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The Impacts of Fossil Fuel Subsidy Removal on Bangladesh Economy

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This paper investigates how the removal of fossil fuel subsidy affects the welfare of a small, oil-importing country like Bangladesh. In doing so, an energy augmented Dynamic Stochastic General Equilibrium (DSGE) model is developed. The model is calibrated and simulated for the Bangladesh economy under three scenarios, and the results reveal that a 10 per cent reduction in fossil fuel subsidy results in an overall increase in household welfare by 0.36 per cent. However, complete removal of fossil fuel subsidy would increase welfare by 1.89 per cent. The results also show that the subsidy removal schemes improve the country's fiscal burden. We highlight the fact that fossil fuel subsidy acts as a barrier to the development of renewable energy technologies in Bangladesh which can play a significant role in promoting the country's future energy security. So, the paper suggests that the government should use the revenue earned from the fuel subsidy removal to offer incentives to new electricity generators who would enter in the market planning to produce electricity with renewable technology. Following a revenue-neutral subsidy scheme, the government should also encourage the existing electricity generators to adopt renewable technologies in generating electricity.

Keywords: Fossil Fuel Subsidy, DSGE Model, Renewable Energy, Bangladesh
JEL Classification: D58, Q41, Q48, H20

I. INTRODUCTION

Global fossil fuel subsidies are vast and have involved arguments for and against them (Kojima 2016). On the one hand, fossil fuel subsidy benefits an economy by reducing the adverse effects of global price fluctuations and inflationary pressurey, increasing the competitiveness of the firms by keeping input fuel prices low, and by making energy more accessible to the different

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economic entities. It is often argued that fossil fuel supply can transform peoples' lives and does serve as an engine for economic and social opportunity. On the other hand, fossil fuel subsidies distort input choices in the production of goods and services, delay the adoption of energy-efficient technologies, and crowd out high-priority public spending, including spending on physical infrastructure, education, health, and social protection. Therefore, fossil fuel subsidy provision has long been a subject of extensive debate among scholars and policymakers.

Researchers have endeavoured to examine the effects of subsidy reforms on the economy and found mixed results. For example, using a small open-economy model, Plante (2014) found that the presence of substantial subsidies would distort the market prices and reduce the aggregate welfare in both net oil importing and exporting countries. He argued that replacing subsidies with lump-sum transfers of equal value would be a better alternative policy as it could eliminate the market distortions and increase aggregate welfare. Adagunodo (2013) examined petroleum product pricing reforms and welfare in Nigeria and concluded that if implemented correctly, the removal of subsidy would save the largest amount from government budget and the subsidy funds could lead to major development gains for the country.

Oktaviani, Hakim and Siregar (2007) used a CGE model to analyse the elimination of fuel subsidies in Indonesia and concluded that the short to medium-term macroeconomic performance of the economy was adversely affected by the removal of subsidies. They revealed that the reduction of fuel subsidies increased the overall impact of poverty in the Indonesian economy from 8.9 to 12.9 per cent of the population, with rural areas worst affected. Coady *et al.* (2006) simulated both the direct and indirect effects of fossil-fuel subsidy reform in Bolivia, Ghana, Jordan, Mali, and Sri Lanka. They confirmed that the best solution was liberating markets.

Anand *et al.* (2013) assessed the impacts of fuel subsidy reform on household welfare in India. They found that removal of fuel subsidies would decrease household real incomes by exerting inflationary pressures. However, they recommended that a planned and structured elimination of fuel subsidies would fully protect lower-income households and could still generate substantial net fiscal savings. Glomm and Jung (2013) constructed a dynamic general equilibrium model to analyse the effects of large energy subsidies in a small open economy. They calibrated the model for the Egyptian economy and revealed that households and firms could either face decrease of GDP by 3 per cent or increase of GDP by the same amount. Growth in GDP can be realised only if the government re-invests into infrastructure.

Bangladesh has recently been upgraded to a lower middle-income country status, where energy plays an important role (Amin and Rahman 2019). For instance, net installed electricity generation capacity has increased from 5,272 Megawatt (MW) in 2009 to 16,892 MW in 2018. This improvement in generation comes mostly from the privately-owned Quick Rental (QR) power plants. Bangladesh government allowed the QR power plants to generate electricity on short-term contracts (three to five years) in 2009-2010. Since most of these QR power plants were powered by liquid fuel (Diesel, High-Speed Furnace Oil), fossil fuel subsidy is large in Bangladesh.

