

Assessing climate-financial risks: lessons for macro-prudential regulation

Irene Monasterolo, Prof. of Climate Finance, Utrecht University

*Banco de Portugal, Annual Financial Stability Conference
2nd October 2023*

Financial stability implications of climate risks: climate stress tests

- **Battiston et al. (2017): climate stress-test** embedded climate scenarios in a stress test of individual portfolios and the financial system:
 - Late transition: large losses for individual institutions, financial stability implications
- **Climate risks taken up by central banks:**
 - From Carney (2015)'s Tragedy of the Horizons
 - To NGFS creation (2017)
 - *I. Schnabel (2023): Dealing with financial risks is the core task of prudential supervision. **Climate-related and environmental risks (C&E risks) are now an important focal point for supervisors.***

Banks' exposures to Climate Policy Relevant Sectors can generate financial risk in a late sudden transition

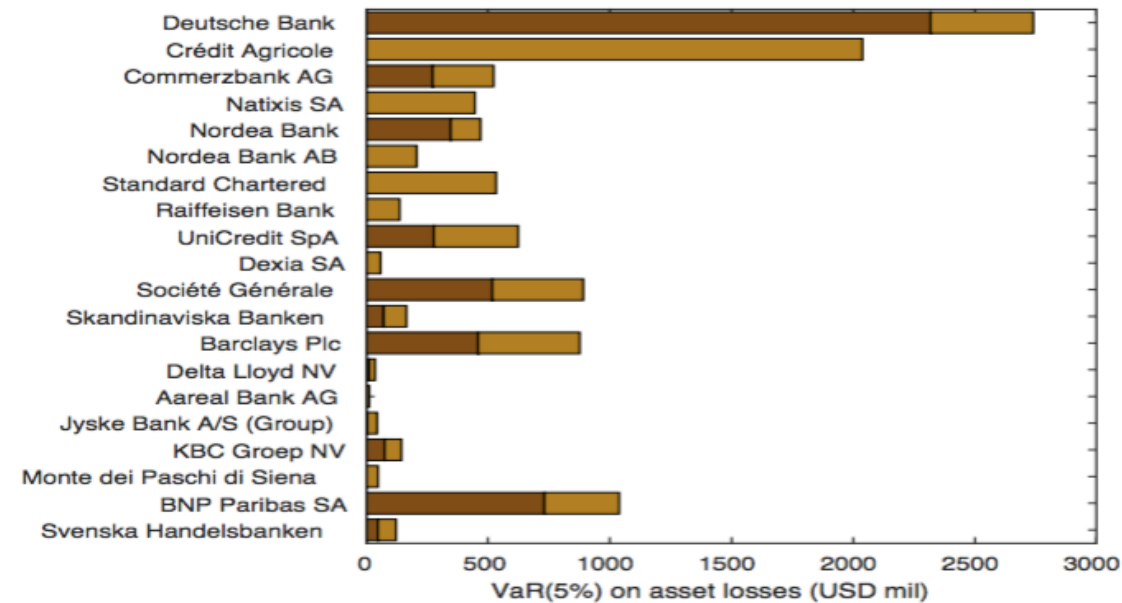
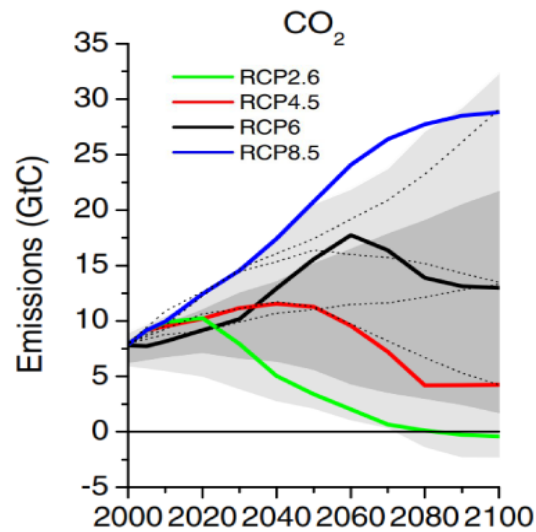


Fig. Climate Value at Risk (5% significance) on holdings of 20 most affected EU banks under scenario of business as usual investment strategy. Dark/light colors: first/second round losses.

Climate stress-test framework

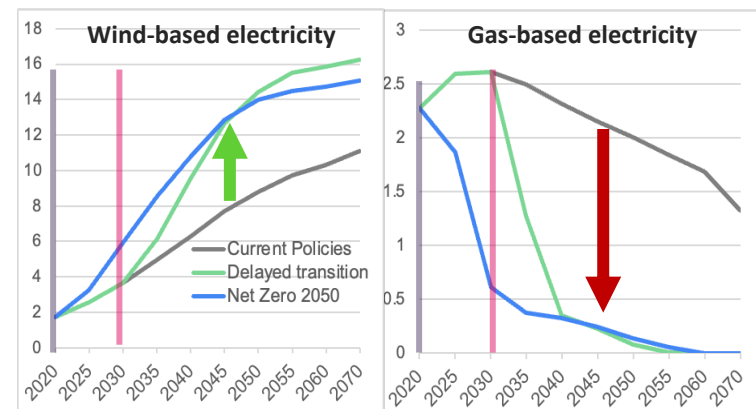
Climate scenarios



IPCC AR5 2014



Output trajectories

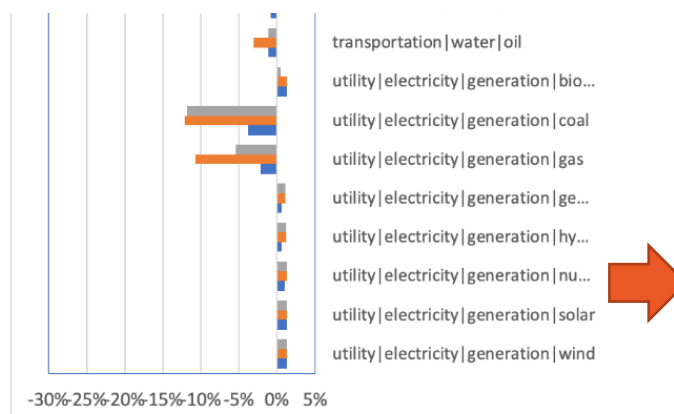


Own elaborations on NGFS 2022

Adjustments in investors' expectations regarding occurrence of transition scenarios:

- estimates of sectors' production, and cash-flow streams of securities' issuers/borrowers
 - valuation adjustment of issuers' default probability, bond spread, credit risk etc.
- reallocation of capital to less risky assets
- improved financial stability, lower risk

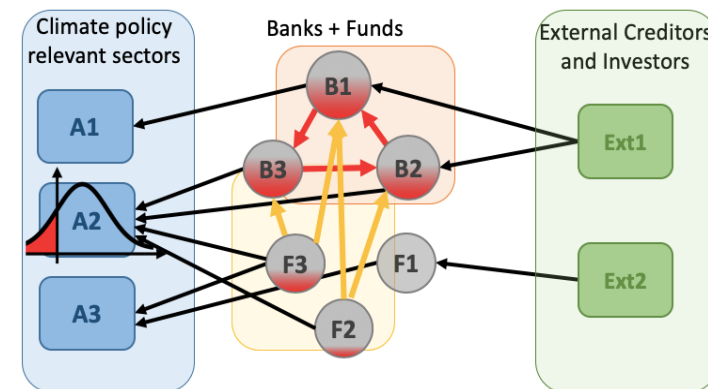
Financial valuation adjustment



Battiston ea. 2023

Monasterolo_BdP_panel_2023

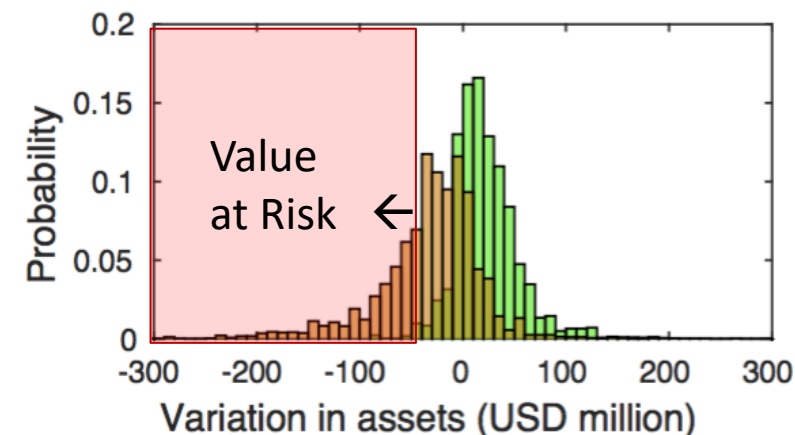
Amplifications via financial networks



Roncoroni ea. 2021

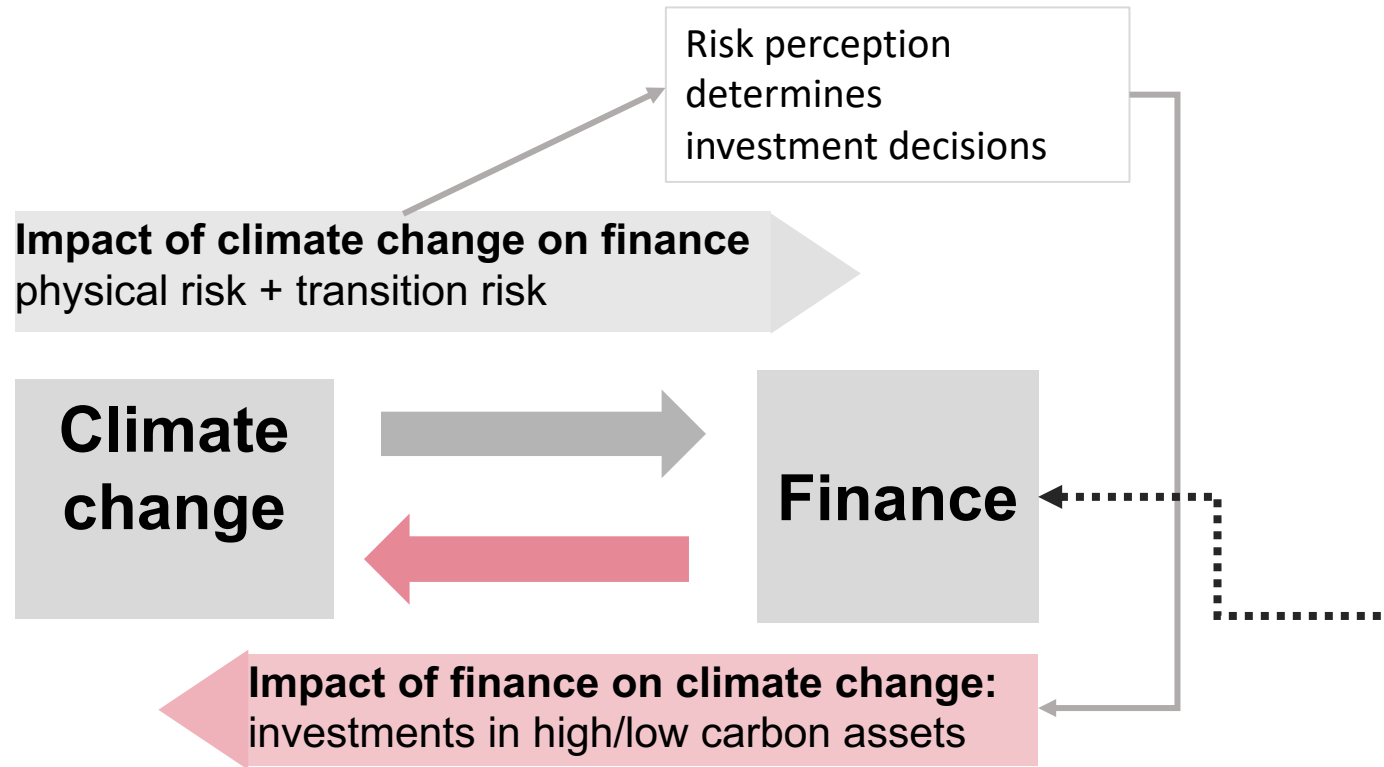


Adjustment of gain/losses distribution



Battiston ea. 2017

Why it matters: poor risk assessment prevents capital reallocation, limits supervision and leads to litigation risk



