

ERCST work and initiatives

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Andrei Marcu



India case study



OBJECTIVE

- The issue of quantifying the impacts of the implementation of response measures has been well studied.
- But there has been relatively little analytical attention paid to dynamic analysis that takes into account the adaptive response of the impacted countries.
- In this study we will use **Computable General Equilibrium (CGE)** modelling to **assess the impacts/incentives** involved for a large complex developing economy (India) when faced with **destination-based carbon pricing from key developed country markets**.



- The case study will analyse the impact of a destination-based carbon pricing implemented in the US, the EU, the UK, Canada, Australia and Japan in four different reference scenarios. The scenarios assume timely decarbonization for developed economies that implement the destination-based carbon pricing.
- Our hypothesis is that while response measures such as destination-based carbon pricing would have significant economic and social impacts for developing country exporters such as India, there are also important incentives for those exporters to achieve decarbonization in a world where such response measures become more widespread.



CARBON PRICING

- In a first step average carbon prices in 2017 are calculated using the revenue for model regions by mapping reported revenue from World Bank data to the appropriate model region. This revenue is divided by carbon emissions reported in the GTAP database in the sectors that are targeted by the respective policy scheme. For the period 2017-2035, the EU price forecast (carbon pulse) serves as a target. We assume a graded convergence of carbon prices as follows (Figure 3):
 - **OECD:** full convergence to EU prices until 2035
 - China: 75% convergence until 2035
 - Middle-income and Middle East: 50% convergence until 2035
 - Low-income: 15% convergence until 2035.





Projection tool: "What will happen?"

METHOD: A GLOBAL COMPUTABLE GENERAL EQUILIBRIUM MODEL (CGE)

- Simulation tool: "What if?"
 - Effects of policies, i.e., policies that affect multiple sectors or regions and/or result in changes of behaviour
 - "What if"-type of scenarios (ex-ante)
- Theoretically consistent: based on micro/macro theory
- Highlights the importance of linkages between sectors and agents (producers, workers, consumers, government, trade partners)
- Incorporates unique features of an economic system.

Method: A Global Computable General Equilibrium Model (CGE)

- GLOBE model (Thierfelder, 2024)
- Recursive dynamic
- Series of single countries linked through bilateral trade relationships and current account transactions
- Energy use in the model allows for substitution in production between different energy inputs, e.g., fossil fuels and electricity



Thierfelder, K., (2024). A Standard Applied General Equilibrium Model: Technical Documentation – GLOBE. mimeo (www.usna.edu).



Global model data

- Calibrated to use the GTAP-Power v11 database (Chepeliev, 2023) in Social Accounting Matrix (SAM) format, GTAP-E based GHG intensities
- 21 regions
- 5 factors of production
- 35 sectors:
 - 2 agriculture and food, 4 extraction,10 manufacturing, 10 energy and 9 services sectors

Regions			
India	Russia, KAZ, TKM		
China	EU		
Japan	Rest EFTA + UK		
Asia - Oil	USA		
Asia - High income	Canada		
Asia - Lower Middle Income	Latin America Oil		
Gulf states	Other Latin America		
North Africa	Australia		
Africa - Low Income, non-oil	New Zealand		
Africa - oil exporters	Rest of the World		
SACU	•		



POLICY SIMULATION

- Hypothetical destination-based carbon pricing
- Implemented in the US, the EU, the UK, Canada, Australia and Japan
- Covered sectors for destination-based carbon pricing:
 - Iron & Steel: basic production and casting
 - Non-Ferrous Metals: production and casting of copper, aluminium, zinc, lead, gold, and silver
 - Petroleum & Coke: manufacture of coke and refined petroleum products
 - Manufacture of chemicals and chemical products
 - Paper & paper products
- Timeline: until 2040



FOUR REFERENCE SCENARIOS

		Other emerging countries or developing countries	
		No/ late decarbonization	Timely decarbonization
India	No/ late decarbonization	Status quo	Late comer
	Timely decarbonization	First mover	Global action

These reference scenarios are based on the shared socioeconomic pathways (SSPs).



The five shared- socioeconomic pathways (SSPs)

The SSPs are part of a framework that the climate change research community has adopted to facilitate the integrated analysis of future climate impacts, vulnerabilities, adaptation, and mitigation (O'Neill et al., 2017; and Riahi et al. 2017). The SSPs distinguish five pathways that represent different mitigation and adaptation challenges



Socio-economic challenges for adaptation



Emission pathways for India in million tons of CO2



Decarbonisation instruments

The reference scenarios employ several decarbonisation instruments.

- 1. First, a carbon price may be implemented for selected regions and countries. The carbon price is applied on fossil use in the following sectors:
 - Iron & Steel: basic production and casting
 - Production and casting of aluminium
 - Petroleum & Coke: manufacture of coke and refined petroleum products
 - Cement

2. The second decarbonisation instrument represents the investment in renewable energy sources with accelerated depreciation of fossil electricity generation. All regions (except India) are assumed to invest 25% of carbon tax revenue in renewable electricity generation (wind, hydro and solar). India invests 80% of carbon tax revenue in renewable electricity generation (implemented in RS2 and RS4).

3. Third, we assume that India invests 20% of carbon tax revenue in the transformation of its steel sector towards less emission intensive steel production. The additional investment is invested in secondary steel production and combined with accelerated phasing out of primary steel plants.

- Manufacture of fertilizers
- Electricity
- mining of coal, oil and gas



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Effects of BCA on real exports (2035, in % changes, relative to reference scenarios)





Effects of BCA on real exports (2035, in % changes, relative to reference scenarios) (continued)



Each dot represents the effect for a specific region.



Effects of BCA on nominal GDP (in % changes, relative to reference scenarios)





Effects of BCA on nominal GDP (in % changes, relative to reference scenarios) (continued)



Each dot represents the effect for a specific region.