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How Much Would Bangladesh Gain from the Removal of Subsidies on Electricity and Natural Gas?

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Abstract

As in many countries around the world, subsidies to energy in Bangladesh impose a significant fiscal burden, with benefits that disproportionately accrue to high-income households. Any reforms of energy subsidies should benefit the overall economy rather than those who use energy the most. Using a computable general equilibrium model, this study investigates the economywide impacts of the removal of direct subsidies in the electricity sector and indirect subsidies in natural gas in Bangladesh. The study finds that removal of energy subsidies would be beneficial to the economy and would increase gross domestic product. The magnitude of the economic impact depends on how the budgetary savings from the removal of the electricity subsidies and increased revenues due to the removal of indirect subsidies to natural gas are reallocated to the economy. Recycling the savings (or the new revenues) to fund investment would benefit the country most, followed by the case of utilizing them to fund cuts in income taxes, and finally to fund cuts in indirect taxes. Although the reallocation of budgetary savings to households through lump-sum transfers is found to be inferior to the other recycling options considered, it would be the preferred option from the distributional perspective.

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How Much Would Bangladesh Gain from the Removal of Subsidies on Electricity and Natural Gas?[1]

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1. Introduction

Energy subsidies are a significant financial burden for many governments as well as resulting in inefficiency in resource use and imposing environmental costs (McKitrick, 2017; Coady et al. 2015). Although subsidies are intended to benefit low-income households, they often miss their target with a major share of benefits accruing to high-income households (Rao, 2012 and del Granado et al., 2012). Reforms or removal of energy subsidies have been considered in many countries, with some successes and many failures (Inchauste and Victor, 2017). Effective communication to the general public of the rationale for subsidy removal or reform is an important factor in the success of subsidy removal (Inchauste et al. 2017; Beaton et al. 2017 and Addo et al. 2017). Quantification of the benefits of subsidy removal can be a critical piece of such communication efforts. This study contributes to the literature on quantification of the benefits of subsidy reform by developing a computable general equilibrium (CGE) model for Bangladesh and using it to analyze the impacts of removing electricity and natural gas subsidies in the country.

Like many developing countries, Bangladesh subsidizes the consumption of electric power and natural gas. The consumer price of electricity is set at a level much below its long-run marginal cost of production. This has led to a situation in which the government needs to provide a direct (budget) subsidy to the Bangladesh Power Development Board (BPDB), the state-owned electric utility responsible for supplying electricity in the country. BPDB acquires electric power from its generating subsidiaries and independent power producers and sales to distribution companies. At present, the bulk tariff at which BPDB sells electricity to distribution companies, and the latter to final consumers, is lower than the supply cost of electricity. The gap between the supply cost and the tariff entails a subsidy that is directly transferred from the government to the BPDB. This transfer to the BPDB was US$800 million in 2012, equivalent to 0.6% of the country's GDP. In 2015, it had increased to almost US$1,200 million (Sadeque and Bankuti, 2017).

The electricity sector is not only subsidized directly by the government through a budget transfer, it is also subsidized indirectly because the price of natural gas, the main fuel to produce electricity in Bangladesh, is set at a level below its opportunity cost. In 2015, the average price of domestically produced natural gas in Bangladesh was $2.61/GJ, which was considerably lower than that of LNG delivered in India ($8.53/GJ). In fact, the price paid for gas by power producers in Bangladesh has long been among the lowest levels in the world (ADB, 2013). Moreover, Bangladesh's domestic reserves of natural gas are limited and supply at current prices is rapidly declining. The import of LNG started in 2018 and, by 2030, a large share of natural gas demand is projected to be supplied through imported LNG (Dorsch Consulting, 2012). Since the power sector is not the only sector that uses natural gas in Bangladesh, it would not be appropriate to price natural gas at its opportunity cost only for power generation. We analyze the impacts of reducing the indirect subsidy to natural gas used in all sectors in the country.

As elaborated in the next section, the economic impact of removal (or reform) of subsidies for energy has been analyzed for many countries, such as China, the Arab Republic of Egypt, the Islamic Republic of Iran, Kuwait and Malaysia. However, this issue has not been thoroughly investigated for Bangladesh.

Since the literature assessing the economic impacts of energy subsidy removal or reform is evolving, the methodologies used in early studies are either incomplete or, in some cases, inappropriate. For examples, studies of China (Jiang et al. 2015; Hong et al. 2013; and Jiang and Tan, 2013) employ input-output (I-O) methods to analyze the economic impacts of energy subsidy removal. A study used for Gulf Cooperation Council (GCC) countries (Al Iriani and Trabelsi, 2015) uses an econometric approach for the same purpose. The I-O and econometric methodologies are not good analytical tools to assess the economic impacts of subsidy removal because these are partial equilibrium approaches and do not capture the effects of recycling the funds saved through subsidy removal. The findings of these studies, suggesting that energy subsidy removal is bad for the economy, are inconsistent with economic theory and misleading because they miss the positive potential of the savings from reduction or removal of subsidies. More recent studies have used computable general equilibrium (CGE) models (Glomm and Jung, 2014; Elshennawy, 2014; Gharibnavaz and Waschik, 2015; Breton and Mirzapour, 2016; Gelan 2018) that can capture both the negative impacts of price increase due to subsidy removal and the positive effects of the reallocation of funds generated by the removal of subsidies. The net effect of subsidy removal, which can be positive under some schemes of reallocating the saved funds within the economy, is not captured in some of these studies (Glomm and Jung, 2014; Elshennawy, 2014; Breton and Mirzapour, 2016), suggesting the need for further refinement of the methodology. This study contributes to the literature on the methodological front by analyzing the impacts of subsidy removal together with the impacts of recycled savings. It recommends that analysis along the lines presented here should be undertaken to inform decisions on removing energy subsidies.

In this study, we analyze the economic impact of removing direct subsidies to consumption of electricity and indirect subsidies to the consumption of natural gas using a CGE model of Bangladesh. In both cases, we consider four alternative schemes to reallocate the funds saved. Consistent with economic theory, our findings confirm that removal of subsidies for the use of electricity and natural gas would have positive economic impacts overall (i.e., increase GDP) in Bangladesh.

This paper is organized as follows. Section 2 presents the literature analyzing the economic impacts of subsidy removal. This is followed in Section 3 by the analytical model (the CGE model) developed for the study and a description of how it incorporates the removal of direct and indirect subsidies in the energy sector. Section 4 lays out the results from model simulations. It is followed by a discussion of policy implications in Section 5. Finally, we draw key conclusions in Section 6.

2. Review of Literature

A number of studies have been carried out to analyze the economic effects of energy subsidy removal in different countries over the last few years. These studies include Jiang et al. (2015), Hong et al. (2013) and Jiang and Tan (2013) for China; Glomm and Jung (2014) and Elshennawy (2014) for Egypt; Solaymani and Kari (2014) for Malaysia; Blazquez et al. (2018) for Saudi Arabia; Gelan (2018) for Kuwait; Breton and Mirzapour (2016) and Gharibnavaz and Waschik (2015) for the Islamic Republic of Iran. These studies differ significantly in the methodology used, types of fuels considered, and findings. Table 1 compares these studies.

A few studies, especially for China (e.g., Jiang et al. 2015, Hong et al. 2013, and Jiang and Tan, 2013) assess the impacts of energy subsidy removal using input-output models. Their findings are, therefore, limited to the impacts on energy prices due to subsidy removal. As expected, they find that removal of energy subsidies would result in an increase of energy prices. These results are not only intuitive but also do not provide any insights on the impact of energy subsidy removal or reforms on the economy. Al Iriani and Trabelsi (2015) examine the effects of energy subsidy removal on the economies of seven members of the Gulf Cooperation Council (GCC), which have historically heavily subsidized energy, using an econometric cum algebraic approach. The study first establishes a causal relationship between energy consumption and GDP growth using data for the period 1980-2013. The causal relationship is then used to deduce the impacts of subsidy removal on the economy. The authors find that the causal relationship between energy and GDP is positive (the growth hypothesis) in Oman, implying that subsidy removal would negatively affect Oman's economic growth. They find that GDP drives energy consumption (the conservation hypothesis) in Bahrain and Kuwait, thereby implying that the removal of energy subsidies may not have significant negative effects on economic growth; instead it could enhance energy efficiency. The study finds a bi-directional causal relationship between energy and GDP in Qatar and Saudi Arabia (feedback hypothesis). pointing to the need for compensation policies to avoid a negative impact of energy subsidy removal on economic growth.

Table 1. Examples of recent studies analyzing impacts of energy subsidy removal

Country	Study and Year	Methodology	Key findings
China	Jiang et al. (2015)	Input-Output model	The removal of petroleum product subsidies has the greatest impact on households, followed by the removal of electricity and coal subsidies, respectively; indirect impacts of energy subsidy reform are greater than direct impacts on households.
	Hong et al. (2013)	Energy input and monetary output type Input-Output model	Prices of fuels increase from 6% (coal) to 47% (electricity); sector outputs drop from 2% (manufacturing) to 11% (service)
	Jiang and Tan (2013)	Standard Input–Output model	Prices of fossil fuel intensive commodities (e.g., electricity, transportation services) increase but at a small-scale (< 5%)
Malaysia	Solaymani and Kari (2014)	Static CGE model	Removal of energy subsidy increases GDP and terms of trade, whereas it decreases household consumption and welfare.
Iran, Islamic Rep.	Breton and Mirzapour (2016)	Partial equilibrium type empirical model	The direction of economic impacts (negative or positive) and their magnitudes depend on how the subsidy removal indirectly affects production costs of non-energy goods.
	Gharibnavaz and Waschik (2015)	CGE model with 20 types of households by income, and 21 production sectors	Energy and food subsidy reforms would cause welfare gain if the saved subsidies are recycled to households through a lump-sum transfer. The subsidy removal is a progressive policy as it causes higher benefits to low income households as compared to high income households.
Egypt, Arab Rep.	Elshennawy (2014)	Intertemporal general equilibrium model with 10 types	Significant loss of welfare; instantaneous elimination of subsidies would reduce household welfare from 2.7% to 3.6% depending upon the type of households.

