The Macro-Critical Implications of Transition Spillover Risks: Evidence from Indonesia

Régis Gourdel, *Vienna University of Economics and Business*,
Irene Monasterolo, *EDHEC Business School, EDHEC-Risk Institute*,
& Kevin Gallagher, *Global Development Policy Center, Pardee School of Global Studies, Boston University*
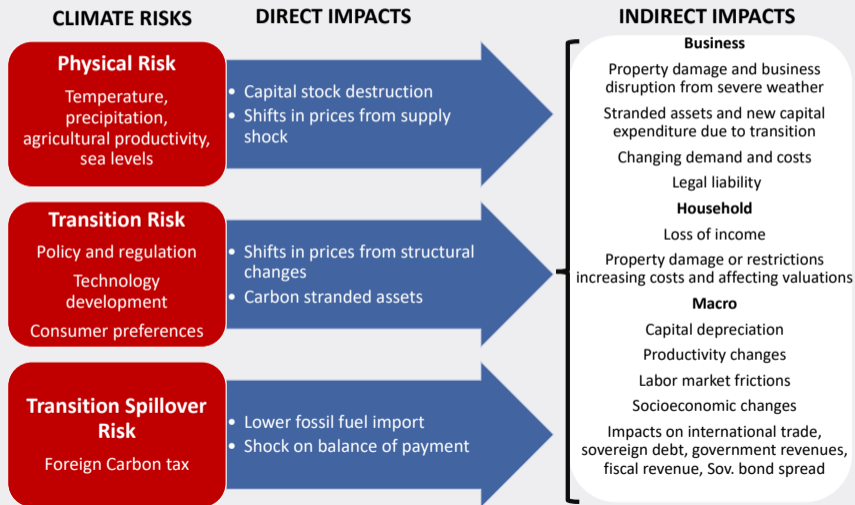
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Background and motivation

The macro-critical aspects of climate change and climate change policy for developing countries

CLIMATE RISKS

DIRECT IMPACTS

INDIRECT IMPACTS

Physical Risk
Temperature, precipitation, agricultural productivity, sea levels

- Capital stock destruction
- Shifts in prices from supply shock

Transition Risk
Policy and regulation
Technology development
Consumer preferences

- Shifts in prices from structural changes
- Carbon stranded assets

Transition Spillover Risk
Foreign Carbon tax

- Lower fossil fuel import
- Shock on balance of payment

Business
Property damage and business disruption from severe weather
Stranded assets and new capital expenditure due to transition
Changing demand and costs
Legal liability

Household
Loss of income
Property damage or restrictions increasing costs and affecting valuations

Macro
Capital depreciation
Productivity changes
Labor market frictions
Socioeconomic changes
Impacts on international trade, sovereign debt, government revenues, fiscal revenue, Sov. bond spread

Research questions

- What are the macro-critical implications of carbon pricing in China on Indonesia?

- Through which channels would a coal demand shock to Indonesia impact macroeconomic performance?

- What lessons for IMF and domestic policy?

What this paper does

1. We elaborate on the concept of climate-related "transition spillover risks" and the channels that such risks can have macro-critical impacts on developing economies.

2. We adapt the EIRIN stock-flow macro-financial model that is being used by an increasing number of central banks in the NGFS to examine physical and transition risks in national economies—to examine transition spillovers (Monasterolo and Raberto, 2018).

3. We apply this application under the most recent NGFS scenarios to estimate the impact of a demand shock for coal exports due to climate transitions in China.

4. We draw some lessons regarding how the International Monetary Fund might deploy these insights into their toolkit as they develop an overarching climate strategy at the IMF.

NGFS scenarios

Description of scenarios

We consider 3 scenarios developed by the Network for Greening the Financial System in 2021:

- **Current policies**: assumes that only currently implemented policies are preserved. Emissions grow until 2080 leading to about **3°C** of warming and severe physical risks: "hot house world" or "business-as-usual".
- **Below 2°C**: gradually increases the stringency of climate policies, with an immediate start, with 66% chance of limiting global warming to below 2°C.
- **Net zero 2050**: ambitious scenario that limits global warming to **1.5°C** by the end of the century (with a 50% chance) through stringent climate policies introduced immediately and innovation.

