Strengthening financial supervision in the era of climate risks: lessons for climate stress tests

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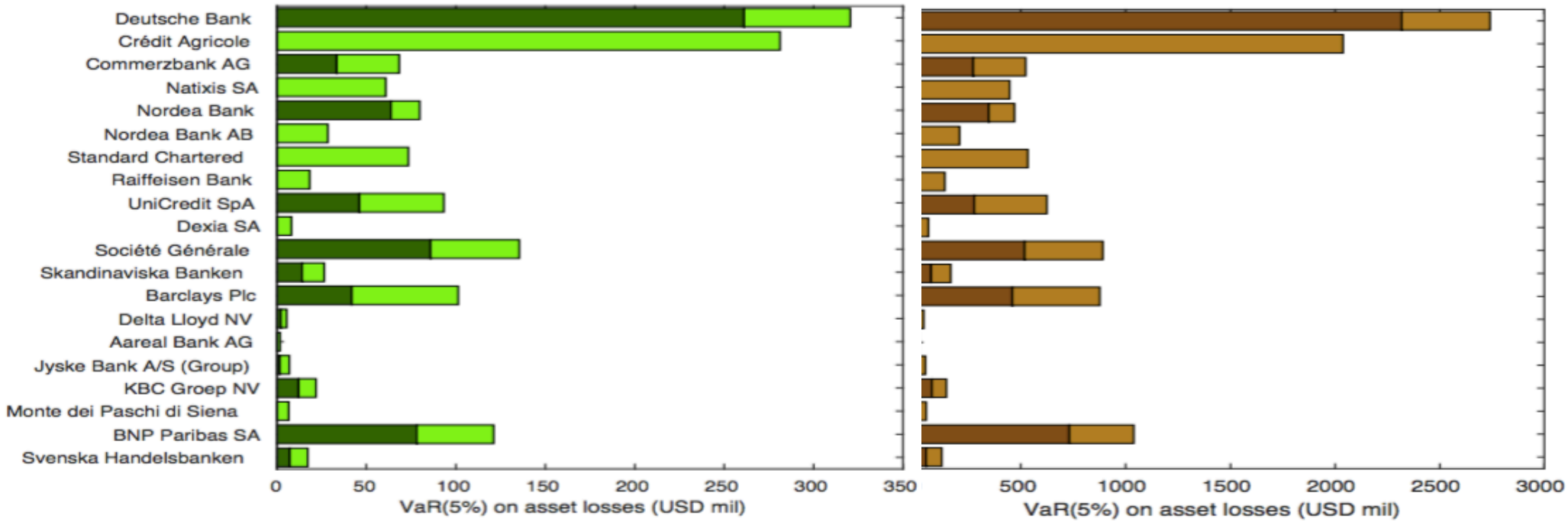
Back to…2017: a disorderly transition could lead to large losses for individual financial institution, with potential implications on financial stability

A climate stress-test of the financial system

Stefano Battiston ✉, Antoine Mandel, Irene Monasterolo, Franziska Schütze & Gabriele Visentin

Nature Climate Change **7**, 283–288 (2017) | Cite this article

Banks' exposures to Climate Policy Relevant Sectors (CPRS) and their investment strategy (high/low-carbon) can drive financial risk in their portfolio (see VaR losses)

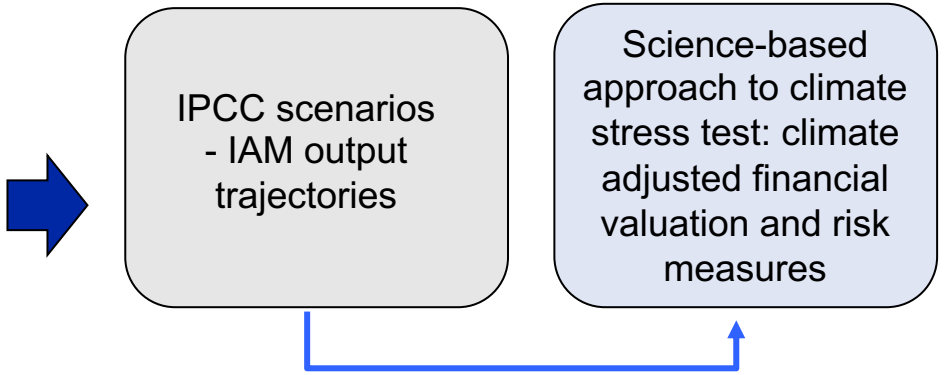


Value at Risk *(5% significance) on equity holdings of 20 most affected EU banks under scenario of green (brown) investment strategy. Dark/light colors: first/second round losses.*

