

Climate transition spillovers and sovereign risk: evidence from Indonesia

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Cross-border climate change impacts and systemic risks in Europe and beyond

Background and motivation

Climate risk studies and scope:

- Physical risk and (domestic) transition risk are widely studied and well understood in their transmission channels
- Lesser understanding of climate spillover transition risk, i.e. the exposure to climate transition risk from the introduction of climate policies in trading partner countries

Research questions:

- What are the macro-critical implications of decarbonization in Asia on Indonesia?
- Through which channels would a coal demand shock to Indonesia impact macroeconomic performance?

Indonesia's export profile

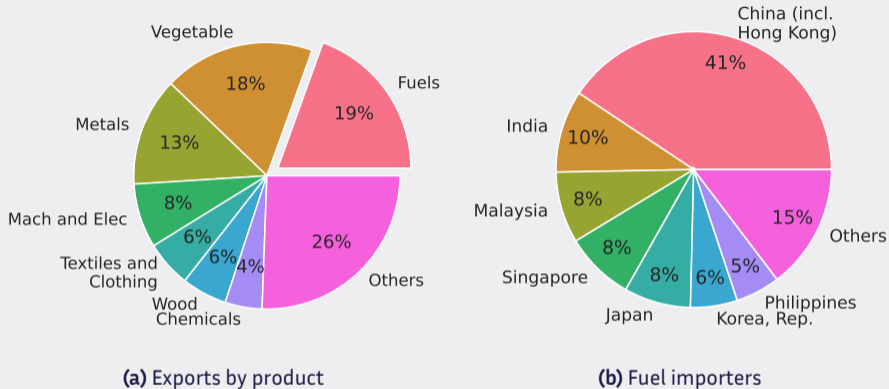


Figure Details of Indonesia's exports, looking at the breakdown of merchandises exported and the top trading partners for fuel.

Source: WITS - UNSD Comtrade.

Coal: net importers and exporters

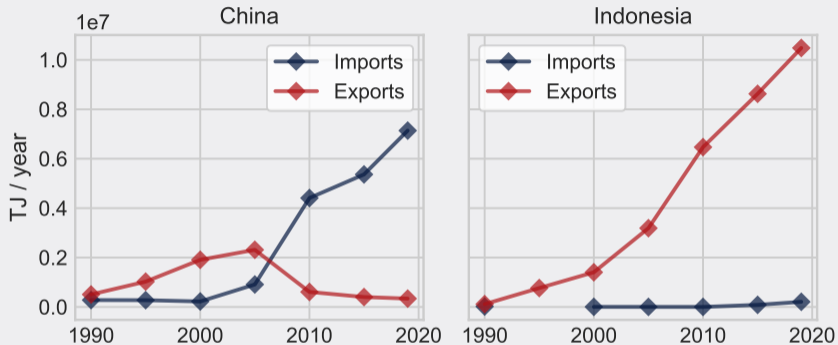


Figure Exports and imports of coal by China and Indonesia in tera Joule.

Source: IEA.

What this paper does

1. Elaborate on the concept of climate transition spillover risks and the channels leading to macro-critical impacts on developing economies
2. Adapt the EIRIN stock-flow macro-financial model to examine physical and transition risks in national economies—to examine transition spillovers (Monasterolo and Raberto, 2018)
3. Apply it to NGFS scenarios to estimate the impact of a demand shock for coal exports due to the low-carbon transition in Asia

The EIRIN macro-financial model

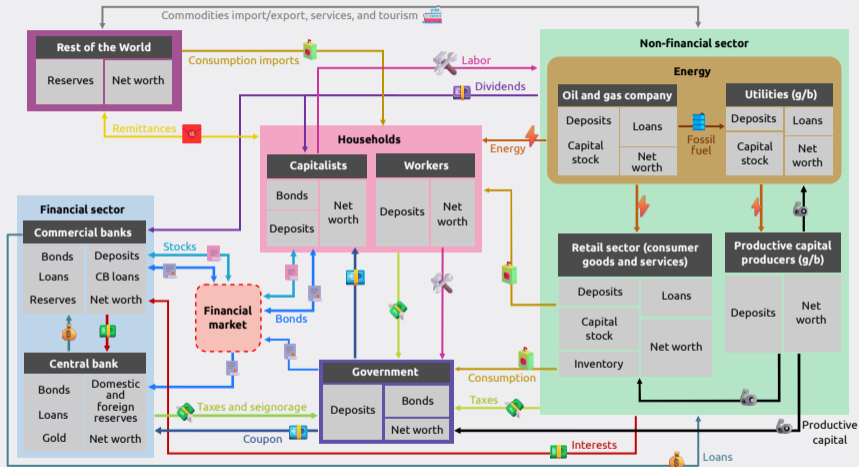


Figure EIRIN framework: capital and current account flows. Agents and sectors interact through real and financial markets.

