Climate-related risks for the macro-financial system

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Climate-related macro-financial risks (CMRs)

- Risk
  - Potential for adverse consequences (risk $\neq$ impact)
- Climate-related
  - Physical (biophysical $\rightarrow$ socio-economic impacts)
  - Transition (structural change, financing, stranding)
- Macro-financial
  - Macroeconomic (production, taxation, inflation)
  - Financial (banks, asset management, insurance)
  - Macro-financial (money, financial stability, macro-prudential)

Risk components

- Hazards
  - Potential occurrence of event/trend that may cause negative impacts
- Exposure
  - 'Presence' of agents, ecosystems, assets etc. in at-risk settings
- Vulnerability
 - Propensity to be adversely affected → resilience, preparedness, adaptation
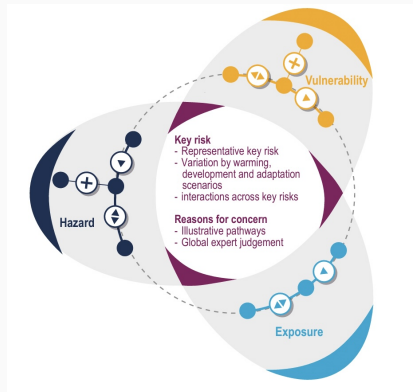
IPCC climate risk framing. Source: IPCC AR6 WGII, Ch.1 (2022)

CMRs: hazards, exposure, vulnerability

CMRs: Hazards

- Physical impacts
  - Acute: hurricanes, heat waves, floods..
  - Slow-onset: temperature, sea level rise..
- Transition 'shocks'
  - Policies: too rapid/unanticipated/delayed implementation
  - Technologies: reduction of relative costs (see solar), breakthrough (clean but also CCS; fusion)
  - Preferences: change in demand patterns (see Gilets Jaunes, Thunberg, Fukushima, Ukraine..)
- How large can/will the shocks be?
  - To some extent endogenous: depends on system/policy choices
  - To some extent already locked in (esp. physical impacts)
  - Compounding risks (geopolitical, unknown?)

- Direct exposure
  - Human: mortality, health, productivity
  - Physical: crops, firms/estate located on the coast
  - Production: input suppliers/clients, trade, transport
  - Financial: banks lending, ownership, debt
- Indirect exposure
  - Production networks: micro→macro perturbations
  - Financial networks: cross-exposure of financial institutions
- Aggregate macro-financial exposure?
  - Climate Minsky moments, Green swans
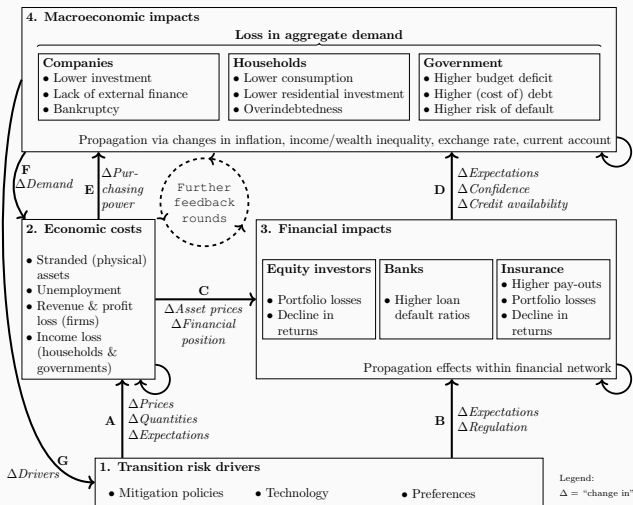
An overview of transition risk dynamics. Source: Semieniuk et al. (2021)

CMRs: Vulnerability

- To what extent have we internalised climate-related risks?
  - To what extent are agents aware/informed?
  - What do they expect from the future, and how are expectations formed?
  - How much is the future worth to them? $\rightarrow$ discounting
- How would the system react?
  - Micro $\rightarrow$ macro aggregation
  - Sentiment volatility, herding, norms, cognitive biases
- How strong is our safety net?
  - How resilient are our societies/economies?
  - Policy and institutional mechanisms to deal with shocks

How do we study CMRs?

