

CAPTIVE POWER GENERATION, GRID CONNECTIVITY, AND HOUSEHOLD WELFARE IN BANGLADESH

Sakib Amin
Tooraj Jamasb
Manuel Llorca
Laura Marsiliani
Thomas Renström

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Durham
University
Business School

INTRODUCTION

- ❑ Electricity crisis was one of the major problems in Bangladesh during the early 1990's mainly because of:
 - *Poor performance of the state owned energy utilities*
 - *Lack of appropriate organisational structure, efficiency in decision making process*
 - *Low electrification rate*
 - *Low generation capacity*
- ❑ To overcome this crisis and to provide uninterrupted electricity supply to the growing industrial sector, Bangladesh initiated widespread reforms in the energy sector.

MAJOR REFORM INITIATIVES IN BANGLADESH

- ❑ The main reform programmes in Bangladesh tended to include the following elements:
 - i. Restructuring of the Core Utilities (Creation of Dhaka Electric Supply Authority (1991), Dhaka Electric Supply Company Limited (1996), Power Grid Company of Bangladesh (1996))*
 - ii. Privatisation (Private Sector Power Generation Policy (1996), Policy Guideline for Small Power Plant (SPP) in Private Sector (1998))*
 - iii. Establishment of Independent Regulatory Authority (Bangladesh Energy Regulatory Commission was established (2003))*
 - iv. Power and Energy Sector Road Map (2011)*
 - v. Sustainable & Renewable Energy Development Authority (SREDA) was set up (2014)*

THE CAPTIVE POWER PLANTS (CPPs) IN BANGLADESH

- ❑ The private power generation policy in 1996 allowed the industrial users in Bangladesh to build up Captive Power Plants (CPPs).
- ❑ The industries immediately responded building up their own power plants mainly because:
 - *The national grid supply was poor*
 - *High transmission and distribution losses*
 - *Abundance of natural gas*
 - *The electricity provided by the national grid was overpriced for the industrial sector*

STYLISTED FACTS OF BANGLADESH ELECTRICITY SECTOR BETWEEN 2009 AND 2019

	2009	2019
Number of power plants	27	138
Installed generation capacity	4,942 MW	17,764 MW
Captive generation capacity	741.3 MW	2,880 MW
Maximum peak generation	3,268 MW	11,396 MW
Per capita electricity generation	220 kWh	464 kWh
Access to electricity	47%	93%
Share of private sector in generation	41.77%	49%
T &D losses	16.85%	11.87%

Source: Power Division, Government of the People's Republic of Bangladesh (2019), Bangladesh Power Development Board Annual Report 2017-2018

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THIRD-PARTY ACCESS AND CPPs IN BANGLADESH

- ❑ Jamasb and Sen (2012) argue that the implementation of the third-party access to the grid in India is a successful reform.
 - i. *If excess electricity is generated by the CPPs and transmission capacity to national grid is available, the CPPs can sell the excess electricity to distribution companies subject to agreement between them.*
 - ii. *While India is strengthening the public-private network and encouraging the CPPs to sell surplus electricity through third-party access, Bangladesh is yet to fully capitalise the national policy for CPPs.*
- ❑ The share of CPPs in supplying excess electricity to the national grid in Bangladesh is very limited.

UNDERLYING PROBLEMS BEHIND THE SLUGGISHNESS OF GRID CONNECTED CPPs

- Under the current policies, CPPs do not have incentive to sell their excess electricity to the national grid:
 - i. CPPs need to bear all the distribution and transmission related charges*
 - ii. The government-regulated selling prices are not high enough to ensure a profit for the CPPs*
 - iii. The captive power generators are subjected to pay customs duty, VAT, supplementary duty as clearance stage and not receiving tax holidays or exemptions for importing the electricity generation equipment.*

MAIN RESEARCH QUESTIONS

- ❑ In addition to addressing the prevailing difficulties of selling CPP generated surplus electricity to the national grid, a thorough economic analysis is needed before opening up the grid.
- ❑ So, we develop a Dynamic Stochastic General Equilibrium (DSGE) model for Bangladesh economy to address the following question:

How would the Bangladesh economy perform in the long run when the CPPs are grid connected?