		of households and 20 production sectors	
	Glomm and Jung (2014)	Dynamic model of small open economy with multiple generations of households	Economic impacts (i.e., GDP impacts) are sensitive to the schemes of recycling the saved subsidies to the economy; energy subsidy removal causes welfare gain in most cases of recycling the saved subsidy.
Kuwait	Gelan (2018)	Static CGE model	Reduction of energy subsidies causes GDP to drop if the saved subsidy is not recycled to the economy, whereas it would increase the GDP if the saved subsidy is recycled to consumers as a cash transfer.
Gulf Cooperation Council (GCC) countries	Al Iriani, M.A. and M. Trabelsi (2015).	Econometric estimates of causal relationships between energy consumption and GDP and implying the effects of subsidy removal based on this relationship	Impacts differ across GCC countries; some countries are likely to have negative impacts of subsidy removal (Oman) while others have no impacts (Bahrain, Kuwait) or small negative impacts, which can be compensated through other policies (Saudi Arabia, Qatar)

The approaches used in the input-output or econometric studies discussed above are not adequate to capture the economic impacts of energy subsidy removal for two reasons. First, these approaches do not account for linkages between the economic agents (e.g., households, governments, industries and rest of the world), although input-output models capture the linkages within industry sectors through fixed coefficients. Second, these models do not account for the opportunity cost of the subsidy. The savings from subsidy removal can contribute to economic growth if they are invested in productive sectors which have a comparative advantage. The savings could increase social welfare if they are recycled to households as a cash transfer instead of subsidizing household energy consumption. This would have a significant distributional or equity effect if savings are recycled to low-income households. Since the input-output and econometric approaches used in existing studies are not capable of measuring the full economic impact of subsidy removal, some researchers have developed partial equilibrium models to analyze the economic impacts of energy subsidy removal or reform (see, e.g., Breton and Mirzapour, 2016).

Defining the price difference between the border price (or opportunity cost) and actual price in the retail market (i.e., the price that consumers actually pay) as the energy subsidy, Breton and Mirzapour (2016) investigate the impacts of energy subsidy removal in the Islamic Republic of Iran by developing a partial equilibrium empirical model. Their study finds that typical consumers would benefit from subsidy removal if they are compensated through a direct cash transfer when the removal of the subsidy does not affect non-energy production costs. But, if energy subsidy removal increases the non-energy costs of other production sectors, the benefits get diluted depending upon the share of energy in total consumer expenditure, energy intensity and the existing rate of energy subsidy. While the Breton and Mirzapour (2016) study has its own limitations (e.g., being a partial equilibrium analysis, it does not adequately capture interactions between economic agents and between production sectors and it does not account for international trade), the approach is more appropriate than the input-output and econometric approaches used in the other studies discussed above.

Computable general equilibrium (CGE) models are more credible than the other approaches discussed above (econometric, input-out, partial equilibrium) when it comes to analyzing the economic impacts of energy subsidy removal or reform. Therefore, recent studies of the economic consequences of energy subsidy removal/reform increasingly employ CGE models (see e.g., Gelan, 2018; Gharibnavaz and Waschik, 2015; Elshennawy (2014); Glomm and Jung, 2014; Solaymani and Kari, 2014).

Using an intertemporal general equilibrium model of Egypt with 10 types of households and 21 industrial sectors, Elshennawy (2014) finds that energy subsidy removal reduces welfare no matter whether the subsidy is reduced instantaneously or gradually. However, the findings of this analysis are not convincing, as the paper does not mention how the savings from subsidy removal are utilized. If the savings are not used to compensate consumers through a transfer or tax cut or invested in production sectors which have a comparative advantage, it is possible that subsidy removal could cause welfare loss. A CGE modeling study for Kuwait (Gelan, 2018) confirms this. It finds that a 25% reduction of subsidies to oil, gas and electricity causes a 0.28% reduction of GDP if the saved subsidy is not recycled to the economy (i.e., government uses it for public consumption and/or savings). On the other hand, subsidy removal increases GDP by 1.01% if the saved subsidy is recycled to consumers as a cash transfer. Gharibnavaz and Waschik (2015) also report similar findings for the Islamic Republic of Iran. Employing a CGE model of the Islamic Republic of Iran with households differentiated by income (into 20 groups) and 21 production sectors, it finds that energy and food subsidy reforms that increase real government revenues by 30% would cause welfare of all households together to increase by 45% if households receive lump-sum transfers from the saved subsidies. More interesting is that low-income households have much higher welfare gains (in percentage) as compared to high-income households. This is because the lump-sum transfers are distributed equally to all households and low-income households have a lower income base. The findings of the study are intuitive and convincing, although the study does not consider other possible schemes to recycle saved subsidies to the economy (e.g., cutting existing distortionary taxes, investing in sectors with comparative advantage, etc.).

Glomm and Jung (2014) consider alternative uses of the savings from subsidy reform. Developing a dynamic open economy model for Egypt, they show that a reduction of energy subsidies could increase or decrease GDP depending on how the saved subsidy is recycled within the economy - a 15% reduction of the energy subsidy to households and firms can lead to an increase in GDP of 3% if the saved subsidy is used for infrastructure investment; on the other hand, a 3% loss of GDP is observed if the saved subsidy is recycled to households as a lump-sum transfer. Although GDP impacts are sensitive to the scheme of recycling of the saved subsidy, welfare impacts are not. The study finds welfare improvements due to subsidy removal in all schemes of recycling the savings from subsidy reform except when the savings are used to finance a cut in income taxes (since the generation that has already retired by the time subsidy removal takes place does not benefit from lower income taxes). The difference in impacts between GDP and welfare is also reported by Solaymani and Kari (2014) for Malaysia. Using a CGE model to analyze the impacts of energy subsidy removal in Malaysia, they find that removal of energy subsidies increases GDP and the terms of trade, whereas it decreases household consumption and welfare when the government does not redistribute subsidy savings to households.

3. Methodology and Data

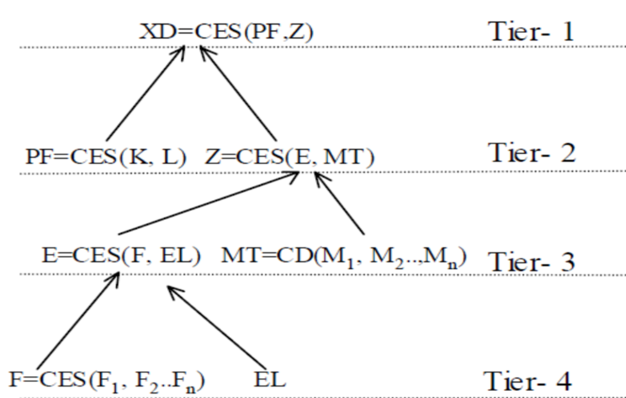
This study uses a computable general equilibrium (CGE) model to assess the economy-wide impacts of energy subsidy removal. In this section, we first briefly present the structure of the CGE model used for the analysis, followed by a description of the method of incorporating electricity and natural gas subsidy removal policies into the model. Key data used for the analysis, along with the main assumptions made, are presented at the end of this section.

3.1 The CGE Model

In the CGE model, the Bangladesh economy is aggregated into 17 production sectors and corresponding commodities. The sectors and commodities represented in the model are: (1) Agriculture and fisheries; (2) Forest, wood products, pulp and paper, printing; (3) Food and beverages; (4) Jute, textile and leather; (5) Fertilizers and chemicals; (6) Petroleum products; (7) Non-metallic minerals; (8) Primary and fabricated metals; (9) Machinery and equipment; (10) Other manufacturing products; (11) Construction; (12) Electricity; (13) Natural gas; (14) Mining; (15) Wholesale and retail trade; (16) Transport services; and, (17) Other services.

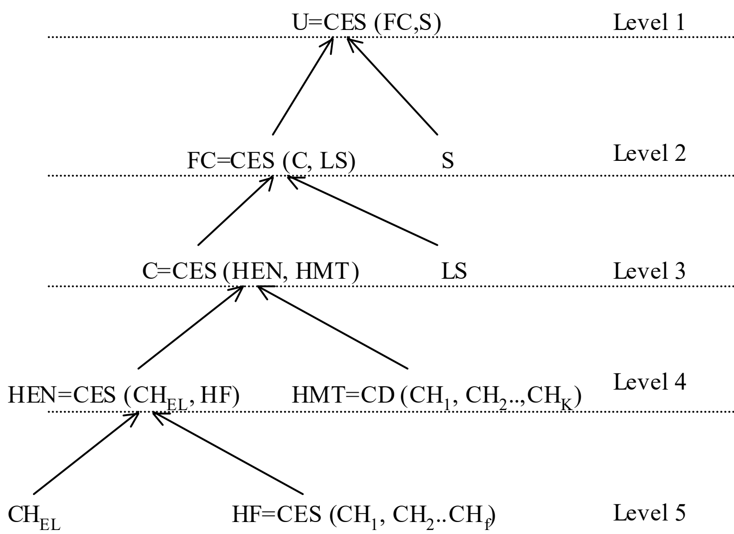
The model closely follows the structure of the models used in Timilsina and Shrestha (2002 and 2007). The production behavior of each sector is represented by nested constant elasticity of substitution (CES) production functions as illustrated in Figure 1a. This study considers a representative household that follows a five-step hierarchical optimization process to maximize its utility (Figure 1b) using a nested CES utility function. In contrast to many CGE models, (e.g., Glomm and Jung, 2014; Elshennawy, 2014; Solaymani and Kari, 2014) where household utility is derived from the consumption of goods and services, this model allows the household to make a choice between leisure and labor, and also between present consumption and future consumption (i.e., savings) while representing the household through the nested CES utility function.

Figure 1a: Nested Structure of Production Sectors



Note: CES refers to a constant elasticity of substitution functional form and CD refers to a Cobb-Douglas functional form, XD represents gross output, PF and Z refer to primary factors of production and intermediate inputs, respectively. E and MT refer to the energy composite and material composite; K, L, F and EL refer to capital, labour, aggregate fossil fuels and electricity.