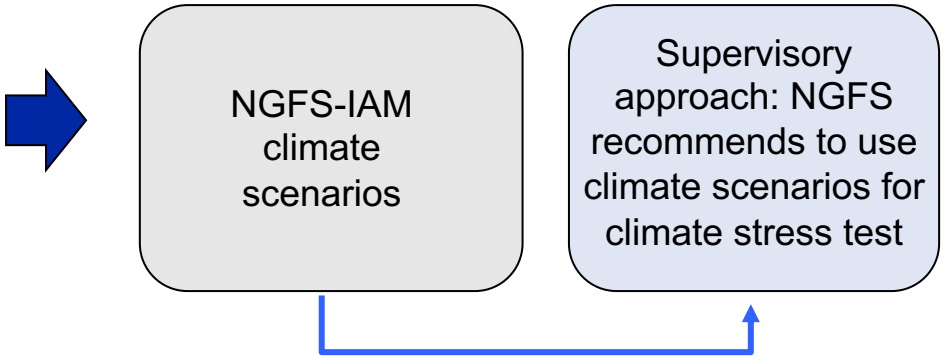
Source: Battiston ea (2017)

Climate risks and financial stability: the importance of climate stress tests

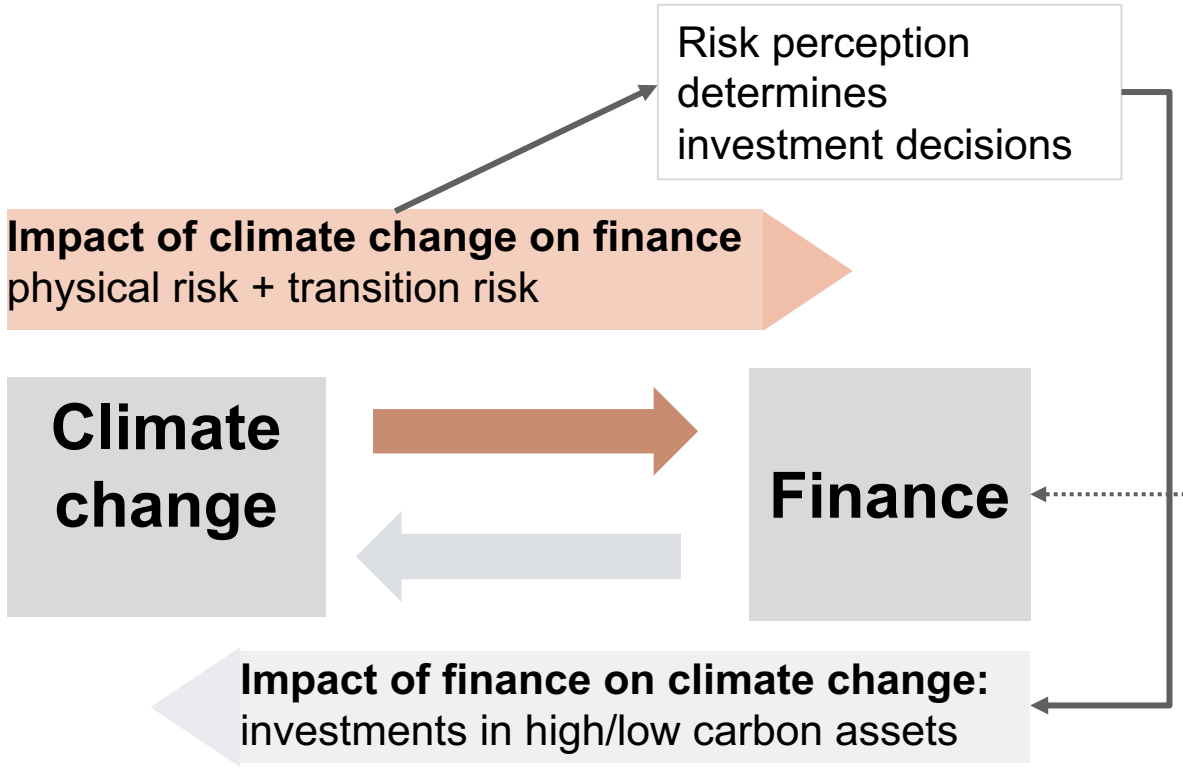
- Climate-stress tests were developed to assess climate-related financial risks for investors
- **Battiston ea 2017:** first methodology to translate trajectories of process-based Integrated Assessment Models (IAM) across scenarios into adjustment of default probability (PD), financial valuation of contracts, individual and systemic risk:
  - Results: investors are highly exposed (40% portfolio of pension funds) to transition risk by holding contracts of firms in CPRS.
  - Losses amplified **by interconnectedness** in the network



- **Since 2020, NGFS developed climate scenarios and climate stress tests,** using similar approach to climate financial risk assessment (BdF 2020, DNB 2020, ECB 2021, OeNB 2021)



