A model of system-wide stress simulation: market-based finance and the COVID-19 event

  

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We build a model to simulate how the euro area market-based financial system may function under stress. The core of the model is a set of representative agents reflecting key economic sectors, which interact in asset, funding, and derivatives markets and face solvency and liquidity constraints on their behaviour. We illustrate the model's behaviour in a two-layer approach. In Layer 1 the deterioration in the outlook for the corporate sector triggers portfolio reallocation by the model's agents. Layer 2 adds a rating downgrade shock, whereby a fraction of investment grade corporate bonds is downgraded to high yield, which creates further rebalancing pressure and price movements. The model predicts (i) asset flows (purchases and sales of marketable securities) across agents and (ii) balance sheet losses. It also provides quantitative evidence on equilibrium effects of the macroprudential regulation of non-banks, which we illustrate by varying investment fund cash buffers.

A brief summary of the model's building blocks

The paper builds a system-wide stress simulation model to estimate how different shocks can affect – and be amplified by – the market-based financial system. As the economy becomes progressively more reliant on markets and non-banks, this type of analyses aims at capturing amplification effects emerging from market interactions among bank and non-bank intermediaries in times of stress. Although stylised and based on representative agents, the framework is rich enough to be simulated on real data for the euro area financial system. As an example, this specific contribution focuses on the effects of some COVID19-related shocks to the euro area non-financial corporate sector. However, our simulations do not consider the swift and unprecedented support measures introduced in early 2020 by central banks and governments, which had major impacts on financial markets. The model is calibrated to end-2019 data and exploits several datasets.

The core of the model is a set of six representative agents representing aggregate euro area sectors: banks, insurance companies, pension funds, investment funds, hedge funds, and a central bank. They interact in asset, funding, and derivatives markets and face solvency and liquidity constraints on their behaviour, all reflecting either relevant regulations of different sectors (e.g. Basel III for banks or Solvency II for insurers) or market-induced constraints (e.g. flow-performance relationships for investment funds). Marketable assets considered in the model are: a representative government bond, an investment-grade (IG) non-financial corporate bond and an equity instrument. These should be thought of as the average government bond issued by sovereigns in the bloc and the average IG corporate bond and equity issued by euro area non-financial companies (NFCs). Euro area investors also hold high-yield (HY) non-financial corporate bonds, whose yield is for simplicity modelled by applying a (constant) spread over IG yields. Funding is available in a single repo market, where agents can borrow cash against government bond collateral. Finally, there is a derivative market, where agents can hedge or increase their interest rate risk by trading interest rate swaps. Agents must post collateral to participate in the interest rate swaps market, providing government bonds as initial margin, and cash as variation margin, against their swap positions. Before shocks, asset, funding and derivatives markets are assumed to be in equilibrium. Then shocks affect the demand for securities and funding from different agents, who react by seeking their optimal portfolio allocation. The model finds the new equilibrium prices at which aggregate purchases and sales balance in each asset market, and funding market quantities clear.

What the model adds to the literature on system-wide stress testing

Our work builds upon a number of strands of the existing literature. An emerging strand of literature seeks to simulate stress to the financial system as whole, i.e. going beyond well-established stress-testing of individual sectors taken in isolation. Baranova et al. (2017) build a representative agent model in which broker-dealers and hedge funds supply liquidity in corporate bond markets. They assess the degree to which redemptions and subsequent sales of assets by open-ended investment funds could have a destabilising effect on market prices. In this respect, our approach is more similar to Aikman et al. (2019), where a larger set of representative agents and markets is considered. With respect to that contribution, we introduce several novelties in terms of agents (e.g. our model includes a central bank) and their roles in various markets (e.g. the bank in our paper also intermediates fixed-income markets), as well as the way the model's structure is adapted to investigate relevant shocks, such as large-scale rating downgrades. Within the system-wide stress-testing literature, Sydow et al. (2021) have model with banks and investment funds where contagion operates through liquidity and solvency risk. This approach does not include key players in the market-based financial system, such as insurance companies and pension funds. Furthermore, in line with the traditional perspective of bank stress testing, it does not take an equilibrium approach. More specifically, price impact functions are assumed to calculate the effects of asset sales. Practically, this means assuming that there are external agents – not modelled – who would be willing to buy assets that are liquidated by model's agents. In our model, instead, we have equilibrium prices and asset flows emerging from the market interaction between buyers and sellers of securities, both modelled. Our model also examines the role of different constraints and frictions in generating fire sales of assets, similar to Shleifer and Vishny (1992), Greenwood et al. (2015), and Brunnermeier and Pedersen (2008). In these contributions, balance sheet, regulatory and behavioural constraints contribute to amplifying changes in equilibrium asset prices when some agents are forced to liquidate. As a theoretical underpinning to our model, di Iasio and Kryczka (2021) provide a framework to study market interactions between banks, insurance companies and investment funds. Finally, a strand of literature focuses on how financial institutions respond to changes in asset prices, and how such responses vary with their business models and balance sheet structures. sheet structures. Braouezec and Wagalath (2016) show that, as a result of capital and liquidity constraints, banks may choose to deleverage in response to certain shocks. Douglas et al. (2017), Douglas and Roberts-Sklar (2018) and Fache Rousova and Giuzio (2019) study the response of insurance companies and pension funds to different shocks, highlighting the potential for pro-cyclical behaviour. Chevalier and Ellison (1997) and Goldstein et al. (2017) are examples of papers that outline the channels through which investors in open-ended investment funds might act pro-cyclically, causing asset management firms to initiate sales of assets as their prices fall.

