicals and electricity, also use oil and gas as an intermediate input. As these industries contract, so does their demand for crude oil and gas. Column 1 shows that increased export demand contributes 3.8 percentage points to the change in total production. Note that the contribution in column 2 is zero - no crude oil or gas is imported. Thus for the largest industry in Saudi Arabia, the story is a mixed one. Cuts in domestic subsidies reduces domestic demand. But some of this lost demand is offset by increased foreign demand, leading to a relatively mild

1.1 per cent contraction in output. Note that exports expand, while local demand falls, because GEMSA gives Saudi oil and gas producers the capacity to shift between the two general sources of demand with fairly minimal cost.

As mentioned above, domestic users of crude oil and gas decreased their demand for crude oil and gas because their production activities contract as a consequence of higher energy prices. We see this confirmed in Table 2 which shows that the electricity and petroleum industries, are among the worst performing industries with their output falling by 25.3 and 16.4 per cent respectively (line 2 and 4, column 4). With the price of petroleum and electricity increasing for all buyers of these commodities, it is not surprising that nearly all of the decrease in domestic production (column 4) is explain by the fall in domestic demand for petroleum and electricity (column 3).

Other industries affected negatively by the removal of energy subsidies, such as other transport equipment (line 3), basic metals (line 6), other machinery and computers and machinery equipment (line 11), have some common features, namely: (i) they face strong import competition on local markets; and (ii) they sell mainly to investors in the creation of capital.¹⁶ For example, the data suggests that 93.7 per cent of other transport equipment used in KSA is imported. Table 2 shows that the total production of other transport equipment falls by 17.6 per cent in 2035. The fall in total domestic demand for transport equipment contributes 6.3 percentage points (column 3), while the change in relative price favouring imported transport equipment contributes a further 10.2 percentage points (column 2). Land and air transport industries are among the worst performing industries because as large share of their production costs is petroleum. With the increase in the price of petroleum, the price of their output increases, thereby reducing their competitiveness. As with other industries, the contraction of the domestic market (column 3) as well as the change in relative price favouring imported transport commodities, contributes to the fall in their domestic output.

The industries that gain most in terms of production include wearing apparel, tobacco, hotel and restaurants, food and beverages, financial services and recreational activities. A common feature of these sectors is that they face relatively little trade exposure, and sell primarily to households. As illustrated in Figure 8, aggregate consumption is above baseline throughout the simulation period and therefore industries producing commodities mainly consumed by household's benefits. Wearing apparel (line 22) is projection to experience an increase in domestic production of 6.4 per cent (column 4). The increase in domestic demand for wearing apparel contributes 4.7 percentage points in the rise of domestic output.¹⁷ However, column 2 shows that due to a relative price change favouring locally produced wearing apparel, output of the domestic wearing apparel industry increases by an additional 1.6 percentage points (over the growth in domestic demand). The first column shows that increased export demand accounts for 0.19 percentage points of the total expansion in wearing apparel production.

¹⁶ As illustrated in Figure 5 and in the adjacent discussion, the deviation in capital and investment are below baseline throughout the simulation period.

¹⁷ Nearly 85 per cent of wearing apparel is sold to households.

Table 2. Decomposing output results from Sim 1, 2035 (%)

	Industry	Trade effects		Market effect	Total Output
		Export	Import replacement		
		1	2	3	4
1	Crude oil and gas	3.8	0.0	-4.9	-1.1
	<i>Worst performing</i>				
2	Refined petroleum	0.4	0.3	-26.0	-25.3
3	Other transport equipment	-1.0	-10.2	-6.3	-17.6
4	Electricity	0.0	0.0	-16.4	-16.4
5	Air transport	-4.7	-3.0	-8.3	-15.9
6	Basic metal products	-0.3	-4.5	-10.8	-15.6
7	Recycling	-0.1	-0.3	-14.3	-14.7
8	Fabricated metal products	-0.4	-2.1	-10.9	-13.4
9	Other machinery and computers	0.0	-3.3	-7.0	-10.3
10	Land transport	-1.8	-1.9	-6.4	-10.0
11	Machinery equipment n.e.c	-0.1	-3.2	-6.5	-9.8
	<i>Best performing</i>				
12	Textiles	-0.28	-1.28	3.56	2.0
13	Health and social work	0.00	0.51	1.79	2.3
14	Financial services	0.37	0.40	1.64	2.4
15	Leather products	-0.13	-0.51	3.23	2.6
16	Water	-0.29	0.00	3.22	2.9
17	Recreation, cultural and sporting activities	0.00	0.04	3.09	3.1
18	Food and beverages	-0.04	0.11	3.36	3.4
19	Real Estate	0.27	0.24	3.33	3.8
20	Hotel and restaurant	0.25	0.72	3.84	4.8
21	Tobacco	0.00	0.89	3.98	4.9
22	Wearing apparel	0.19	1.56	4.68	6.4

7.4 Introducing incentives (support) to industries and households (Sim 2 and Sim 3)

In Sim 2 and Sim3, we evaluate the impact of introducing support to industries to ensure that investment decisions planned for 2018 onwards remains unaffected by the removal of subsidies. In Sim 2, monies are partly returned to the directly affected industries while in Sim 3, monies are returned to all manufacturing industries. The remainder is handed to households as a non-distorting lump sum payment.

