The Impact of Electricity Subsidy Removal on Renewable Electricity Generation_ The Case of Bangladesh

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1st AIEE Energy Symposium
2 December, 2016
Milan, Italy

INTRODUCTION

- Bangladesh considers energy as a prerequisite for her technological, societal and economic growth.

- Energy subsidies exceeded 3% of GDP in Bangladesh where petroleum products and electricity accounts for nearly 90% of subsidies.

LITERATURE REVIEW

- Blanchard and Gali (2007)
- Dhawan and Jeske (2007)
- Erdogdu (2011)
- Glomm and Jung (2013)
- Hamilton and Herrera (2004)
- Jamasb (2006)
- Jamasb and Nepal (2011)
- Jorgenson (1998)
- Kydland and Prescott (1982)
- Finn (2000)
- Kim and Loungani (1992)
- Perira and Perira (2011)

MAIN RESEARCH QUESTION

- Despite of the extensive literature on Dynamic Stochastic General Equilibrium (DSGE) models, there is no model that focuses on a detailed disaggregation of the energy sector for the mixed economy till now.
- This paper investigate the impact of subsidy removal on Bangladesh energy sector.

THE MODEL

- The model considered in this paper is a DSGE model of a small economy that needs to import oil to generate electricity.
- There are four sectors in the economy:

1. the production sector
2. the energy sector
3. the household sector and
4. the government sector

THE PRODUCTION SECTOR

- There are three production sectors in the model: a service sector and an industrial sector where final goods are being produced using energy as an additional productive input which is produced in the third sector, the energy sector.
- The representative firm uses labour, capital and electricity to produce the final good of the respective sector.

THE PRODUCTION SECTOR

$$Y = A_t^Y \, l_{Y,t}^{\alpha_Y} \left[(1-\psi_Y) \, k_{Y,t}^{-\nu^g} + \psi_Y \cdot g_t^{-\nu^g} \right]^{\frac{\upsilon^Y}{\nu^{gg}}}$$

$$X = A_t^X \, l_{X,t}^{\alpha_X} \left[(1-\psi_X) \, k_{X,t}^{-\nu^s} + \psi_X \cdot s_t^{-\nu^s} \right]^{\frac{\upsilon^X}{\nu^{ss}}}$$

THE ENERGY SECTOR

- Energy enters in our model as consumption good for households in the form of electricity, as a production of input for industrial and service sectors.

$$G = A_t^G \, l_{G,t}^{\alpha_G^G} \left[(1-\psi_G) \, k_{G,t}^{\bar{v}^{m,G}} + \psi_G \cdot m_{G,t}^{\bar{v}^{m,G}} \right]^{\frac{\upsilon^G}{v^{m,G} G}}$$

$$I = A_t^I \, l_{I,t}^{\alpha_I^I} \left[(1-\psi_I) \, k_{I,t}^{\bar{v}^{m,I}} + \psi_Y \cdot m_{I,t}^{\bar{v}^{m,I}} \right]^{\frac{\upsilon^I}{v^{m,I} I}}$$

$$H = A_t^H \, l_{H,t}^{\alpha_H^H} \left[(1-\psi_H) \, k_{H,t}^{\bar{v}^{h}} + \psi_H \cdot h_t^{\bar{v}^{h}} \right]^{\frac{\upsilon^H}{v^{h} h}}$$

THE ENERGY SECTOR

- We further assume that a certain amount of electricity (χ) is lost while transmitting by the distribution companies to the end consumers. So, equilibrium in electricity market:

$$e + s + g = H + I + G - \chi(H + I + G)$$

THE HOUSEHOLD SECTOR

- The representative household maximizes expected utility subject to the following resource constraint:

$$MaxE \sum_{t=0}^{\infty} \beta^t \phi \log [X_t(\theta c_t^{\rho} + (1-\theta) e_t^{\rho})]^{\frac{1-\gamma}{\rho}} + (1-\phi) \log(1-l_t)$$

$$s.t.$$

$$k_{t+1} + c_t + n.X_t + q_t^e.e_t = (1-\tau^l) w l_t + B + (1-\tau^k) r k_t + (1-\delta) k_t$$

