

OMEGA BRAZIL

BEYOND CARBON MARKETS: UNPACKING THE POLICY INTERACTIONS IN BRAZIL'S CLIMATE STRATEGY

SEMINÁRIO CEPAL-AFD

TRANSFORMAÇÃO ECOLÓGICA NO BRASIL: FERRAMENTAS DE ANÁLISE E CONSTRUÇÃO DE POLÍTICAS PÚBLICAS



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Motivation

Why an Open-economy, Multi-sector, Endogenous Growth Assessment (OMEGA) model?



No historical precedent of climate change

Accurate modelling is critical to assess climate action and climate impact because there are insufficient historical data to rely on statistical methods alone.



Suite-of-models approach

The World Bank follows a suite-of-models approach to assess climate action and climate impact from various angles.
OMEGA fills important gaps in the World Bank's suite of models.



Designed for policy analysis

“Scenario analysis” offers insights but can be misleading.
OMEGA tells a coherent economic story from shock to effect without “outside” interpretation.



Comparative advantage of OMEGA

Role of policy credibility.
Role of structural reforms.
Private sector incentives.
Carbon markets.

Core Model Features

OMEGA is a large-scale, integrated framework for climate-economic policy analysis.



Open economy

A domestic country vs. the rest of the world including trade, financial flows, and foreign direct investment.



Multi-sector

Input-output structure of up to 10 value-added sectors and 4 final-good producers.

Short- and long-run elasticities of substitution.



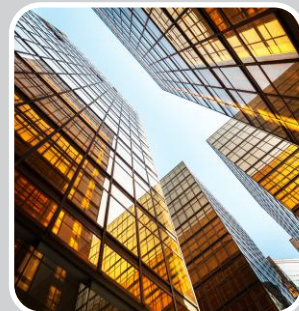
Endogenous growth

Long-term growth determined by human capital accumulation and learning-by-doing externalities.



Financial sector

Variety of financial instruments including equity shares, bonds, loans, and deposits with endogenous risk premia, borrowing constraints, and asset pricing.



Market imperfections

Externalities, financial market imperfections, and a variety of nominal and real rigidities including monopoly power, staggered wage and price setting, and adjustment costs.



Policy interventions

Taxes, subsidies, tariffs, carbon markets, granular public investment in production and infrastructure, mandates, and green finance.



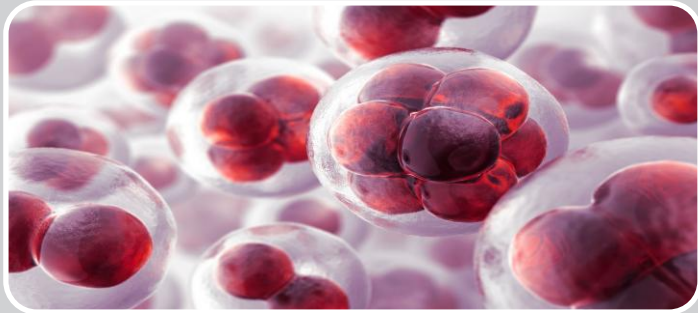
GHG emissions

Granular greenhouse gas emission from production activities, fossil-fuel combustion, and land use change.

OMEGA - Open-Economy Multi-sector Endogenous-Growth Assessment model

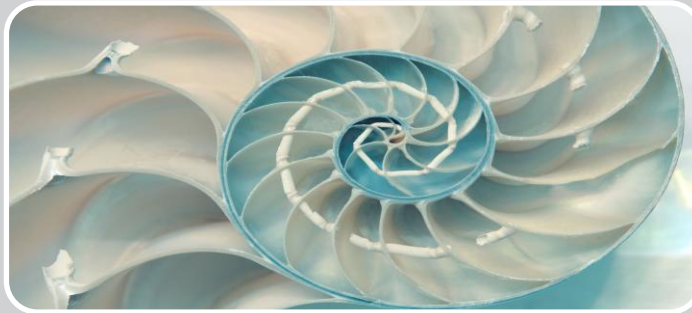
Core Methodological Pillars

OMEGA utilizes state-of-the-art methodologies of macro-economic modelling, estimation, and simulation.



Micro-foundations

Economic behavior is characterized by micro-economic problems.



Forward-looking expectations

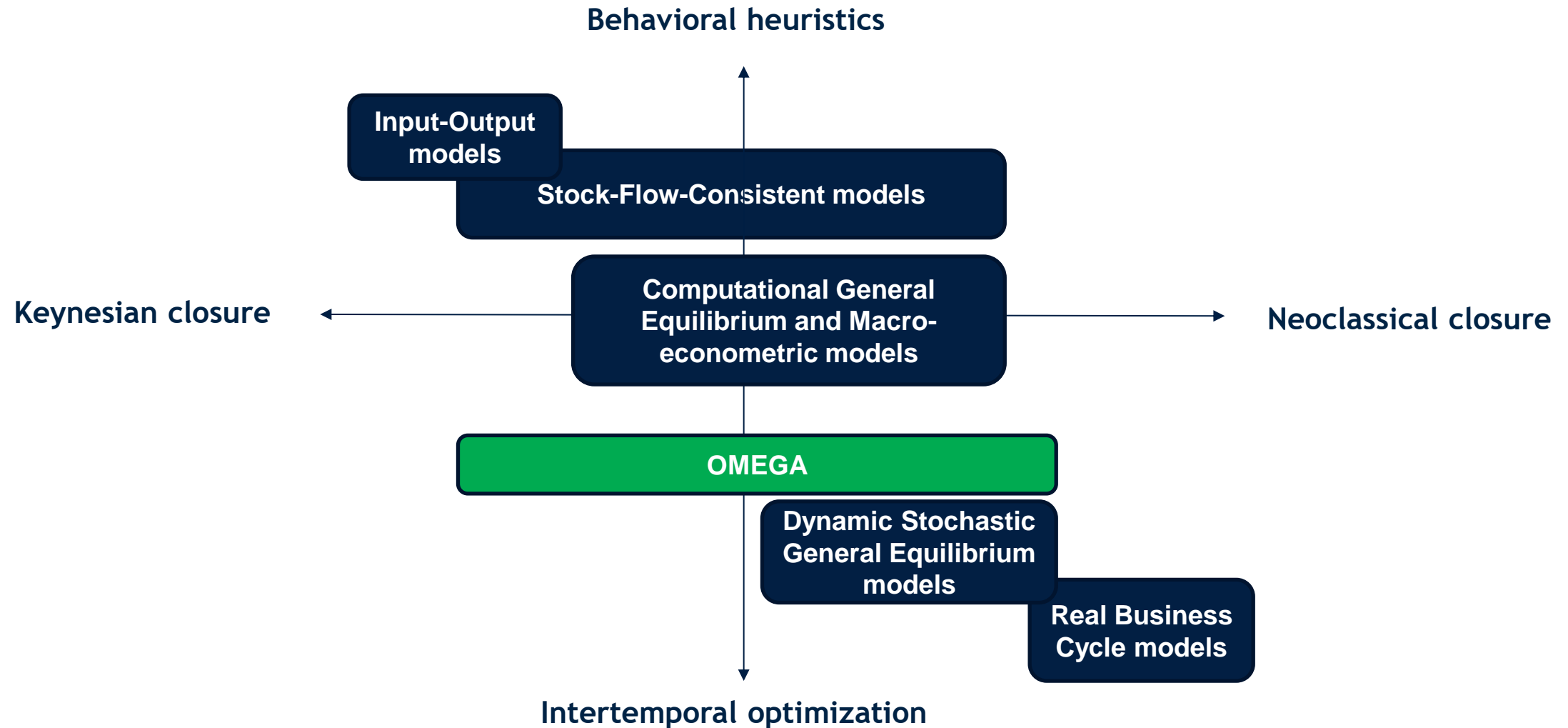
Expected future events affect current economic behavior.