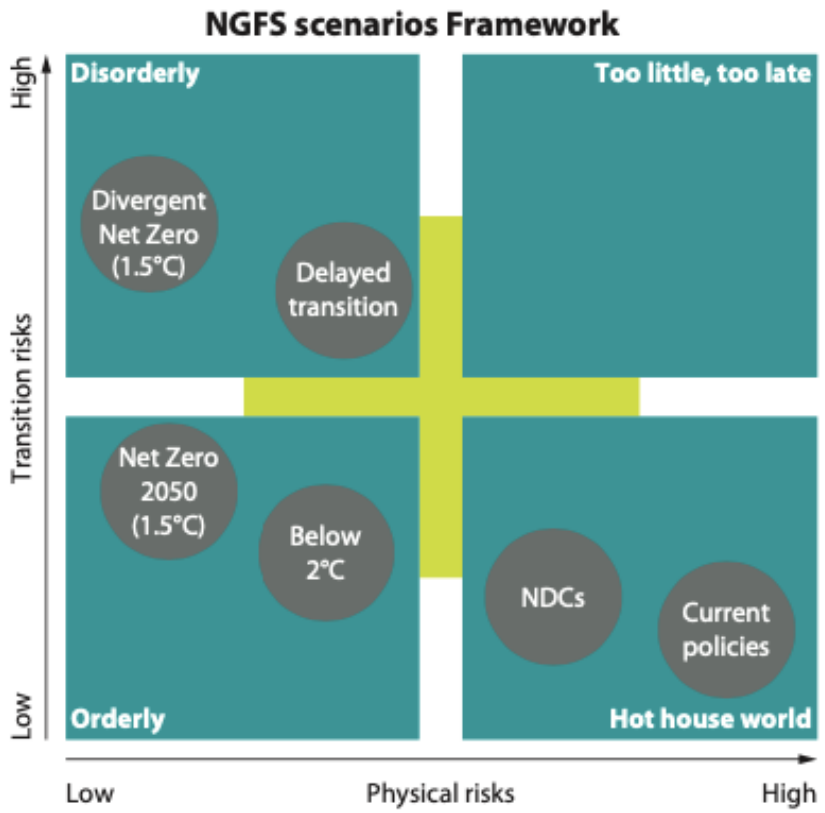
2022, IPCC AR6 chapter 15: poor climate risk assessment is main barrier to mitigation



Source: courtesy of S. Battiston, IPCC lead author

- Firms make investment decisions (CAPEX) in high/low carbon equipment (e.g. wind vs coal power plants)
  - These decisions give rise to sectors' output trajectories of IAM in NGFS scenarios
- **Financial actors influence these decisions** by making capital more/less expensive for firms (e.g. interest rate)
- **The feedback btw climate financial risk assessment – investment decisions is not considered by NGFS scenarios**

The importance of the NGFS's climate scenarios for climate stress tests



Scenarios by process-based IAM assessed by IPCC (2014, 2022)*:* distinct features of the transition.

Given a **carbon budget** (eg. 2C-aligned), IAM compute sectors' output trajectories (high/low-carbon sectors)

Dimension and assumptions:

- Timing of climate policies (carbon price): e.g. 2030
- Emissions and temperature target (1.5C, 2C)
- Reliance on Carbon Dioxide Removal (CDR): low, medium reliance
- Technology development

- <u>NGFS has followed these dimensions to identify 4 high-level scenarios: orderly, disorderly, hothouse, tltl</u>

Source: NGFS 2021

However, main gaps remain with regard to:

1. **scenarios**
2. **climate risk exposure data and metrics**
3. **macroeconomic models to assess climate damages**

1 What's wrong with current scenarios?

Physical risk:

- Current supervisory scenarios neglect **acute risks** (risk stemming from climate-related hazards e.g. from floods, droughts) and **the compounding** of shocks (e.g. recurring floods, hazards and pandemics, Ranger ea 2022)
- **Why this matters?** Because when risks compound, they amplify the magnitude and duration of economic shocks and financial losses (Dunz ea 202) -> implications for fiscal and financial risk management (Monasterolo ea 2021)

Transition risk:

- Current supervisory scenarios **neglect the role of finance:** investors' expectations about scenarios and their impact on credit risk adjustment («climate sentiments» Dunz ea. 2021)
- **Why this matters?** Because when we account for finance, and feedback financial risk assessment into IAM trajectories, orderly/disorderly transitions differ greatly**:** important implications for financial supervisors! (Battiston ea 2021)