Ahmed, Sattar and Alam (2016) report that the energy sector in Bangladesh is constrained by the prevalence of high subsidy and distorted energy prices. Historically, energy prices in Bangladesh were controlled and regulated by the government. Many state-owned power utilities in Bangladesh are in serious financial hardship. The government has to support these institutions by providing subsidies and these subsidies adversely affect the government's ability to finance spending for education, health, and social protection. Moreover, when there is a rise in the international oil price, the government could not pass on the cost increases to the consumers. This resulted in an upward gap between the average cost of oil products and the selling price to the consumers, leading to a surge in the subsidy bill of the government.

The removal of fuel subsidies is crucial but this requires proper implementation plan to prevent any social disruptions.. This paper asks the question of how the removal of fossil fuel subsidy affects the welfare of a small, oil-importing country like Bangladesh. DSGE model is used. DSGE models are instrumental in forecasting changes in the level of welfare that would result from a change in market conditions such as a new government subsidy or tariff policy.

The model is simulated for the Bangladesh economy, and our results show that governmental intervention in the energy market as a fossil fuel subsidy provider in Bangladesh is not justified as the overall household welfare increases by 0.36 per cent and 1.89 per cent and GDP increases by 0.10 per cent and 1.86 per cent respectively under the partial and complete subsidy removal schemes. Bangladesh economy is also found to be less vulnerable to oil price shocks if the government removes fossil fuel subsidies and moves towards a free market economy. Our results suggested that the fossil fuel subsidy reform policy is found to be an effective policy mechanism that could improve national potential energy savings by reducing the dependency on fossil fuel consumption and promoting the usage of renewable energy consumption.

The paper is organised as follows. The DSGE model is presented in section II which is followed by a discussion on the calibration of the parameters in section III. Section IV discusses the results. Finally, conclusions and policy implications are presented in section V.

II. THE MODEL

The model considered in this paper is a DSGE model of a small economy that imports oil to generate electricity. Electricity is also generated by locally produced natural gas. There are four main sectors in the economy: the industrial and service production sector, the electricity production sector, the household consumption sector, and the government sector. Three different electricity generating firms have been considered in this model. Final output in all the sectors is produced with a Constant Elasticity of Substitution (CES) technology, exhibiting Decreasing Returns to Scale (DRS) in the inputs: labour, capital and energy/electricity (Equations 1-5 in Appendix Table A.1).

The household receives utility from three types of consumption goods: electricity-oriented goods, normal consumption goods and service-oriented goods and all these goods are imperfect substitutes in the consumption basket (Equation 6 in Appendix Table A.1). The household's income comes from selling the capital stock, offering labour supply, receiving transfer payment and dividends (Equation 7 in Appendix Table A.1).

The government receives income from taxing household labour and capital income, selling natural gas to other electricity generating firms, and trading electricity to the national grid. On the expenditure side, the government has to incur the costs of labour, capital, and natural gas for its electricity production. Moreover, the government offers a lump sum transfer to the households. The government further provides fossil fuel subsidy to the electricity producer to fill the gap between the world oil price and domestic oil price faced by the producer (Equation 8 in Appendix Table A.1).

The government also provides a subsidy to household electricity consumers who would not be able to purchase electricity (Equation 9 in Appendix Table A.1). The equilibrium in the electricity market is given in (Equation 10 in

Appendix Table A.1). The economy is small and open and its behaviour does not affect the rest of the world. A shock in the price of oil is the primary source of fluctuation in the economy (Equation 11 in Appendix Table A.1). The basic structure of the model regarding technology is similar in its set-up to Kim and Loungani (1992) and Amin (2015).

The Lagrangian constrained for the household can be defined as follows:

$$L = \sum_{t=0}^{\infty} \beta^t [(\varphi \log\left[X_t^{\gamma}\left(\theta c_t^{\rho} + (1-\theta) e_t^{\rho}\right)^{\frac{1-\gamma}{\rho}}\right]) + (1-\varphi)\log(1 - l_t)] - \lambda_t[k_{t+1} + c_t + nX_t + q_t^e . e_t - (1-\tau^l)wl_t - ъ - (1-\tau^k)rk_t - (1-\delta)k_t - \pi] \tag{12}$$

The subsequent Euler equations are as follows:

$$\frac{c_{t+1}}{c_t} = \beta[(1-\tau^k)r_{t+1} + (1-\delta)] \frac{1+(\frac{\theta}{1-\theta})^{\frac{1}{\rho-1}}.q_t^{e\,\frac{\rho}{\rho-1}}}{1+(\frac{\theta}{1-\theta})^{\frac{1}{\rho-1}}.q_{t+1}^{e\,\frac{\rho}{\rho-1}}} \tag{13}$$

$$\frac{c_t}{1-l_t} = \frac{\varphi(1-\gamma)}{(1-\varphi)} . \frac{1}{1+(\frac{\theta}{1-\theta})^{\frac{1}{\rho-1}}(q_t^e)^{\frac{\rho}{\rho-1}}} . w(1-\tau^l) \tag{14}$$

The Euler equation explains that the marginal disutility of reducing normal consumption in the current period should be equal to the discounted utility from future normal consumption. The Euler equation to leisure infers that the disutility from extra working hour should be compensated by a rise in utility due to producing extra output.