Bayesian estimation

The model is estimated using prior information and historical data.

Where to locate OMEGA?



Disequilibrium vs. General Equilibrium (Schoder 2017 SCED, 2020 EM)

Labor-market elasticity of wage inflation
How sensitive do wages respond to labor-market tightening?

zero



infinity

Pure Keynesian disequilibrium closure

- > Principle of effective demand
- > Demand shocks drive output
- > Productivity shocks drive input demand

Pure neo-classical general equilibrium closure

- > Factor-market constrained output
- > Demand shocks drive inflation
- > Productivity shocks drive output

Elasticity is estimated and model closure determined by the data.

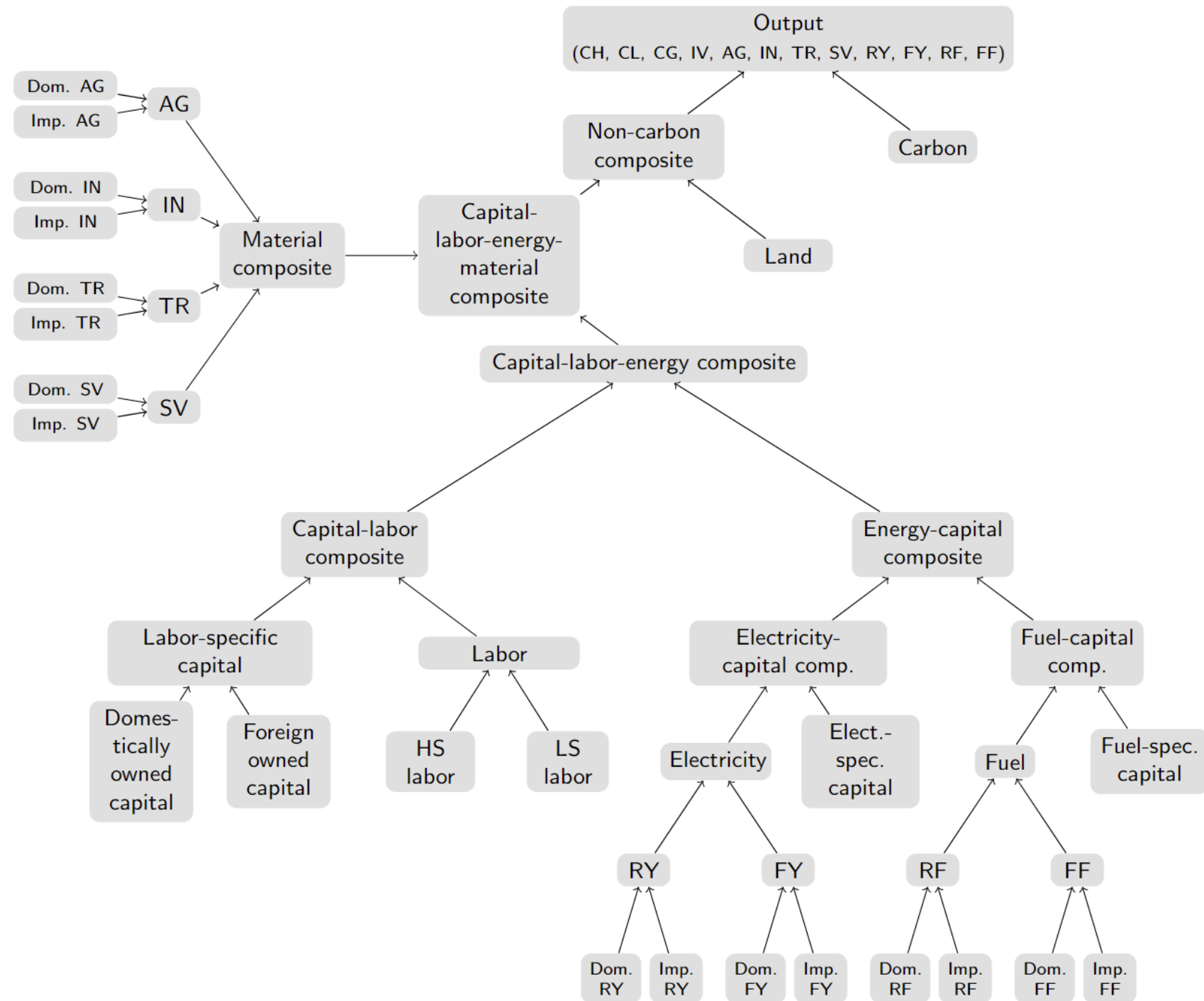
Core assumptions

Production structure

CH High-skilled consumption goods
 CL Low-skilled consumption goods
 CG Government consumption goods
 IV Investment goods
 AG Agriculture
 IN Industry
 TR Transport
 SV Services
 RY Renewable electricity
 FY Fossil electricity
 RF Renewable fuels
 FF Fossil fuels
 HS High-skilled
 LS Low-skilled

Notes:

- The sector decomposition of the material composite can be modified according to GTAP but due to computational constraints the number is limited to 6 material sectors.
- Every node is a Constant-Elasticity-of-Substitution (CES) aggregate of 2 inputs except for the material composite which has 4 inputs.
- Carbon and land are natural resources.
- Capital is partly private and public. Public infrastructure is not part of productive capital but affects the productive capital's productivity (see below).



The Ecological Transformation Plan as interpreted by OMEGA Brazil

Policies and scenarios

Core policies (policy package):

- Emission trading system (ETS) with a 2.1% cap reduction per year and voluntary carbon market.
- Green public investment in electricity and low-carbon transport infrastructure: BRL 212 billion or 2.1% of 2023 GDP – 90% financed by private sector.
- De-risking of renewable electricity and biofuel sectors.
- Removal of finance premium on electricity-specific capital investment.
- Linking regulated lending rate to low-carbon practices in agriculture.
- Restrictive policy stance on deforestation.