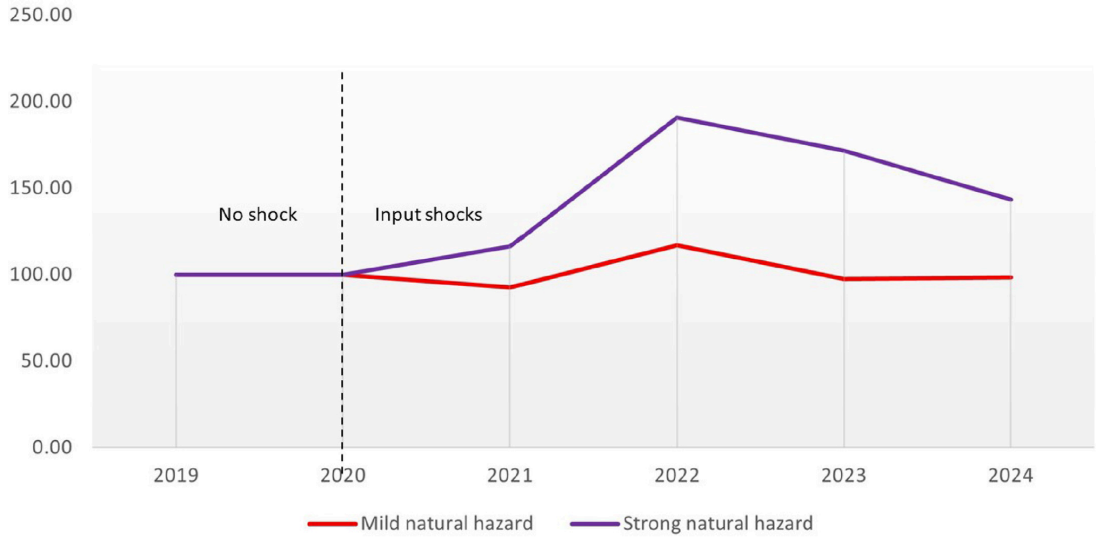
Example: compounding of shocks

ELSEVIER
Journal of Banking & Finance
Available online 8 September 2021, 106306
In Press, Corrected Proof

Compounding COVID-19 and climate risks: The interplay of banks' lending and government's policy in the shock recovery

Nepomuk Dunz [a, c], Arthur Hrast Essenfelder [b, e], Andrea Mazzocchetti [b], Irene Monasterolo [c, d] ✉, Marco Raberto [f]

- Climate risks (physical, transition) don't happen in isolation but can compound with other shocks e.g. COVID-19 and debt crises, amplifying magnitude and duration of losses.



Compound risk indicator: *x-axis: simulation until 2024 on annual basis. y-axis: value of compound risk indicator indexed against the sum of the singular event scenarios of hurricane only and COVID-19 only, at 100. Dunz ea (2021)*

Accounting for finance is key for climate mitigation pathways

STEFANO BATTISTON, IRENE MONASTEROLO, KEYWAN RIAHI, AND , BAS J. VAN RUIJVEN Authors Info & Affiliations

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- IAM scenarios don't account for role of finance nor investors' expectations:
  - There are **no financial actors** that decide whether to make an investment or not based on risk assessment
  - **Investments** assumed available **without frictions** (no credit constraints)
- *Thus, trajectories don't reflect the impact of financial risk assessment on scenarios -> financial risk associated with scenarios can be underestimated*

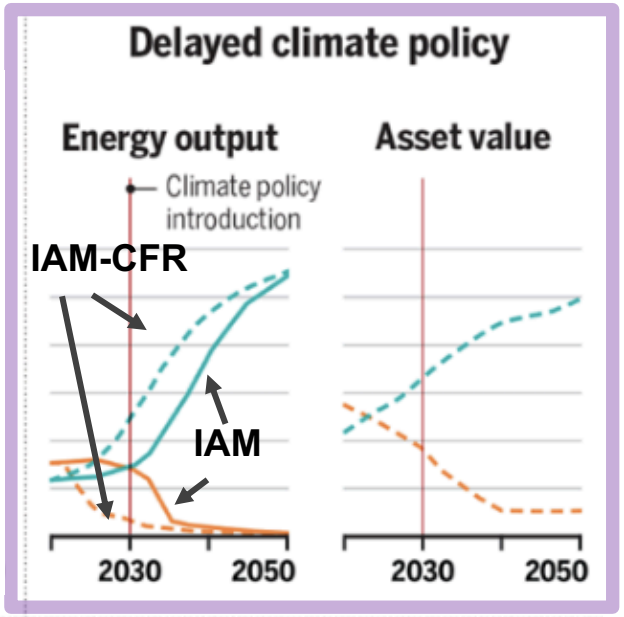
- Embedding this feedback is crucial to analyse the conditions for finance to enable/hamper the transition: a new generation of climate finance scenarios has been recently introduced to fill this gap (next slide, Battiston ea 2021).

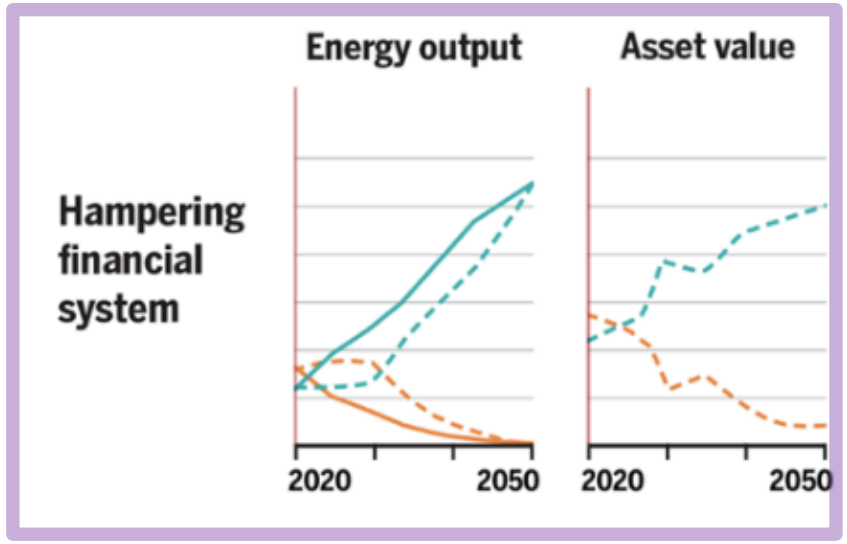
New trajectories that embed climate financial risk assessment into IAM scenarios