- 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 supervisory climate scenarios (e.g. NGFS)
- **Financial actors influence these decisions** by making capital more/less expensive for firms (e.g. interest rate)

Source: [Battiston et al 2021](#)

3 open issues for macro-prudential regulation

1. **Climate impacts:** how are we representing future climate shocks and their interactions (e.g. compound risk)?
2. **Climate risk disclosure:** are we considering the relevant variables and level of disaggregation?
3. **Macroeconomic impacts:** a story of lost losses and co-benefits (models matter: this is why we do not see relevant shocks on GDP)

1 Climate scenarios for climate stress-test

Climate risks are forward looking – thus we need to assess them using scenarios:

- The later (or never) the low-carbon transition, the larger risks and cascading effects (non-linearity)
- Thus past occurrences and losses are a poor proxy of future losses: implications for risk management

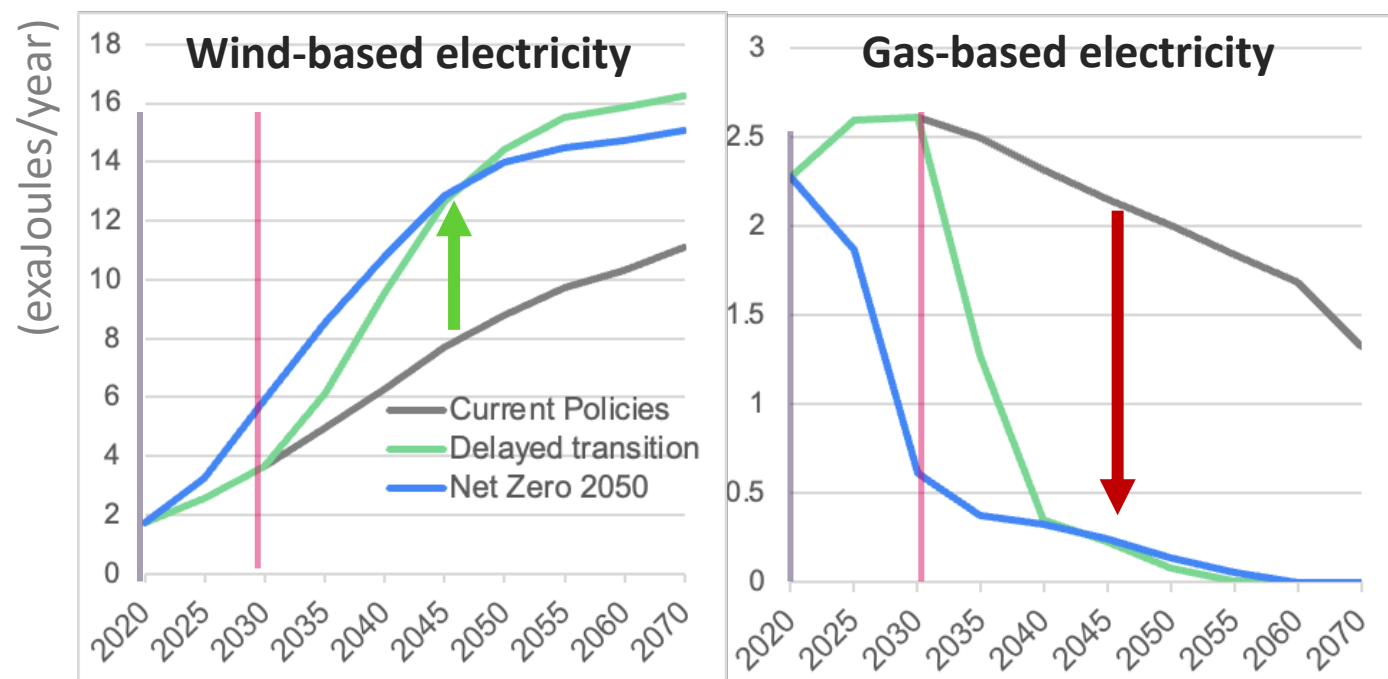
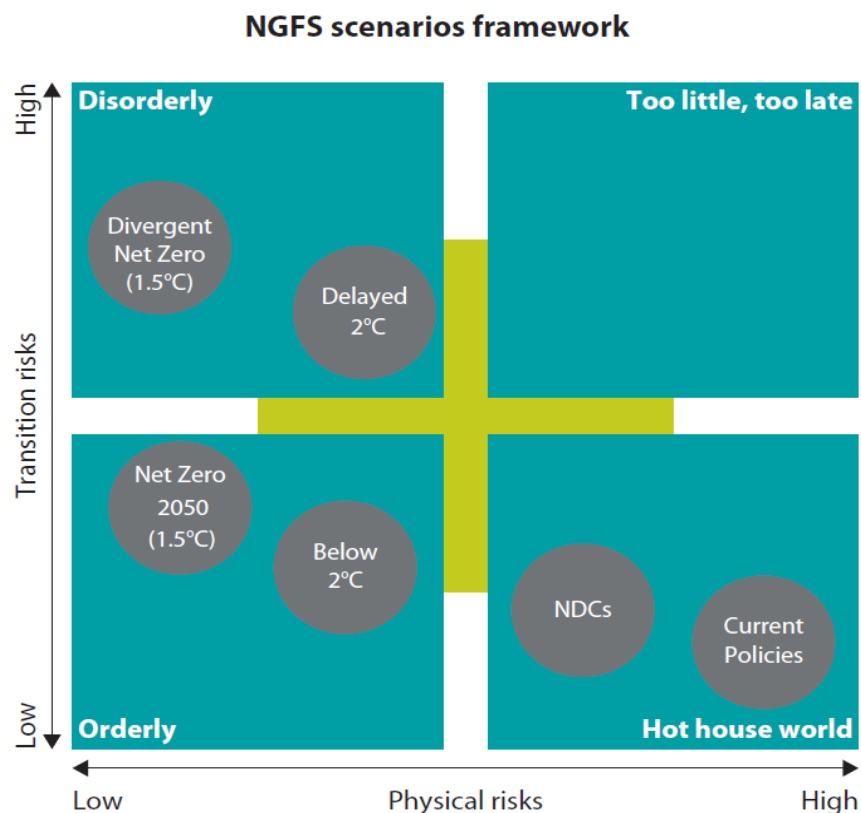