OMEGA Dashboard

<https://datanalytics.worldbank.org/omegareultsbrazil/>

- Compare indicators by policy scenario or by credibility scenario
- Results reported in level units, per-capita units, deviations from base quarter, deviations from base line, share of trend GDP, share of actual GDP.

OMEGA Simulation Results for Brazil Scenarios Policy Interventions Results

Select the Variable Group

Macroeconomic Variables

Select the Variable

Private Investment

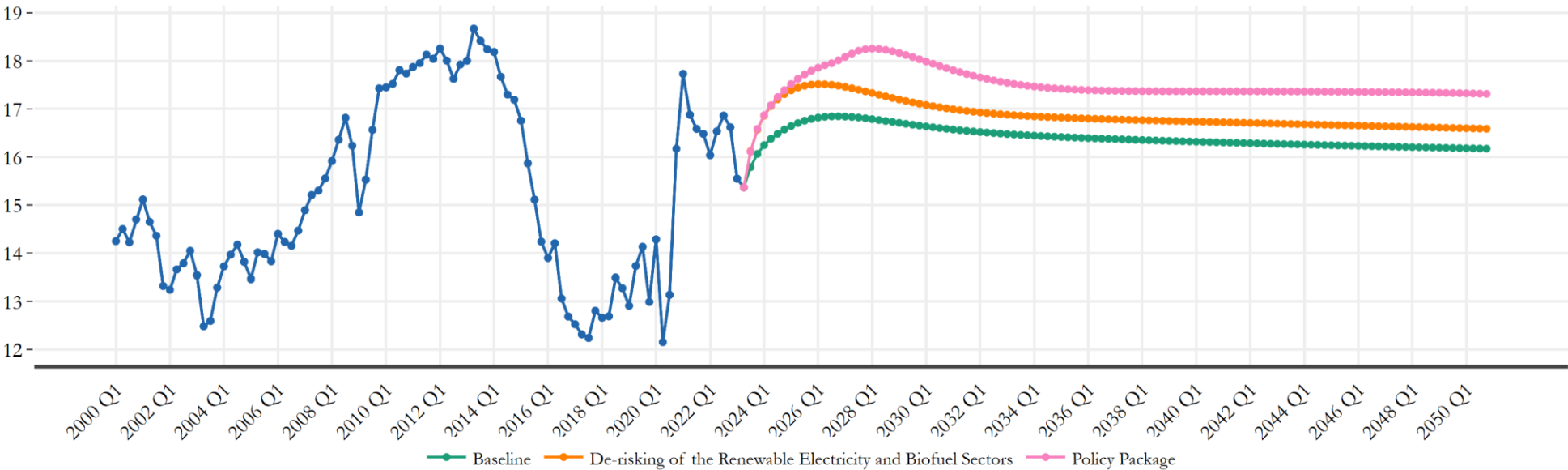
Compare by

Policy Scenarios

Select the Policy Scenarios

- ☒ Baseline
- ☐ Conditioning the Regulated Lending-rate on Emission Reductions
- ☒ De-risking of the Renewable Electricity and Biofuel Sectors
- ☐ ETS with an Annual 2.1% Cap Reduction
- ☐ Permanent Increase of Electricity and Transport Infrastructure Capital
- ☒ Policy Package

Private investment as shares of actual GDP (percent)



Source: OMEGA Simulations for Brazil.
Perfect Foresight: The government announces the paths of the future policy interventions to the public who deems the announcement fully credible.; Baseline: Autonomous energy efficiency improvement 2% per year, re improvement 1% per year, process emission intensity reduction 2% per year. Unsustainable deforestation phases out at a rate of 1% per quarter.; Policy Package: Baseline plus ETS with 2.1% cap reduction per year, electi infrastructure investment, derisking of renewable electricity and biofuel sectors, reduction of finance premium for electricity-specific capital investment, and restrictive deforestation policy stance.; De-risking of the Renew Biofuel Sectors: Baseline plus permanent elimination of equity risk in renewable electricity sector and biofuels sector at a phase-out rate of 5% per quarter..

Policy scenario: ETS with 2.1% cap decrease

Key policy parameters of the compliance carbon market

Shares of emissions covered by the compliance market in each sector:

Agriculture	Industry	Transport	Services	Renewable electricity	Fossil electricity	Renewable fuels	Fossil fuels
0%	80%	50%	50%	0%	70%	0%	90%

Share of free carbon allowances:

Gradually decrease from 100% to 0% over 20 years.

Share of abatement-backed and reforestation-backed carbon credits in total emission permits:

5% each

Start date of ETS:

Immediate

Policy scenario: Public investment in electricity infrastructure

Infrastructure vs. production capital

			Agriculture	Industry	Transport	Services	Electricity	Fuels
Annual production investment delta as % of trend-GDP:	Annual infrastructure investment delta as % of trend-GDP:		0%	0%	0.3%	0%	0.3%	0%
		Externalities of infrastructure categories on the productivity of private capital types in each sector						
0%	Agriculture	Labor-specific capital	<p>Matrix of elasticities</p> <p>By how much does an increase in infrastructure investment in category “electricity” raise the marginal product of private “labor-specific capital in industry?”</p>					
0%		Electricity-specific capital						
0%		Fuel-specific capital						
0%	Industry	Labor-specific capital						
0%		Electricity-specific capital						
0%		Fuel-specific capital						
0%	Transport	Labor-specific capital						
0%		Electricity-specific capital						
0%		Fuel-specific capital						
0%	Services	Labor-specific capital						
0%		Electricity-specific capital						
0%		Fuel-specific capital						
0%	Renewable Electricity	Labor-specific capital						
0%	Fossil Electricity	Labor-specific capital						
0%	Biofuels	Labor-specific capital						
0%	Fossil Fuels	Labor-specific capital						

Policy scenarios

Figure 1A: Government-issued Carbon Credits under the ETS (MMTCO₂e)

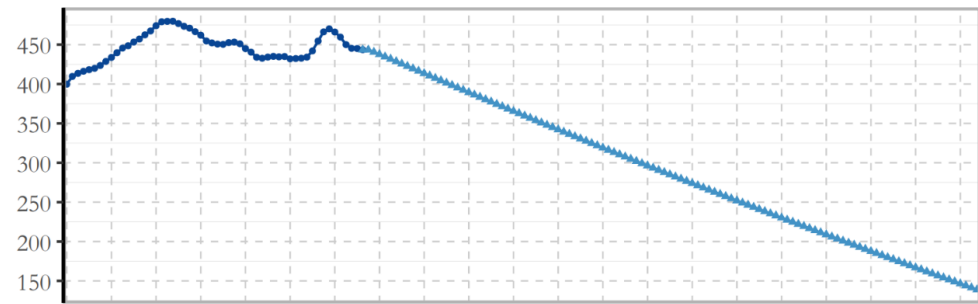


Figure 1B: Public Infrastructure Investment in Electricity and Low-Carbon Transport in Annualized Levels (\$US2015 Billion)