We consider scenarios trajectories developed with the process-based Integrated Assessment Model (IAM) REMIND-MAgPIE 2.1-4.2 (geographical downscaling).

Carbon pricing (NGFS scenarios, South East Asia)

Carbon taxes are collected on all sectors based on their total emissions, the tax rate is applied uniformly to all.
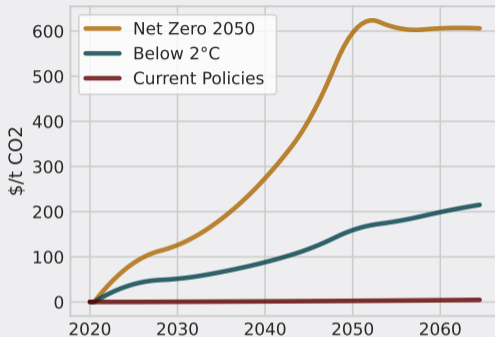

Figure: Evolution of the carbon price in USD 2010 per ton of CO2-eq under the different scenarios.
Source: NGFS scenarios 2021, from the model REMIND-MAgPIE 2.1-4.2 IntegratedPhysicalDamages (median), region "other Asia".

Shock on Chinese coal demand

Big coal importers like China are expected to wind down their use of carbon as a primary energy source. Although the scenario of numerous coal power plants closure is little expected, from recent policy commitment.
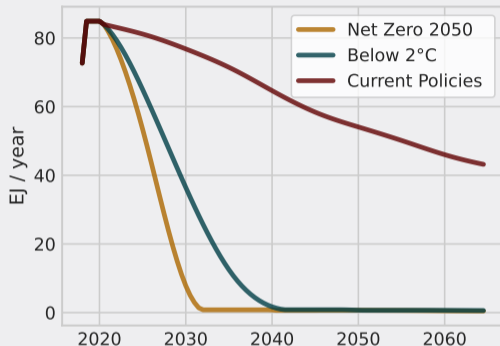
Figure: Use of coal by China, as a reference series to shock the quantity exported by Indonesia. Source: NGFS scenarios 2021, from the model REMIND-MAgPIE 2.1-4.2.
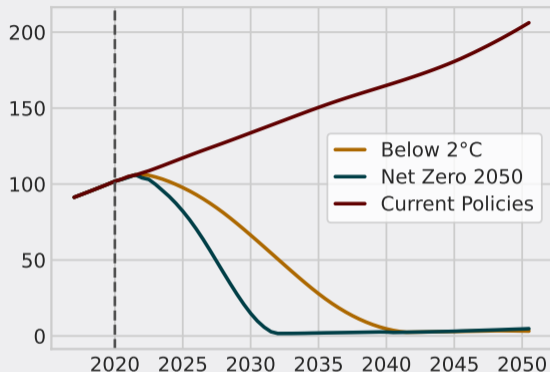
Macro-financial risk transmission channels
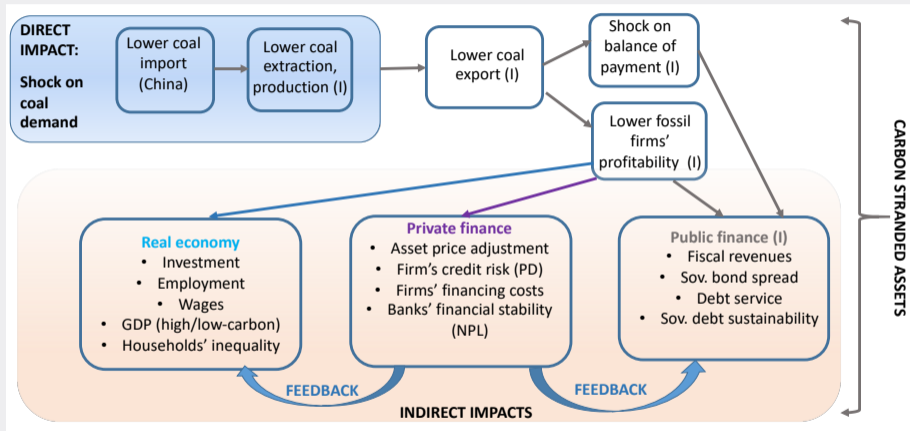
Results

Export of Indonesian mining industry

Quantities of fossil fuel exported follow very different path, given endogenous pricing of fossil fuels.