III. CALIBRATION

It is discussed in the literature that except for some special cases, dynamic models lack a closed form solution and they have to be solved using numerical methods (Oviedo 2005, Guerrieri and Iacoviello 2015). The model considered in this paper has no closed form solution, and therefore model calibration and computation is needed to solve the model.

In this section, we use the term calibration for the process by which researchers choose the parameters of their DSGE model from various sources. For example, Cooley and Prescott (1995) calibrate their model by choosing parameter values that are consistent with long-run historical averages and microeconomic evidence. Dhawan and Jeske (2007) calibrate parameters to produce theoretical moments of model aggregates that reproduce, as best as possible, the empirical moments obtained from the empirical data.

However, following Amin (2015) and Amin and Marsiliani (2015), we have generally adopted three approaches regarding calibrating parameters for our model. Some of the parameters are picked from the existing DSGE literature for developing and developed countries. Some of the parameter values are chosen by using steady-state conditions of the model. Rest of the parameter values are directly taken from Bangladesh Bureau of Statistics (2012), Annual Report of Bangladesh Power Development Board (2012), Annual Report of Bangladesh Energy Regulatory Commission (2012), Annual Report of Bangladesh Petroleum Corporation (2012), Annual Report of Summit Power Limited (2012), Annual Report of Dutch Bangla Power and Associates Limited (2015), *Bangladesh Tax Handbook* (2012), and *Bangladesh Household Income and Expenditure Survey* (2012). Due to data constraints, all parameters in our model are calibrated for annual frequency.

There are 46 parameters in total with 43 structural and 3 shock related parameters in the model. Structural parameters are categorised into utility and production function related parameters. It is important to have a good understanding of the rationale behind picking different parameter values in order to accurately calculate the fit of the model. The labour share (α) in all the sectors except the industrial sector is calculated from first order conditions and using the data of the labour cost in relation to the total revenues in the respective sectors. Following Roberts and Fagernas (2004), I set the labour share in the industrial sector, α_Y equals to 0.2.

The share of energy/electricity used in production (ψ) in all the sectors except the governmental sector is calculated by employing the first order conditions and DRS assumptions. For example, in industry, Ψ_Y, can be calculated as follows.

Given the values of $\frac{w.l_Y}{Y}$ and $\frac{q^g.g}{Y}$, q^g, r, $\frac{r.k^Y}{Y}$, $\frac{Y}{q^g.g}$, $\alpha_{Y,}$ ν^g and $\acute{\upsilon}^{gg}$, and using the following two equations derived from the first order conditions, calculate the value of Ψ_Y equals to 0.0733.

$$\frac{r.k_Y}{Y} = \frac{\left(\upsilon^Y \frac{\nu^g}{\acute{\upsilon}^{gg}}\right)(1-\Psi_Y)}{(1-\Psi_Y)+\Psi_Y\left(\frac{k_y}{g_t}\right)^{\nu^g}} \tag{15}$$

$$where,\ \frac{k_y}{g_t} = \frac{q^g}{r} \cdot \frac{r.k_Y}{Y} \cdot \frac{Y}{q^g.g} \tag{16}$$

Since the government is s cost-minimiser, using the following first-order condition, we estimate Ψ_G equals to 0.3020.

$$v^m.\alpha_G\left[(1-\Psi_G)k_{G,t}^{-v^m}+\Psi_G.m_{G,t}^{-v^m}\right]=\left(\vartheta^G\frac{v^{m,G}}{\acute{v}^{m,GG}}\right).\Psi_G.m_{G,t}^{-v^m-1}.l_G.w \quad (17)$$

We further estimate v^h, $v^{m.i}$, $v^{m,g}$, v^Y and v^X equals to 0.1 from Thompson and Taylor (1995). Finally, we assume that $\acute{v}^{hh}$, $\acute{v}^{m.i}i$, $\acute{v}^{m,gg}$, $\acute{v}^{YY}$ and $\acute{v}^{XX}$ equals to 0.2 to fulfill DRS assumptions.