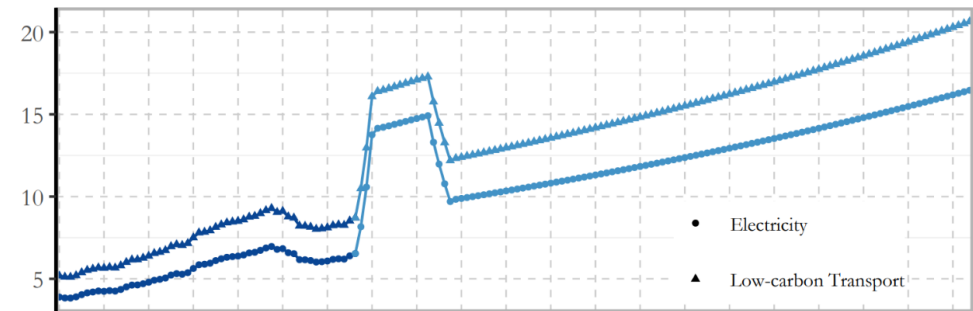


Figure 1C: Equity Risk Premium for Renewable Electricity and Biofuels (Voluntary under the ETS) in Annualized Levels (Percentage Points)

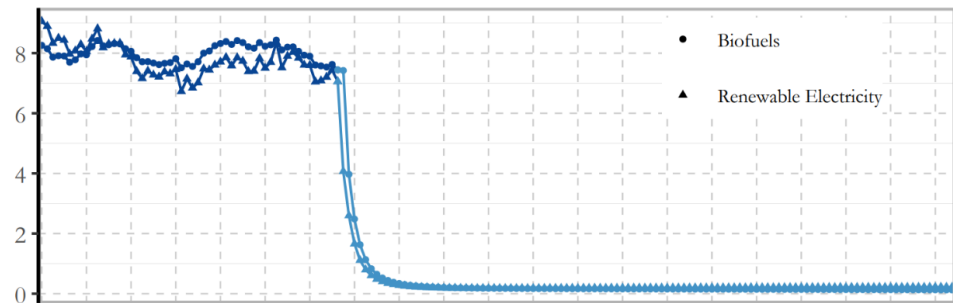


Figure 1D: Short-term Electricity-specific Capital Investment Finance Interest Rate in Annualized Levels (Percent)

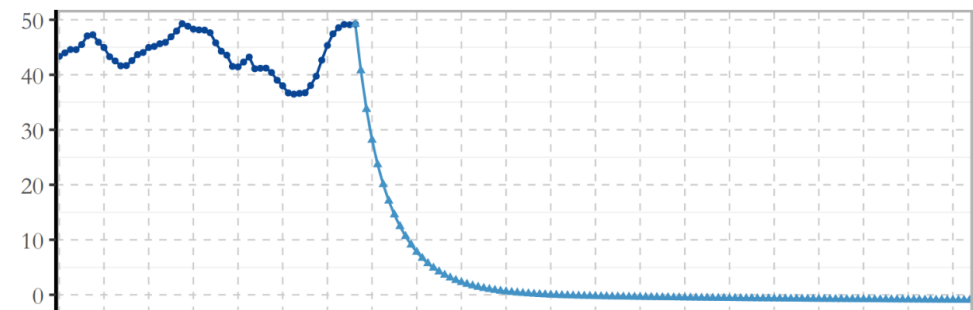


Figure 1E: Spread between the Policy Lending Rate and the Sustainability-linked Lending Rate for Agriculture (Percentage Points)

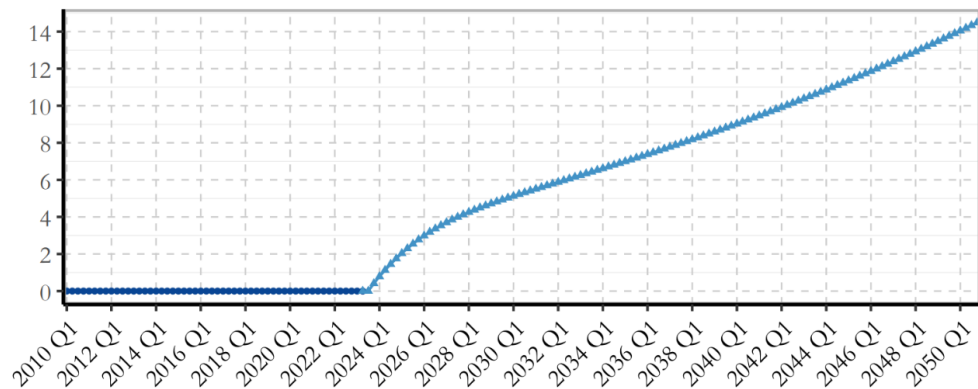
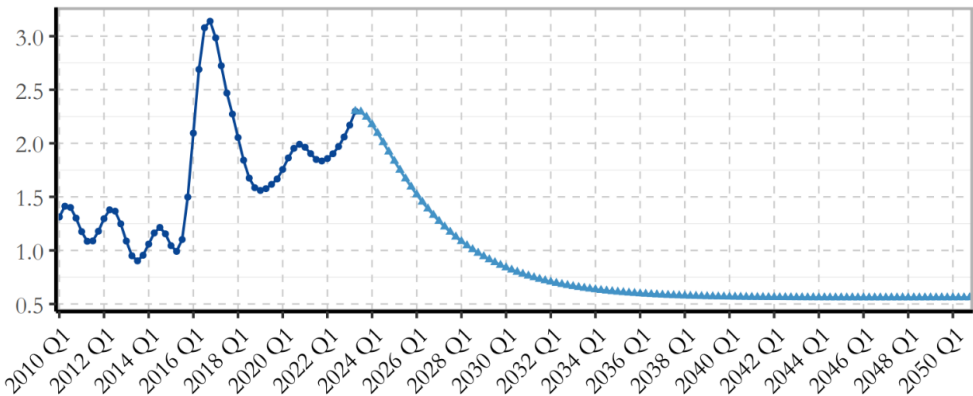
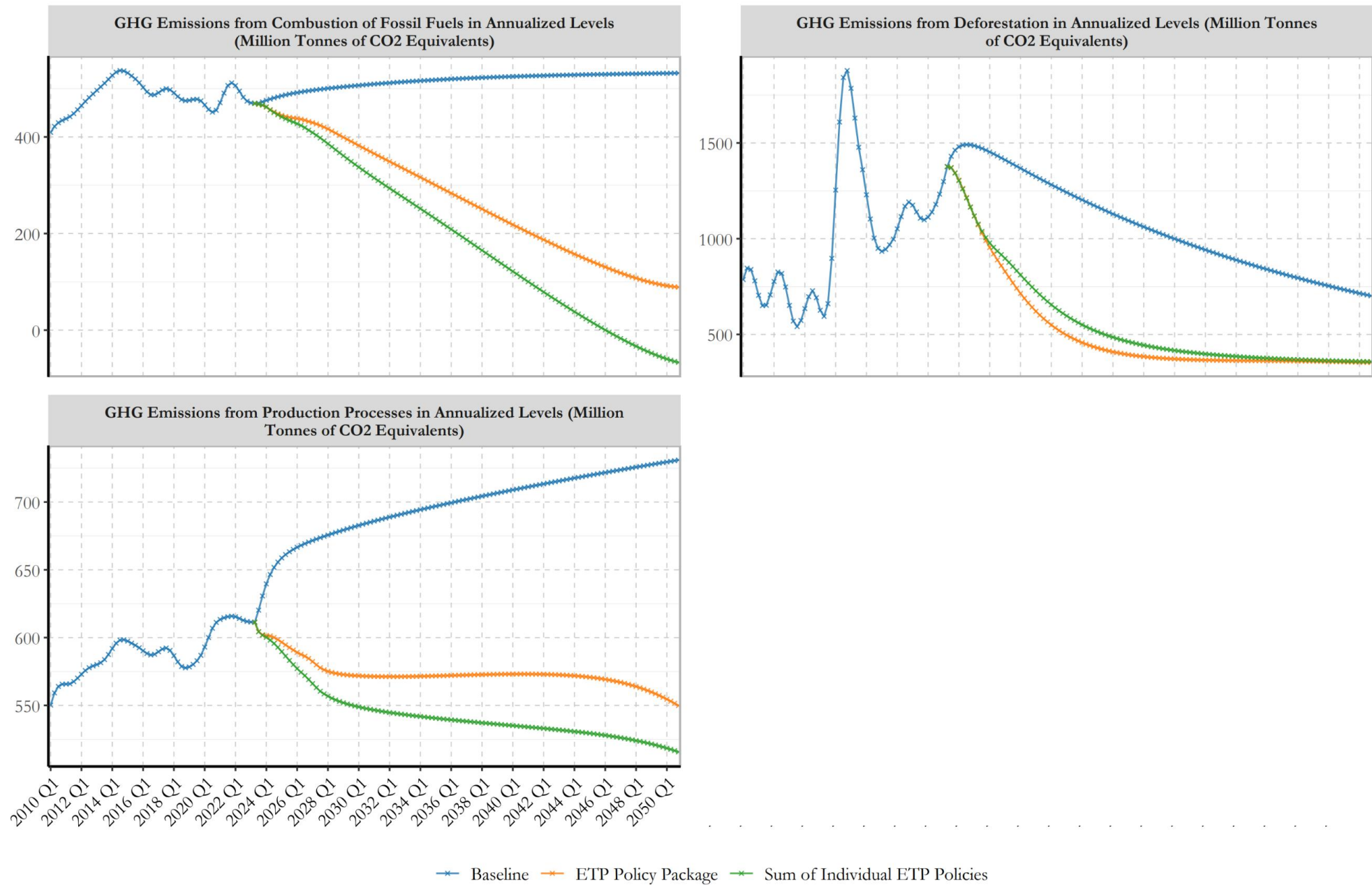