Policy
Financial system

Immediate climate policy

Enabling financial system





Source: Battiston ea (2021), Science

Endogenizing orderly/disorderly transition:

- An immediate transition to 2C classified in NGFS scenarios as orderly. But in hampering case: delayed transition, large and sudden financial value adjustments as in a disorderly scenario.
- **Delayed** transition to 2C : **disorderly**. But in enabling case gradual price adjustments more consistent with orderly
- In **hampering** role: disorderly transition could also lead to higher risk than in NGFS disorderly

Legend:

2 What's wrong with climate data and metrics?

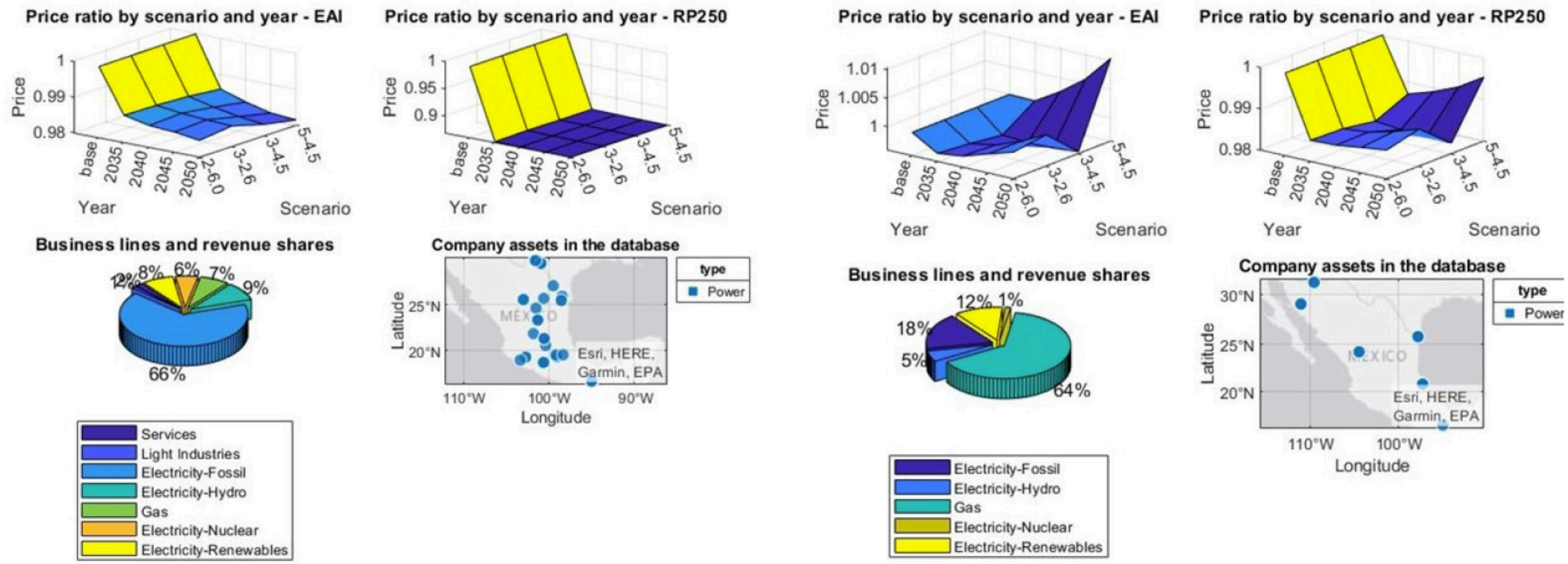
Physical risk:

- Current supervisory scenarios lack the asset level dimension (physical plants) of firms' business lines and revenues models, i.e. climate, business, finance information.
- **Why this matters?** Neglecting the asset level dimension leads to large errors in estimate of climate financial losses and non coherent investment decisions (see Bressan ea 2022)
- Exposure of firms' plants to acute and chronic risks is heterogeneous (geo-location, tech). Also, plants differ in relevance for firms' revenues

Transition risk:

- Climate transition risk currently captured via carbon footprint, GHG emissions, ESG. But:
  - A coal-based utility could reduce its Scope 1 emissions intensity by expanding its business in trading, without investing in decarbonization of its plants.
  - GHG emissions disclosed mostly by large and listed firms, leaving SME out
  - ESG scores "aggregate confusion" (Berg ea 2021, Billio ea 2021) and greenwashing (Amenc ea 2021, Giuliani ea 2022).
- **Why this matters?** In 5 years, all finance is sustainable but not enough green investments in the economy -> bye Paris