The EIRIN markets

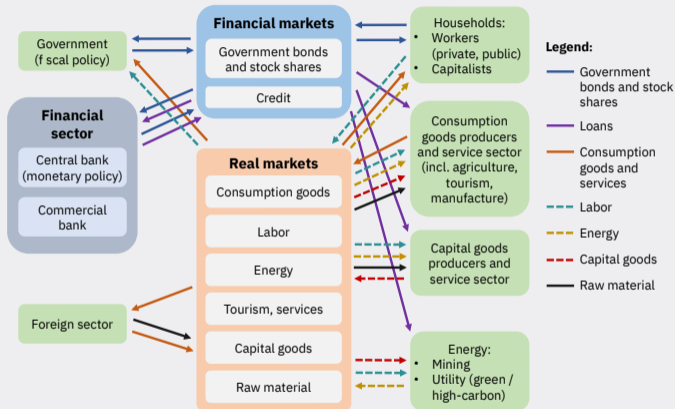


Figure Interaction of EIRIN sectors and markets. EIRIN is a *stock-flow consistent model* where agents are endowed with specific expectations.

Modelling finance: financial markets

Equity market:

- the number of shares available is fixed;
- shares pay dividends, which then influence prices on the market.

Bond market:

- the government issues bonds, which are bought by banks on the primary market;
- they are traded by the bank and capitalist households;
- the central bank buys some bonds on the secondary market.

Modelling finance: the credit market

- The bank grants and extends **credit** to other sector, under the condition that their investments have a positive net present value
- The repayment of loans can be impaired: we endogenously simulate the ratio of Non-Performing Loans (**NPL**) within each sector
- In contrast to other SFC models, EIRIN simulates the impact of **defaults** happening in the system
 - We model the partial bankruptcy of a sector, i.e. only a share of firms are defaulting, due to insolvency
 - Consistent with the principle of endogenous money creation
 - The bank recovers part of the assets, and fire sales happen within sectors in trouble, at the benefit of non-defaulting firms

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.

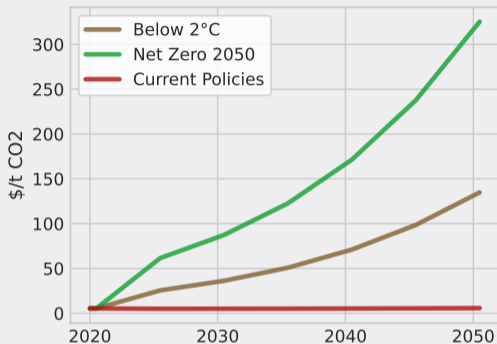


Figure Evolution of the carbon price in USD 2010 per ton of CO₂-eq under the different scenarios.

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.

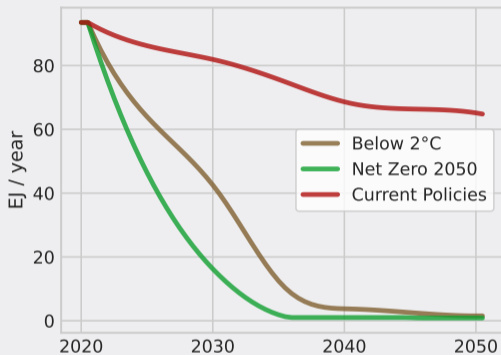
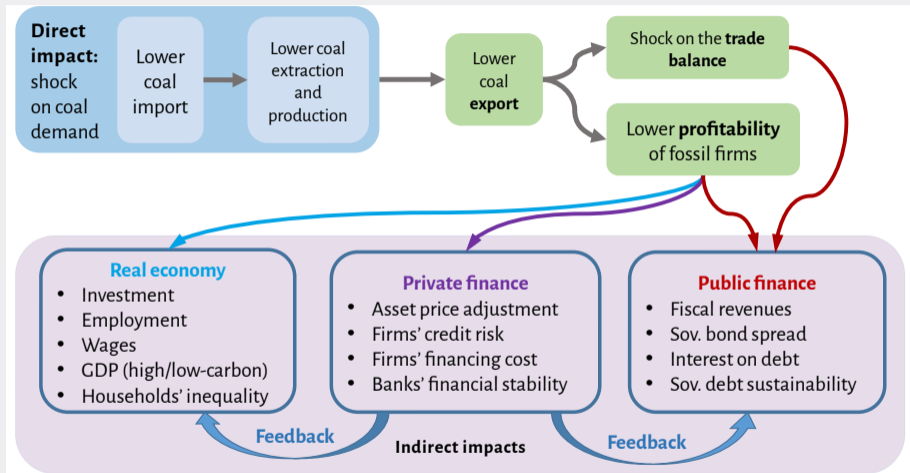


Figure Use of coal by China, as a reference series to shock the quantity exported by Indonesia. Source: NGFS scenarios 2021, from the model REMIND-MAgPIE 2.1-4.2.