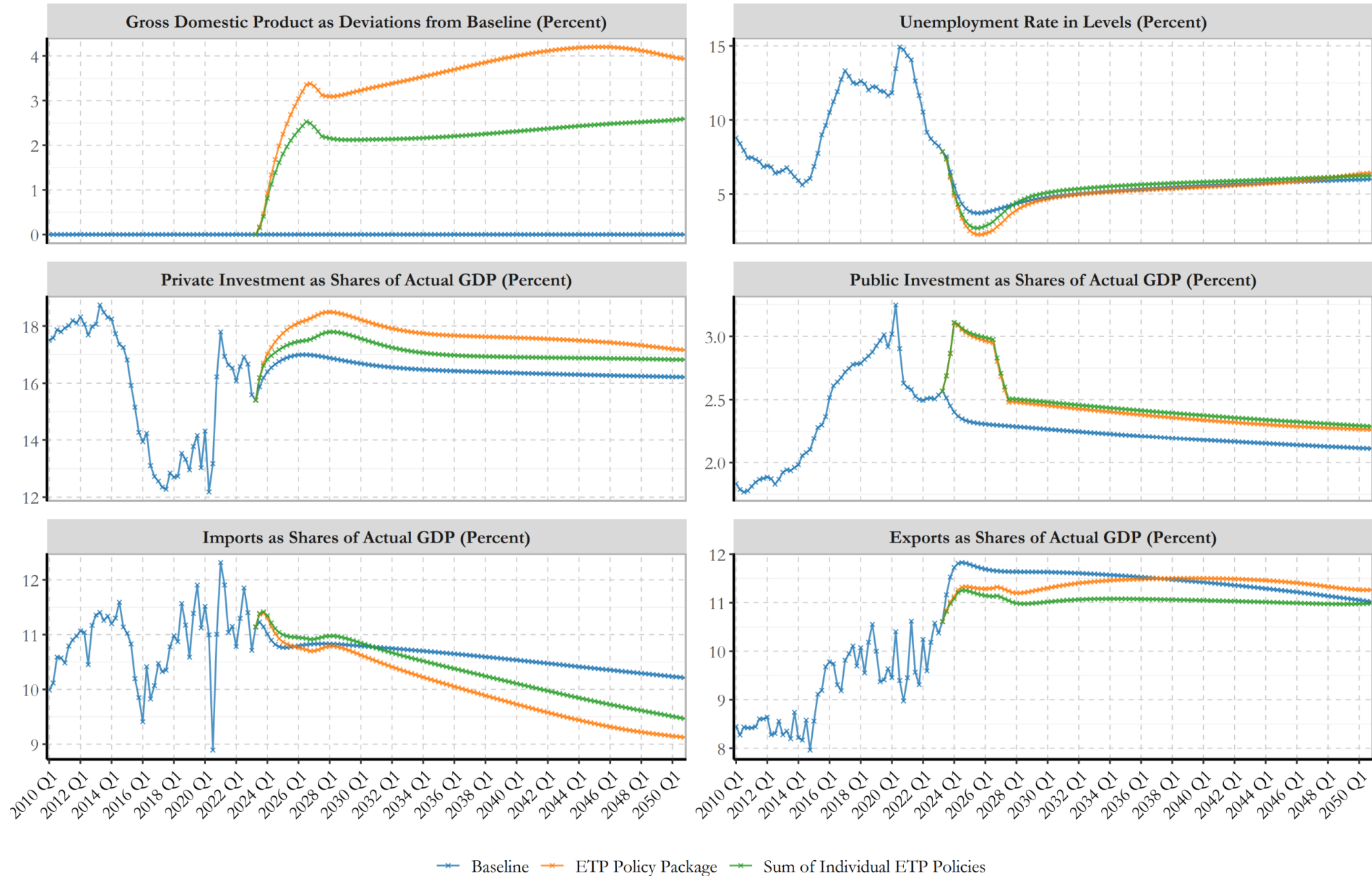
Figure 1F: Total Deforestation of Primary Forest in Annualized Levels (Million Hectares)