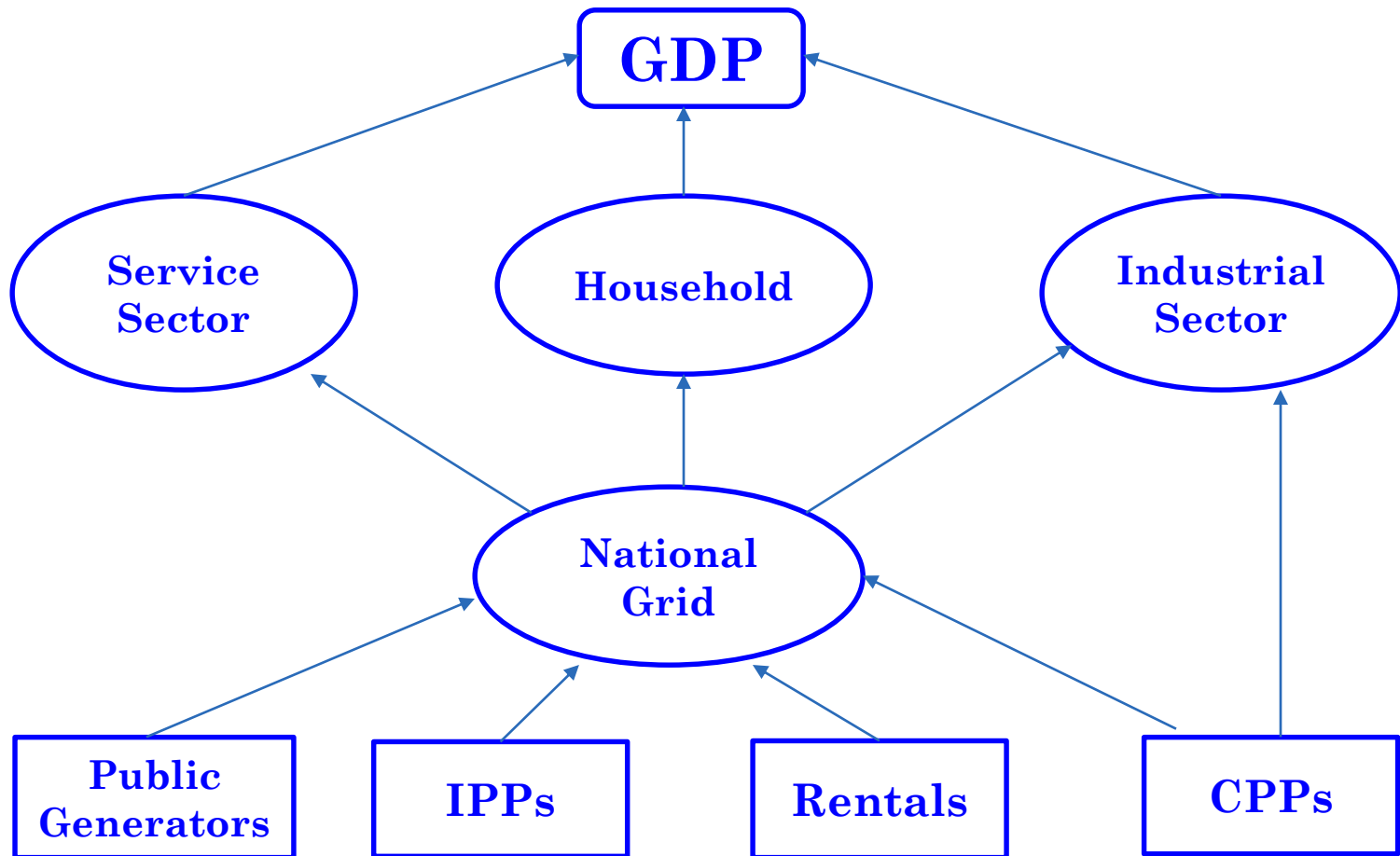
- ❑ To do so, we run a captive-related policy experiment:
 - i. A model economy where the CPPs sell excess electricity to the national grid*

THE DSGE MODEL

- Our model economy has the following four sectors:
 - i. **The production sector** (Two industrial and one service production sector who produce final output using labour, capital and electricity)
 - ii. **The energy sector** (the public power producers, the independent power producers, the captive power producers and the rental power producers who produce electricity using natural gas and imported oil)
 - iii. **The household sector** (receives utility from consumption goods and leisure and pays taxes to the government)
 - iv. **The public sector** (earns revenue from taxes and provides subsidies to the energy consumers and producers)

Note: More analytical details on the DSGE model is provided in the technical appendix (Slides 11-12)

THE CONCEPTUAL MODEL



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TECHNICAL NOTE: DSGE MODEL

□ **Household Utility Function:**

$$\varphi \log \left[X_t^\gamma (\theta c_t^\rho + (1 - \theta) e_t^\rho)^{\frac{1-\gamma}{\rho}} \right] + (1 - \varphi) \log(1 - l_t)$$

□ **Household Resource Constraint:**

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

□ **Government Resource Constraint:**

$$\tau^l . w.l_t + \tau^k . r.k_t + (v^m - \delta^c)(m_{I,t} + m_{G,t} + m_{C,t}) + P^G . G_t - r.k_{G,t} - w.l_{G,t} - v^m . m_{G,t} - \mathfrak{b} = b$$