Now, we discuss parameters related to household utility. Following Amin (2015), we set the CES parameter of the household's utility function, ρ, equals to -0.11, which is negative and indicates that normal and electricity oriented consumption are somewhat complementary. Given the values of household electricity prices, the ratio between electricity consumption and normal consumption, and the ratio between service consumption and normal consumption, we can obtain the share of non-electricity consumption in the household aggregator, θ and the share of service aggregator γ.

Finally, the share of electricity consumption and normal consumption goods in the household's utility function, φ is calculated using the following equation.

$$\frac{(1-\varphi)}{\varphi}=\frac{(1-\gamma).\theta.(1-l_t).\frac{w.l}{Y}.\frac{\left(1-\tau^l\right)}{l}.\frac{Y}{c}}{\theta+(1-\theta)\left(\frac{e_t}{c_t}\right)^p} \quad (18)$$

Remaining parameters are simply taken from the standard literature or data. β, the discount factor, is set to 0.96, which is quite standard in DSGE literature. The capital and labour income tax rates τ^k and τ^l are set as 0.15 and 0.10. The household consumer price of electricity, q^e; the industry consumer price of electricity, $q^{g,}$ and the service consumer price of electricity, q^s are taken as 4.93 Taka/Kwh, 6.95 Taka/Kwh and 9.00 Taka/Kwh respectively from BPDB for the year 2012. The selling prices of electricity by QR (P^H), and IPP (P^I) are set as 7.79 Taka/Kwh and 3.20 Taka/Kwh respectively and are obtained from Dutch Bangla Power and Associates and Summit Power Limited Company. However, the selling price of electricity by BPDB (P^G) is calibrated using country data and it is equal to 2.3075.

Finally, the world market price of oil (v^e) and the domestic market price of oil (v^h) are taken as 8.19 Taka/Kwh and 5.72 Taka/Kwh respectively from Bangladesh Petroleum Corporation (BPC). The market price of natural gas (v^m) is considered as 0.7755 Taka/Kwh which is taken from Summit Power Limited

Company. The extraction cost of gas (δ^C) is set equal to the world gas price which is 1.1 Taka/Kwh.

We follow King, Plosser and Rebelo (1988) in setting the persistence of our two exogenous shocks equal to 0.95 and standard deviation of the shocks equal to 0.01.

IV. RESULTS AND DISCUSSIONS

At first, the impacts of oil price shocks on the model variables are analysed through Impulse Response Functions (IRFs) when the government provides fossil fuel subsidy and removes fuel subsidy partially. Then, the steady-state conditions are discussed under three different scenarios: when the government provides fossil fuel subsidy, removes fossil fuel subsidy partially and removes fossil fuel subsidy completely. Dynare 4.4.3 is used to simulate the model.

Figure 1 describes the impulse responses to an oil price shock when the government provides the fossil fuel subsidy. A rise in world oil price (*v_e*) in the world market reduces the GDP of the country since it makes the country worse off concerning Terms of Trade (TOT). The income effect is dominant when oil price is high and the households reduce normal consumption (*c*), electricity consumption (*e*) and service consumption (*X*). Since taxes and other prices are fixed, higher world oil price makes the government worse off and reduces government transfer (*g_t*). Labour supply would increase in the market since government transfers are curtailed and excess labour supply reduces the market wage rate. Industry booms due to cheap labour which also counteracts the trade deficit to some extent. Lower wages coupled with fixed domestic prices allow the private power generators to produce electricity at a cheaper cost. As a result, more resources are devoted to IPP (*e_i)* and QR (*e_h*) sectors through factor markets which expand both IPP (*e_i*) and QR (*e_h*) electricity production. Since QR power plants are facing domestic oil price (*v_h*) which is fixed and controlled by the government, QR sector is not affected by the adverse impact of higher oil prices. The cost of oil becomes high, and the other prices are not adjusted. Thereby, government intervention is required and accordingly, government subsidy increases (*g_s*).

Figure 1: **Impulse Responses to an Oil Price Shocks when Government Provides Subsidy**