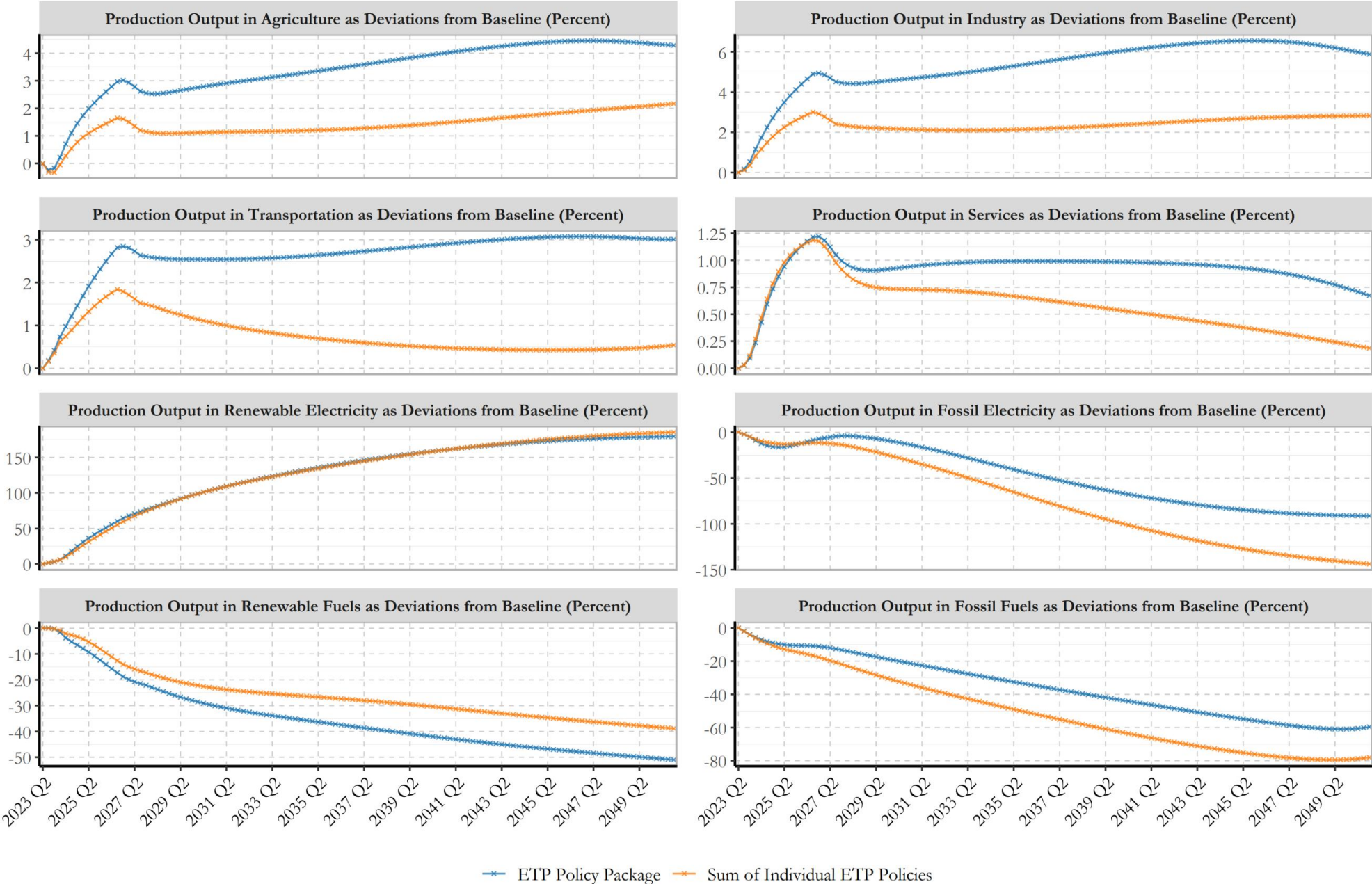
Results: GHG emissions



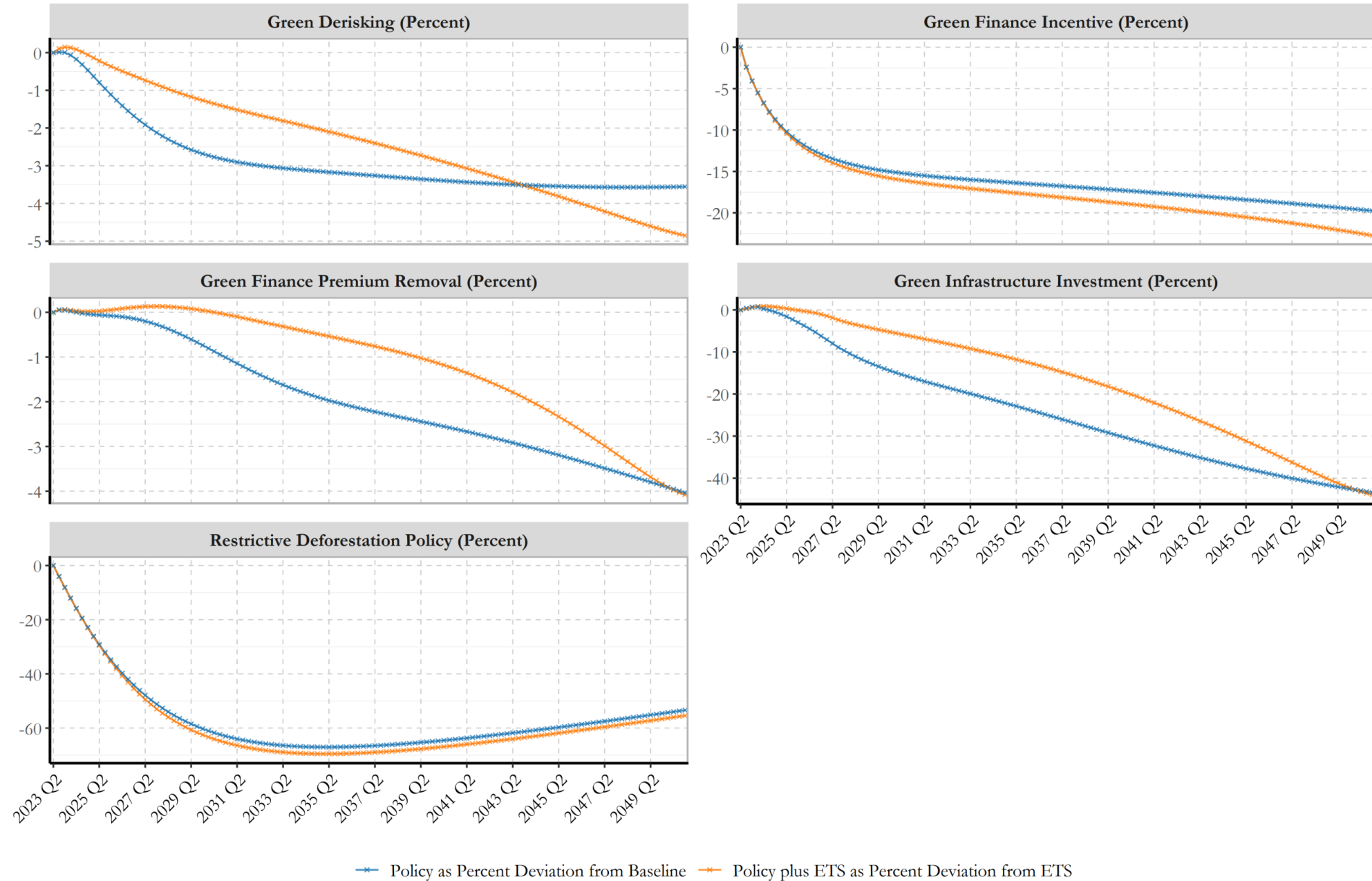
Results: macroeconomic indicators



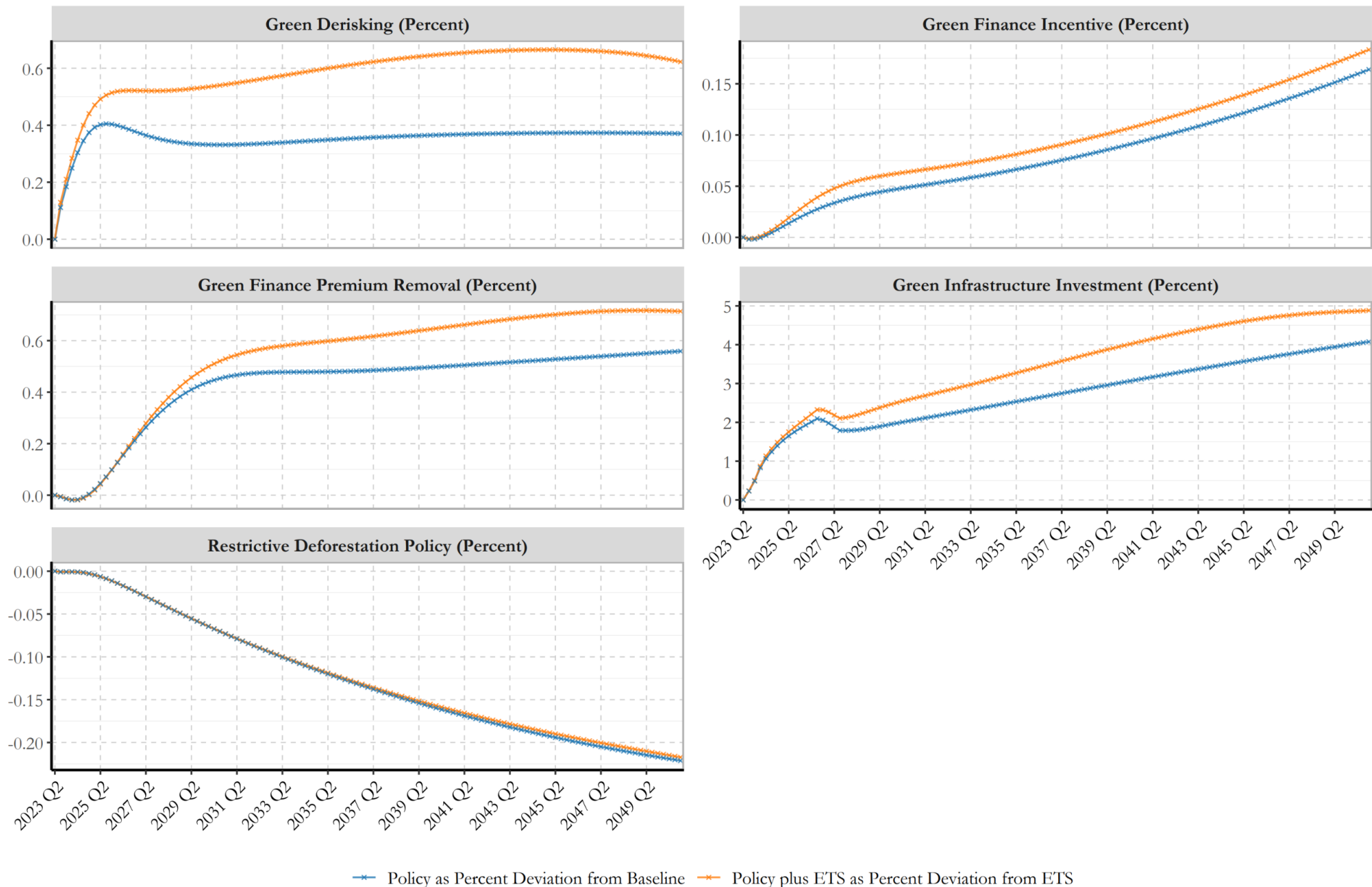
Results: sector-specific indicators



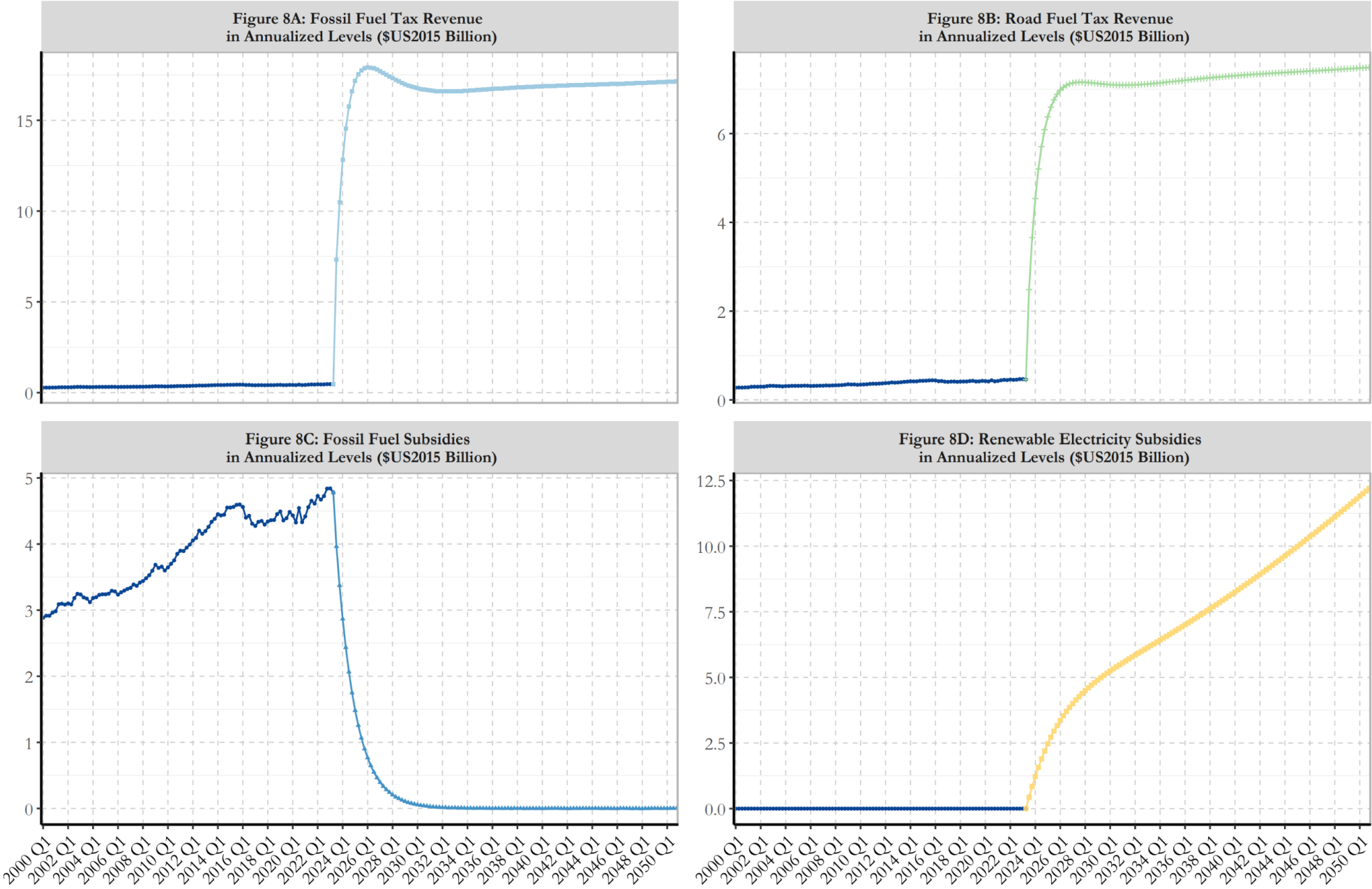
Results: interaction of ETP policies with ETS – GHG emissions



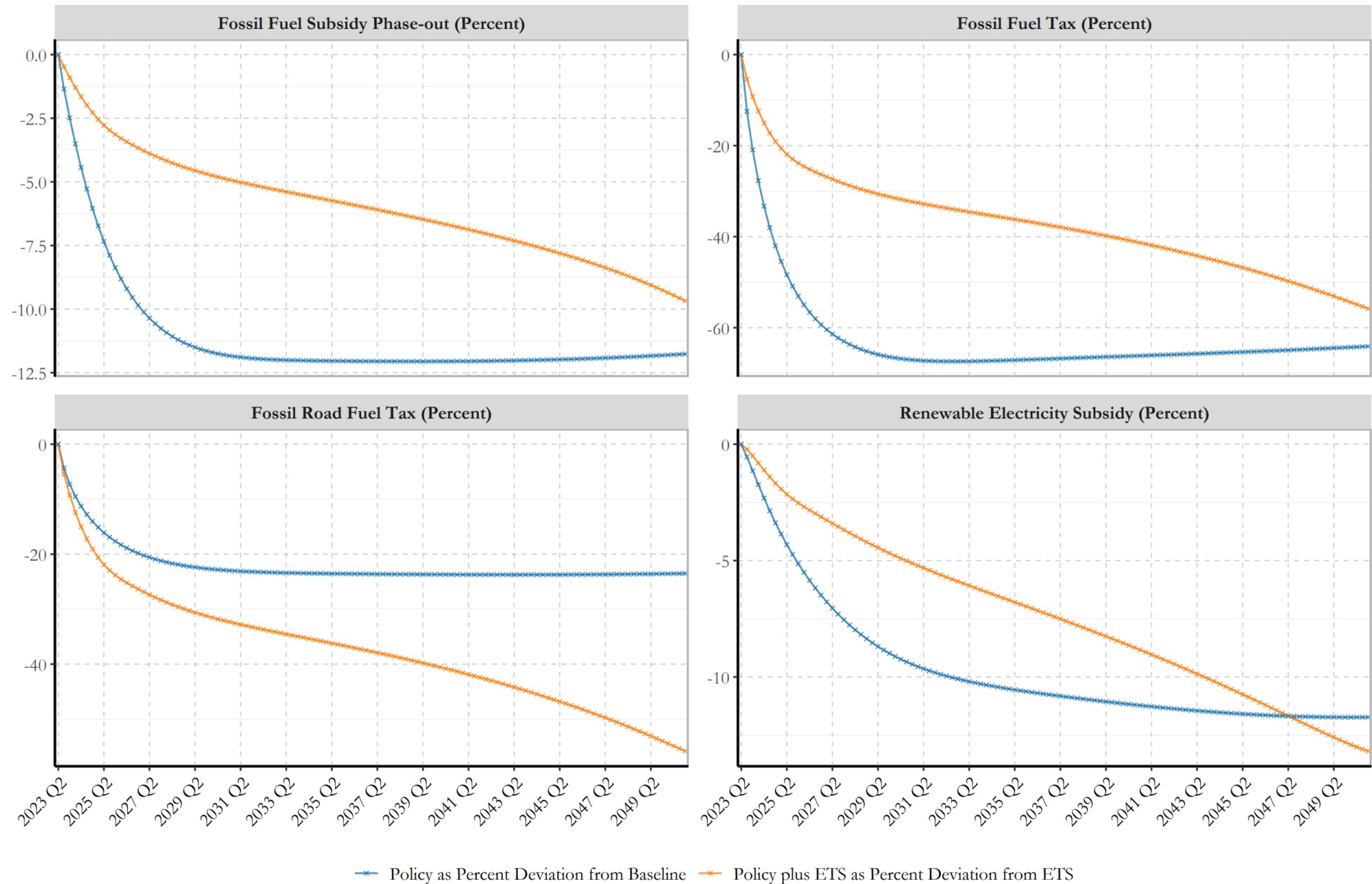
Results: interaction of ETP policies with ETS – GDP



Additional policies



Results: interaction of additional policies with ETS – GHG emissions



Concluding remarks

Overall, OMEGA projects the ETP to keep non-deforestation GHG emissions roughly constant.

Emissions from agriculture are the primary culprit. Emissions from transport and services keep increasing, too.

The ETS is projected to reduce GDP slightly, but public infrastructure investment can easily compensate.

Of all policies in the policy package, the ETS is the most effective one to curb emissions.

However, combining additional policies with an ETS is challenging due to the “waterbed” effect. They need to be designed carefully or they will primarily affect the price for carbon credits. Finance incentive works well in AG.

Browse through all simulation results: <https://datanalytics.worldbank.org/omegareresultsbrazil/>

Obrigado!