Figure 1b: Nested Structure for the Household Sector



Note: U represents household utility, FC and S refer to full consumption and savings; C and LS refer to aggregate goods/service consumption and leisure; HEN, HF, HMT and CH refer to the aggregate energy consumption, the aggregate fuel consumption, the aggregate material consumption; and the individual goods/service consumption; subscript EL refers to electricity.

The government collects taxes, saves part of its income, and, also provides transfers to households. In the case of electricity, the government also provides direct subsidies to bridge the gap between production costs and sales price to consumers. Explicit representation of the government sector is important for this study because removal of electricity subsidies and increase in the price of gas are both implemented through this sector.

We assume domestically produced and imported goods are imperfect substitutes. The total demand for a good is assumed to be a CES composite of its domestic components and imported components. Export demand follows Timilsina and Shrestha (2002, 2007), which assume export demand responds to the relative price of exports with respect to corresponding international prices. Total current investment demand in the economy is considered equal to the total delivery of investment goods in the economy.

In the model, the total production of a good equals the sum of domestic consumption and exports of the good. Total domestic demand consists of intermediate and final demand (i.e., household consumption, government consumption, capital goods, and inventories). The total time endowment (i.e., the active population) of the economy is assumed not to change with either policy change, implying that the total amount of labor supplied in the economy depends only on the wage rate and labor supply elasticity. It is assumed that total labor supply is equal to the total demand for labor in the economy (Walras' law). People who are legally eligible to work are assumed to spend their time either working or consuming leisure. The model permits capital mobility across the production sectors. However, the total capital stock in the economy is assumed to remain unchanged with a policy change. The difference between total value outflow (e.g., imports of goods and services) from the country and the total value inflow (e.g., exports and transfers from the rest of the world) to the country is defined as the current account balance, while total investment is the sum of total savings comprising of household saving, government saving and the current balance.

3.2 Incorporating energy subsidy removal into the CGE model

In order to incorporate the direct government subsidy to the electricity sector, we compared the size of the subsidy to the total value of electricity sold. In 2012, the base year of our model, direct electricity subsidy was equivalent to 33% of the value of electricity sales reported in the social accounting matrix (SAM), the main database required by a CGE model. This means that the non-subsidized average price of electricity for consumers would have been 33% higher than the reported value. The elimination of this subsidy would mean increasing the electricity price to 1.33 times its starting (subsidized) value. This is implemented in the model as a 33% tax added onto the subsidized price of electricity. It is assumed that the government saves the amount which has been transferred to the electricity sector as a subsidy. This saving could be used in the economy for other purposes. Alternative options to utilize the saved subsidies will be discussed later.

In the case of natural gas, the situation is different. The gas sector does not receive a direct subsidy from the government; instead gas is sold at a price lower than its opportunity cost. The opportunity cost is the cif price of imported LNG. Under the baseline (business as usual) the price of gas sold in Bangladesh is expected to be a weighted average of the prices of domestically produced and imported gas. Over time the gas mix used in Bangladesh will tend towards being 100 percent imported, so the weighted average price of gas will approach the price of imported gas in the long run (we have assumed this would occur by 2030). Therefore, the natural gas subsidy removal policy simulated here requires an increase over time in the domestic retail price of natural gas (i.e., the weighted average price of domestically produced and imported gas) to the price of imported gas. Table 2 depicts the evolution over time of the ratio of the imported price of natural gas and the weighted average price of gas. The forecast for the volume of gas supplied domestically and the volume of imports is taken from Petrobangla (2012). It is beyond the scope of this analysis to investigate the merits of the gas consumption forecast. Moreover, the demand for natural gas might have been suppressed due to the shortage of supply. However, an assessment of latent or suppressed demand for natural gas is a separate topic which is beyond the scope of this study.

Table 2: Evolution of gas price over time

Year	Domestic Supply (TJ)	Imports (TJ)	Weighted average price of gas (US$/GJ)	Ratio of import price to weighted average price
2018	1,179	237	3.60	2.37
2019	1,178	237	3.60	2.37
2020	1,244	161	3.29	2.60
2021	1,192	199	3.45	2.47
2022	1,043	337	4.05	2.10
2023	933	441	4.51	1.89
2024	820	556	5.00	1.71
2025	696	691	5.56	1.53
2026	630	772	5.87	1.45
2027	568	852	6.16	1.38
2028	548	893	6.28	1.36
2029	530	934	6.38	1.34
2030	488	1,005	6.59	1.29

Note: This uses prices for domestic and imported gas for 2015, which are 2.61 and 8.53 US$/GJ, respectively.

Table 2 also shows that the ratio of the import price to the weighted average price decreases over time as the volume of (higher priced) imported gas increases. Since Petrobangla is a state-owned enterprise, the additional revenue generated through the price increase accrues to the government. For example, increasing the 2018 price of domestically produced natural gas to import parity so that the weighted average price equals the import price of LNG ($8.51/GJ) would result in almost $7 billion of additional government revenue (with consumption assumed to be unchanged – a simplifying assumption), which is more than 3% of Bangladesh's GDP in 2016. Since it seems unrealistic to expect the Government of Bangladesh to increase the consumer price of gas to 2.37 times its original value in one go, we assume that the increase will occur gradually. For this analysis, we assume Bangladesh will increase the consumer price of natural gas to1.53 times its starting value (i.e., by 53%) by 2025.

We consider four schemes (Table 3) to recycle the saved subsidy from the electricity sector (due to subsidy removal) and increased revenue from the natural gas sector (due to the price increase). The schemes are revenue neutral for the government, meaning that the incremental government revenue after the introduction of the policies will be recycled to the economy.

Table 3: Schemes to recycle savings or increased government revenues

Scenario Name	Scenario definition
Excise tax	Use the savings or revenue to cut excise or indirect tax rates on all goods and services consumed in Bangladesh
Income tax	Use the savings or revenue to cut income or direct tax rates imposed on individuals and firms in Bangladesh
Lump-sum	Transfer the savings or revenue to households increasing their disposable income
Investment	Invest in the economy to increase the total capital stock in Bangladesh

A large number of other options, such as using the savings for public consumption (or providing larger fiscal space), using the savings for reducing public debt, and using the savings to subsidize or finance clean energy technologies, are possible. However, we have not included them here because these additional schemes may not be necessarily better than the ones we considered here. Reviewing a large number of existing studies on the recycling of carbon tax revenues, Timilsina (2018) implies that using the savings or new revenues for public consumption would be the least preferred option because of its costs (GDP and welfare loss). The study also shows that recycling revenues for cutting public debt or financing clean energy technologies would not be efficient from the options considered here.

3.3 Data

The main data required for this analysis are as follows:

(i) Social Accounting Matrix (SAM) for Bangladesh
(ii) Elasticity of substitution and other parameters
(iii) Direct government transfers (subsidies) made to electric utilities in Bangladesh
(iv) Prices of domestically supplied natural gas in Bangladesh and delivered price of LNG in India

The latest SAM available for Bangladesh is for 2012 and, because of this, 2012 is the base year for the analysis in this paper. The SAM was provided to us by SANEM, a policy think-tank based in Dhaka, Bangladesh. The SAM was adjusted to overcome some missing values by distributing across the cells of the 'USE' matrix[3] the total value of domestically produced goods and services consumed by the productive sectors (intermediate consumption), using technology coefficients from the GTAP[4] 2007 SAM for Bangladesh. The use of 2007 GTAP coefficients means ignoring possible structural change between 2007 and 2012 in the Bangladesh economy.

All elasticity parameters are taken from Timilsina and Shrestha (2007). As it is difficult to empirically estimate the elasticity of substitution across commodities for individual countries, using values from the literature is the norm. Data on government transfers to BPDB were obtained from the Medium Term Macroeconomic Policy Statement of the Ministry of Finance, Government of Bangladesh, while quantity forecasts for natural gas and LNG were obtained from Petrobangla (2012), with natural gas price data for 2015 for Bangladesh coming from Petrobangla and LNG price data for India from Sen (2015).

4. Results and Discussion

In this section, we first discuss results from the CGE model simulations of electricity subsidy removal followed by results from simulations in which the price of natural gas is increased to its opportunity cost. Under each set of results, aggregate level results, such as impacts on GDP, total sectoral outputs, total household demand, total exports, total imports, total investment, disposable income, the trade balance, and government income are discussed first; this is followed by a discussion of sectoral and commodity level impacts.

4.1 Impacts of electricity subsidy removal

4.1.1 Aggregate economic impacts

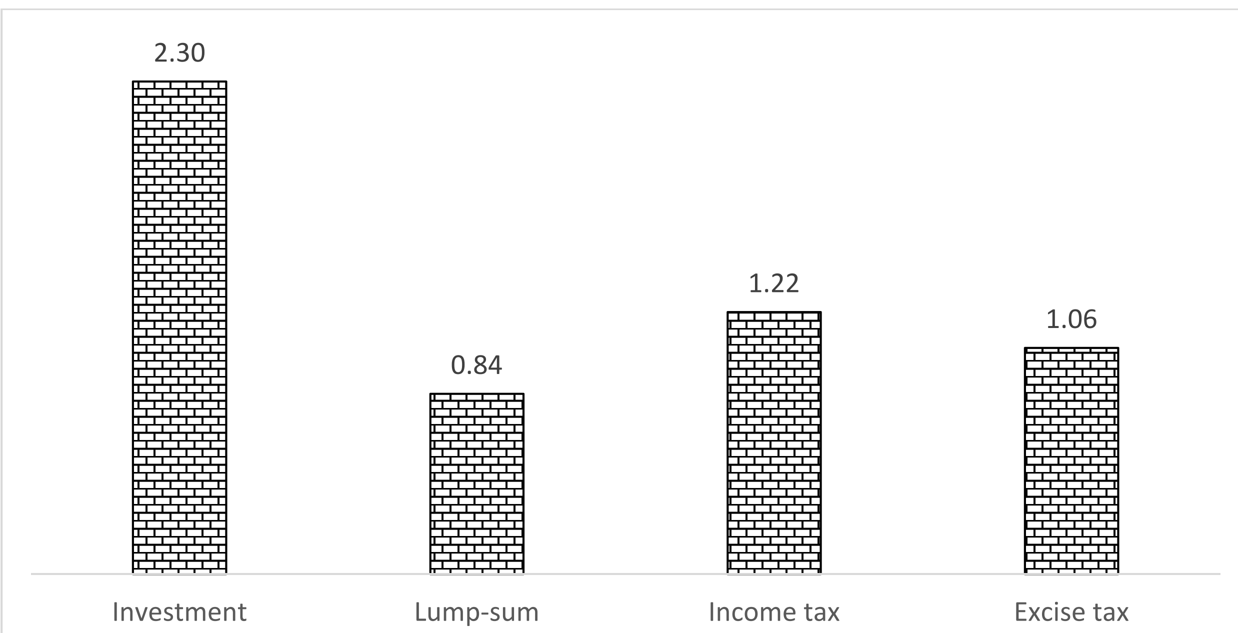
Elimination of the electricity subsidy and recycling the associated budgetary savings to the economy would be beneficial because this would end distortions caused by the electricity subsidy,

[3] The 'USE' matrix in a SAM refers to inputs of different goods and services for the production of various goods and services.