Figure: Total value of coal and other fossil fuel exported by Indonesia, indexed at 100 at the start of the scenarios and adjusted for inflation.

GHG emissions of Indonesia

Consistently with the scenario designs, total GHG emissions are smaller for "Net Zero 2050" and "Below 2°C", but not to the extent planned by the NGFS (due to the absence of CDR). The reduction comes mostly from the mining sector's operations. This adds to lower emissions on the side of coal importers with the transition paths.
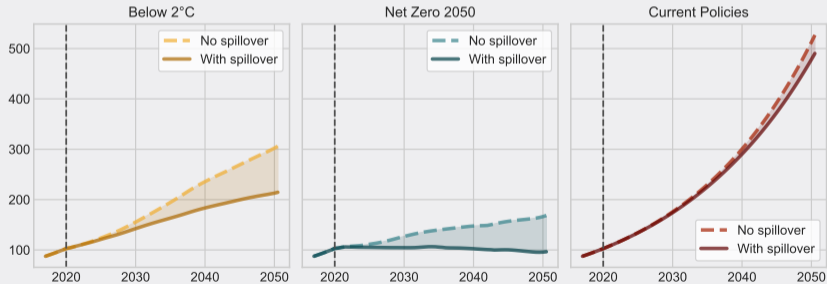

Figure: Total GHG emissions from the domestic economy, indexed at 100 at the starting time of the scenarios.

GDP growth in Indonesia

Spillover risk leads to lower GDP growth in all scenarios for most periods:

- direct effect: export is a component of GDP;
- indirect effect: reduces the activity of the mining company $\longrightarrow$ decreases its demand for labour and profits reversed to the government, etc.
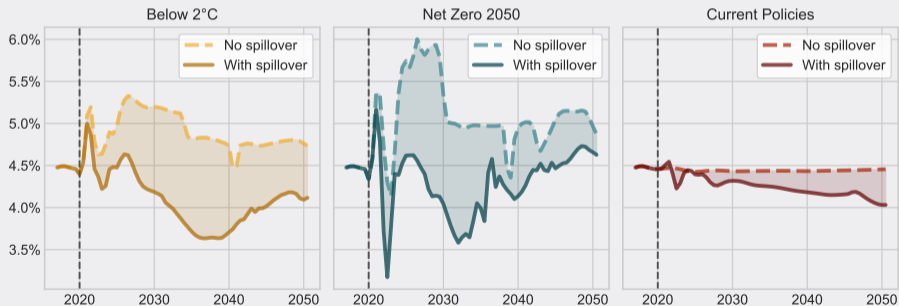
Figure: GDP growth in percentage points.

Balance of Payments (BOP) in Indonesia

BOP deteriorates, in particular in Below 2°C and Net Zero scenarios. This reflects the shock on fossil fuel exports and is in line with the weight of the mining sector.
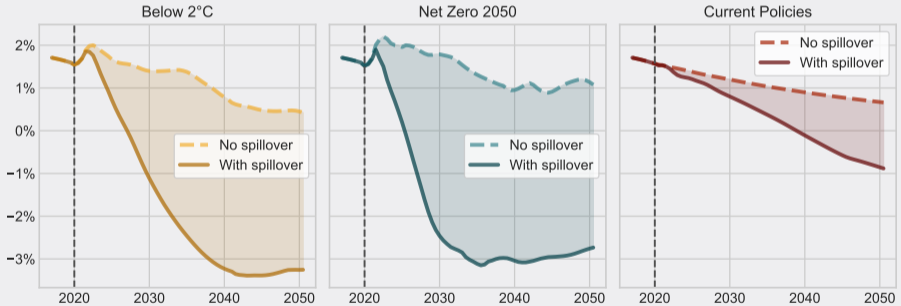
Figure: Evolution of the balance of payment, as percentage of GDP.