Research avenues

- Hazards:
  - Advances in climate system modelling
  - Biophysical $\rightarrow$ socioeconomic impacts, valuation, feedbacks
- Exposure:
  - Granular, spatial, open-access (e.g. Global Energy Monitor)
  - Bank/financial data $\rightarrow$ central bank datasets
  - Network analysis `Stranding cascades`
- Vulnerability:
  - Evidence on expectations and beliefs
  - Individual/group/system behaviour dynamics
  - Macro preparedness, institutions

Capturing expectations and beliefs

- Study asset prices
  - Apply econometric methods to financial market data
  - Financial econ on the problem, but still conflicting evidence
- Elicit opinions
  - Run surveys of households/firms/investors
  - Surprisingly little data Refinitiv survey
- Study communications
  - Social media posts, queries, newspaper articles, speeches by officials, parliamentary acts..
  - Soon available: central bank speech dataset (with Deyris & Romelli) $\approx$ 30,000 speeches from 118 countries

Dynamic behaviour

- Individual/group behaviour $\rightarrow$ experiments
  - Study incentivised behaviour/interactions online, in the laboratory, in the field
- System behaviour $\rightarrow$ prospective modelling
  - Normative/prescriptive: usually neoclassical e.g. look for optimal carbon price path, with/without damages
  - Positive/descriptive: behavioural macro, study system dynamics in scenarios, usually backward-looking expectations
  - $\rightarrow$ Methodological pluralism necessary

Improving climate/transition modelling

- A more realistic representation of expectations
  - Forward-looking with finite horizon, biased, heterogeneous
  - Neoclassical vs behavioural macro approaches
  - Middle grounds to explore `beliefs paper`
- Inclusion of network effects
  - Dynamic production networks (IO/CGE/ABM) `network paper`
  - Multi-layer networks (production + financial)
- Inclusion of uncertainties
  - Recursive IAMs, inclusion of financial theory `transition paper`
  - Computationally intensive + no insights on wrong paths
  - Behavioural macro on this?

Macro-institutional preparedness

- Economic preparedness
  - Markets, technology, knowledge..
- Institutional preparedness
  - Transition governance $\rightarrow$ what should be the role of central banks?
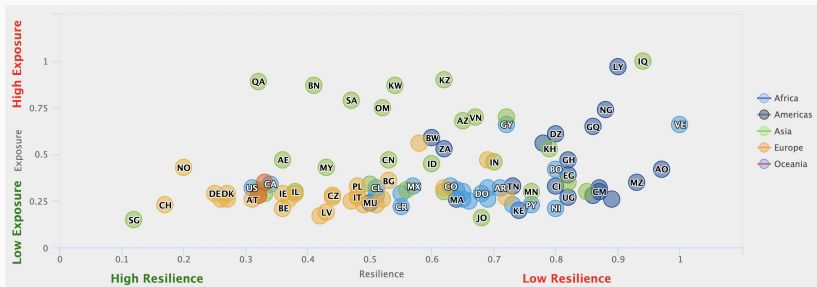
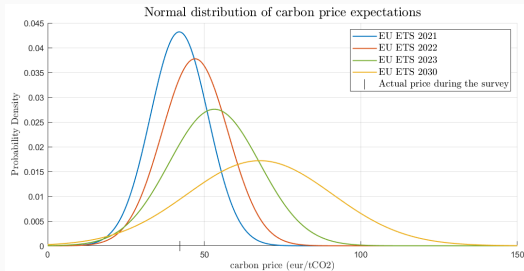Source: IMF Climate Change Dashboard with data from Peszko et al. (2020)

Thank you!

Support slides

Cascades of physical capital stranding
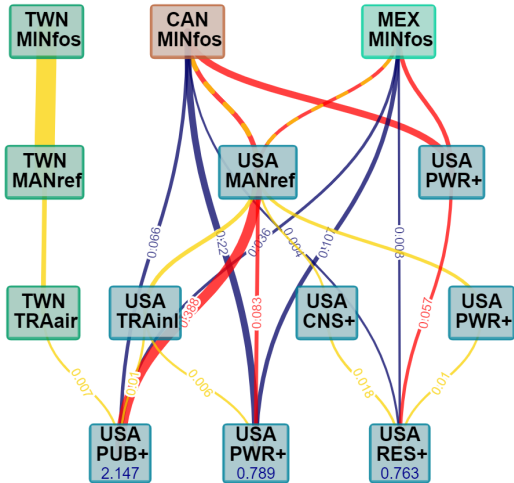
Main fossil exposure links for the USA ($r = 2$). Source: Cahen-Fourot et al. (2021)
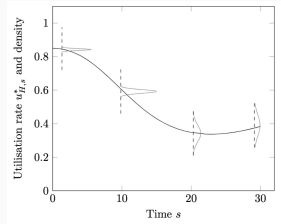
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Left: log-normal distribution of expected EU-ETS carbon price. Right: dominant narrative and moving heterogeneity of expectations. Source: Cahen-Fourot, Campiglio, Daumas, Miess, Yardley (forthcoming) with Refinitiv carbon market survey Back

