Final Report

Climate Change and Finance: Metrics to assess Risks and Opportunities

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1 Context

The aim of the following report is to analyse an example of transition risk in finance. Assessing the impact of climate change risk in general on the financial system is currently one of the most discussed topics in both research and policy (Battiston et al. 2017). Besides physical damages due to the increased frequency and severity of extreme climate events[1], a risk to the financial sector can occur due to the political effort to transition to a low-carbon economy. Using the definition of Görgen et al. 2020, "this new kind of risk includes all positive and negative impacts on firm values that arise from uncertainty in the transition process from a brown to a green economy" (Görgen et al. 2020, p.2). It is to be highlighted that a key variable in this definition is **uncertainty** - this means, that in particular a disorderly transition could lead an unanticipated and sudden adjustment of asset prices with potentially adverse effects for financial stability.

The scientific consensus points towards a clear increase in global average temperature and increased severity and frequency of extreme climate events, as reported by the Intergovernmental Panel on Climate Change (IPCC) (Pachauri et al. 2014). Not only can this change be attributed to human activity, but also does climate change pose potential threats to society and financial stability. Therefore combating climate change falls within the mandate of both political decision makers and financial regulators. The policy framework today is largely governed by the United Nations Framework on Climate Change (UNFCCC)[2], an international treaty addressing climate change, including the Kyoto protocol (1997) and Paris agreement (2015), aiming to limit global warming to well below 2 degree Celsius, compared to pre-industrial levels[3]. As an effort on the European level the EU Technical Expert Group on Sustainable Finance (TEG)[4] assists in developing the EU taxonomy (determine whether an

[1] The physical climate risk is mainly a topic discussed in insurance, as for example by Charpentier 2008
[2] https://unfccc.int/
[3] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
[4] https://ec.europa.eu/info/publications/sustainable-finance-technical-expert-group$_en$

economic activity is environmentally sustainable), an EU Green Bond Standard, and provides guidance to improve corporate disclosure of climate-related information. Moreover several associations have formed on the industry and regulatory level. These include the Task Force on Climate-related Financial Disclosure (TCFD) from the Financial Stability Board (FSB)[5] and the Network for Greening the Financial System (NGFS)[6].

Regarding financial markets, the evidence on whether transition risk is priced in the market is mixed. Görgen et al. 2020 and Roncalli et al. 2020 investigate the pricing of transition risk on the international equity market and find that it is priced in at the stock-level, though the intensity varies both over time and geography. In the bonds market multiple studies compare the pricing between so called "green" and "brown" bonds. For example Jin et al. 2020 find that a green bond index can hedge carbon market risk, indicating that climate change risk is priced[7].

Having provided arguments for the relevance of climate transition risk in finance, how can firms manage climate transition risk? The management of transition risk naturally depends on the nature of the firms activity. In the following report data from the energy sector is analysed, which plays a key role in a low-carbon transition. The main source of anthropogenic greenhouse gases is due to the burning of fossil fuels (Pachauri et al. 2014), hence in a low-carbon transition these assets are likely to get stranded[8]. Academic effort has been made to determine the impact and magnitude of stranded assets of fossil-fuel companies (McGlade and Ekins 2015) or to estimate the systemic risk arising from a transition to a low-carbon economy, by analyzing investments in climate-policy relevant sectors and simulating market shares of the energy sector in alignment with commonly used transition scenarios (Battiston et al. 2017). However data availability with granularity at firm-level activity regarding climate policy relevant activities is scarce.

2 Illustrative analysis of an energy bond portfolio

This reports makes an example analysis of a bond portfolio in the energy sector. The analysis aims to analyse the effect of climate transition risk on bond valuation, given the occurrence of certain climate policy scenarios.

Scenarios are alternative states of the world, typically centered on a narrative. They are neither a model, nor a prediction, but models may be used to determine characteristics and examine impacts on firm business (CFRF 2020). The most commonly used scenarios are the Special Report on Emissions Scenarios (SRES) (used in the third (2001) and fourth (2007)

[5] https://www.fsb-tcfd.org/

[6] https://www.ngfs.net/en

[7] These references are merely provided to argue that there exists evidence that climate change physical risk is priced in financial markets, and hence must be managed by investors. An extensive literature review of this question would exceed the scope of the present report.

[8] The term stranded assets refers to assets that due to financial decisions no longer provide financial value.

assessment report of the IPCC), and the Representative Concentration Pathway (RCP) scenarios, used in the fifth assessment report of the IPCC (2014). The RCP scenarios are developed using integrated assessment models (IAMs) and include scenarios for future emissions of important gases and aerosols, specify concentrations and corresponding emissions (Pachauri et al. 2014). Whereas scenarios mainly present emission pathways, they can be translated into temperature changes using a wide range of climate models, or economic damage using IAMs.

The following report uses data from the CD-LINKS scenario explorer hosted by the International Institute for Applied Systems Analysis (IIASA)[9]. The Scenarios analyse include the the business as usual scenario (BAU), also called no policy scenario, and compare it to four action scenarios with different carbon emission budget between 400 and 1600 $GtCO_2$ for the years 2011 to 2100[10]. In order to assess the impact on energy emissions the IAM REMIND-MAgPIE is used.