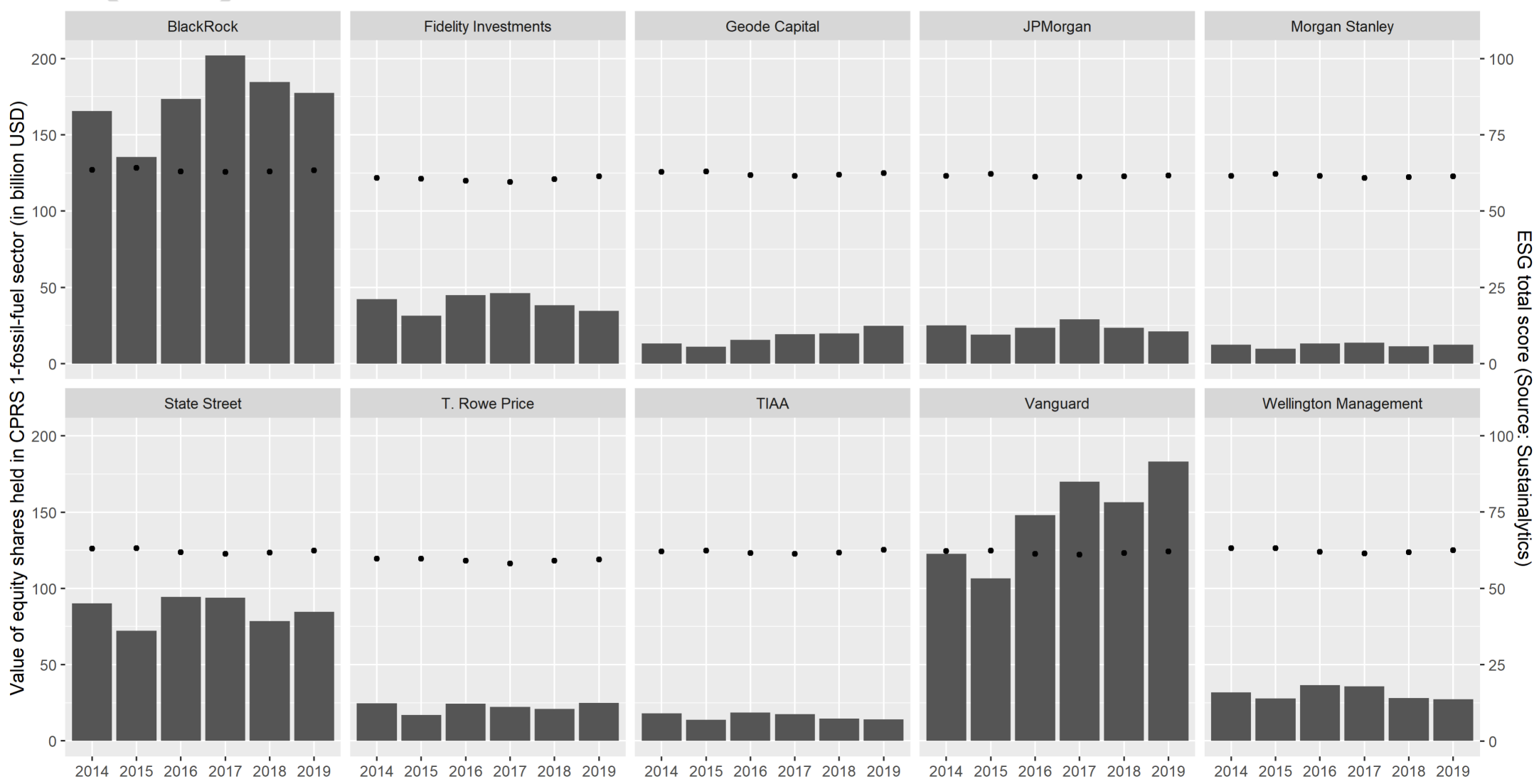
Example: financial performance (stock price) of two firms with (RP250)/without (EAI) asset level info



Source: Bressan ea 2022

Figure: Examples for (left) a company mostly engaged in electricity business, (right) a gas and electric utility. For each company: fig show stock price ratios under EAI and RP250, business lines, geolocalization of assets
Strong effects from hazard can strengthen macroeconomic effect (left) or they can counterbalance them (right). Net effect depends on firm's composition, assets risk exposure (geolocalization, type, tech).

Example: what do ESG scores tell us about climate alignment of universal investors? Little



Source: Giuliani ea (2022)

3 Modelling climate shocks in the economy and finance

Why we do not see large economic impacts of climate change in a time horizon that is relevant for investors' decisions? Let's look at the macroeconomic models

- Aggregate damage function smooths losses (Keen ea 2021, 2022)
- Assumptions about forward looking expectations and market clearing prices, and agents' representativeness, lead to fast recovery
- Lack of integration of finance and its complexity (e.g. leverage, interconnectedness) in firms' investment dynamics

- Dynamic balance sheet assessment to properly assess:
  - Shock entry point in the economy and transmission channels (direct, indirect)
  - This, in turn, is crucial to assess the double materiality of climate risks: feedbacks financial- risk assessment - economy – climate scenarios (Gourdel ea 2022).