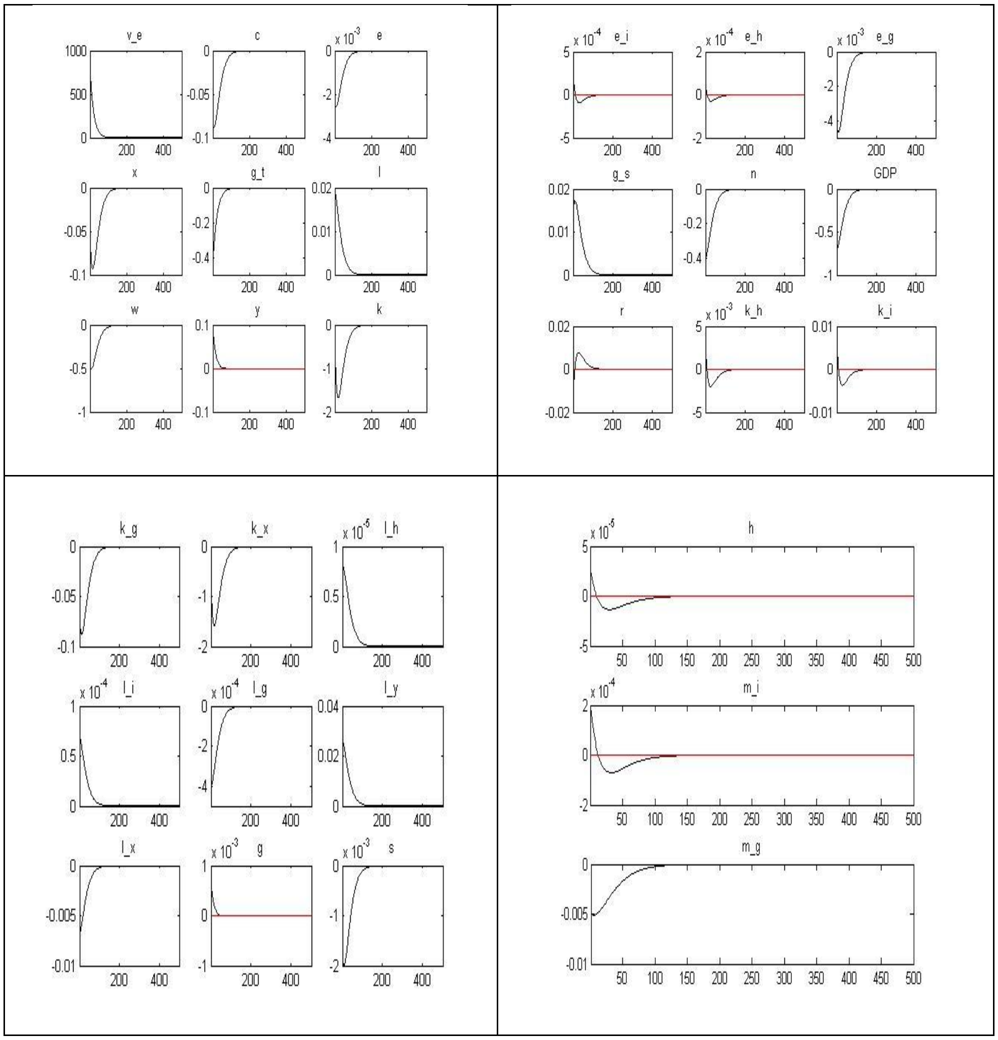
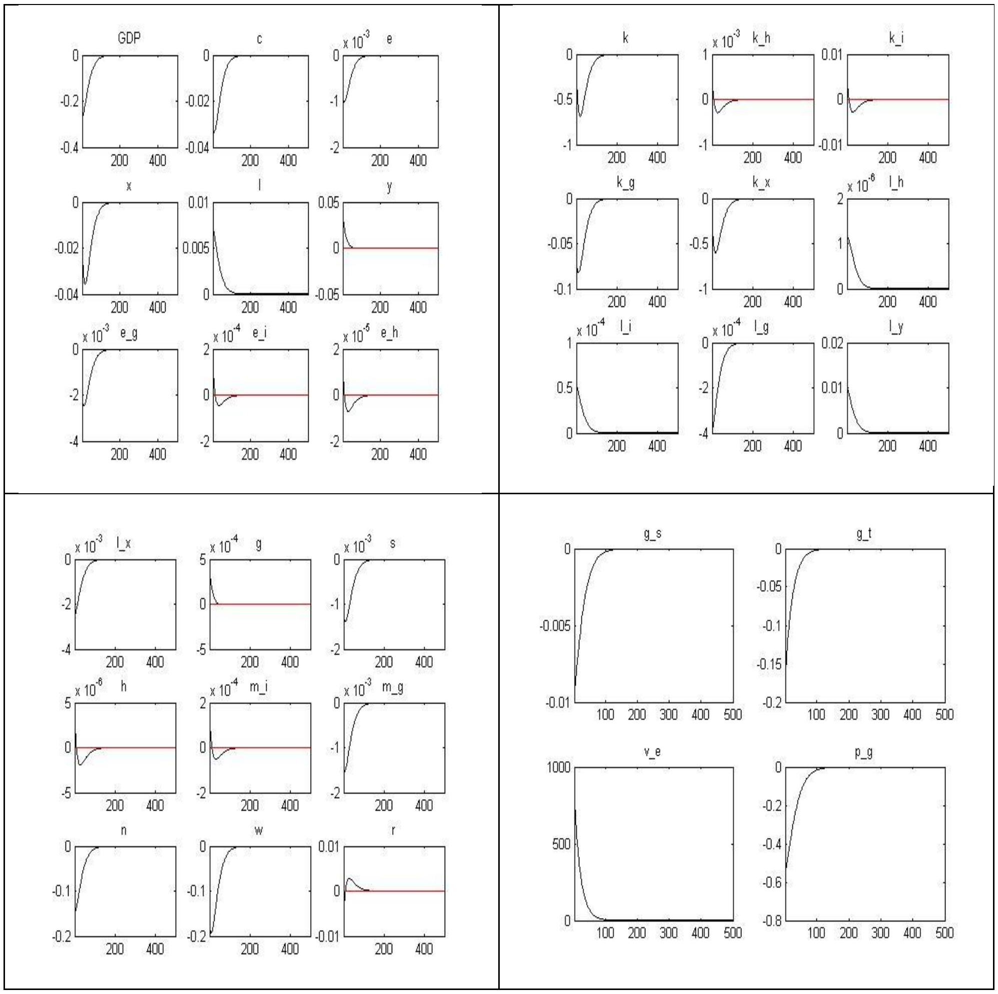


