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Headline

The study develops a network-based climate stress-test to understand the degree to which financial actors' investments are exposed to climate risk. It analyzes the impact of green (or brown) investment strategies and finds that investors' portfolios in equity holdings bear large exposures to climate-policy-relevant sectors, and that pension funds are particularly affected. The results suggest that prompt and stable climate policies do not imply systemic risk. Rather, the lack of their implementation could lead to systemic adverse effects to the economy. The results are relevant to the ongoing debate on the need for asset managers and institutional investors to disclose to their clients their exposure to climate-relevant financial risk.

Executive Summary

The urgency of estimating the impact of climate risks on the financial system is increasingly recognised among scholars and practitioners. Yet, traditional cost-benefit analyses provide aggregate estimates of the effects of climate policies and are inadequate to identify individual risks and how these might propagate through the financial system.

Our study develops a complementary approach based on the network analysis of financial dependencies and shows that direct and indirect exposures to climate-policy relevant sectors represent a large portion of investors' equity holdings portfolios – in particular for investment funds and pension funds. For banks, these exposures represent a portion of loan portfolios that is comparable to banks' capital. Although loan portfolio data is not available at the level of individual banks, we illustrate how a network-based climate stress-test can be carried out for “green” and “brown” investment strategies using data from equity holdings of large EU banks, to deliver individual levels of climate Value at Risk.

Our results suggest that the disclosure of climate-relevant financial information is key to improve risk estimations and create the right incentives for investors. However, better disclosure may not be sufficient: the timing and credibility of the implementation of climate policies matter. An early and stable policy framework would allow for smooth carbon-asset values adjustments and lead to potential net

winner and losers. In contrast, a late and abrupt policy implementation would have adverse systemic consequences for the financial system.

Further details on the results and their relevance to societal and policy issues

Climate policies: systemic risk or opportunity for green growth?

In the occasion of the upcoming German presidency of the G20 in 2017, Bank of England's governor Mark Carney has spoken of a "historic chance to mainstream climate finance and turn risk into opportunity".¹ Moreover, OECD general director Angel Gurría has highlighted the contribution of green public policies to restore a stable growth path². These statements demonstrate the increasing attention to the policy discussion on whether the implementation of climate policies to meet the 1.5C COP21 agreement could generate systemic risk in the financial system or, instead, opportunities for low-carbon investments and economic growth. Accordingly, there is growing attention to climate finance - broadly speaking referring to the set of actors and instruments to channel public and private investments into economic projects that explicitly contribute to climate change mitigation and adaptation programs.

Direct and Indirect Exposures to Climate Policy Relevant Sectors

By investing in fossil fuel companies, financial institutions hold direct "high-carbon exposures", which for European actors have been estimated to be, relative to their total assets, about 1.3% for banks, 5% for pension funds and 4.4% for insurances [10]. However, because climate-policies are likely to affect (positively or negatively) numerous other economic sectors beyond fossil fuel production, we analyse the exposures of financial investors using a new classification³ of economic activities in terms of *climate-policy relevant sectors* (i.e. fossil-fuel, utilities, transport, energy-intensive, housing). The following picture emerges. First, the relative equity portfolio exposures of all investors types to the fossil sector are limited (i.e. ranging from 4.4% for Individuals to 12.9% for Governments) (see SI Table 6). Second, their relative equity portfolio exposure to the combined climate-policy relevant sectors is large (i.e. ranging from 45.2% for Insurance and Pension Funds to 47.7% for Governments), and mostly accounted for by the energy-intensive sector. Third, since investors' exposures to the financial sector itself range from 13% for Industrial Companies up to 25.8% for Other Credit Institutions, they bear additional indirect exposures to climate-policy relevant sectors.

These exposures are not necessarily a threat, but because they are large they demand scrutiny. Climate mitigation policies are commonly thought to have an adverse effect on the value of assets in the fossil-fuel sector [5], as well as an adverse effect on the whole economy (see IPCC report [21], chapter 6). However, other studies (for a discussion on this see [22]) argue that a transition to a low-carbon economy can have net positive aggregate effects for growth and economic welfare. Moreover, the effects of climate policies are likely to vary across firms and sectors.

¹ <http://www.bankofengland.co.uk/publications/Pages/speeches/2016/923.aspx>

² <https://www.euractiv.com/section/climate-environment/interview/angel-gurria-climate-challenge-should-be-seen-as-an-opportunity/>

³ The existing classifications of economic sectors such as NACE Rev21 or NAICS2 were not designed to take into account climate policy impact and thus cannot be directly applied to estimate financial exposures to risks deriving from climate policies.