Figure 9 shows the GDP results for the three simulations. The results for Sim 2 and Sim 3 shows that GDP improves in the long run when monies are returned to the industries. GDP result for Sime 1 s consistent with Figure 5. When only the affected industries receives support, GDP is approximately 1 per cent above base, while it is 1.5 per cent above base when all

manufacturing industries receive support. The support to industries mutes the negative deviation in investment and therefore capital in the long run (Figure 10). Consequently, the negative impact on GDP is muted. Private consumption remains above baseline throughout the simulation period, partly due to the lump sum paid to households, which is sufficient to compensate for the lower APC.

Figure 9. GDP for all simulations (% deviation from baseline)

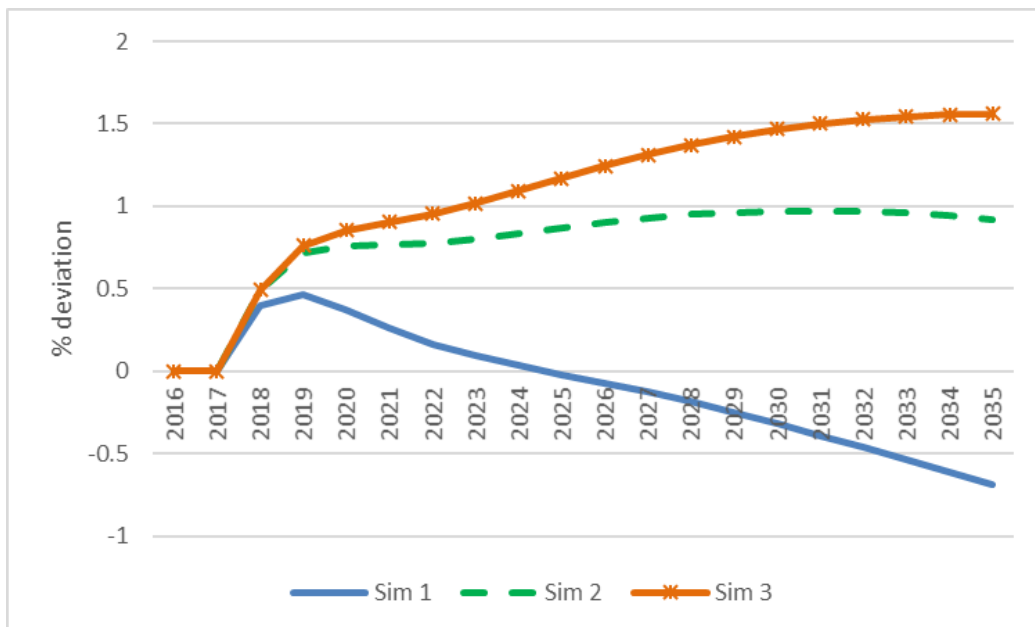
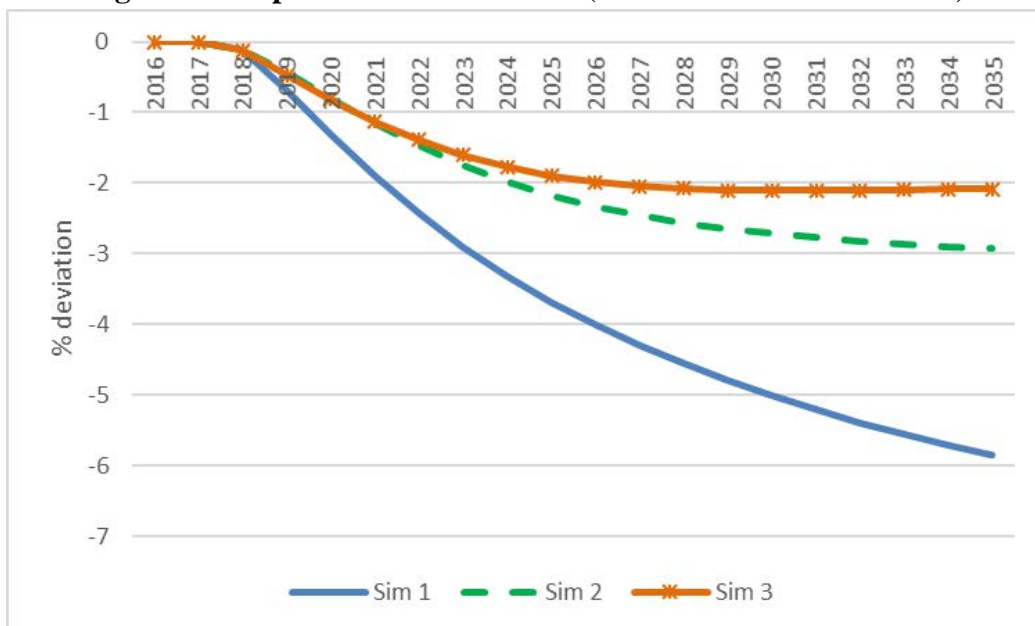