[4] GTAP is a global network of researchers who conduct quantitative analysis of international economic policy issues, especially trade policy. A key output of the network is a global economic database, covering many sectors and all parts of the world. It is coordinated by the Center for Global Trade Analysis, Department of Agricultural Economics, Purdue University, West Lafayette, IN.

at the same time, the saved funds could be allocated to areas where their opportunity costs are higher. GDP is seen to increase in all schemes of recycling the saved budget (Figure 2). However, the magnitude of the impact on GDP depends on the specific scheme to recycle the saved funds. If the saved budget is reinvested in the economy to increase the total capital stock, GDP gain would be the highest. A significant increase in GDP is also noticed when the saved budget is used to lower personal and corporate income taxes or to cut excise taxes. The results showing higher benefits to the economy when increased government revenue from a policy shock is used to cut distortionary taxes (e.g., income tax, sales tax) than when it is recycled to households as a lump-sum transfer, are consistent with the literature (Timilsina and Shrestha, 2007). Note that the size of the subsidy was 0.6% of GDP in 2012. The removal of the subsidy and re-directing the funds to more productive activities can potentially result in an increase of GDP of 1-2.3% depending on how the saved budget from subsidy elimination is recycled within the economy.

Figure 2. Impact on GDP (% change from the base case)



Cutting the electricity subsidy and recycling the saved budget to the economy boosts all economic activities resulting in higher gross output and household demand (Figure 3). Total imports also increase due to increased demand for goods and services in the production and household sectors. As production increases so do exports. However, the increase in domestic household consumption is proportionately higher when the saved funds are transferred to households as a lump-sum. This results in a decline in total exports in that case.

Figure 3. Impacts on gross output, total household demand, total imports and total exports (% change from the base case)

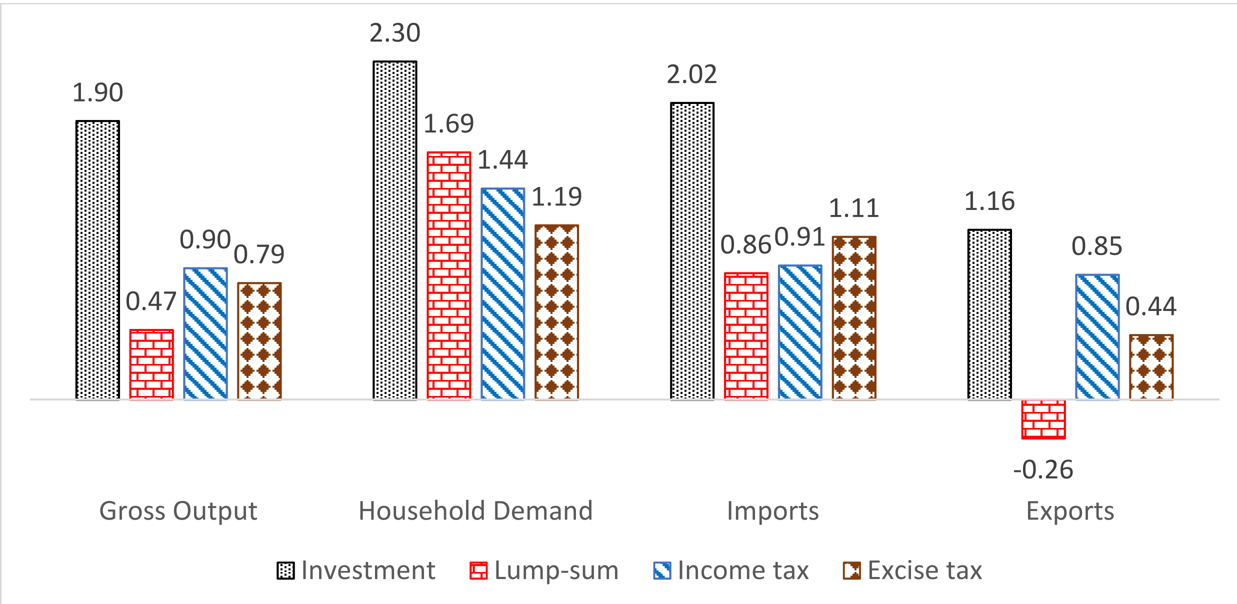
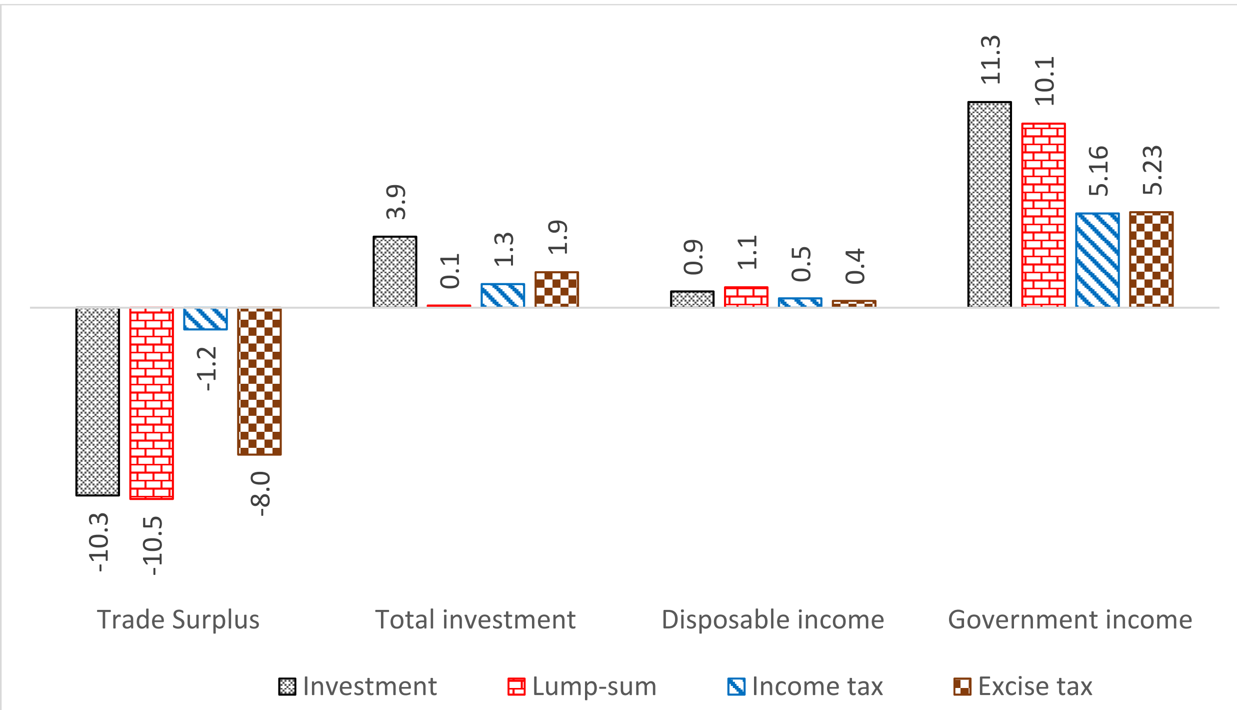


Figure 4 presents the impact on other macroeconomic variables such as current account balance/surplus, household income, and total investment. In the base year, Bangladesh has a surplus on the current account, i.e., the flow of value into the country (e.g., export revenues, remittances) is higher than the flow of value out of the country (e.g., cost of imports), amounting to 2.1% of GDP. The removal of the electricity subsidy causes the trade surplus to shrink because net exports decrease due to relatively higher increase of imports as compared to that of exports. [5] Note that GDP increases despite the drop in net exports because the other components of GDP (i.e., final consumption of goods and services) increase. As would be expected, government revenues in the tax cut scenarios (income tax and excise tax cuts) would be smaller than in the two

[5] The movement of exports depends on the movement of producer prices. When producer prices, which are export prices here, increase, domestic production becomes relatively expensive vis a vis imports (this is because the international price remains the same since Bangladesh is a small country in trade terms and cannot influence world prices), so exports decrease and imports increase. Across the four scenarios studied, producer prices are the highest under the lump-sum case (see also in Figure 5).

other scenarios (i.e., lump-sum transfer to households and increase in public investment spending) because of the reduction in existing income or excise taxes. While the cuts on the existing taxes cause government revenues to be smaller in these revenue recycling cases (i.e., tax cuts) as compared to other revenue recycling cases; there would still be increase in government revenue from the base case because of positive spillover caused by subsidy removal (e.g., increase in GDP).