Macro-financial risk transmission channels



Export of Indonesian mining industry

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

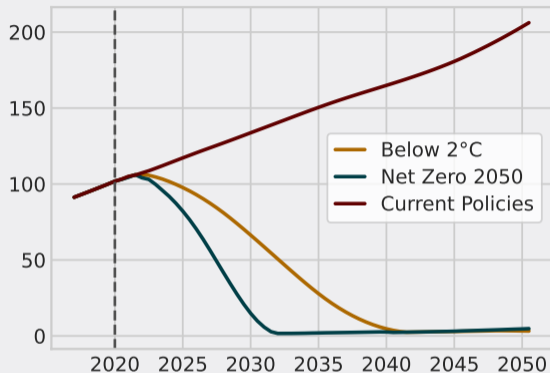


Figure Total value of coal and other fossil fuel exported by Indonesia, indexed at 100 at the start of the scenarios and adjusted for inflation.

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.

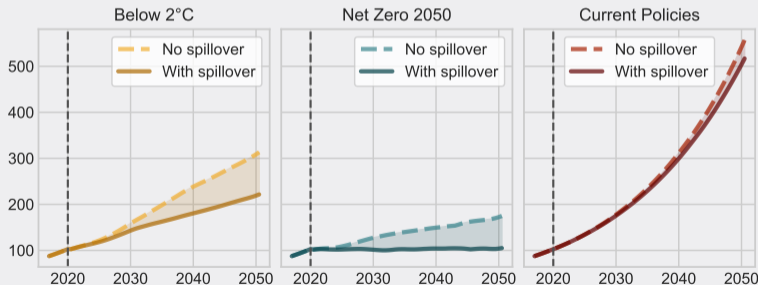


Figure Total GHG emissions from the domestic economy, indexed at 100 at the starting time of the scenarios.

GDP evolution 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 → decreases its demand for labour and profits reversed to the government, etc.

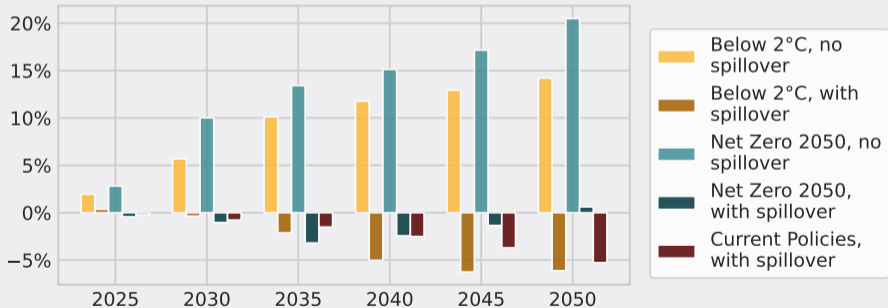


Figure GReal GDP compared to the scenario of current policies without spillover.

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.

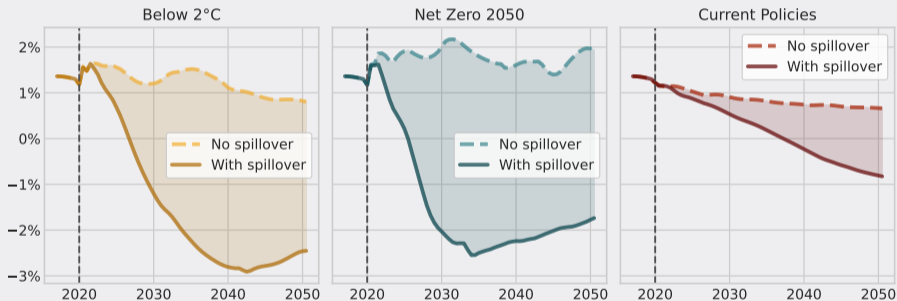


Figure Evolution of the balance of payment, as percentage of GDP.