Fig. NGFS scenario data, region EU, 2020-2070, model “REMIND-Mag-Pie, 3 NGFS scenarios/ Source: Authors’ own elaboration

NGFS scenarios' limitations: climate physical risks

1. Limited consideration of **acute physical risks** within economic projections (impacts only for tropical cyclones and pluvial floods. No droughts, etc.)
2. **Poor granularity of exposures, and aggregated damage functions** (hazard, sector, country) fail to capture the overall magnitude of losses
3. **Macroeconomic impacts** from chronic physical risk don't account for (i) transmission channels and (ii) future impacts of climate change that are not captured in historical data, **e.g. tipping points**
4. **The compounding of shocks is neglected** – yet can lead to persistent shocks (see e.g. countries' analyses in Dunz et al. 2021, Ranger et al. 2022).

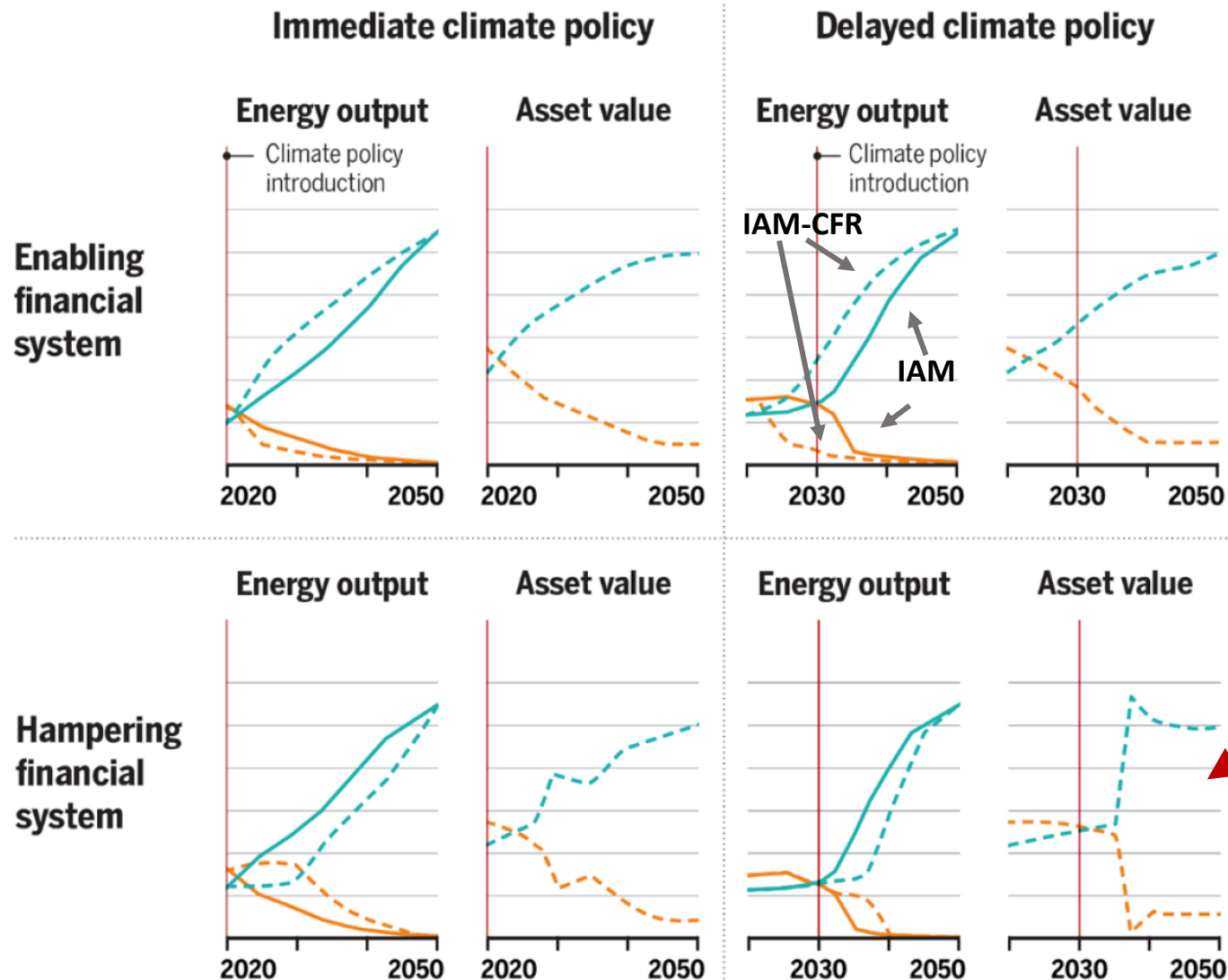
Source: Monasterolo, I., et al. (2023). The good, the bad and the hot-house world. Conceptual underpinnings of the NGFS Scenarios and suggestions for improvement. *Banco de España working paper series*

NGFS scenarios' limitations: climate transition risks

1. NGFS trajectories embed implicit **carbon price** that doesn't distinguish between levies on GHG emissions (tax, trade system, environmental regulations, subsidies)
2. **Potential trade-offs** of different climate policy tools not captured (thus the policy impact could be under/overestimated)
3. **Carbon prices are assumed to generate fiscal revenues** (internalized in countries' general budget). But in reality they may not (governance)
4. Investments do not account for cost of capital: **finance is missing but a key driver of the transition (via risk assessment)!**
5. ***Rationale expectations lead to smooth transition risk shock on investments, consumptions and GDP***

Source: Monasterolo, I., et al. (2023). The good, the bad and the hot-house world. Conceptual underpinnings of the NGFS Scenarios and suggestions for improvement. *Banco de España working paper series*

Why accounting for finance is key for climate risks



What happens when we account for finance?