Figure 4. Impacts on other macroeconomic variables (% change from the base case)



4.1.2 Sectoral/commodity impacts

Sectoral results reflect the electricity intensity of each sector, which is the main factor influencing the impact of subsidy removal or price increases. However, this is not the only factor to influence the impact on sectoral output and prices since indirect impacts mediated through other inputs (which are affected by the increase in electricity prices) can be expected to play a role in the overall impact as well. For example, activities that consume a lot of metals or chemicals, which are both electricity intensive, may also see large effects even if their own direct electricity use is relatively low. The electricity intensities of various sectors are presented in Figure A1 in the appendix.

The removal of the electricity subsidy, which amounted to 33% of the value of total output in the electricity sector, would reduce electricity output by 9% to 10% depending on how the saved funds from subsidy removal are recycled within the economy. The outputs of electricity intensive industries would also drop significantly (Figure 5). On the other hand, outputs of sectors that are relatively less electricity intensive would increase (e.g., agriculture, food and beverages, jute, textiles and leather, transport).

Figure 5. Impacts on sectoral outputs (% change from the base case)

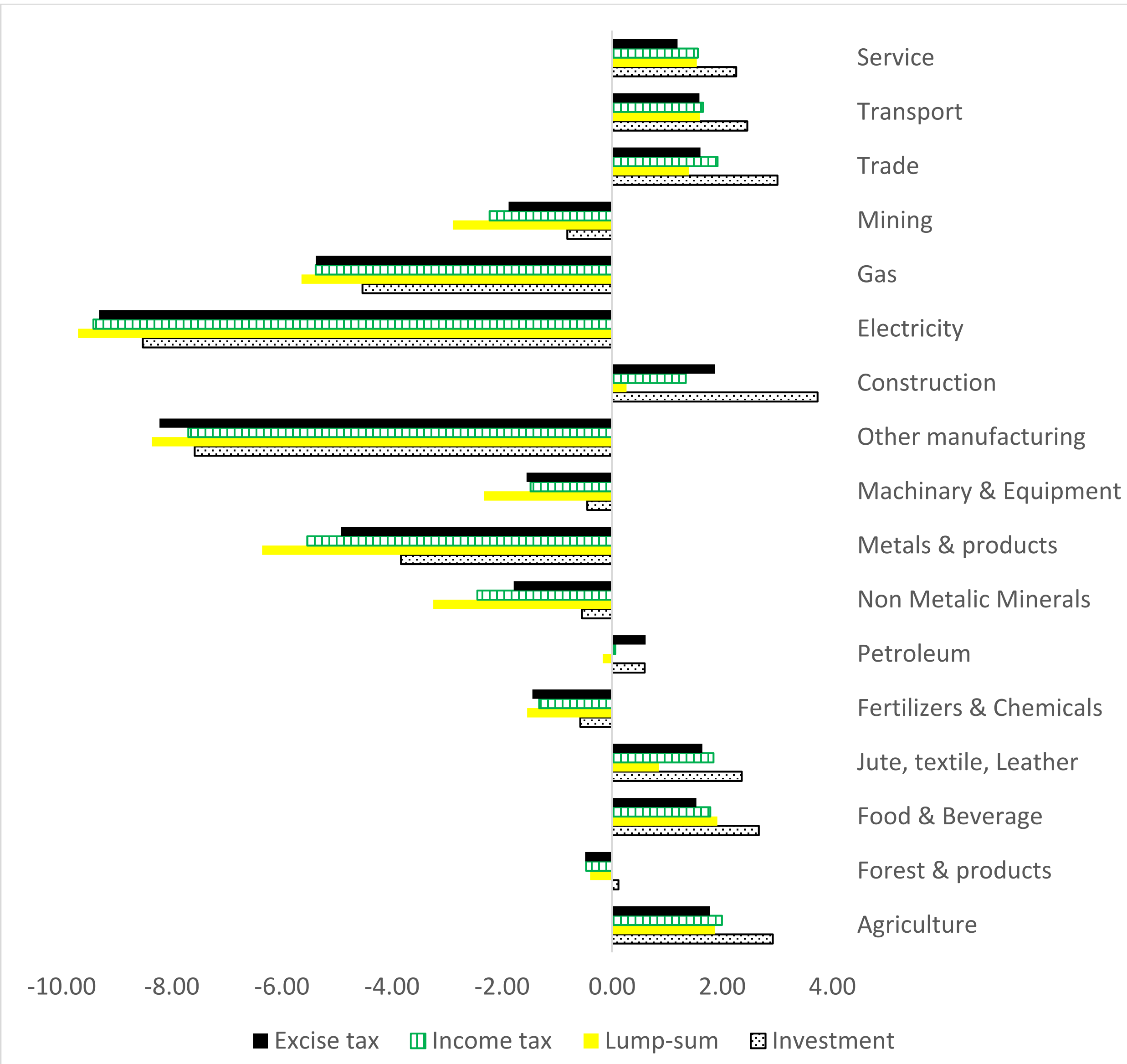
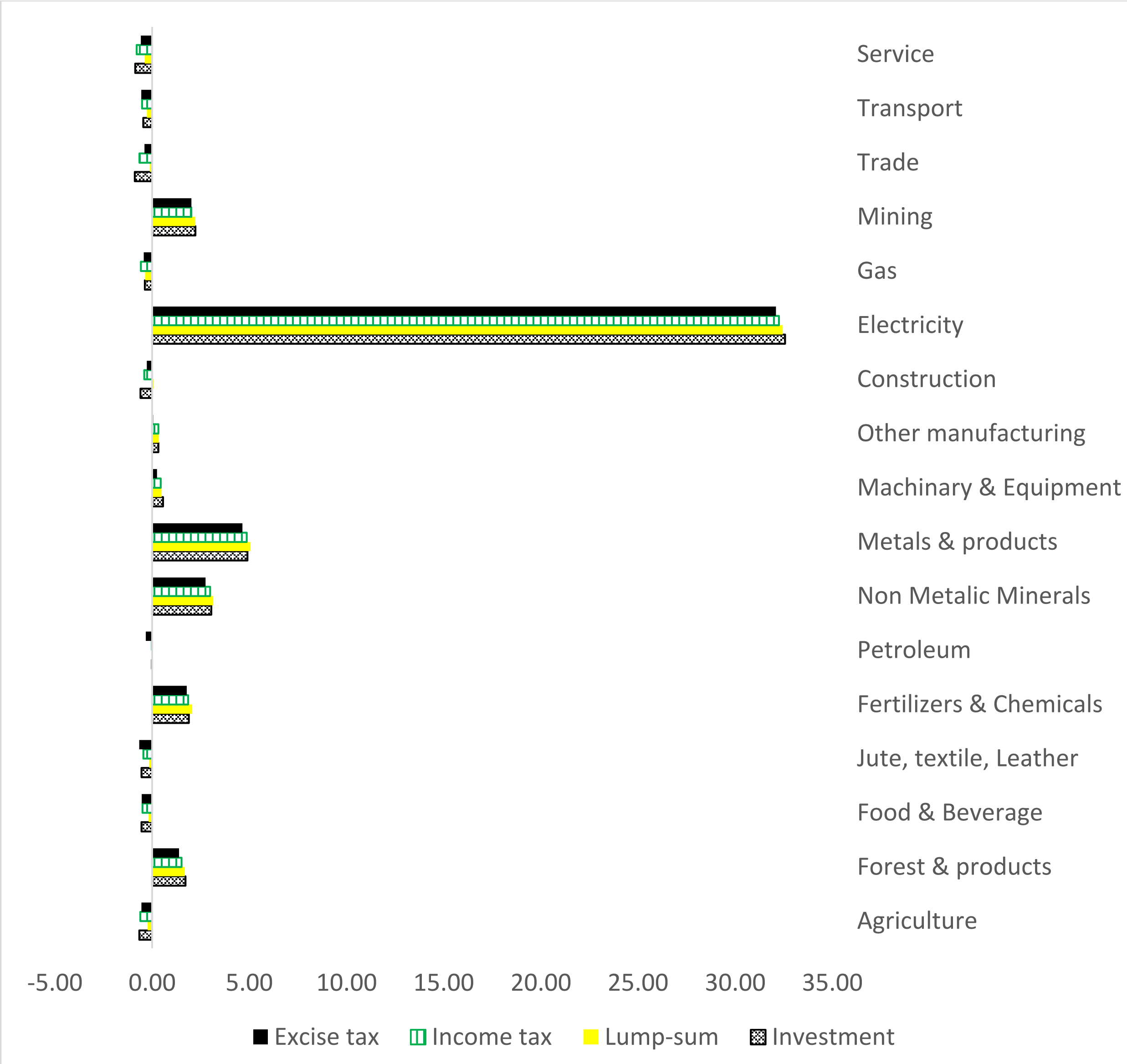


Figure 6 shows the impact of electricity subsidy removal on commodity prices (inclusive of taxes and subsidies). When the subsidy is removed, the final electricity price increases by 32 to 34% depending upon the scheme to recycle the budgetary savings within the economy. The increase in the price of electricity leads to an increase in the prices of other commodities, especially those produced by electricity intensive industries (e.g., metals and fabricated metals, minerals, fertilizers and chemicals, furniture). The change in prices differs in magnitude and direction under different recycling schemes because the second-round effects of the redistribution schemes vary. For example, transfers to households will raise the demand for goods consumed by households, while if money is recycled into investment it is investment goods whose demand and prices will rise.

Figure 6. Impacts on consumer prices (% change from the base case)



The aggregate change in commodity prices due to the removal of the subsidy on electricity is reflected in the consumer price index (CPI). The CPI increases by 2.4% when the budgetary savings are recycled through a lump-sum transfer to households; the impact is not significantly different in the other recycling scenarios.