The assumptions of the calculation are as follows: Each scenario includes a pathway for future energy use, per energy segment (i.e. coal, oil, gas etc.). It is assumed that the shock associated with a certain scenario corresponds to the change in emissions in a emission reduction scenario, compared to the business as usual pathway. It is further assumed, that these shocks translate directly to shocks in revenues, and via an elasticity factor translate to a shock on the bond price of the firm. Bonds are usually valued by discounting future coupon payments and the notional, hence changes in value occur mainly through the discount factor. I assume, that the rationale of the methodology applied is that reduction in the energy output can change the investors perception about the probability of default of the bond, and hence a decrease in revenue of the firm would lead to a price reduction of the bond.

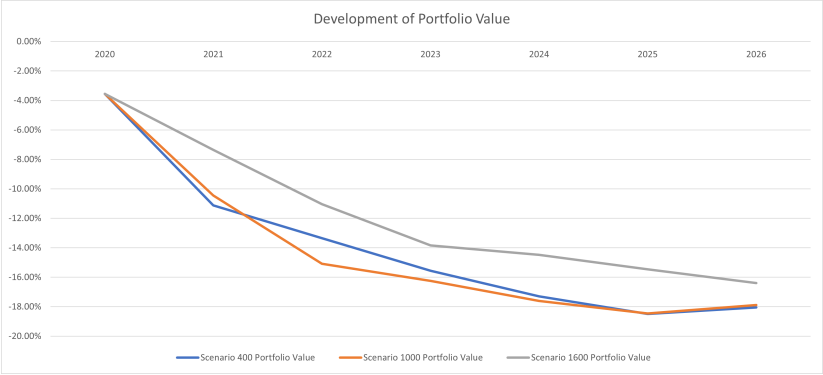

Figure 1: Development of bond portfolio value (Source: own calculations)

The results in Figure 1 show that for a mixed energy-sector bond portfolio, the value of the portfolio decreases for each of the transition scenarios. The least reduction is naturally a

[9]https://data.ene.iiasa.ac.at/cd-links//login

[10]The scenarios used are NoPolicy, NPi2020400, NPi20201000, NPi20201600 and a more detailed description is provided by the IIASA: https://db1.ene.iiasa.ac.at/CDLINKSDB/dsd?Action=htmlpagepage=10

response to the least strict emission reduction scenario (1600 $GtCO_2$ budget for 2011-2100), whereas a stricter reduction in emissions leads to even larger reductions in portfolio value[11].

3 Discussion

The illustrative analysis of the bond portfolio shows that the financial effects of the climate change policy transition can be very large, leading to losses of up to 16% in attribution to carbon emission reductions. This implies, that the transition has to occur in an orderly way, in order to avoid sudden and unanticipated shocks. These can not only lead to huge and sudden losses, but also propagate through the financial system and lead to financial distress, as showed by multiple network studies (for example Battiston et al. 2017).

However, one has to be aware that the above made calculations are subject to multiple limitations. Firstly, the analysis has to be interpreted as a "what if" analysis, as the scenarios used are based on assumptions, and do not provide real-world probabilities of possible events. Moreover, as discussed by Crost and Traeger 2013, the analysis with IAMs replicates uncertainty by averaging Monte Carlo runs of deterministic models, as all uncertainty is resolved before the first time period. This may not represent actual policy decision making, in which feedback effects between observed effects and decisions make can occur. Another source of feedback effects to policy decisions might be the financial sector itself. Moreover, several parameters were assumed, such as the maximal shock on energy production, revenues and the sensitivity of bond prices to revenues. As visualized in the appendix of the calculation sheet using the Fortum bond (as a bond of a company active in multiple segments), altering the elasticity factor by 0.1 can change the losses on the bond to about 5pps by 2050.

It should however be stressed, that the above limitations do not reduce the value of the analysis, but simply have to be taken into account when interpreting the results. Moreover they could potentially be used to build more involved analysis. For example, the current analysis focuses on translating scenarios of future emission pathways into bond values. I would be very curious, if it would be possible to combine this with an analysis that takes a market-view, and tries to fit parameters according to observations in the market, e.g. fitting the sensitivity parameter according to past observations. Though naturally it is not always wise to focus too much on past data, I would be curious if that provides estimates different from the assumed ones.

Overall, the following report argues that transition risk is a risk to be actively managed by financial institutions, including investors, individual firms and regulators. The argument arises from the fact that both policy decision makers and financial regulators take action, leading to consequences for financial markets. Moreover, as far as I could distinguish from the literature, climate change risk seems to be priced to some extend to financial markets,

[11] The sheet for the analysis can be found under https://www.dropbox.com/s/f2iup3ux9uedqug/finalReport$_sg.xlsx?dl$ = 0.

justifying that market participants do or will eventually react to policy decisions. Moreover, as the example analysis shows, losses can potentially be large and hence exposure to climate policy relevant sectors has to be actively managed. Moreover further analysis would be simplified with the availability of more granular data.

References

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