Budget balance in Indonesia

Effects on budget balance are similar, mostly due to loss of revenues from taxes and government-owned mining sector, plus indirect effects.
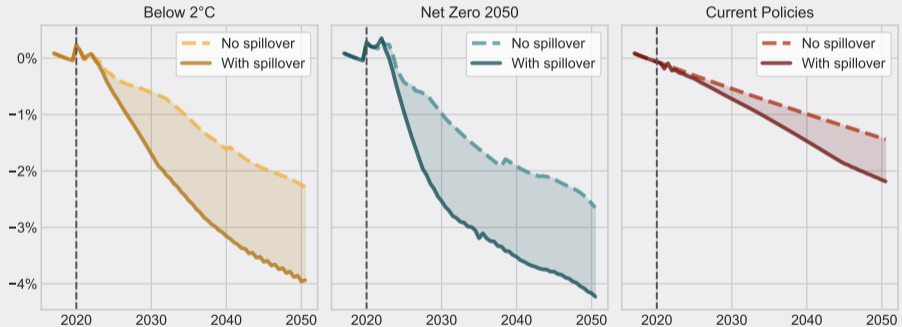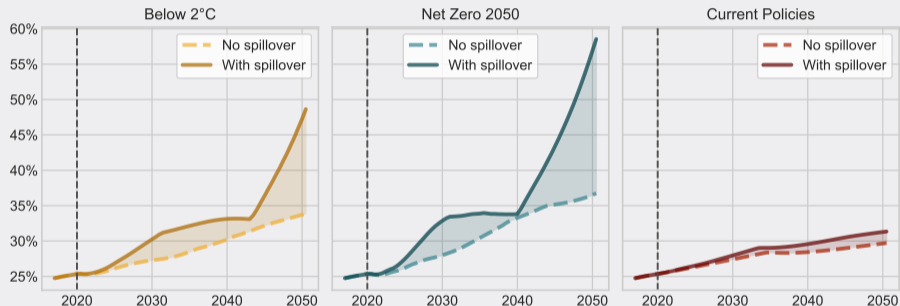

Figure: Evolution of the government's budget balance, as percentage of GDP.

Public debt in Indonesia

Public debt increases in all NGFS scenarios when we account for spillover transition risk, in line with worsening budget balance.

Figure: Evolution of public debt ratio to GDP in percentage points.

Conclusion

Conclusion

- Main results:
  1. Climate transition spillovers can lead to lower GHG emissions in Indonesia.
  2. However, it can also lead to significant sovereign risk
     - slowdown in economic growth largely due to a significant slowdown in coal production;
     - negative impact on balance of payments and public debt balances;
     - potential losses from stranded assets.
- Results call for coordinated transitions in the South-East Asia region.
- IMF has a key role to play in smoothing the macro-critical adjustment costs of a just transition through financing and surveillance activity
- Results from EIRIN modeling efforts can guide the IMF in its advisory functions $\longrightarrow$ reforming FSAPs and Article IV reports.

Appendix

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Transition spillover risk and climate policies in Indonesia

- China is first importer of coal from Indonesia, increasing after tensions with Australia and Beijing loosened curbs on imports to tackle its power crisis (39.08 million tonnes in 2020).
- Resulting increase in coal prices helped Indonesia to bounce back from the covid-19 pandemic (Ruehl, 2021)
- Indonesia produces 53% of it electricity from coal, the highest number for the Southeast Asia region (ADB, 2021)
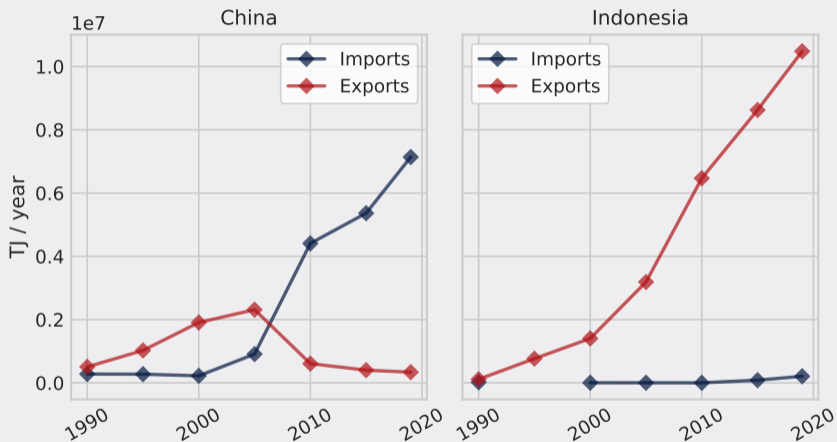- 64% of the new coal projects have a negative NPV (Ray et al., 2021)

