CEMRACS 2026 *Modeling and AI for Environmental Transition* subject proposal: Dynamic Top-Down Model for Financial Loss Distribution Under Climate, Credit & Market risks

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Keywords: multivariate stochastic modeling, macroeconomic modeling, climate physical and transition risks, structural credit risk, XVAs, Monte-Carlo methods, risk measures, stochastic orders, financial regulation, risk management, stress tests.

The purpose of this work is to propose a risk management framework capturing both financial and capital markets, economics and climate related risks answering both regulatory and top management challenges driven by regulatory requirements (EBA/PRA/CCAR Stress Test, SREP ICAAP and ILAAP). This includes formulation of financial flows and propagation across economies and related networks including their link to climate related risks, modeling of the various sources of randomness and the design of dedicated numerical approaches. These will serve to assess not only risk measurements (credit provisions, collateral valuation, initial margining setup, liquidity shortfall assessment, XVAs & reserves, regulatory capital and economic capital, stress test scenario analysis), but also the impact of various risks (geopolitical, cyber, biodiversity and nature, technological) on those measurements. Though the conducted work should ensure compliance with regulatory instructions, it should also permit fundamental revisiting of certain key concepts, including those deployed by regulation standards and exploration of novel approaches.

With respect to the previous literature, we make Bastide, Crépey, Drapeau, and Tadese (2023) dynamic, which then allows us to add climate risk features to the modeling. This leads us to try and extend Bastide and Crépey (2025) to dynamic setups, perhaps using tools from functional convex ordering literature (see e.g. Liu and Pagès (2023) for references) or the work on supermodular and stop-loss orders conducted in Müller (1997); Müller and Stoyan (2002); Kella and Mandjes (2023) with applica-

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tions to financial markets portfolios under a static setup in Cousin and Laurent (2008); Bastide and Crépey (2025).

To account for financial sectors dependence to macroeconomics and climate scenarios, we adopt a common-factor approach à la Garnier, Gaudemet, and Gruz (2021), Gaudemet, Deschamps, and Vinciguerra (2022), made *(i)* dynamic, to see how stress test scenarios unfold over time, *(ii)* microfounded, for economic relevance, and *(iii)* granular, i.e. we model default events instead of default probabilities simply, to be able to embed hard wrong-way risk features.

We emphasize randomness in the modeling, as required by regulators (Basel Committee on Banking Supervision, 2022; Financial Stability Board, 2022; European Central Bank, 2022a,b) for economic capital computations (even if they only provide deterministic scenarios). We include not only transition climate risk, but also physical climate risk (extending concepts in Vasily Pozdyshev and Alexey Lobanov and Kirill Ilinsky (2025)), with sector practices analyzed in Veer Singh and Ricardo Ordonez and James Law (2025), which we address by means of adequate damage functions.

Scenarios exploration is demonstrated on the basis of intensive Monte Carlo simulations calibrated to real datasets (Office of Financial Research for the U.S., EBA Stress Test Exercises for Eurozone, Single Supervisory Mechanism, European Central Bank, Federal Reserve Board, Organisation for Economic Co-operation and Development, Futures Industry Association, Bank of International Settlements).

Technical and coding knowledge in probability theory, stochastic calculus, Monte Carlo methods and macroeconomics as well as knowledge in the various financial risks shall greatly help in this project. The capacity to formulate mathematically financial flows, including climate sustainable features, and their dynamic propagations through the financial sector will help in framing the overall project.

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