Figure 2 reports the behaviour of the IRFs for the variables from an oil price shock when the government removes fossil fuel subsidy by 10 per cent. However, the only difference is that the magnitude of the changes is smaller under the post-subsidy removal phase, which implies that if the government removes subsidy, the country is prone to experience fewer deviations from the steady state situation. We do not report the IRF's from a complete fossil fuel subsidy removal regime as the directions of the variable remain unchanged.

Figure 2: **Impulse Responses to an Oil Price Shock when Government Removes Subsidy**



We then analyse the percentage changes of the steady state variables and also calculate the household welfare under the three scenarios. Our results show that household welfare varies inversely with the level of fuel subsidy. When the government removes the fossil fuel subsidy by 10 per cent, overall household welfare increases by 0.36 per cent and GDP increases by 0.10 per cent. Since the producers are facing less subsidy than before, they reduce their oil import by 19 per cent which lowers QR electricity generation by 7.25 per cent. The IPP generation is also reduced by 0.77 per cent and government generation increased by 9.74 per cent. This implies that the private and public sectors respond contrariwise to subsidy reductions. The total use of gas has increased by 1.59 per cent. Although market reform is necessary, the removal of partial fossil fuel subsidies creates a huge burden on electricity-intensive industries which lead to disruption in production. As a result, industrial production deceases by a small margin (-0.051 per cent) in Bangladesh. In the case of complete removal of fossil fuel subsidy, household welfare increases by 1.89 per cent and GDP increases by 1.86 per cent.

V. CONCLUSIONS AND POLICY RECOMMENDATIONS

Energy demand is rising rapidly in Bangladesh. Rapid urbanisation will also add to the energy intensity of the country. The energy pricing policies of Bangladesh is therefore increasingly important for the efficient use of the overall energy supply and future energy security. Systemic subsidisation of fossil fuels by governments restrains sustainable development by crowding out investments in the productive sectors. Huge opportunities to invest these resources more productively are lost every year because of such subsidies. Given their cost and persistence, it is likely that these price distortions and subsidies have important macroeconomic implications for the economy. For example, fuel subsidies affect wages, distort input choices in the production of goods and services, altering the demand for production factors. These effects also lead to changes in the composition of sectoral and overall output.

Thus, this paper develops an energy augmented DSGE model for a mixed economy like Bangladesh and includes a detailed disaggregation of the energy sector to analyse the consequences of the fuel subsidy removal on household welfare and macroeconomic conditions in Bangladesh.

Our results reveal that complete removal of fossil fuel subsidies in Bangladesh is the most efficient outcome as it can increase welfare by 1.89 per cent and GDP by 1.86 per cent. On the other hand, a 10 per cent reduction in electricity subsidy results in an overall household welfare increase by 0.36 per cent and GDP by 10 per cent. Since the private electricity producers face less subsidy than before, they reduce their oil import which lowers private electricity generation under both circumstances. However, government generation increases by 10 per cent. The findings imply that the private and public sectors react inversely to subsidy reductions. Because the stock of natural gas in Bangladesh is limited, it is essential to focus on fuel diversification programmes.

Our results further suggest that fossil fuel subsidy can act as an obstacle to the expansion and deployment of renewable energy technologies, which can play a significant role in mitigating energy crisis in Bangladesh.