Indonesia's Fossil Fuel Exports: The Key Role of Coal
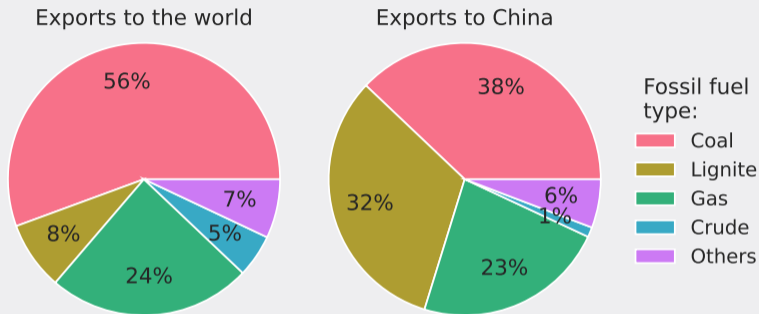
Figure: Breakdown of Indonesian fossil fuel exports, globally and to China in particular. Source: UNSD Comtrade.
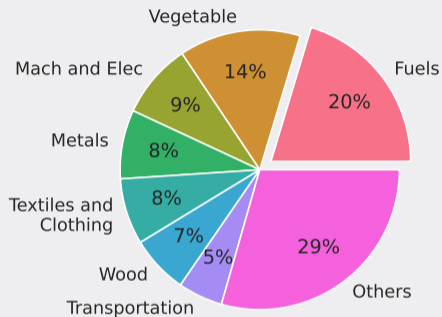
Coal: net importers and exporters

Figure: Exports and imports of coal by China and Indonesia in tera Joul.
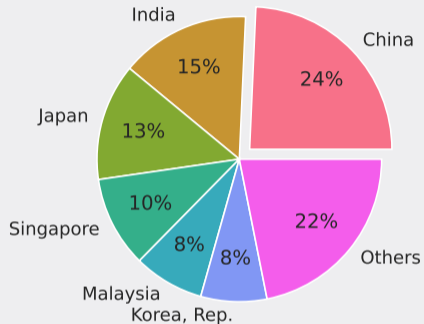Source: IEA.

Indonesia's export profile

(a) Exports by product

(b) Fuel importers

Figure: Details of Indonesia's exports, looking at the breakdown of merchandises exported and the top trading partners for fuel.
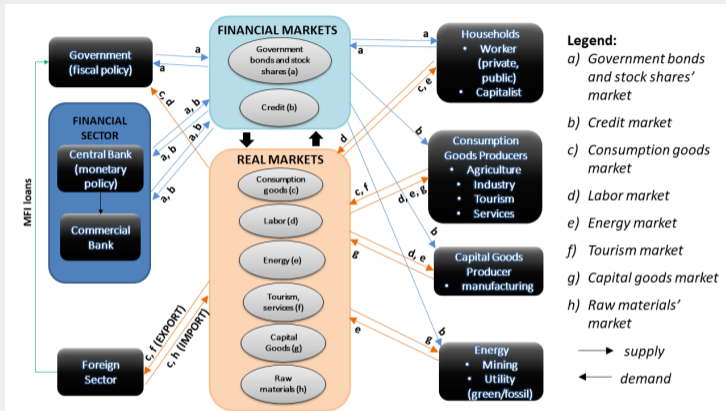Source: WITS - UNSD Comtrade.