- An immediate transition to 2C classified in NGFS scenarios as orderly. But in the 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
- **Hampering**: could also lead to higher risk than in NGFS disorderly

Legend:

Trajectories from IAM scenarios Trajectories from IAM-CFR framework
 — Renewable energy — Coal - - Renewable energy - - Coal

Source: Battiston S. et al. (2021). Accounting for finance is key for climate mitigation pathways. Science, 372(6545), 918-920

2 Disclosure of physical risk – assets matter for exposure

- Which entity is exposed to climate risks and through which channels?
 - Physical risks: location, type of business, adaptation investments

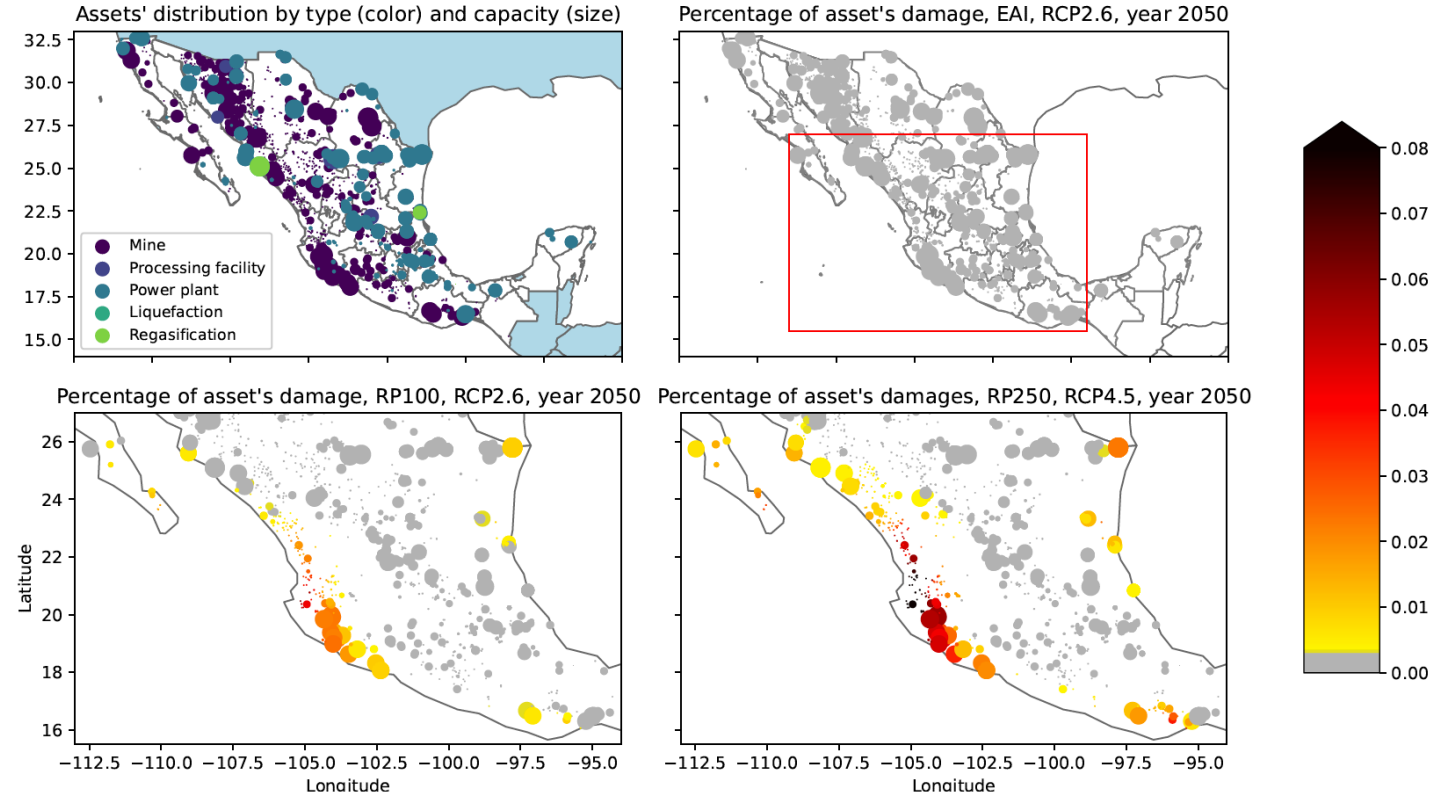


Figure: Assets' distribution and direct impact of tropical cyclones on assets across climate scenarios, in Mexico.
Source: [Bressan et al. 2022](#)

Physical risk – underestimation of financial losses

- Recent analyses use aggregate scores of physical risk for firms
- Using firm-level instead of asset-level data can lead to a large underestimation of losses - up to 70.8% for investors' portfolios
- This, in turn, affects (i) micro and macro-economic assessment of risk (incl. sovereign), (ii) risk management strategies, (iii) (the need for) regulation

Case	Underestimation range (%) firm-level vs. asset-level
Acute RP250 (tail)	67.4-92.3
Chronic and acute RP250 (tail)	58.0-70.8

Table: Comparison of portfolio-level results for losses computed using aggregate firm-level data vs asset-level data, ME, SSP3-RCP4.5, 2040. Source: [Bressan et al. 2022](#)

Last column: how large the underestimation of losses is when using firm score vs disaggregated assets: a value of 50% means we fail to capture 50% of losses

Transition risk disclosure requires to go beyond emissions

GHG emissions and transition risk:

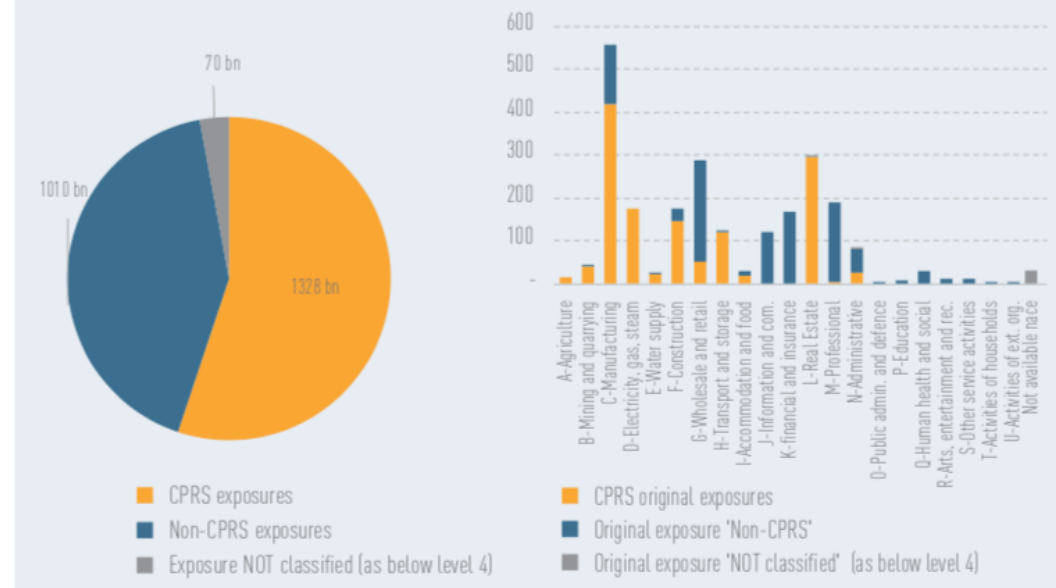
- Data gaps: no SMEs coverage (90% of EU firms)
- When data is provided by firms, limited transparency and poor quality (Scope 3, affecting ESG scores: Bressan et al. 2022)
- “Aggregate confusion” (Berg et al. 2023)



Tracking investments across technologies is key:

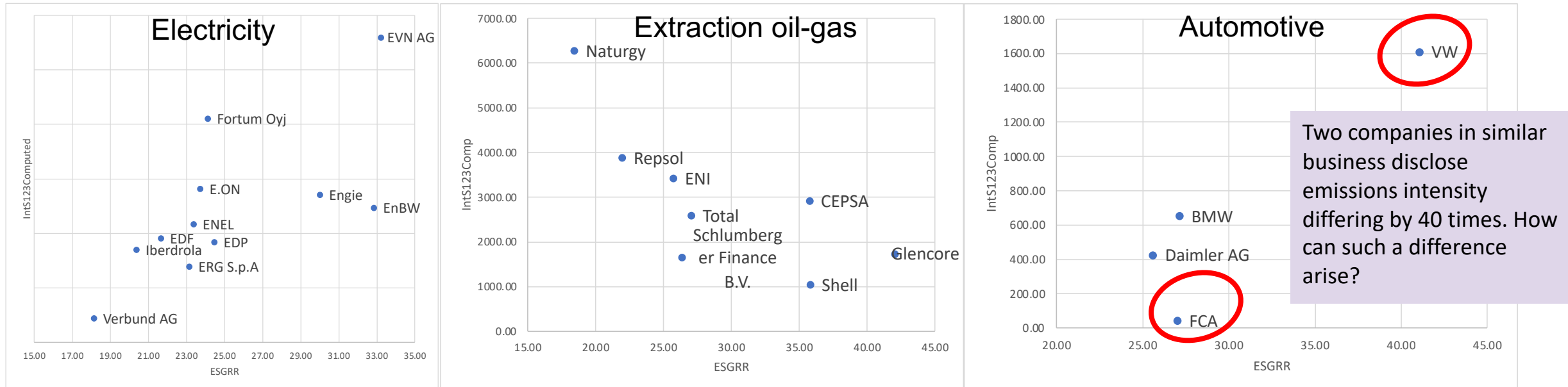
- Company's readiness for the transition, drivers of risk
- Message introduced in Battiston et al. (2017)'s Climate Policy Relevant Sectors
- *Technology lately taken up by policy (EBA 2020, ECB 2023). Yet most supervisory analyses still focus solely on GHG emissions.*

Figure 17: CPRS classification at EU level (left) and CPRS classification by NACE 2 level 1 (right), (in EUR billion) in December 2019
Source: 2020 EBA analysis of climate risk.



Limits of disclosure using GHG emissions

- Green portfolio rebalancing (ECB PEPP) on GHG emissions and alignment plans. **Data (2020):**
 - Emission intensity (Scope1+2+3)/Revenues, ESG Risk Rating (ESGRR, Sustainalytics) for bonds
- **Results:** reporting discrepancies exist also intra-sector, challenging investors' evaluation of firms' sustainability, **portfolio rebalancing and prudential regulation:**
 - **Key factor: inconsistency of Scope 3 reporting (see Stellantis vs VW).**



Source: [Bressan et al. \(2022b\)](#)

Feeling good?

Chart 21

Impact of climate change on banks' credit standards and terms and conditions for loans to firms

(net percentages of banks; over the past 12 months and the next 12 months)