However, it is important to note that subsidy rationalisation policy is a risky proposition since the resulting higher fuel price is expected to raise the prices of other goods and services, thereby eroding the purchasing power of households. The removal programmes can also hamper the industrial output. So, the government should ensure that policies that will improve the welfare of the low-income citizens and provide support to affected sections are adequate.

Incentives could be given to electricity generators to produce electricity from renewable energy. For example, incentives could include tax rebates, long-term subsidised loans for purchasing equipment, access to foreign exchange at preferred rates, etc. A limited amount of subsidy could also be reallocated to the electricity generators for the use of renewable inputs or the introduction of renewable technology. The policy implications of our results are clear and relevant not only for Bangladesh but also for many other developing countries sharing a similar electricity sector.

Since household heterogeneity is a crucial element in the determination of what impact the energy market reforms will have, the model developed in this paper can be extended to heterogeneous households to examine the distributional effects more closely. It would be interesting to examine how a revenue-neutral subsidy removal programme with cash payment optionsto households would affect Bangladesh economy. This field, however, is left for future research.

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Appendix

Table A.1: The Model Structure

The Production Sector	
$Y_t = l_{Y,t}^{\alpha_Y}[(1-\Psi_Y)k_{Y,t}^{-\nu^g} + \Psi_Y g_t^{-\nu^g}]^{-\frac{\vartheta^Y}{\acute{\upsilon}^{gg}}}$	(1)
$X_t = l_{X,t}^{\alpha_X}[(1-\Psi_X)k_{X,t}^{-\nu^s} + \Psi_X s_t^{-\nu^s}]^{-\frac{\vartheta^X}{\acute{\upsilon}^{ss}}}$	(2)
The Energy Sector	
$\mathrm{G_t} = l_{G,t}^{\alpha_G}[(1-\Psi_G)k_{G,t}^{-\nu^{m,G}} + \Psi_G m_{G,t}^{-\nu^{m,G}}]^{-\frac{\vartheta^G}{\nu^{m,GG}}}$	(3)
$\mathrm{I_t} = l_{I,t}^{\alpha_I}[(1-\Psi_I)k_{I,t}^{-\nu^{m,I}} + \Psi_I m_{I,t}^{-\nu^{m,I}}]^{-\frac{\vartheta^I}{\nu^{m,II}}}$	(4)
$\mathrm{H_t} = l_{H,t}^{\alpha_H}[(1-\Psi_H)k_{H,t}^{-\nu^h} + \Psi_H h_t^{-\nu^h}]^{-\frac{\vartheta^H}{\nu^{mh,h}}}$	(5)
The Household Sector	
$\mathrm{c_t^A} = \mathrm{X_t^\gamma}\left(\theta \mathrm{c_t^\rho} + (1-\theta)\mathrm{e_t^\rho}\right)^{\frac{1-\gamma}{\rho}}$	(6)
$k_{t+1} + c_t + n.X_t + q_t^e.e_t$ $= (1-\tau^l)w.l_t + \text{ъ} + (1-\tau^k)r.k_t + (1-\delta)k_t + \pi$	(7)
The Government Sector	
$\tau^{\mathrm{l}}.\mathrm{w.l_t} + \tau^{\mathrm{k}}.\mathrm{r.k_t} + (\mathrm{v^m} - \delta^{\mathrm{C}})(m_{I,t} + m_{G,t}) + (\mathrm{v^h} - \mathrm{v^e})h_t + \mathrm{P^G}.G_t -$ $\mathrm{r.k_{G,t}} - \mathrm{w.l_{G,t}} - \mathrm{v^m}.m_{G,t} - \text{ъ} = \mathrm{b}$	(8)
$-b = q^e.e_t + q^s.s_t + q^g.g_t - P^H.H_t - P^I.I_t - P^G.G_t$	(9)
Market Equilibrium	
$e_t + s_t + g_t = H_t + I_t + G_t - x(H_t + I_t + G_t)$	(10)
Model Shock	
$ln\, v_t^e = {}'\Omega^v + \omega ln v_{t-1}^e + \kappa_t$	(11)

