The Macrodynamics of India's Green Transition: An RBC Perspective

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OBJECTIVES

- Investigate India's environmental policy to understand macrodynamics of a green transition in production sector
  - Environmental policy based on incentivizing economic agents
  - Focus on energy sector
- Environment policy:
  - Carbon Credit Trading Scheme (CCTS)
  - India Carbon Market (ICM)

Research Question

- Macroeconomic dynamics of transition in the presence of a CCTS guidelines
- The interplay between CCTS and the environmental protection attitude of the government and the economic agents - producers
- Does the trading structure provide incentive to producers to reduce emissions?

CCTS Background

- An intensity target policy for high emitting firms
- Notified on 28th June 2023 and scheduled to be introduced in the financial year 2026-27
- Government announces an intensity target
- Certificate issued to target achievers
- Certificate trading at India Carbon Market
- Carbon pricing under CCTS does not generate revenue for the government

Literature Review

- Fischer and Springborn 2011, Heutel 2012, Angelopoulos et al. 2010; Angelopoulos et al. 2013, Annicchiarico and Di Dio 2015: Explored effectiveness of various climate policy instruments
- Heutel 2012 and Angelopoulos et al. 2013 focus on cyclical properties of optimal emission taxes in response to economic fluctuations
- Annicchiarico and Di Dio 2015; Annicchiarico and Di Dio 2017 and Economides and Xepapadeas 2018: Environmental and monetary policies simultaneously considered then economic stability improves.
- These papers, when modeling cap-and-trade, do not model the trading system of the environmental policy.

Literature Review (cont...)

- Our place: Energy sector in DSGE framework
- Tumen et al. 2016; Atalla et al. 2017; Argentiero et al. 2018: Substitution effect between energy sources and their impacts on economic dynamics and emissions.
- Dissou and Karnizova 2016: Considering an energy mix is crucial to demonstrate the dynamics of environmental regulations and welfare.
- Silva and Silva 2024: Access to renewable energy leads to substitution in presence of productivity shocks.

Literature Review: India

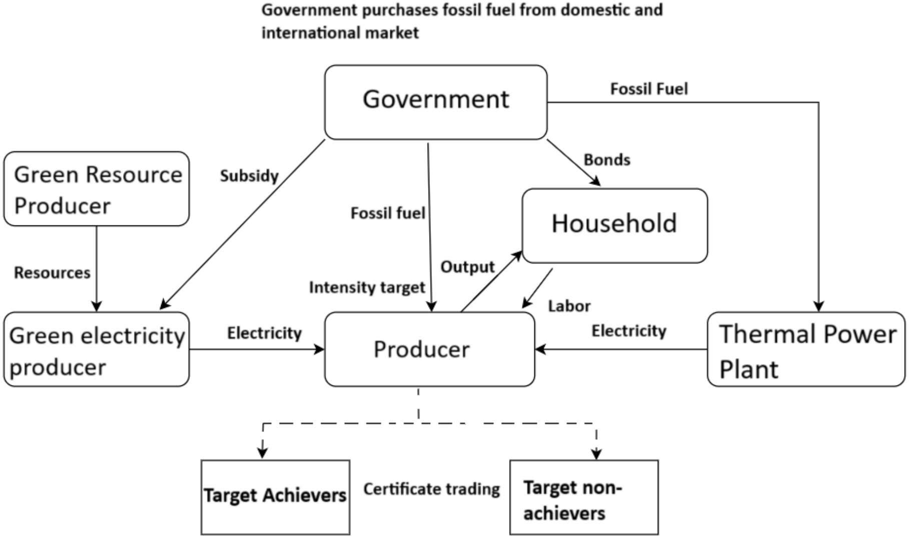
Methodology	Papers
CGE	Weitzel et al. (2014) Pradhan and Ghosh (2019) Ojha et al. (2020) Pradhan and Ghosh (2022)
NK-DSGE	RBI Monetary Policy Report (2024)

RESEARCH GAP

- A CCTS framework DSGE model for India
- A model with carbon certificate trading
- Government only a regulatory authority
- Model with thermal power plant and green electricity sector (E2-DSGE model)
  - Give a better understanding of impact of energy prices and dynamics (Silva and Silva 2024)
- Interaction between environmental policies and environmental awareness of industries

Model

- An RBC-based E-DSGE framework
  - Similar to E2-DSGE model by Silva and Silva 2024.



- ϱ proportions of the firms are achievers.