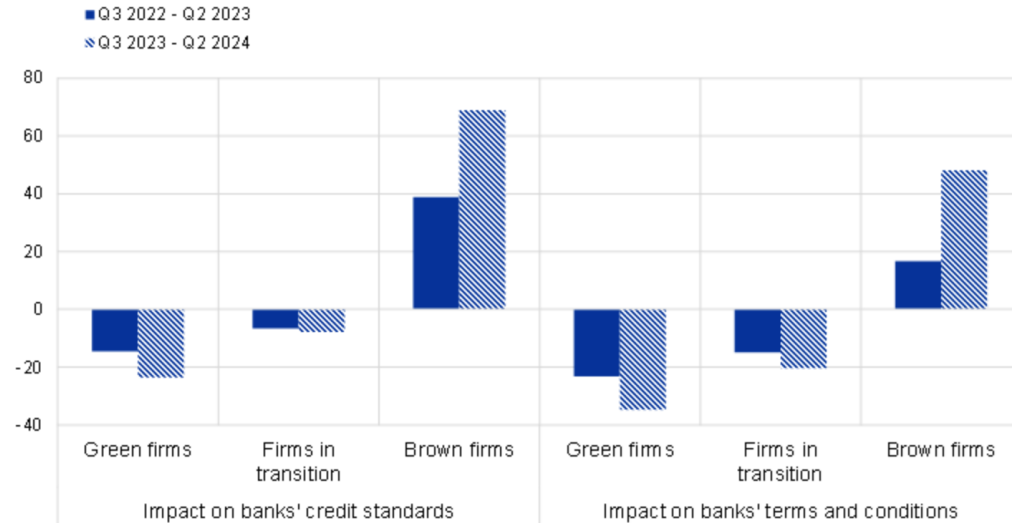
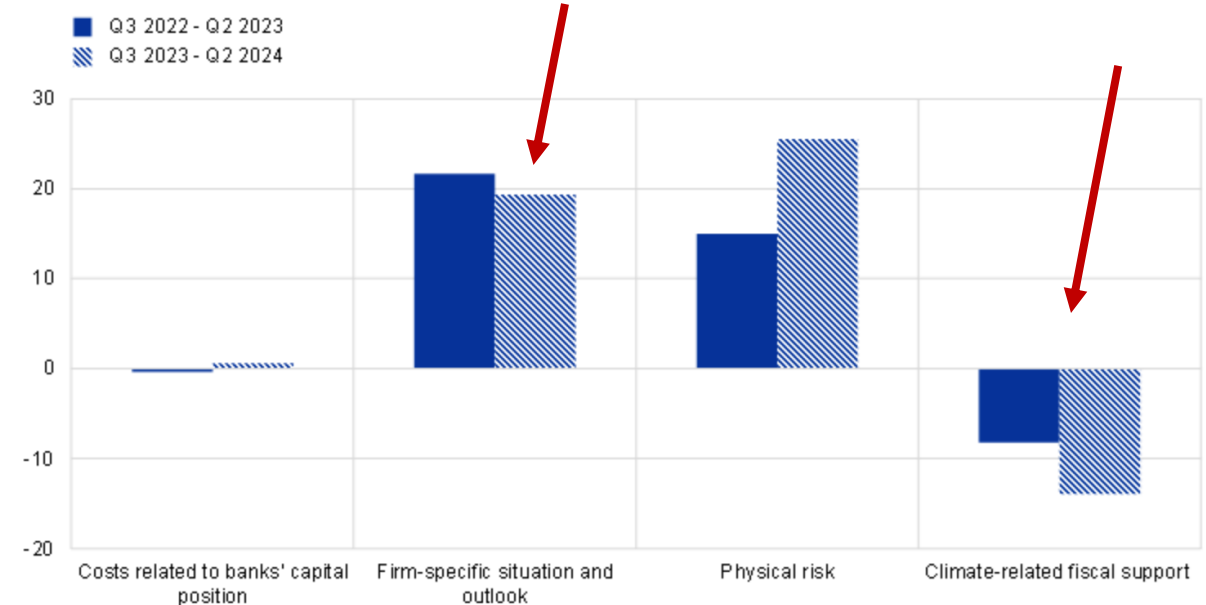


Chart 22

Impact of climate-related factors on banks' lending policy to firms

(net percentages of banks; over the past 12 months and the next 12 months)



- “Green firms”: do not contribute/little to climate change; “firms in transition”: contribute to climate change but making progress in the transition; “brown firms”: contribute significantly to climate change and have not yet started the transition
- ***Banks’ replies were based on a range of sources, e.g. firm-specific information from financial statements, sustainability reports on emission data and, if available, transition plans, questionnaires. To assess the climate risk for loans to SMEs, sector-average information and estimates were often used. Source: ECB’s bank lending survey July 2023***

Climate risks: how important is how we look at them?

- **Nov 2022:** ECB's thematic review on how banks manage climate and environmental risks (107 banks supervised + 79 supervised by national supervisors)
- **Banks continue to significantly underestimate the breadth and magnitude of such risks, and almost all banks (96%) have blind spots in identifying them.**

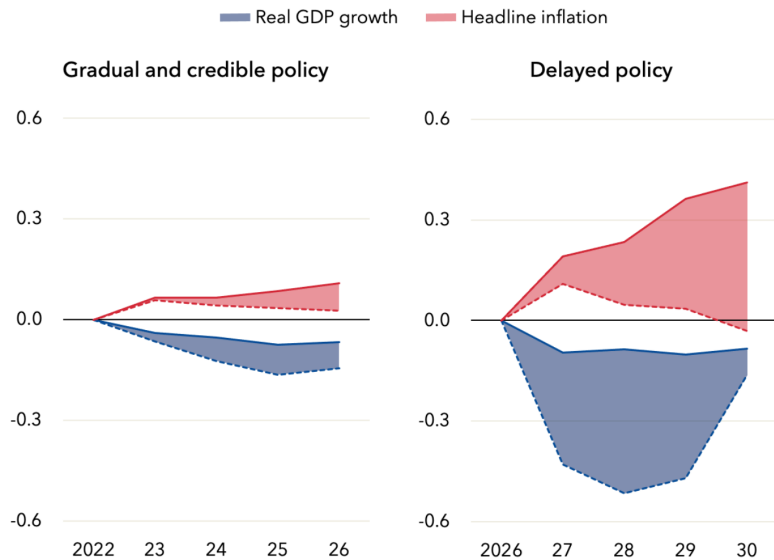


- **July 2023** ECB's bank lending survey: Climate risks increasingly reflected in lending conditions
- "Euro area banks indicated that climate risks of euro area firms and measures to cope with climate **change had a net tightening impact on credit standards and terms and conditions for loans to brown firms over the past 12 months**, while they had a net easing impact for loans to green firms and firms in transition.

3 Climate risks: lost in the macro?

- Getting the macro right is challenging due to climate risks (non-linearity, tail risks, endogeneity)
- Yet it is crucial (GDP shocks: magnitude, persistence) for financial stability and supervision
- **GDP losses estimates are surprisingly mild even in risky scenarios**
- Why? (i) disclosure (previous slides) and (ii) macroeconomic models' assumptions matter

US GDP (IMF)



Source: Global Macroeconomic Model for the Energy Transition; and IMF staff estimates.
Note: The chart shows the range of values for growth and inflation for different monetary policy objectives in the United States; stabilizing an expanded core inflation index that includes GHG taxes (dotted line) is more costly in terms of growth.