THE GOVERNMENT SECTOR

- The government , like any other entity in the economy, must satisfy the following resource constraint:

$$w.l.\tau^{l} + r.k.\tau^{k} + (v^{m} - \delta^{c})(m^{I} + m^{G}) + (v^{h} - v^{e})h + p^{G}.G - r.k^{G} - w.l^{G} - v^{m}.m^{G} - \mathrm{B} = b$$

THE GOVERNMENT SECTOR

- **Total Subsidy is :**

$$-b = q^{e}.e + q^{s}.s + q^{g}.g - p^{I}.I - p^{H}.H - p^{G}.G$$

- **Combining household resource constraint, government resource constraint and the subsidy equation, the economy wide resource constraint can also be derived.**

$$k_{t+1} = Y_t - c_t - v^{e}.h + (1-\delta)k_t - \delta^{c}(m^{I} + m^{G})$$

Model Shocks

- **Our model is driven by five different shocks:**

$$\ln v_t^e = \Omega^v + \omega \ln v_{t-1}^e + \kappa t$$

$$\ln A_t^Y = \Omega^Y + \mu^Y \ln A_{t-1}^Y + \eta_t^Y$$

$$\ln A_t^G = \Omega^G + \mu^G \ln A_{t-1}^G + \eta_t^G$$

$$\ln A_t^I = \Omega^I + \mu^I \ln A_{t-1}^I + \eta_t^I$$

$$\ln A_t^H = \Omega^H + \mu^H \ln A_{t-1}^H + \eta_t^H$$

Dataset, Parameter and Calibration

The model is calibrated for Bangladesh economy following Kydland and Prescott (1982).

The dataset is reported in the following table and reflects the variable values in 2011-2012.

Dataset: Main Model Parameters									
q^e=4.93	q^g=6.95	q^s=9.00	p^H=7.79	P^I=3.20	V^m=.775	V^h=5.72	V^e=8.19	δ^C=1.1	P^G=2.30

Dataset, Parameter and Calibration

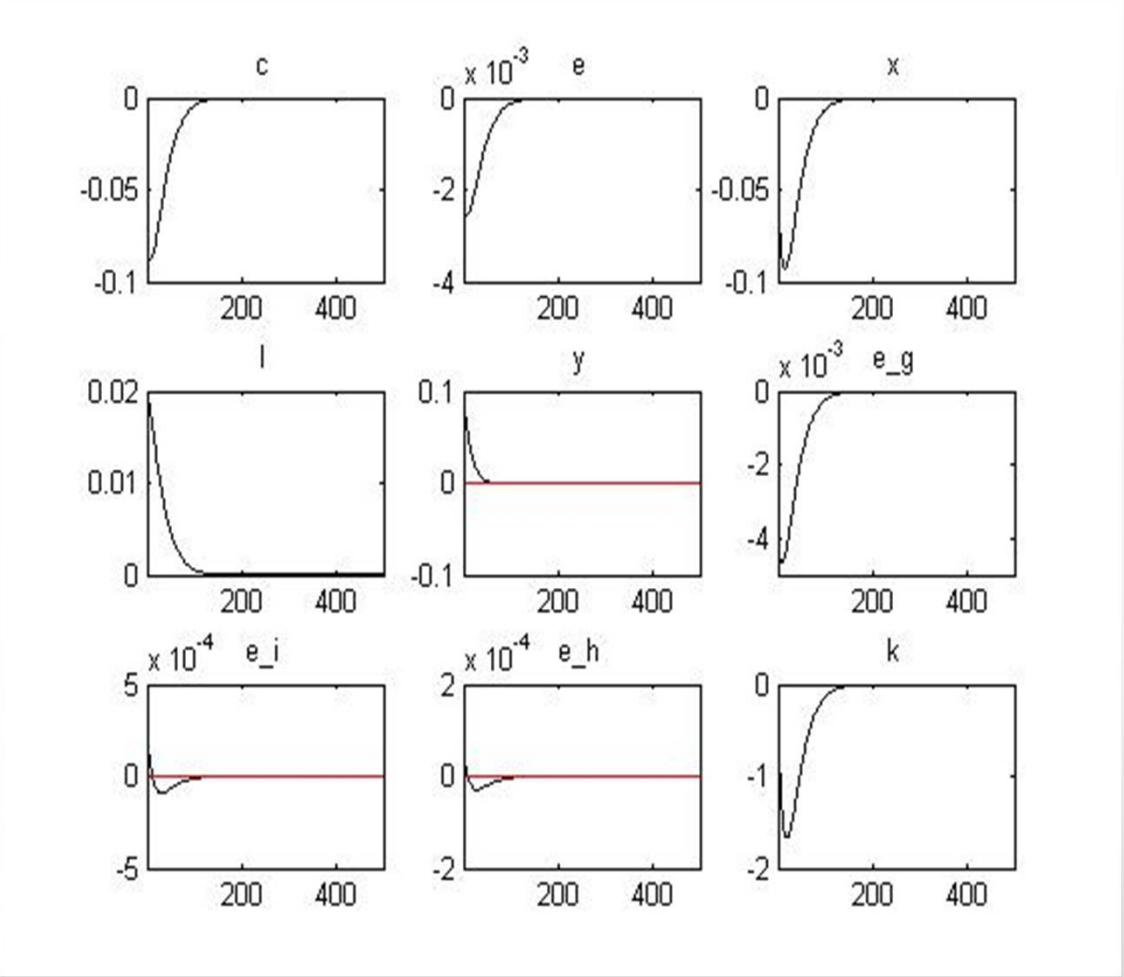
Parameter values are reported in the following table:

Calibration: Main Model Parameters									
β=0.96	φ=0.60	θ=0.91	ρ=-0.11	γ=0.81	α_H=0.004	α_I=0.036	α_G=0.058	α_Y=0.2	α_X=0.31
Ψ_H=0.59	Ψ_I=0.30	Ψ_G=0.30	Ψ_Y=0.073	Ψ_X=0.079	ϑ_H=0.89	ϑ_I=0.86	ϑ_G=0.85	ϑ_Y=0.7	ϑ_X=0.58

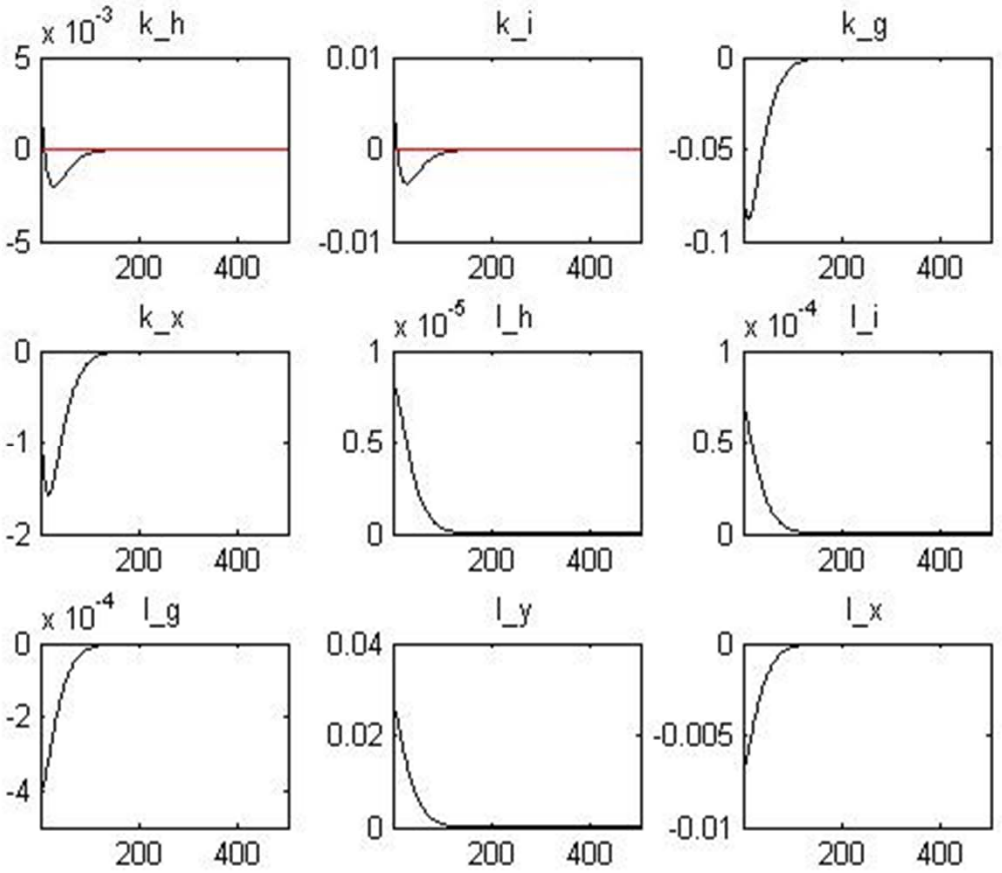
SOLUTION ALGORITHMS

- We run the program Dynare version 4.4.3 to solve and simulate the model and to approximate the dynamics of our model economy (Adjemian et al, 2011).