ASSUMPTIONS

- Household does not have energy consumption in the model
- Abatement efforts take time to materialize
- Abatement efforts are only taken by the target achieving firms
- Demand of certificates by non-target achievers equals supply of certificates by target achievers
- Government purchase fossil fuel from domestic and international market and sells to production sector and thermal power plants at zero profit

Features of the Model

- Separate electricity sector - with different thermal power plant and green electricity sector
- Trading of certificates among firms
- Model captures direct, indirect, and process based emissions (as mentioned in CCTS guidelines draft)

Exogenous Shocks

- Productivity shock (A_t^Y)
- Productivity shock in Green electricity sector (A_t^G)
- Fossil fuel price shock (p_t^R)

Some Key Equations

Production function: $Y_t = A_t^Y (\Lambda_t L_t)^\alpha J_t^{(1-\alpha)}$

Energy mix: $J_t = \left[\omega_1 (E_t^F)^{-\varepsilon} + \omega_2 (E_t^G)^{-\varepsilon} + (1-\omega_1-\omega_2) R_{1,t}^{-\varepsilon}\right]^{-\frac{1}{\varepsilon}}$

Damage function/Labor efficiency: $\Lambda_t = 1 - (\eta_0 + \eta_1 M_t + \eta_2 M_t^2)$

Emission stock equation: $M_t = (1-\delta_M) M_{t-1} + Z_t + Z_t^*$

- Λ represents loss of labor due to environmental impact.
- Depreciation of stock δ_M captures the rate at which stocks are absorbed by ocean, landfills or through chemical reactions
- E_t^F is thermal power, E_t^G is green electricity, and $R_{1,t}$ is fossil fuel required for production process.

Some Key Equations (Certificate Trading)

- Target achievers take abatement efforts (U_t) and consume green electricity (along with other energy sources)
- Announced intensity target: ν
- Non-target achievers only consume green electricity as a measure to reduce emissions (along with other energy sources)

Emissions by target achievers:	$Z_t^{achieved} = (\nu Y_t - (1 - U_{t-1}) E_t \varphi Y_t)$
Emissions by non-target achievers:	$Z_t^{failed} = (\varphi E_t Y_t - \nu Y_t)$
Certificate Market Clearance:	$\varrho Z_t^{achieved} = (1 - \varrho) Z_t^{failed}$

Some Key Equations (cont...)

Green Electricity production:	$E_t^G = A_t^G R_t^G$
Thermal Power:	$E_t^F = A_t^F R_{2,t}$

- R_t^G is the green resources required as input for electricity generation.
- $R_{2,t}$ is the fossil fuel required for electricity generation.

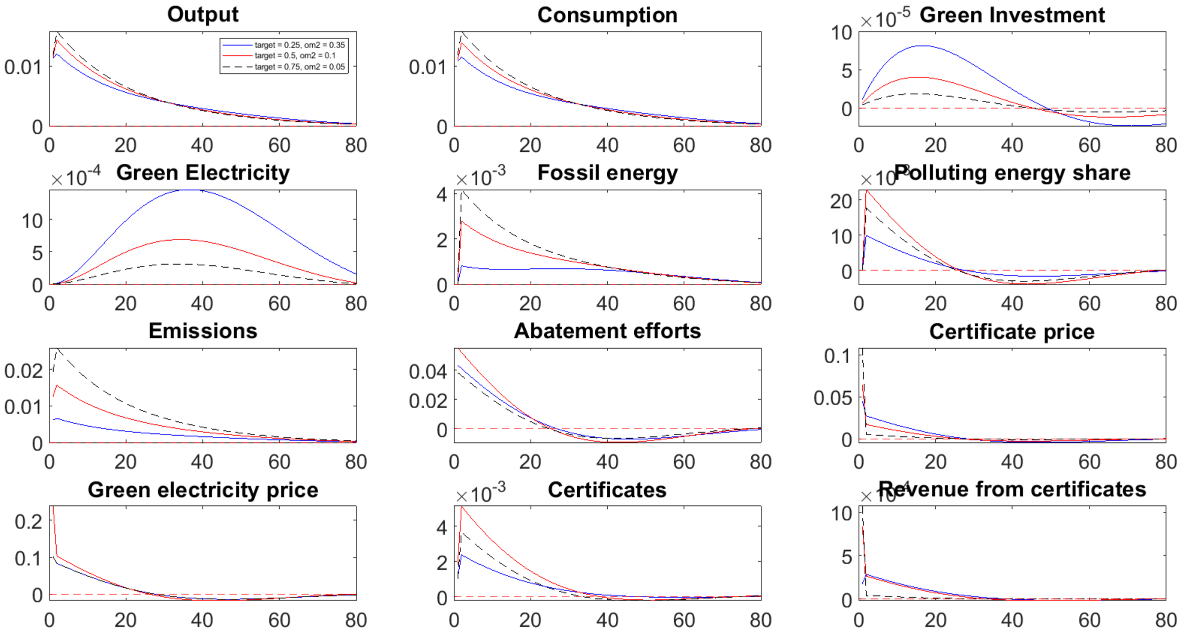
Calibration

- Parameters can be divided into three categories:
  - Standard RBC parameters (Carattini et al. 2023; Banerjee and Behera 2023)
  - Parameters related to environment externalities (Annicchiarico and Di Dio 2015; Carattini et al. 2023)
  - Sensitivity parameters