What can be done already now to strengthen climate stress tests

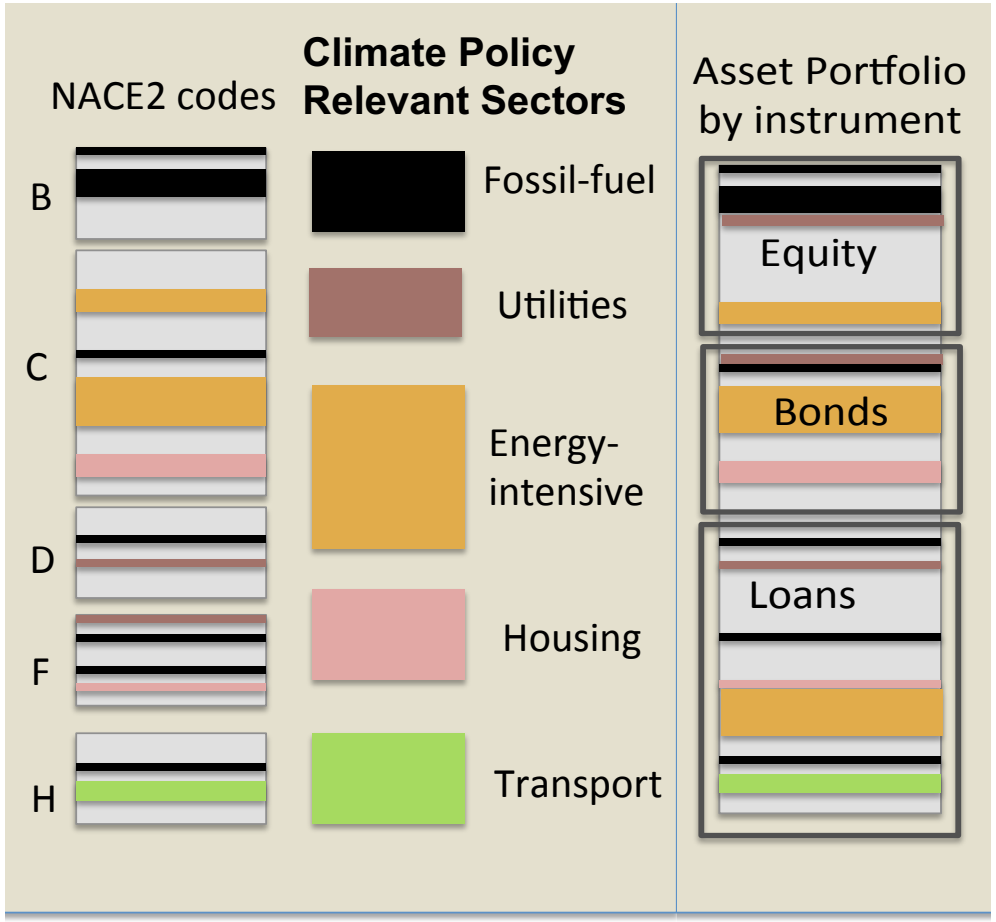
Climate transition risk exposure: Climate Policy Relevant Sectors (CPRS)-Granular

A classification of economic activities in relevant transition risk categories **(CPRS**, Battiston et al. 2017) to **quantify stranded assets** considering:

(i) role in energy value chain, (ii) revenue, business model (input substitutability) (iii) cost sensitivity to policy (ministries, lobbies), (iv) GHG

We map NACE 4 digit codes in CPRS considering different levels of granularity (CPRS1, 2, granular)

CPRS is replicable and comparable across portfolios and jurisdictions, and **is** also compatible with the EU Taxonomy



Source: Battiston ea (2017) https://go.nature.com/3jcQ8SS

CPRS-Granular

- **CPRS-Granular** integrates info about energy tech of plants owned by the firm, considering business lines and contribution to revenues. This info is associated to the financial contracts for adjustments in financial valuation and financial risk metrics.
- **Why this matters?** Because firms' plants may differ by technology thus being positively/negatively affected in the transition. Firm level info would average losses
- **This info is not provided by NACE 4-digit codes nor IAM variables**

CPRS Main	CPRS-2	CPRS Granular
3-energy-intensive	3-energy-intensive	energy-intensive
3-energy-intensive	3-energy-intensive	energy-intensive|cement
3-energy-intensive	3-energy-intensive	energy-intensive|electrical
3-energy-intensive	3-energy-intensive	energy-intensive|fertilisers and agrochemicals
3-energy-intensive	3-energy-intensive	energy-intensive|iron and steel
3-energy-intensive	3-energy-intensive	energy-intensive|non-fossil mining
3-energy-intensive	3-energy-intensive	energy-intensive|other
3-energy-intensive	3-energy-intensive	energy-intensive|pharmaceutical
3-energy-intensive	3-energy-intensive	energy-intensive|rubber and plastics

Source: Battiston ea 2022

Mapping NACE to CPRS-Granular to IAM variables

CPRS-Granular allows us to assign a transition risk profile to IAM variables, and to map NACE 4-digit codes to relevant IAM variables and their trajectories across NGFS scenarios