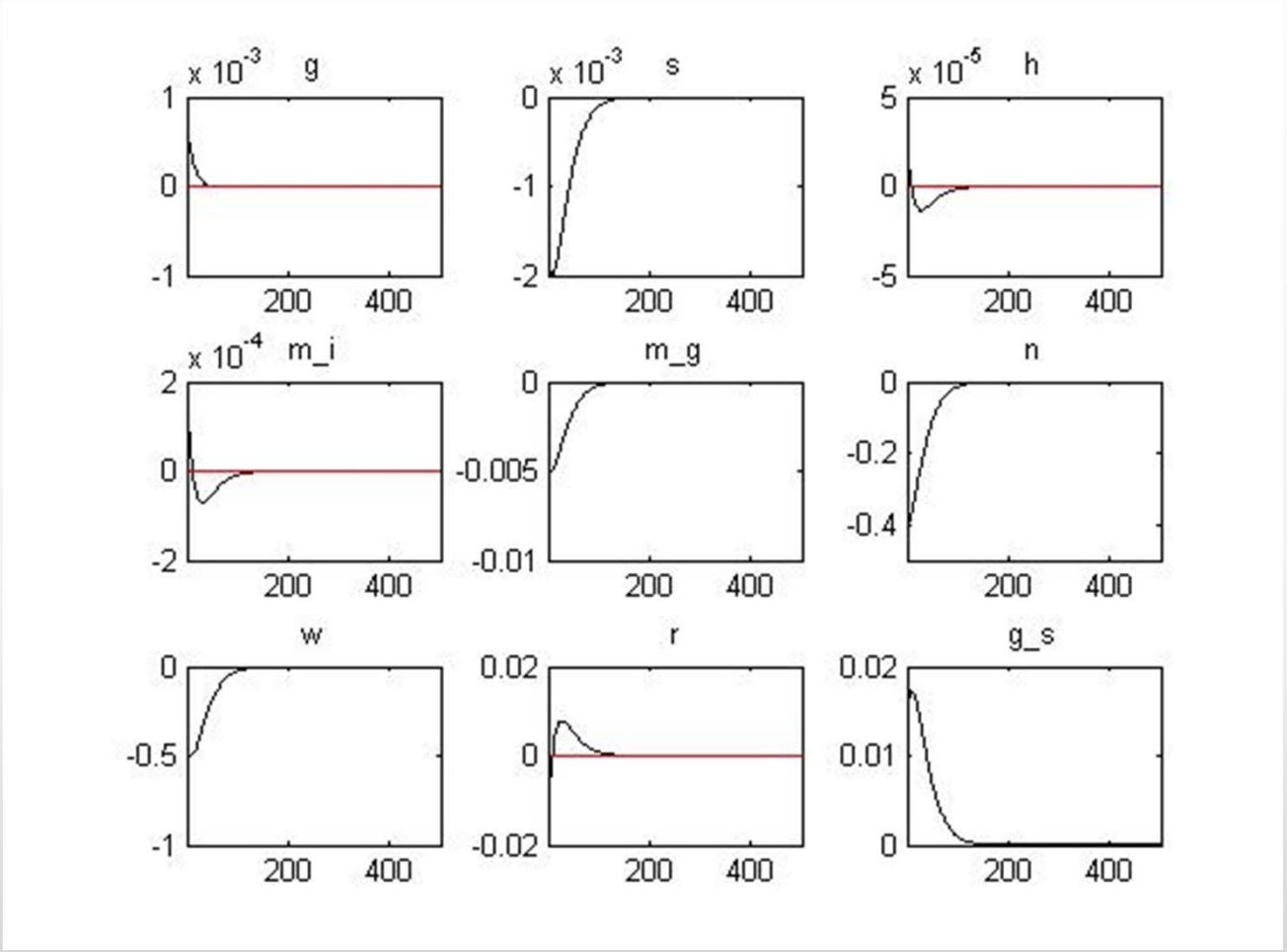
Impulse Reponses to an Oil Price Shocks



Impulse Reponses to an Oil Price Shocks