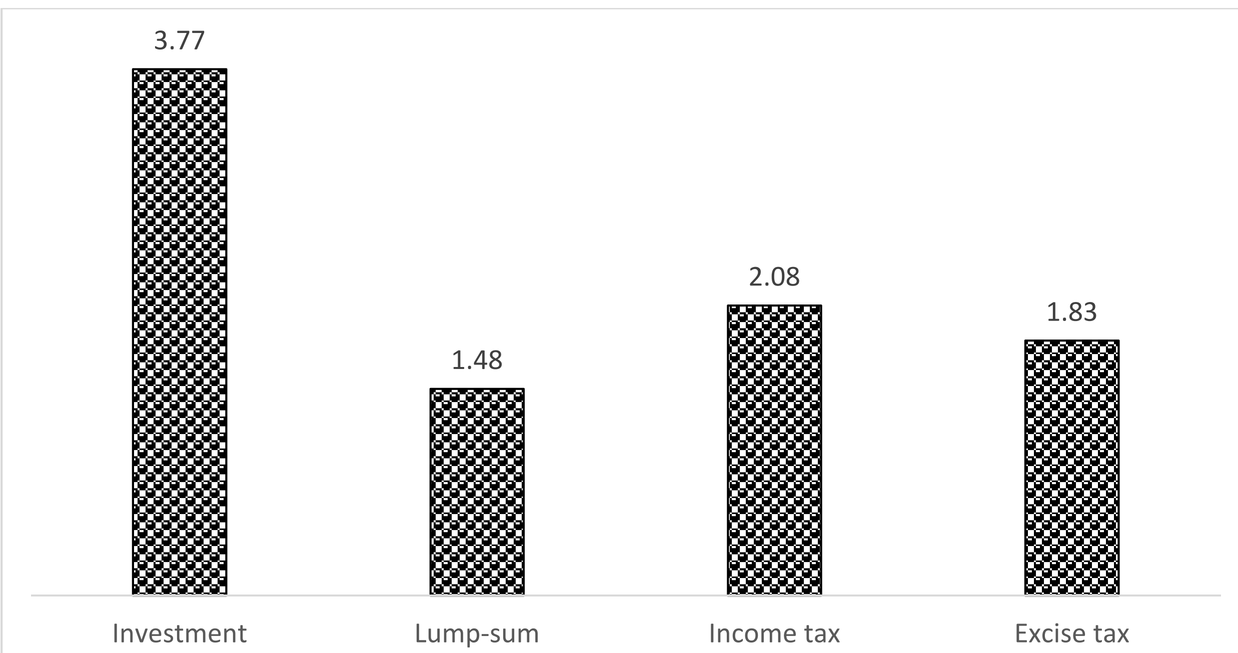
4.2 Impacts of pricing natural gas at its opportunity cost

As in the case of electricity subsidy removal, we first discuss the impact of the increase in natural gas prices on aggregate economic variables, such as GDP, total sectoral outputs, total investment, total imports, total exports, etc., followed by sectoral or commodity level impacts.

4.2.1 Aggregate impacts of natural gas subsidy removal

Based on the forecasts of domestic production and imports and corresponding prices shown in Table 2, the consumer price of natural gas (weighted average price of domestically produced and imported natural gas) would need to be increased by 53% by 2025 for the consumer price of gas in Bangladesh to reach its opportunity cost (i.e., delivered price of LNG) by that year. Figure 7 shows the impacts on GDP of removing the indirect subsidy on consumption of natural gas by 2025 (i.e., increasing the consumer price of natural gas by 53% by 2025) under the four revenue recycling schemes.

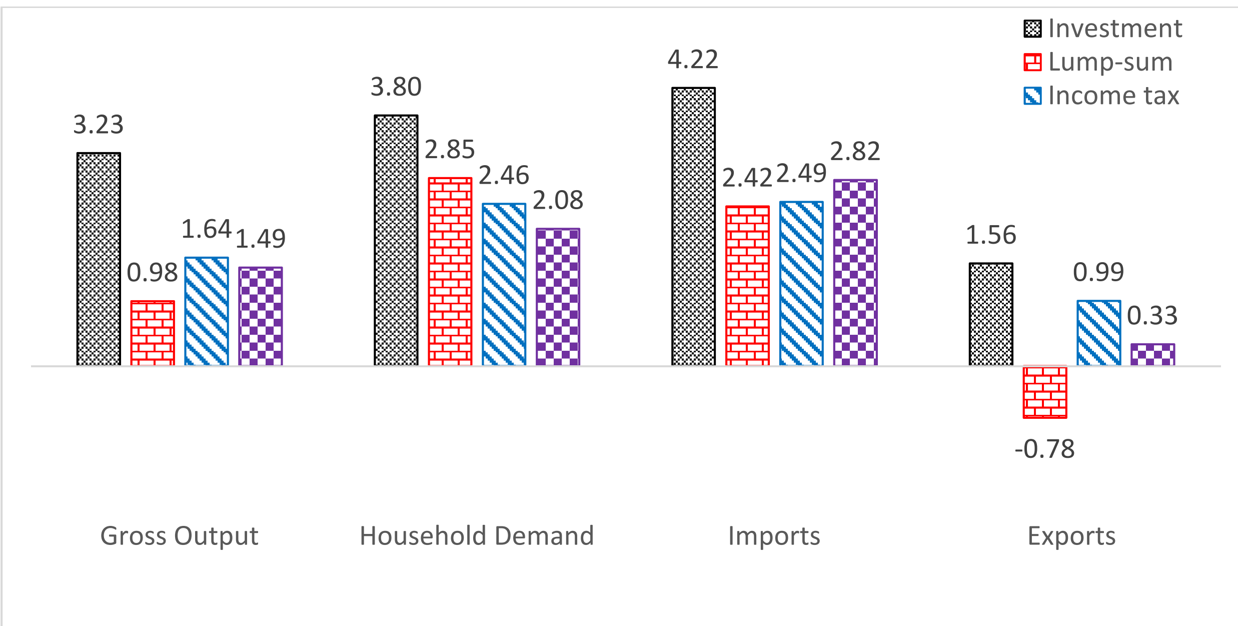
Figure 7. Impact on GDP of 53% increase of natural gas price (% change from the base case)



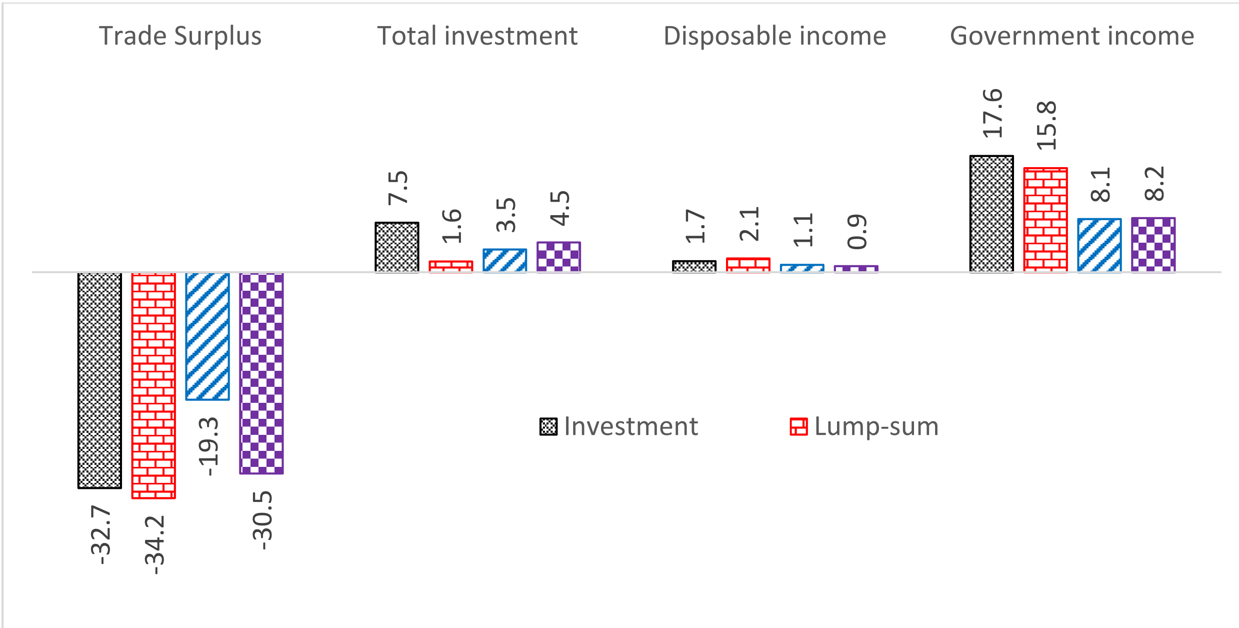
The model shows that there would be a net positive impact on GDP because of the significant government revenues generated due to the increased price of gas, irrespective of the method of allocating the increased government revenues within the economy. Note that the impact on GDP of the policy of removing the indirect subsidy to natural gas is higher than that of removing the direct subsidies provided to the electricity sector. This is because the volume of government revenues recycled to the economy is much higher under gas subsidy removal as compared to electricity subsidy removal. However, the ranking of revenue recycling schemes is the same in both cases. Re-investing the increased revenue would benefit the economy most, followed by cutting existing personal and corporate income taxes, with the gains from a lump-sum transfer to households being least beneficial. The patterns of impacts on other aggregate economic variables are also similar to those under electricity subsidy removal, as shown in Figure 8 (a) and (b).