□ **Production Functions:**

$$Y_{1,t} = A_{1,t}^Y l_{Y1,t}^{\alpha_{1,1}} [(1 - \Psi_{Y1})k_{Y1,t}^{-v^{g,1}} + \Psi_{Y1}g_{1,t}^{-v^{g,1}}]^{-\frac{1-\alpha_{Y1}}{v^{g,1}}}$$

$$Y_{2,t} = A_{2,t}^Y l_{Y2,t}^{\alpha_{2,2}} [(1 - \Psi_{Y2})k_{Y2,t}^{-v^{g,2}} + \Psi_{Y2}g_{2,t}^{-v^{g,2}}]^{-\frac{1-\alpha_{Y2}}{v^{g,2}}}$$

$$Y_{2,t} = A_{2,t}^Y l_{Y2,t}^{\alpha_{2,2}} [(1 - \Psi_{Y2})k_{Y2,t}^{-v^{g,2}} + \Psi_{Y2}(g_2 - g_g)^{v^{g,2}}]^{-\frac{1-\alpha_{Y2}}{v^{g,2}}} \text{ [when grid connected]}$$

$$X_t = A_t^X l_{X,t}^{\alpha_X} [(1 - \Psi_X)k_{X,t}^{-v^s} + \Psi_X s_t^{-v^s}]^{-\frac{1-\alpha_X}{v^{sS}}}$$

$$G_t = A_t^G l_{G,t}^{\alpha_G} [(1 - \Psi_G)k_{G,t}^{-v^{m,G}} + \Psi_G m_{G,t}^{-v^{m,G}}]^{-\frac{\vartheta^G}{v^{m,GG}}}$$

$$I_t = A_t^I l_{I,t}^{\alpha_I} [(1 - \Psi_I)k_{I,t}^{-v^{m,I}} + \Psi_I m_{I,t}^{-v^{m,I}}]^{-\frac{\vartheta^I}{v^{m,II}}}$$

$$g_{2,t} = A_t^C l_{C,t}^{\alpha_C} [(1 - \Psi_C)k_{C,t}^{-v^{m,C}} + \Psi_C m_{C,t}^{-v^{m,C}}]^{-\frac{\vartheta^C}{v^{m,CC}}}$$

$$R_t = A_t^R l_{R,t}^{\alpha_R} [(1 - \Psi_R)k_{R,t}^{-v^R} + \Psi_R h_t^{-v^R}]^{-\frac{\vartheta^R}{v^{H,RR}}}$$

TECHNICAL NOTE: DSGE MODEL (CONT'D)

□ **Total Subsidy:**

$$b = P^G \cdot G_t + P^I \cdot I_t + P^H \cdot G_H - q^e \cdot e_t - q^s \cdot s_t - q^g \cdot g_t$$

□ **Equilibrium Conditions:**

$$l = l_H + l_I + l_G + l_Y + l_X + l_2 + l_C$$

$$k = k_H + k_I + k_G + k_Y + k_X + k_2 + k_C$$

$$e_t + s_t + g_t + g_{2,t} = (G_t + I_t + g_{2,t} + R_t)$$

□ **Exogenous Shocks**

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

$$\ln A_t^{Y,2} = A^{Y,2} + \mu^{Y,2} \ln A_{t-1}^{Y,2} + \eta_t^{y,2}$$

$$\ln A_t^X = A^X + \mu^X \ln A_{t-1}^X + \eta_t^X$$

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

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

$$\ln A_t^C = A^C + \mu^C \ln A_{t-1}^C + \eta_t^C$$

$$\ln A_t^R = A^R + \mu^R \ln A_{t-1}^R + \eta_t^R$$

SOLUTION ALGORITHM

- ❑ We calibrate 74 parameters in total (42 structural parameters, 21 shock-related parameters, and 11 policy-related parameters)
- ❑ To simulate the model and to obtain the steady state values of our model we use the software Dynare 4.4.3 (a pre-processor and a collection of MATLAB routines which solves for the steady states)

MAIN FINDINGS

1. Steady State Values:

Percentage changes of the steady state values of different variables from the benchmark model		
	Policy Experiment	
GDP	1%	↓
Industrial Output	1.4%	↓
Electricity Consumption	1.06%	↓
Standard Consumption	1.06%	↓
Household Welfare	2.4%	↓

2. Impulse Response Functions (IRFs):

The IRFs show that the Bangladesh economy will be more vulnerable to oil price shocks under both experiments.

3. Our results find support for the second best theories which highlights the limitation on regulation policy.

POLICY RECOMMENDATIONS

- ❑ We recommend that the government should not opening up the grid for CPPs, but instead consider the following alternative reforms:
 - i. *All the CPPs should be encouraged to use efficient production technology like the Combined Cycle Gas Turbine (CCGT) which offers 52-60% efficiency-This can save 67 million USD annually (Authors' own estimation) .*
 - ii. *The government should encourage the CPPs to replace the fuel choice with the renewable energies or liquefied gas instead of using natural gas.*
 - iii. *A competitive market environment needs to be ensured to minimise the price distortions and to strengthening the public-private network-A rise in GDP by 2.19% (Authors' own estimation) .*
 - iv. *The distribution and transmission related charges needs to be shared together.*

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THANK YOU FOR YOUR ATTENTION!

QUESTIONS?

Contact of the Presenting Author:

Sakib Amin: sakib.amin@northsouth.edu; s.b.amin@durham.ac.uk