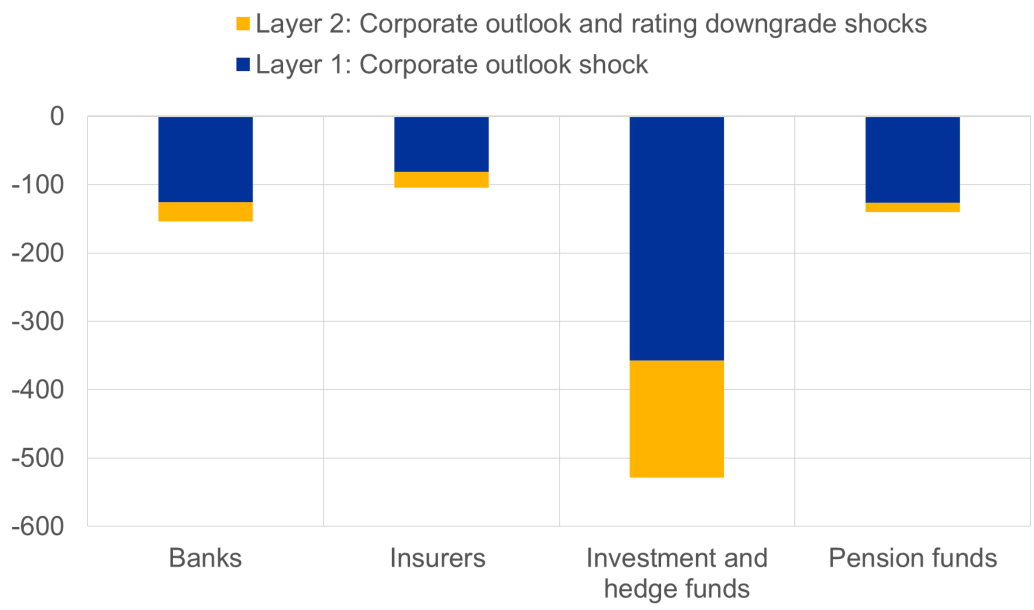
Model's application: the COVID-19 shock and market-based finance

The COVID-19 shock put the market-based financial system under severe stress. We capture this event by employing a two-layer approach. First, a broad-based macro shock hit the non-financial corporate sector (Layer 1 simulation). On top of that, back in spring 2020, major concerns were related to large-scale rating downgrades of companies amid the unprecedented deterioration of macro fundamentals. 'Fallen angel' companies, i.e. those downgraded from investment grade (IG) to high yield (HY), were particularly in the spotlight, because of possible cliff-effects. Indeed, many investors in the corporate bond market are restricted by mandates to invest only in IG assets. In Q2 2020, it was estimated that potential downgrades of euro area NFC BBB-rated bonds to HY could have reached €110bn, €68bn of which were held by the model's private agents (i.e. when excluding those held by the Eurosystem and non-euro area investors). This is reflected in our Layer 2 simulations, where holders of fallen angels are also hit by the rating downgrade shock.

Marked-to-market losses and forced portfolio rebalancing trigger further endogenous reactions in the model. We find that yields of euro area IG NFC bonds increase by 265bps in Layer 1 and by more than 430bps in Layer 2. The model converges towards new equilibrium allocations and we calculate equilibrium asset flows, i.e. buying and selling by different agents in tradable assets. We find that endogenous fund investor redemptions are a very important driver of net sales of corporate bonds. Insurance companies and (to a lesser extent and in Layer 2 only) pension funds take the other side of the market and engage in net purchases, in order to meet their targeted optimal portfolio weights.

Balance sheet losses for euro area financial sectors resulting from shocks and agents' reactions that drive the system towards the new equilibrium are substantial. System-wide losses due to the deterioration of the corporate outlook shock amount to €690bn (Layer 1, see Figure 1). These are driven by a large drop in the valuation of equities and non-financial corporate bonds. The rating downgrade shock results in additional losses of €240bn (Layer 2). For this case also, losses are concentrated in the investment fund sector, while those hitting banks, insurance companies and pension funds are quite limited.

Figure 1: balance sheet losses of selected sectors



Policy implications

The model has implications in terms of financial stability surveillance framework as it captures amplification effects stemming from agents' interactions. It also accounts for the role of occasionally binding constraints, which may affect agents' behaviour. In an extension, we explore the role of higher liquidity buffers of investment funds and show that these can reduce amplification effects and price dislocation. This is an example on how the model can be used to test different possible regulatory tools, especially those under discussion for the asset management industry.

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