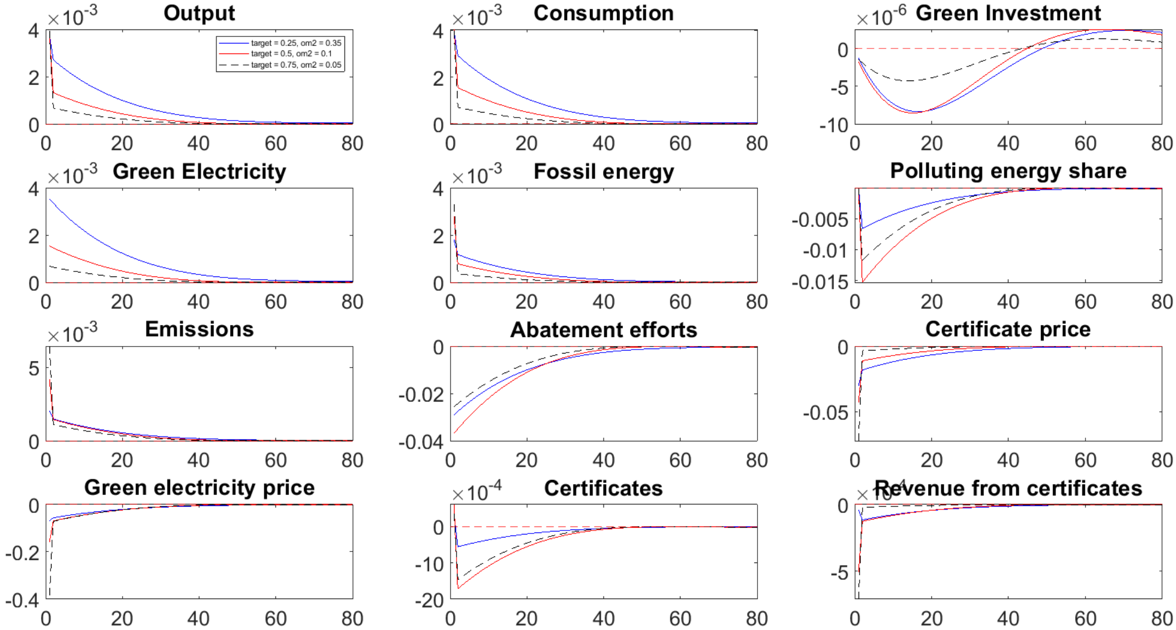
Simulations

- We simulate for different cases:
  - an ambitious government and producer (ν = 25% of 2005 level, $\omega_2 = 0.35$)
  - current ambition (ν = 50% of 2005 level, $\omega_2 = 0.1$)
  - an unambitious government and producer (ν = 75% of 2005 level, $\omega_2 = 0.05$)
  - an ambitious government but non-ambitious producer

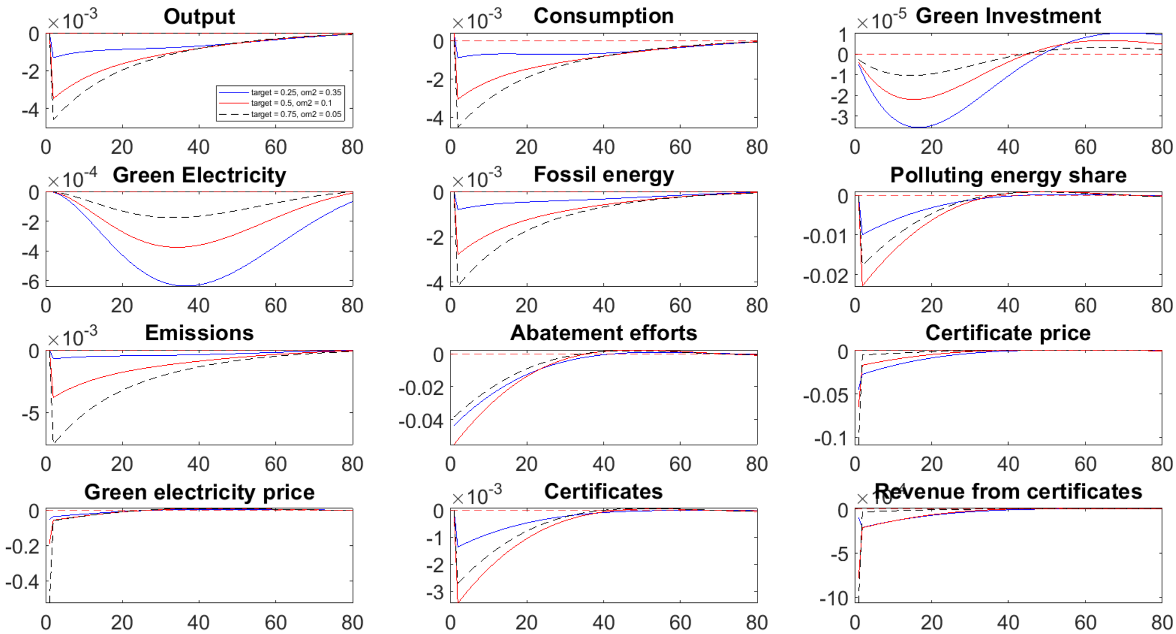
Simulations: Production shock



Simulations: Green electricity production shock



Simulations: Fossil fuel price shock



Conclusion

- CCTS fails to reduce industrial emissions
- Including subsidies on purchase of green energy resources does not have impact.
- CCTS can be utilised as a source of revenue but only when there is a productivity shock.

Thank You !