Figure 8. Impacts of natural gas subsidy removal on key economic variables

(a) Gross output, total household demand, total trade of goods and services



(b) Trade surplus, total investment, disposable income and government income



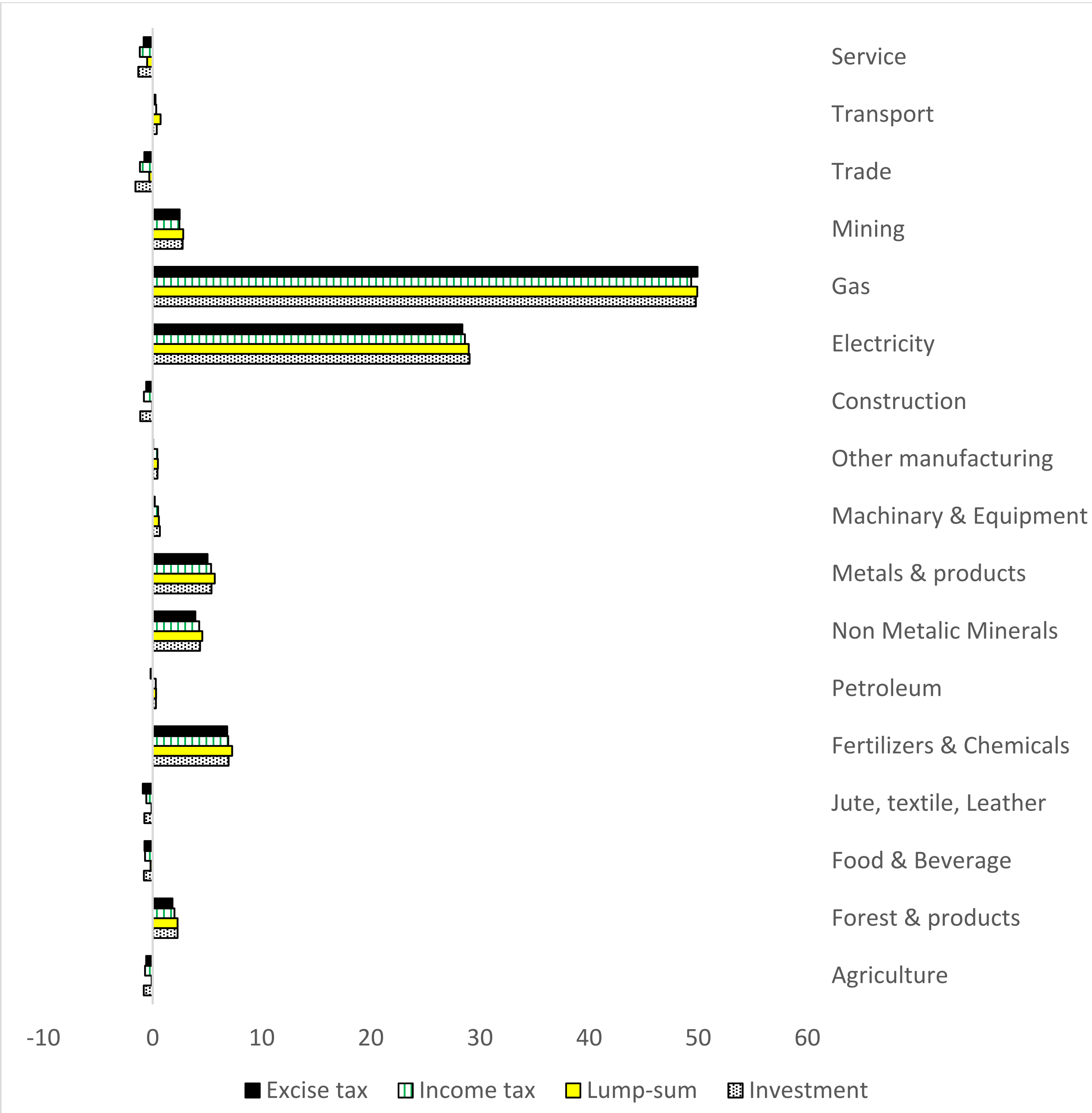
4.2.2. Sectoral impacts of natural gas subsidy removal

Sectoral impacts are sensitive to the gas consumption intensity of a sector and also the possibility of substituting gas by other fuels. Figure A2 in the appendix presents natural gas consumption intensities of various sectors in Bangladesh in 2012, the base year of the model. Electricity is the most gas intensive sector in Bangladesh because the majority of electricity in the country is produced using gas. Almost 70% of electricity sector expenditure is on natural gas. However, the reduction in total electricity output due to the removal of the subsidy on gas consumption/use would be moderate, less than 10%, because gas would be substituted by other fuels, such as oil for power generation. On the other hand, the removal of the subsidy on gas consumption would cause a relatively higher drop in outputs of the chemicals and fertilizer industries and other manufacturing because the possibility of substituting gas with other fuels is smaller. The output of the gas sector falls the most (15 to 17% depending upon the revenue recycling scheme) due to the decline in gas demand from various sectors. The increase in gas price obviously hurts the electricity sector as well -- its output drops by more than 10%. Note that impacts on output are affected by changes of relative prices (see Figure 9). Sectors which are relatively less gas intensive and have greater flexibility to substitute other fuels for gas experience output increases (e.g., food & beverages, jute, textiles, and leather).

Figure 9. Impact of natural gas subsidy removal on sectoral outputs

Figure 10 presents the impact on commodity prices when the indirect subsidy on natural gas is removed. Subsidy removal would cause, by design, a 53% increase in gas price. In response, the price of electricity would increase by 30%. The rise in electricity price is significant because even though the possibility of substituting other fuels for natural gas exists, other fuels are not necessarily cheaper than natural gas. The prices of other gas and electricity intensive sectors (e.g., fertilizers and chemicals, metals and non-metals) are also seen to increase, in line with the gas intensity of sectors and households depicted in Figure A2. The relative prices of goods and services which are less gas intensive drop. Changes in consumer prices are not significantly different across the revenue recycling schemes.

Figure 10. Impacts on commodity prices of natural gas subsidy removal



5. Policy Implications

The key policy insight from this analysis is that the removal of energy subsidies (no matter whether a direct budget subsidy or an indirect subsidy due to the deviation of price from its opportunity cost) would be beneficial to Bangladesh. This positive impact results from the possibility of a welfare enhancing reallocation of the financial resources saved through removal of the subsidy. Subsidy removal in the absence of reallocation of the saved or generated resources would make goods and services more expensive, resulting in a contraction of economic activities and outputs.[6] This is equivalent to adding a new tax or increasing an existing tax. The saved government revenues (in the case of removal of the direct subsidy in the electricity sector) and additional revenues (in the case of removal of indirect subsidies in the natural gas sector) would have a higher positive impact[7] than the negative impact of subsidy removal. The net economic impact is positive.

The magnitude of the net impact would depend on how the government budget savings (due to direct subsidy removal in the electricity sector) and the additional government revenue (due to removal of indirect subsidies by pricing natural gas at import parity) are allocated and used in the economy. The study reveals that allocating these resources to investment would increase GDP the most followed by allocation for capital tax cuts. Simply transferring the savings or new revenue to households would cause the least increase of GDP of the four revenue recycling schemes considered in the analysis. These findings are consistent with the existing literature (e.g., Timilsina and Shrestha, 2002; Timilsina and Shrestha, 2007; McKibbin et al. 2015; Williams et al. 2014) although the focus of the existing literature is on carbon taxation.

While investment or tax cuts are better than other options for allocating the savings from an efficiency perspective, taking distributional aspects into account can change the preference ordering of recycling options. Generally, it is high-income households that are expected to benefit from tax cuts. On the other hand, allocation of savings or new revenues to households as a lump-sum transfer is more likely to benefit the poor, which would make this option preferable from a

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[6] Increased gas price due to the removal of indirect subsidy from natural gas and removal of direct budget subsidy from electricity would increase the cost of goods and services, especially those which are gas and/or electricity intensive. Outputs of these sectors would drop in response and household consumption of electricity and gas as well as electricity and gas intensive products also fall. These negative effects can be termed as pure effects of subsidy removal (i.e., removal of direct subsidies from electricity and indirect subsidies from natural gas).

[7] The positive impacts are generated due to recycling the budgetary savings (electricity) and/or increased revenues (gas). These positive impacts can be termed as the revenue or saving recycling effect.

distribution perspective. This underlines the need for the government to define its objectives before deciding how to reallocate the saved budget or increased revenue from subsidy removal.

The results presented here represent a situation of abrupt (at a single point in time) implementation of the policy actions analyzed (i.e., the elimination of the budget subsidy to the electricity sector or increase of natural gas price through the removal of indirect subsidy). However, the government is more likely to eliminate the subsidy gradually. If prices increase gradually, the impacts will be commensurately lower.[8] The speed and severity of the impact in different sectors can vary as well. A dynamic extension to this model could be developed for deeper analysis of the options and trade-offs over time.

The value of the analysis lies in the indicative results, insights and options provided for decision-makers to consider in their planning and policy formulation. A supplementary distributional analysis would be important to understand fully the potential impact of the policy changes analyzed. This will be an extension of the study.

One could wonder whether the robustness of the policy insights of the study as a model is sensitive to the specification, assumptions and values of parameters used. A sensitivity analysis is a solution to this concern. However, a large body of literature on CGE modeling suggest that the qualitative results (i.e., policy insights) normally do not change with model specifications and values of parameters. The magnitudes of the results (i.e., quantitative results) do change. We could do sensitivity analysis, however, there are too many parameters and possibilities for model specification. That means, if we do sensitivity analysis, we need to do too many, which may not add value on policy insights, instead it would make the results too difficult to comprehend.

6. Conclusions

Simulating the impact of removing direct subsidies to electricity and indirect subsidies to natural gas consumption in Bangladesh using a CGE model, this analysis has shown that both policies would have positive economic outcomes. Removing electricity subsidies frees up budgetary resources and setting the price of domestically produced gas to equal the international price (or its opportunity cost) increases government revenues. When the saved budget or increased

[8] Also, the unit of time over which adjustment occurs is not necessarily one year – it could be 5 or 10 years. The model simply shows the percent change from the baseline once the economy has fully adjusted to the new price.

revenues are reallocated within the economy, GDP expands. Key to maximizing the impact on GDP and its constituents is the route chosen for recycling the budgetary savings/revenues generated. This study has shown that if the savings from electricity subsidy removal are recycled in the form of investment in productive sectors, it would increase GDP and economic welfare and improve the trade surplus. Similar impacts are seen in the analysis of removing the indirect subsidy on natural gas consumption.

It is worth emphasizing that the static analysis undertaken here shows the full impact of the policy changes imposed, i.e., the percent change from the baseline once the economy has fully adjusted to the new prices for electricity and gas respectively. The static model does not specify the period over which this transition occurs, but it is likely to be longer than one year since different sectors will shrink or grow at different rates as they adjust to the prices they face and, given that capital is sunk, as long as firms are covering their operating costs they will continue to operate (and could potentially keep growing albeit at a slower rate than before). It is only after their capital is fully depreciated and not replaced by new investment that the new equilibrium generated by the model in terms of industrial closures, etc., will be achieved.