Table A.2: The Basic Data Set

c, Consumption by Household	As percentage of GDP	0.806
q^e.e, electricity consumption by household	Sectoral Share of GDP (%)	1.45
Y, Industry, value added	(% of GDP)	29.81%
GDP	Value (Taka)	9,147,840,000,000
Y	Value (Taka)	2,726,971,104,000
V^h.h	Value (Taka)	30,803,363,910
V^h.h/ GDP	Ratio	0.003367
c/Y	Ratio	0.337915
nX, Service, value added	(% of GDP)	49.45%
nX/Y	Ratio	1.658839
c/nX	Ratio	0.203706
e/GDP	Ratio	0.002941
e/Y	Ratio	0.009866
e/c	Ratio	0.029197
e, Domestic Electricity Consumption	Million Kilowatt Hours(Mkwh)	11627
g, Industrial Electricity Consumption	Million Kilowatt Hours(Mkwh)	6719
s, Service Electricity Consumption	Mkwh	5612
l^Y, Labour Share of Industry	In Percentage	27.668593%
l^X, Labour Share of Service	In Percentage	71.946050%
l^e, Labour Share of Electricity	In Percentage	0.385356%
q^e, Household Consumer Electricity Price	Taka/Kwh	4.93
q^S, Service Consumer Electricity Price	Taka/Kwh	9.00
q^Z, Industrial Consumer Electricity Price	Taka/Kwh	6.95
p^H, selling price of electricity produced by Quick Rentals	Taka/Kwh	7.79
P^I, selling price of electricity produced by IPP	Taka/Kwh	3.20
V^m, market price of gas	Taka/Kwh	0.7755
V^h, market price of Oil (Domestic)	Taka/Kwh	5.72
V^e, market price of gas(World)	Taka/Kwh	8.19
δ^C,extraction Cost of Gas	Taka/Kwh	1.1

Sources: BBS (2012), BER (2012), BPDB (2012), BPC (2015), Annual Report of Summit Power Limited 2012, Annual Report of Dutch Bangla Power and Associates Limited 2012 and Bangladesh Tax Handbook (2012)

Table A.3: The Structural Parameters

1. β, the discount factor	0.96
2. φ, the share of electricity and non-electricity consumption in the household's utility	0.60
3. θ, the share of non-electricity consumption in household aggregator	0.91
4. σ, the CES parameter of the household's utility function	0.11
5. γ, the share of service in the household consumption aggregator	0.81
6. α_H, labour distributive share in QR	0.0041
7. α_I, labour distributive share in IPP	0.0361
8. α_G, labour distributive share in BPDB	0.0584
9. $\alpha_{Y,}$ labour distributive share in the industrial sector	0.2
10. $\alpha_{X,}$ labour distributive share in the service sector	0.31
11. Ψ_H, the share of capital used in electricity production by QR	0.59
12. Ψ_I, the share of gas used in electricity production by IPP	0.30
13. Ψ_G, the share of gas used in electricity production by BPDB	0.073
15. Ψ_X, the share of electricity used in service production	0.079
16. ϑ_H, the share of non-labour input used by QR	0.89
17. ϑ_I, the share of non-labour input used by IPP	0.86
18. ϑ_G, the share of non-labour input by BPDB	0.85
19. ϑ_Y, the share of non-labour input used in industrial production	0.7
20. ϑ_X, the share of non-labour input used in service production	0.58
21. v^h, Domestic Price of Oil	5.72
22. δ^c, Extraction cost of gas	1.1
23. κ, the fraction of system loss	0.10
24. δ, the depreciation rate	0.025
25. τ^K, tax on capital	0.15
26. τ^l, tax on labour	0.10
27. q^e, consumer price of electricity faced by the household	4.93
28. q^S, consumer price of electricity faced by the service sector	9.00
29. q^g, consumer price of electricity faced by the industry	6.95
30. p^H, the selling price of electricity produced by QR	7.79
31. P^I, the selling price of electricity produced by IPP	3.20
32. P^G, the selling price of electricity produced by BPDB	2.30
33. V^m, the market price of gas	0.77
34. $v^{m,g}$, depends on the elasticity of substitution between capital and gas used by BPDB in generating electricity	0.1
35. $v^{m,i}$, depends on the elasticity of substitution between capital and gas used by IPP in generating electricity	0.1
36. v^g, depends on the elasticity of substitution between capital and electricity used in industry	0.1
37. v^s, depends on the elasticity of substitution between capital and electricity used by commercial (service) production	0.1
38. v^h, depends on the elasticity of substitution between capital and oil used by Quick Rentals in generating electricity	0.1
39. $v^{m,g}$, the degree of homogeneity in CES function in PDB	0.2
40. $v^{m,i}$, the degree of homogeneity in CES function in IPP	0.2
41. v^g, the degree of homogeneity in CES function in industry	0.2
42. v^s, the degree of homogeneity in CES function in service	0.2
43. v^h, the degree of homogeneity in CES function in QR	0.2
44. ω, persistence coefficient of oil price shock	0.95
45. ζ, standard error of oil price shock	0.01
46. Ω^v, the coefficient in the oil Price shock equation	0.10