NACE Level	NACE	CPRS-Granular	IAM
4	G.45.11	transportation|vehicles|combustion	Final Energy|Transportation|Liquids
4	G.45.11	transportation|vehicles|electric	Final Energy|Transportation|Electricity
4	G.45.11	transportation|vehicles|hybrid	Final Energy|Transportation|Electricity
4	G.45.11	transportation|vehicles|hydrogen	Final Energy|Transportation|Hydrogen
4	G.46.71	fuel|fossil|sale	Primary Energy|Fossil
4	G.47.30	fuel|fossil|oil	Final Energy|Transportation|Liquids
4	G.47.99	other	Final Energy|Residential and Commercial|Liquids
4	H.49.10	transportation|infrastructure|land|railways|electric	Final energy|Transportation|Electricity
4	H.49.10	transportation|infrastructure|land|railways|fossil	Final Energy|Transportation|Liquids
4	H.49.20	transportation|infrastructure|land|railways|electric	Final energy|Transportation|Electricity
4	H.49.20	transportation|infrastructure|land|railways|fossil	Final Energy|Transportation|Liquids
4	H.49.50	fuel|fossil|oil&gas|gas	Primary Energy|Gas + Primary Energy|Oil
4	H.51.10	transportation|infrastructure|air	Final energy|Transportation|Liquids
4	H.51.21	transportation|infrastructure|air	Final energy|Transportation|Liquids
4	H.51.22	transportation|infrastructure	Final energy|Transportation|Gases

Source: Battiston ea 2022

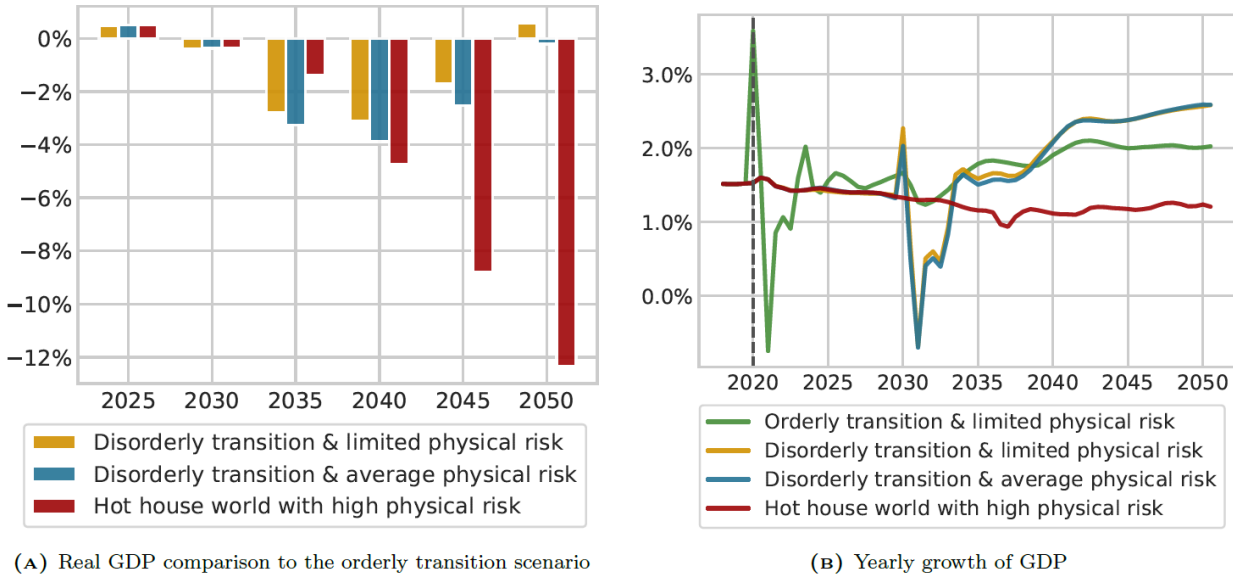
EUROPEAN CENTRAL BANK
EUROSYSTEM

We use the EIRIN SFC model (Monasterolo & Raberto 2018) to assess the double materiality of climate physical and transition risks (NGFS) scenarios in the Euro Area

Working Paper Series

Régis Gourdel, Irene Monasterolo, Nepomuk Dunz, Andrea Mazzocchetti, Laura Parisi

The double materiality of climate physical and transition risks in the euro area



(A) Real GDP comparison to the orderly transition scenario

(B) Yearly growth of GDP

Figures: Real GDP. *The x-axis displays the simulation time. The y-axis shows (i) the real GDP, compared to the orderly transition scenario and (ii) the yearly growth rate of real GDP in percentage points.*

- **Orderly**: short-term costs to economic growth, but significant co-benefits in mid to long term periods.
- **Disorderly**: Lower economic output than orderly but larger trade-off for growth.
- ***Hothouse world:*** *limited economic impact*. Impact from physical risk increases over time. Capital has to be replaced frequently, driving up investment, financing needs, firms' leverage.
- **But risky scenarios still missing, and so are large economic and financial impacts.**

Conclusion

- Doing climate stress test is crucial to inform decision making (investors, financial supervisors, etc). European financial supervisors moved fast to meet the new challenge
- However, being aware of the **methodological challenges,** and addressing them, is fundamental to **avoid the underestimation of risks and opportunties in the transition**
- Closer interaction between financial supervisors and researchers could help to fill existing knowledge gaps and strengthen climate financial risk assessment tools for better climate financial risk management
- **May 2022, EDHEC-Risk and Climate Impact Institute (ERCII): new research center, and a stream of research on finance impact on climate.**

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