IMPULSE REPONSES TO AN OIL PRICE SHOCKS



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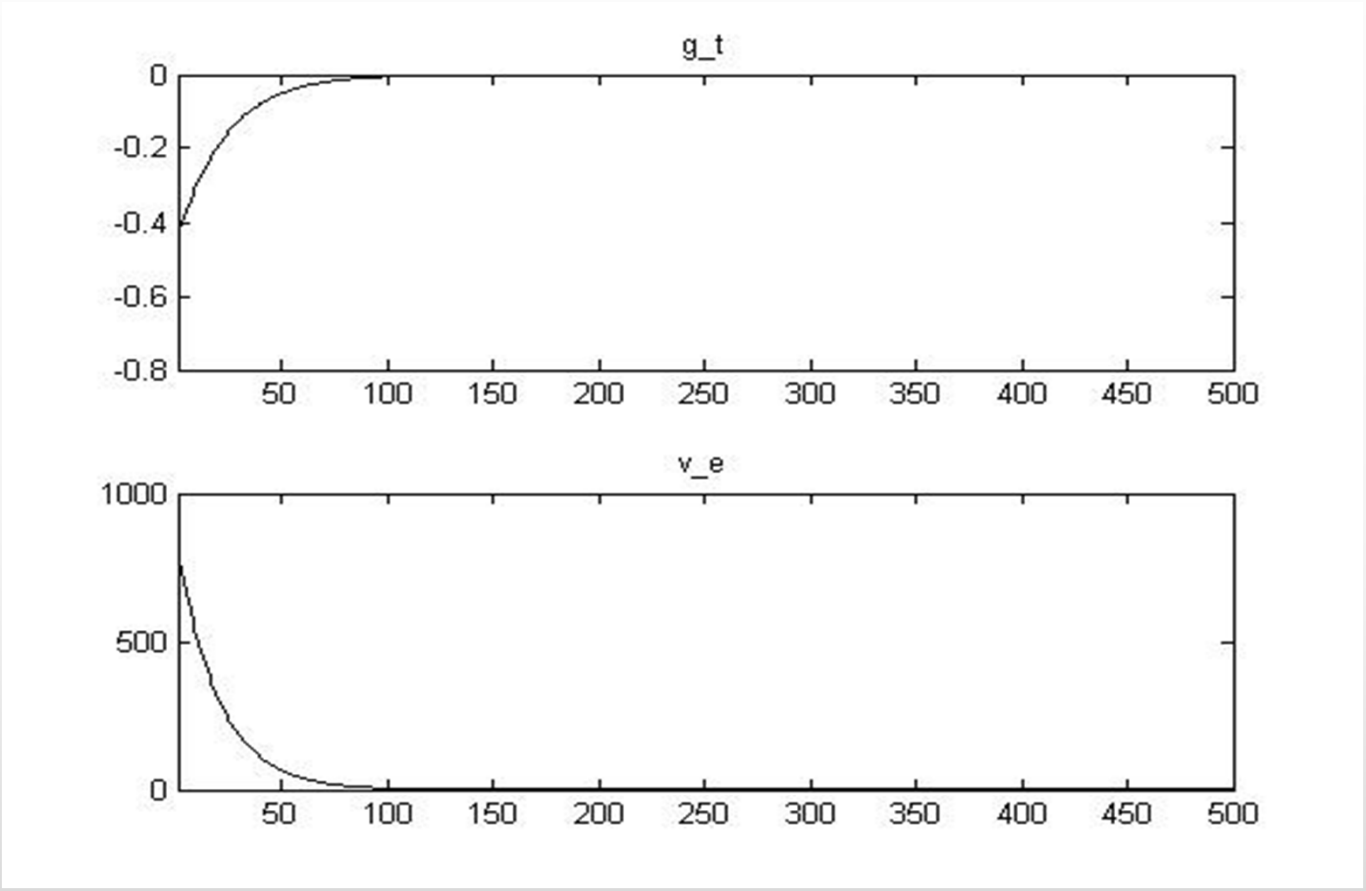