Depending on the speed of adjustment in different sectors, the impact of the shock on the economy could be more or less disruptive and warrants consideration of a glide path to the new equilibrium. Given the magnitude of GDP and sectoral impacts (considerably higher for the gas policy change than for electricity), and the fact that for gas the deviation from baseline and impact is likely to be lower in outer years, a gradual reduction of subsidies as opposed to a big bang seems reasonable. The gains to the budget will be lower but the political and other costs of reform will also be more manageable.

The impacts (on prices and outputs) are likely to be dislocative in many sectors. Particularly for the sectors that are hardest hit by the increase in gas price, such as manufacturing (output decline of 10%), fertilizers and chemicals (declines of ~7%), and metals and petroleum (~5%), transition support is likely to be essential. Even starting from a low base and acknowledging that these may not have been sectors of greatest competitiveness for Bangladesh, the size of declines is significant and will need to be managed with sensitivity through active support for social safety net extension, retraining, and similar initiatives. Several of these same sectors would also be negatively impacted with the removal of electricity price subsidies alone, so the same approach would apply there as well.

A distributional analysis of the impacts of overall and sectoral price adjustments is an important supplement to the macro-economic analysis presented here and will be a natural extension of this study. This is essential to provide a more complete understanding of the poverty and welfare implications of the policy changes discussed, and thus an important input into the formulation of appropriate safety net or other schemes to mitigate the impact, even if transitory, on vulnerable sections.

A clear message produced from this analysis is that there is a tremendous opportunity cost to the subsidies to electricity and gas being provided by the government and welfare could be enhanced by redirecting the spending to more productive channels through various recycling schemes. The findings of the study that suggest some revenue recycling schemes are better than others are purely based on efficiency grounds (i.e., impacts on the overall economy). A revenue recycling scheme attractive from the efficiency aspect would not necessarily be appropriate from a distributional or equity perspective, because an efficient revenue recycling scheme is often regressive. A further analysis focusing on distributional effects is necessary to better understand the equity aspect of energy subsidy reforms in Bangladesh.

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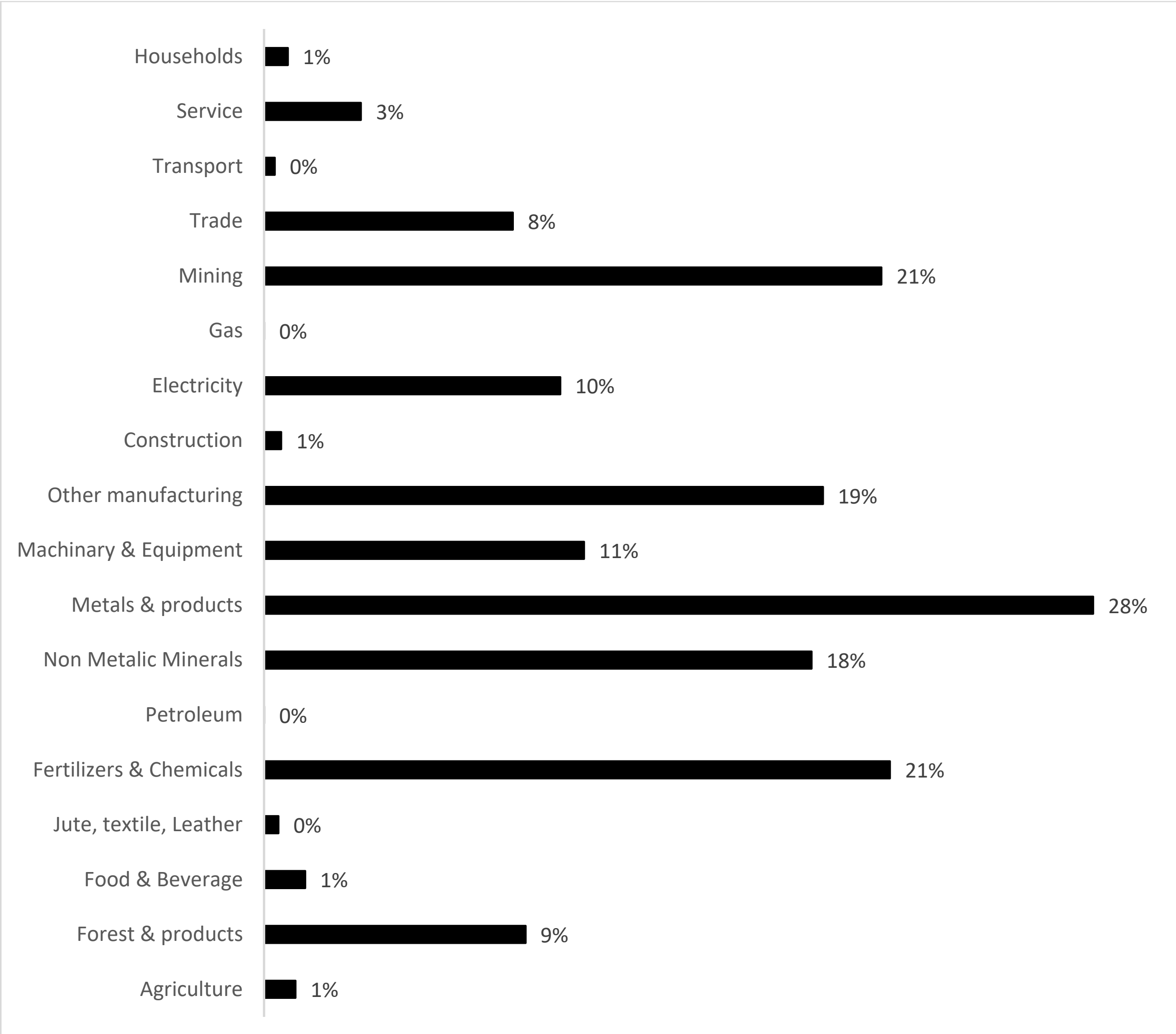
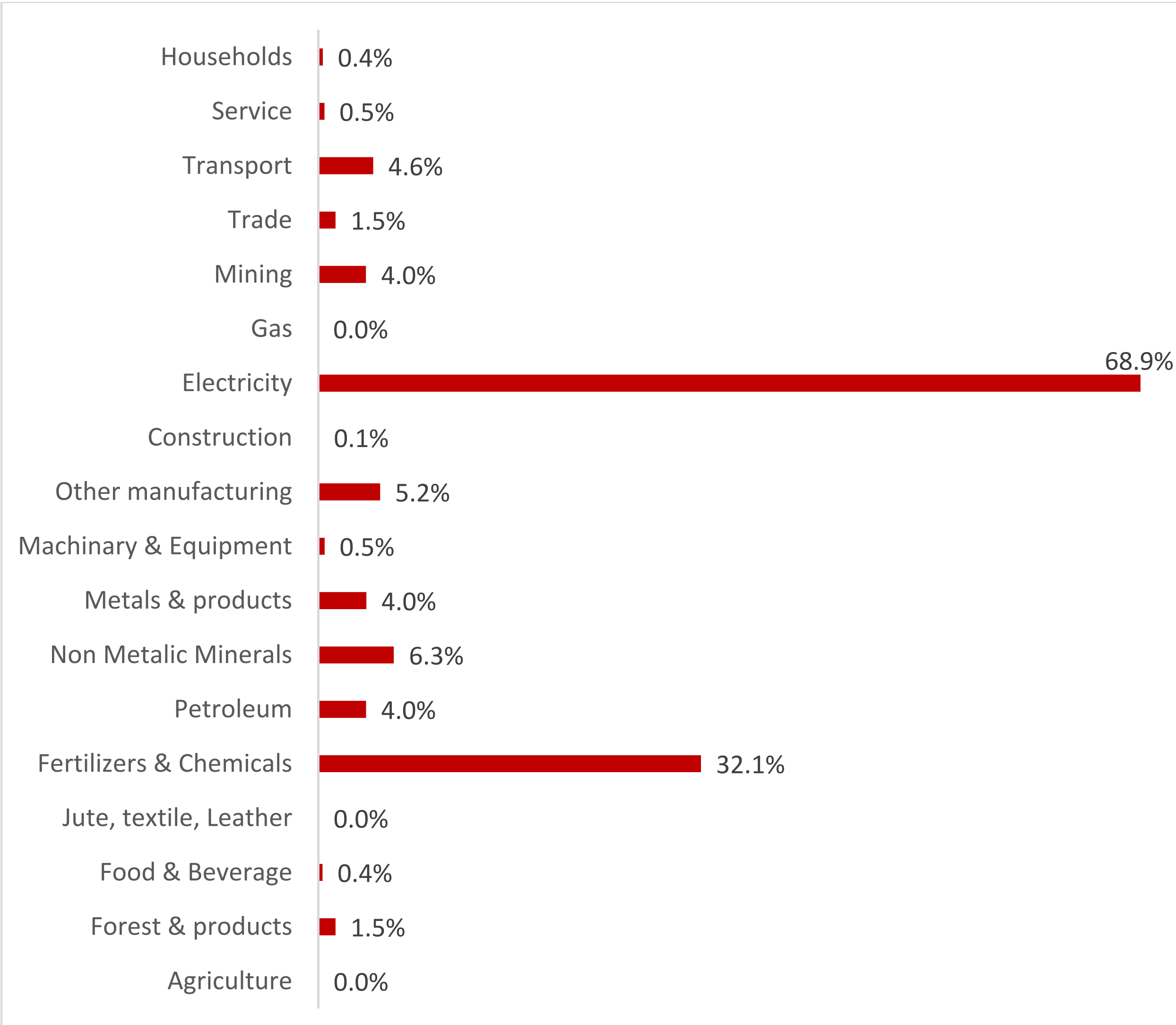
Figure A1. Share of electricity in the total consumption of goods and services by various sectors in 2012 (%)



Source: Social accounting matrix used for this study

Figure A2. Share of natural gas in the total consumption of goods and services by various sectors in 2012 (%)



Source: Social accounting matrix used for this study