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 and other international institutions have a key role to play in smoothing the macro-critical adjustment costs of a just transition through financing and surveillance activity

Appendix

References

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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 its 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

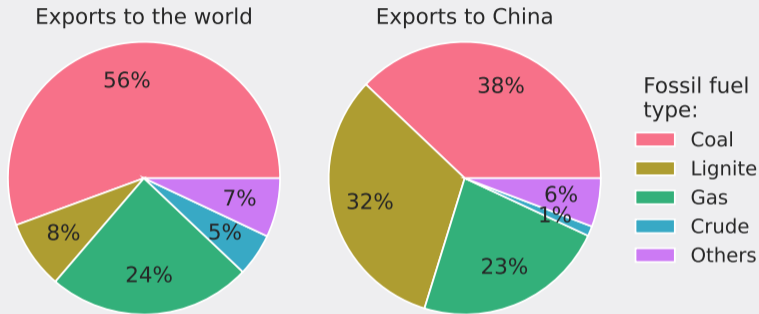


Figure Breakdown of Indonesian fossil fuel exports, globally and to China in particular.
Source: UNSD Comtrade.

EIRIN: main characteristics

- **Agents' heterogeneity:**
 - capitalist/worker households (Goodwin, 1982),
 - 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. (2022), enriched with spillover shock-specific features.

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:

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

with ι the quantity of capital, t the time, p_{Kp} 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

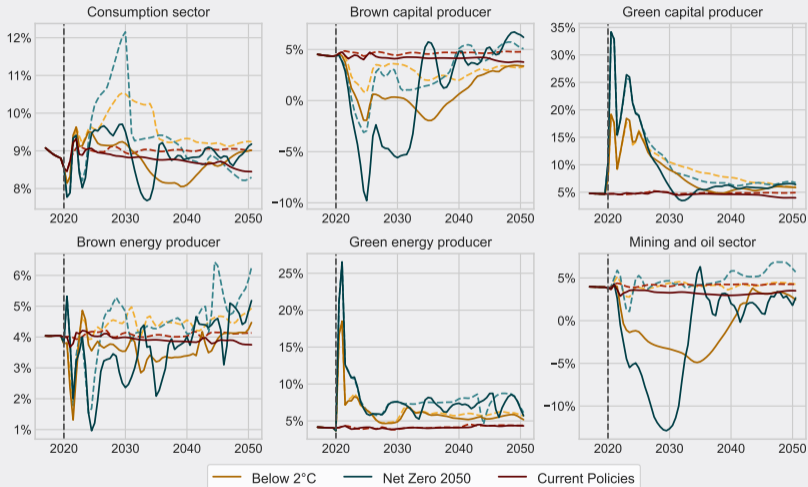


Figure Yearly changes in the value added of the real economy agents.

Renewable energy share

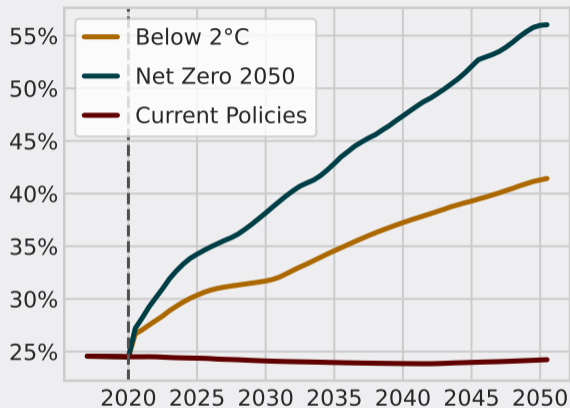


Figure Share of renewable energy over the total produced under the different scenarios, with spillover.

Green policies budget

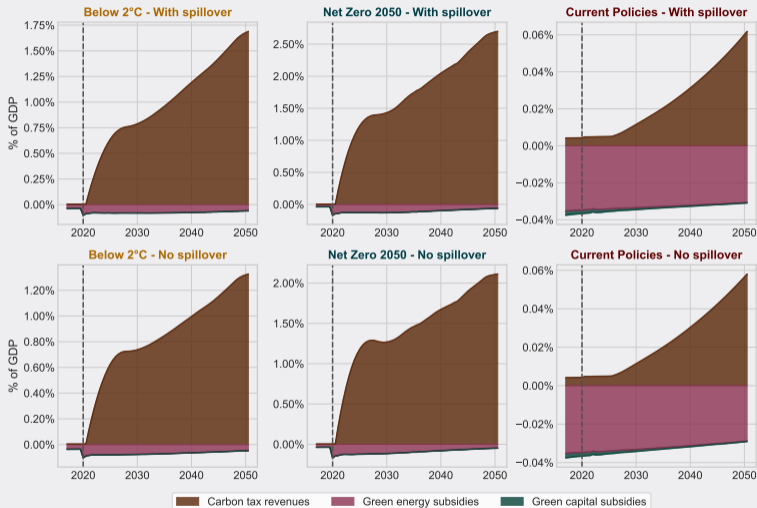


Figure
Revenues and expenses for the government linked to environmental sustainability.