Main Results

Table : Percentage Change in SS Values from 10 % Subsidy Removal

Policy Experiment	c	x	y	H+I+G	GDP	h	$m^I + m^G$
Subsidy Removal	0.12%	0.03%	0.05%	0.09%	0.15%	-18.68%	1.26%

CONCLUSIONS

- Given our results, it is worthwhile that government could use the revenue earned from the subsidy removal and offer monetary and non-monetary incentives to producers who are affected.

REFERENCES

- Blanchard, O., and Gali, J., 2007, "The Macroeconomic Effects of Oil Price Shocks: Why are the 2000s so Different from the 1970s?", Manuscript, MIT.
- Dhawan, R., and Jeske, K., 2007, "Energy Price Shocks and the Macroeconomy: The Role of Consumer Durables", mimeo, Federal Reserve Bank of Atlanta.
- Erdogdu, E., 2011, "The Impact of Power Market Reforms on Electricity Price-Cost Margin and Cross-Subsidy Levels: A Cross Country Panel Data Analysis", Energy Policy 39(3), pp. 1080-1092.
- Finn, MG., 2000, "Perfect Competition and the Effects of Energy Price Increases on Economic Activity," Journal of Money, Credit and Banking 32, pp. 400-416.
- Glomm, G., and Jung, J., 2013, "A Macroeconomic Analysis of Energy Subsidies in a Small Open Economy," Working Papers 2013-02, Towson University, Department of Economics, revised Feb 2013.
- Hamilton, JD., and Herrera, AM., 2004, "Oil Shocks and Aggregate Macroeconomic Behaviour: The Role of Monetary policy", Journal of Money, Credit and Banking 36, pp. 265-286.

REFERENCES

- Jamasb, T., 2006, "Between the State and Market: Electricity Sector Reform in Developing Countries", Utilities Policy 14, pp. 14-30.
- Jamasb, T., and Nepal, R., 2011, "Reforming Small Power Systems under Political Instability: The Case of Nepal", Energy Policy 40(1), pp. 242-251.
- Jorgenson, D.W., 1998, "Growth. Volume 2: Energy, the Environment and Economic Growth", MIT Press.
- Kim, I.M., and Loungani, P., 1992, "The Role of Energy in Real Business Cycles," Journal of Monetary Economics 29, pp. 173-189.
- Kydland, F., and Prescott, E.C., 1982, "Time to Build and Aggregate Fluctuations", Econometrica 50, pp. 1345-1371.
- Pereira, AM., and Pereira, RM., 2011, "Marginal Abatement Cost Curves and the Budgetary Impact of CO2 Taxation in Portugal" College of William and Mary Economics, Working Paper 105.

THANK YOU FOR YOUR ATTENTION

QUESTIONS?