- Heterogeneous/dynamic beliefs on policy credibility → carbon price expectations → capital investment decisions
  - Sentiments volatility → shape and speed of transition
  - Weak commitment or excessive ambition → 'high-carbon trap'
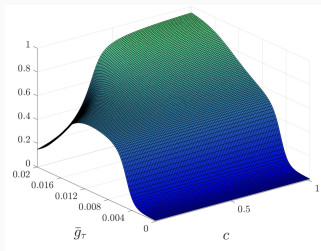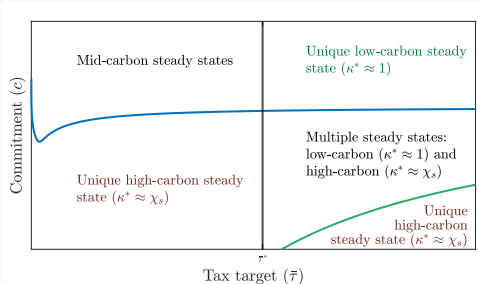
System dynamics as a function of policy-maker commitment and ambition of carbon pricing policy. Source: Campiglio, Lamperti, Terranova (forthcoming) `Back`

The network effects of carbon pricing
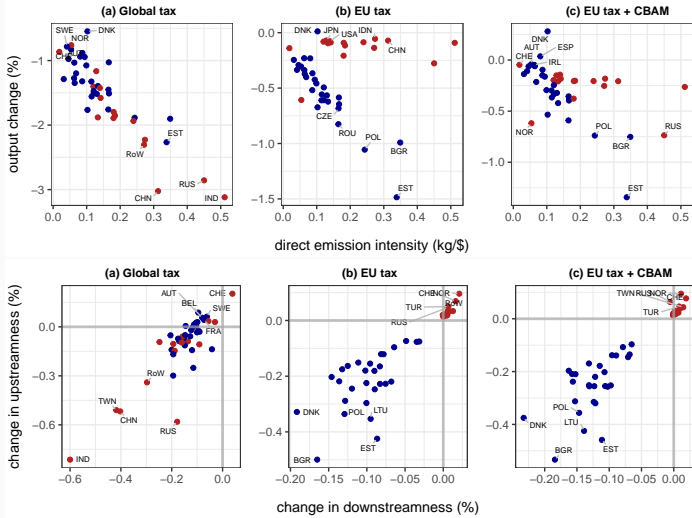
Impact of a US$40 carbon tax (blue: EU; red: non-EU). Source: Campiglio, Massoni, Trsek (forthcoming) Back

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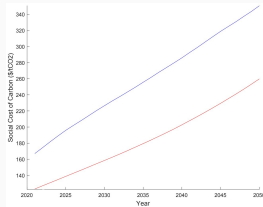# Optimal transition in face of stranding, learning and disasters

- Model with multiple stochastic processes

- Epstein-Zin-Weil preferences + dynamic programming

- Dirty to clean capital → stranding

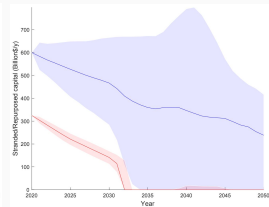- Optimal carbon price paths

- Cost-benefit vs cost-effectiveness
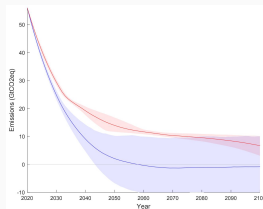
(a) Emissions E
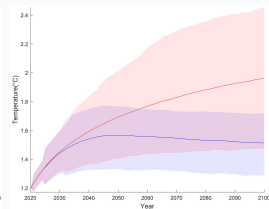
(b) Temperature T

(c) Carbon price p

(d) Dirty capital disinvestment R

Red: cost-benefit. Blue: 1.5°C cost-effectiveness
(Campiglio, Dietz, Venmans) Back