Figure 10. Capital for all simulation (% deviation from baseline)



A point of interest is that the magnitude of the improvement in capital and GDP is more for Sim 2 (where only electricity and petroleum is assisted) than for Sim 3 (where all industries receives support). This result suggests that careful consideration should be given to the nature of support and to which industries support is offered to, as not to reduce the efficiency improvement gained from the removal of energy subsidies.

8 Conclusion

For the GCC countries, the lower oil prices impacted negatively on government revenue from oil sales leading to an increase in budget deficits and a fall in foreign exchange reserves. Apart from long term structural change, the immediate response to lower oil prices is the removal of energy subsidies. Using a dynamic CGE model (GEMSA) for Saudi Arabia, we estimate the impact of removing subsidies on petroleum and electricity commodities used by producers and households. This model is useful because of its detailed representation of the linkages between different agents in the economy and its treatment of taxes and prices. This model further highlights the degree of trade exposure by capturing the share of commodity-specific exports and imports in the local market.

We run three simulations to evaluate the impact of removing energy subsidies under alternative support programs. In Sim1, no support is given to industries or households. The costs saved by the government in removing subsidies improves the government balance. Removing subsidies effectively improves the efficient use of resource. Thus, while we expect capital and labour to fall, GDP should improve due to the efficiency gain. However, although there is an efficiency gain, with no support given to industries or households, investments and capital collapse throughout the simulation period leading to a fall in GDP in the long run. Our results shows that employment falls in the short-run because of an increase in the cost of labour. The cost of labour increases because removing the energy subsidies causes the price of spending (e.g. CPI) to rise relative to the price of production. Over time, the real wage rate and the cost of labour move towards the baseline, forcing employment back towards its baseline value.

In sim 2 and Sim 3 we assume that monies are returned to the petroleum and electricity industries (as in Sim 2) or to all industries (as in Sim 3), as to ensure that their investment decisions are unaffected from 2018 onwards. This support mutes the fall in capital and investment, and ultimately GDP. Under the different scenario's GDP is above base at 0.9 per cent (Sim 2) and 1.56 per cent (Sim 3). The results suggests that consideration should be given to (1) what kind of support (incentives) is given to industries and households (e.g. cash payments) and (2) what other policies, apart from energy price reform, are required to improve GDP. Policies improving productivity as well encouraging diversification of, for example the manufacturing sector, should be encouraged.

Our results show that the main winners are those industries who mainly sell their commodities to the household, such as food and beverages, hotel and restaurants and real estate services. Nearly all of the output results are explained by an increase in local demand for these commodities. The industries that suffer the largest reductions in output are the petroleum and electricity industries, industries having a high share of energy commodities as an input to production (air and land transport), and industries selling most of their output to investment (machine equipment, fabricated and basic metals, and transport equipment). Although most of the change in industry output is explained by a change in local demand, higher production costs increase the demand for imported commodities thereby further depressing local production.

The results for the alternative simulations show that with monies returned to industries and households, the negative impacts on industry outputs become much smaller. In these simulations the support to industries ensure that investment decisions planned for 2018

onwards remains unaffected by the removal of subsidies. Therefore, industries such as construction benefit greatly as a large share of their output is used for investment activities.

The main purpose of subsidy removal in the KSA is to improve the budget deficit. Results from GEMSA highlight that the removal of energy subsidies increases the price of locally produced commodities, making it difficult for import competing industries and export oriented industries to remain competitive. These trade effects in itself will further impact domestic production and use of commodities. Our results also suggests that although support to industries mitigate the increase in domestic price and improve competitiveness, industries whose costs includes a large share of petroleum and electricity, remain among the most severely affected industries.

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