EIRIN: main characteristics

- **Agents' heterogeneity**:
  - capitalist/worker households (Goodwin, 1967),
  - dirty/green sectors
- **Real and monetary flows** (incl. endogenous money creation)
  - Central Bank sets the interest rate according to a Taylor-like rule
  - Banks subject to Basel III Regulatory Capital Adequacy Ratio (CAR)
- **Leontief** production function

- **Agents' adaptive expectations** in the context of deep uncertainty
- **Behavioural rules**:
  - Households' saving/consumption (**Deaton's Buffer-Stock Theory**): maximize their ability to consume in the future
  - Firms' investment decision are endogenous, based on **Net Present Value** (NPV)

Model version similar to the ECB application of Gourdel et al. (2021), enriched with spillover shock-specific features.

The EIRIN macro-financial model

Agents and sectors interact through real and financial markets.
Outgoing arrows: supply. Incoming arrows: demand.

Black boxes: heterogenous agents and sectors.
Blue box: financial markets.
Orange box: real markets.

EIRIN: a network of interconnected balance sheets

Stock-Flow Consistency provides a rigorous accounting framework: equilibrium conditions substituted by accounting identities that hold irrespective of behavioural assumptions.
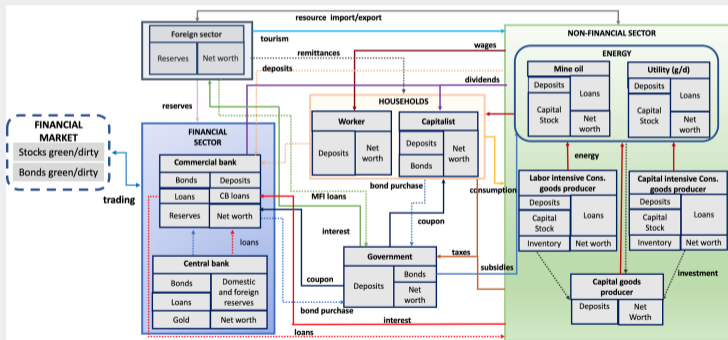
Figure: EIRIN framework: capital (dotted) and current (solid) account flows.

Model calibration

EIRIN depends on more than 100 parameters, which are split in two groups:

1. Parameters that can be calibrated on real data, e.g. taxes or markups;
2. "Free" parameters that cannot be observed directly, but are set such that other endogenously produced values match observed data:
   - growth and inflation,
   - relative value added of the sectors,
   - imports and exports to GDP, with breakdown by sector/products,
   - unemployment rate and sectoral employment share,
   - shares of energy use and carbon emissions of the sectors,
   - ...

Parameters are calibrated based on data from the World Bank, the IMF (WEO), and Bank Indonesia.

Endogenous investments decisions: Net Present Value

The sign of the NPV determines whether the agent makes the **decision to invest**. It compares costs and long term benefits of investment:

$$\text{NPV}(\iota, t) = -p_{\text{K}_\text{P}}(t) \cdot \iota + \sum_{s=t+1}^{+\infty} \frac{\text{CF}(\iota, t, s)}{(1 + \kappa(t))^{s-t}}$$

with ι the quantity of capital, t the time, p_{K_P} the price of capital, κ the interest rate, and CF the **expected cash flow**, made of:

- 1 positive cash flow given by the additional sales due to investment.

- 4 negative:
    1. additional labour costs for increased production capacity,
    2. additional raw materials costs to produce the additional output,
    3. additional energy requirements for producing additional output,
    4. additional carbon taxes from production.

Shock on Indonesian coal exports

- Reduction in coal use by China translates into a reduction of coal import from Indonesia.
- We assume that the Chinese use of coal is representative of the path taken by countries importing from Indonesia.
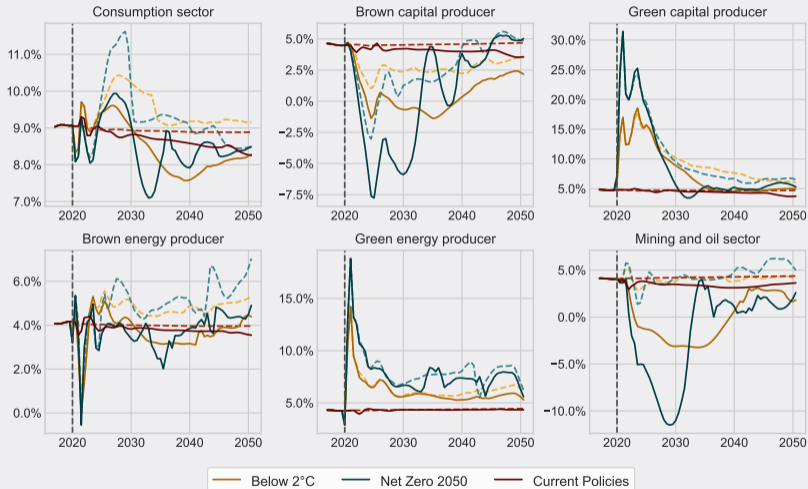
This results in a shock on quantities exported in EIRIN:

$$\tilde{q}(t) = (1 - \varphi(t)) \cdot q(t),$$

where

- q is the baseline export quantity,
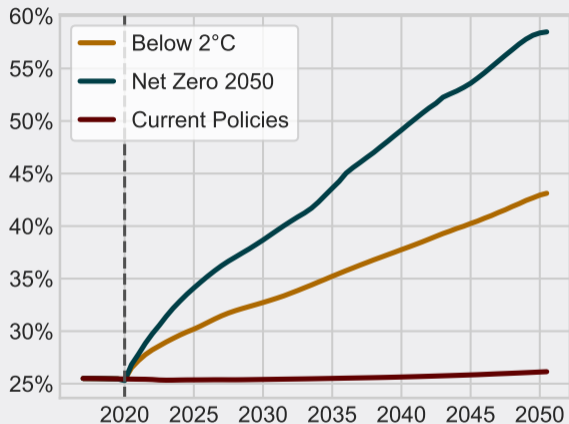- φ describes the relative shock path.

Compared sectoral growth

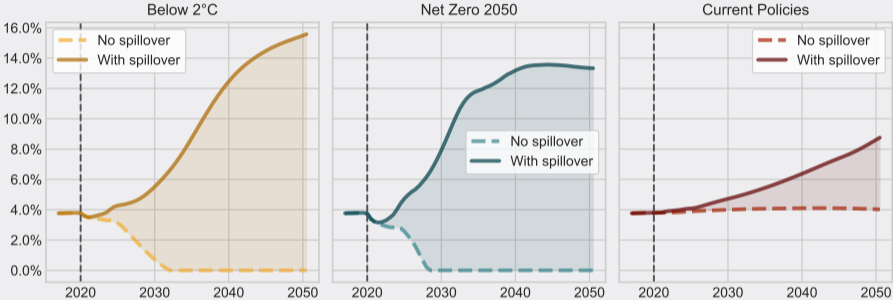**Figure:** Yearly changes in the value added of the real economy agents.
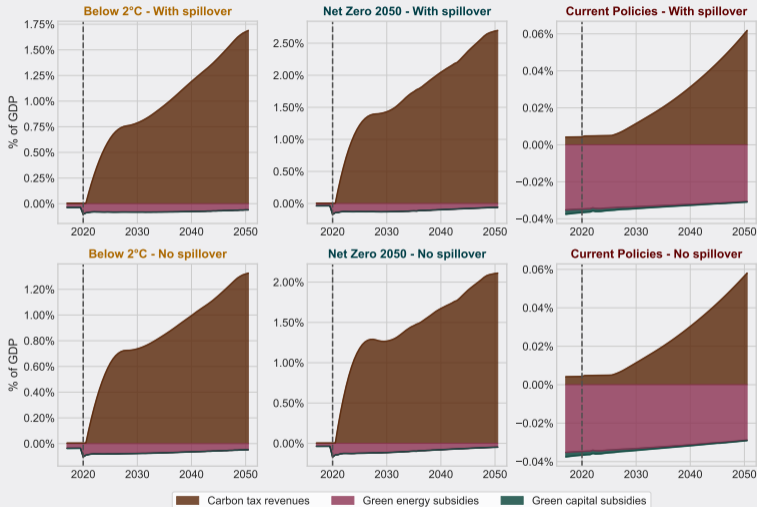
Renewable energy share

Figure: Share of renewable energy over the total produced under the different scenarios, with spillover.

Unemployment rate in Indonesia

Figure: Unemployment rate.

Green policies budget

Figure: Revenues and expenses for the government linked to environmental sustainability.