IMF

EA GDP (ECB)

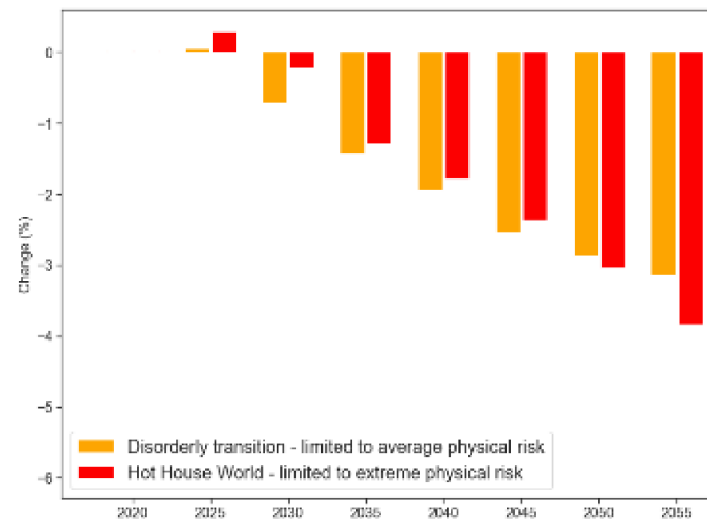


Fig.: Real GDP comparison to the orderly transition scenario. Source: ECB calculation (2021) on NGFS scenarios (2020b).

Monasterolo_BdP_panel_2023

EA GDP (Gourdel ea 2022)

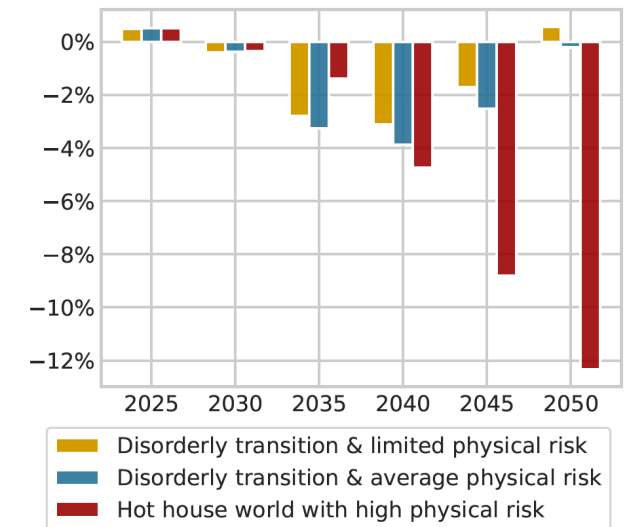


Fig: Real GDP comparison to the orderly transition scenario. Source: Gourdel et al. 2022.

Traditional macroeconomic models may underestimate climate financial risks in the economy

1. **Rationale expectations:** agents anticipate the price impact of transition shocks in their investment/consumption decision, leading to smaller shocks on GDP
2. **Perfect substitutability of production factors:** in the transition skills and technologies not perfectly substitutable (neither raw materials) leading to delays
3. **Representative agents** limit understanding of distributive (even just expected!) effects of the transition, which could increase transition costs (GDP losses), or even delay it (see e.g. “gilet jaune” in FR, or in the NL)
4. **Finance:** missing or stylized, banks are conduit savings to investments. But risk assessment and expectations matter for investment decisions (cost of capital)
5. **No finance-macro feedbacks:** climate financial risk exposure and risk assessment affects firms' investment and the transition

Conclusions

- **Climate financial risk assessment is key to *inform if and how-to macro-prudential regulation***
 - **Lessons: still many gaps (vs growing climate-related losses)**
 - Key issues:
 1. Climate scenarios: finance, biodiversity, short term scenarios
 2. Disclosure (limits of emissions and aggregate scores)
 3. Macroeconomic models: assumptions not coherent with the nature of climate risks
 - The interplay between 1-2-3 already affects the assessment of climate losses and the analysis of potential policy co-benefits
- *We just started a new project “ESG-UPTAKE” aimed to (i) **mainstream ESG and climate stress test** to EU national financial authorities and (ii) **identify Insurance Protection Gap and policy tools** in the EU.*

References

- Battiston S., Mandel A, Monasterolo I., Schuetze F. & G. Visentin (2017). A Climate stress-test of the EU financial system. *Nature Climate Change*, 7, 283–288.
- Battiston S. Monasterolo, I., Riahi, K., and van Rujiven, B. (2021). Accounting for finance is key for climate mitigation pathways. *Science*, 372(6545), 918-920.
- Battiston, S., Mandel, A., Monasterolo, I. and Roncoroni, A. (2023). Climate credit risk and corporate valuation. Working paper, available at SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4124002.
- Bressan, G., Duranovic, A., Monasterolo, I., Battiston, S. (2022). Asset-level climate physical risk assessment matters for adaptation finance. Working paper, available at SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=406227
- Bressan, G., Monasterolo, I, Battiston, S. (2022b). Sustainable investing and climate transition risk: a portfolio rebalancing approach. *Journal of Portfolio Management*, special issue “Novel risks” ed. by F. Fabozzi.
- Dunz, N., Mazzocchetti, A., Monasterolo, I., Essenfelder, A., Raberto, M. (2021). Compounding COVID-19 and climate risks: the interplay of banks’ lending and government’s policy in the shock recovery. *Journal of Banking and Finance*, 106303
- Gourdel, R., Monasterolo, I, Dunz, N., Mazzocchetti, A. and Parisi, L. (2022). The double materiality of climate physical and transition risks in the euro-area. *ECB working paper series*, n. 2665, May 2022. Forthcoming on the *Journal of Financial Stability*.
- Ranger, N., Mahul, O., Monasterolo, I. (2022). Assessing Financial Risks from Physical Climate Shock: A Framework for Scenario Generation. *The World Bank*, Equitable Growth, Finance & Institutions Insight. Washington, DC: World Bank. <https://openknowledge.worldbank.org/handle/10986/37041>