Network-based Climate stress-tests

Probabilistic estimates of macro-economic impacts can be used to assess the Climate Value at Risk from an aggregate perspective [11]. However, they are too broad to define shock scenarios for individual institutions. While estimates of the value of stranded assets are available in the literature at a more granular level, their sectoral coverage is currently too narrow to inform an analysis of systemic impacts. In order to overcome these limitations and construct more refined scenarios that allow to compute a Climate Value-at-Risk for each bank, we construct distributions of shocks for the fossil fuel and utility sectors based on the economic impact assessment of climate policies provided by the LIMITS database [28] (see methods). Two scenarios analysed in the study are of particular relevance here, corresponding to a bank adopting one of two different investment strategies:

- (2) a “green” bank characterized by having all its current equity holdings in Utilities invested in Renewables-based Utilities and having no Fossil-Fuel investments,
- (4) a “brown” bank characterized by keeping all its current equity holdings in Fossil-Fuel and by having all its equity holdings in Utilities invested in Fossil-fuel-based utilities.

Based on individual banks’ equity holdings data, we find low values of Value at Risk even for the brown bank (below 1 per cent). This is also due to the fact that a stress-test should be carried out on the loan portfolio instead, since due to regulation⁴, banks’ equity holdings are small with respect to their capital. Individual banks’ loans data are not available. However, by using aggregate data we estimate that if climate policies imply higher volatility of loan values in (i) the energy-intensive and transport sector or (ii) the housing sector, this would translate also in the volatility of a portion of assets comparable to banks’ capital (44% and 281% of capital, respectively).

Financial investors and climate policies

From the analyses summarized above, we derive the following implications:

1) Banks should not be concerned with climate policies affecting the value of carbon stranded assets, because banks’ exposures to these assets are simply very small, both via equity holdings, and via corporate loans or corporate bonds. Banks should be more concerned with energy efficiency policies that could affect the values of real estate and thus the value of loans to households – their largest exposure to the real economy. However, a diversification strategy towards loans for energy efficient properties could be a net gain. Banks should also be concerned with intra-financial exposures (their largest exposure of all), which can amplify negative shocks.

2) Investment funds should be more concerned with direct losses from the fossil sector. Even more so, pension funds should be concerned with their indirect exposures to equity markets via investment funds and their direct exposures to sovereign bonds (because governments typically hold important stakes in domestic fossil sectors). However, a diversification strategy towards green finance could more than compensate losses from the fossil fuel sector. It is important to notice that the economic value of existing fossil-fuel plants would decay substantially within one decade. As a result, if aging plants are replaced with renewable energy plants, the transition to a low-carbon economy could result in a benefit, or at

⁴ BIS, 2013 www.bis.org/publ/bcbs266.pdf

least not a cost, for institutional investors with exposure to the utilities sector.

The role of financial markets

Institutional investors have influence on holdings of a large portion of real-economy assets in the equity market and in the bond market, either as owners or as fiduciaries. Therefore, while they bear exposures they can also play an important role in an orderly transition to a low-carbon economy. However, this role should not be overestimated. Indeed, there is a consensus on the fact that the Green House Gases (GHG) emissions involved in the use of fossil fuel throughout the economy imply negative externalities. Hence, economic theory states that we cannot expect markets to internalize these externalities, on their own.⁵ While, of course, wrong policies could do even more harm – details matter – there can be policy interventions that are welfare enhancing.

Moreover, an impasse seems to have emerged: on the one hand, policy makers hope that financial markets will trigger the change in mobilizing capital into low-carbon investments, but, on the other hand, financial markets have no incentive to do so, unless policy makers make a credible step to create stable energy policies for a period of 10-20 years. Indeed, on the one hand, several states (within EU, G20, and OECD) seems to have difficulties in establishing long-lasting energy policies for renewable energy sources at domestic levels⁶, probably due to contrasting interests of the various stakeholders and particularly short-term horizon of the political elite in this historic phase. Moreover, states continue to grant subsidies for fossil fuels R&D, production and consumption (Bast et al., 2014), despite vocal recommendations (e.g., IMF 2015) to phase them out. On the other hand, policy uncertainty, both on the level and stability of feed-in tariffs or tax rebate to green investments prevents investors to carry out reliable revenue projections from green energy plants.

Investment strategies in the face of multiple scenarios

Assessing the financial risk of climate policies requires estimations of the likelihood of the introduction of a specific policy. However, the likelihood that a policy is introduced depends on the expectations of the agents on that very likelihood. Thus, the intrinsic uncertainty of the policy cycle undermines the reliability of the probability distributions of asset returns, also because of the presence of fat tails [13]. At best, investment strategies should consider distributions of gains and losses that are *conditional to climate policy scenarios* and, therefore, *conditional Value at Risk*. Based on the results of our empirical analysis about the size of the financial actors and their interdependencies, one can construct at least two possible policy pathways.

In one scenario, climate policies are adopted early-on and in a stable way, with benefits to both the institutional investors and to households who can provide the aggregate demand (necessary to absorb the goods and services produced by the green economy activities), and grant the political support to the implementation of the climate policies at the domestic level. In this scenario, the transition to a low-carbon economy is not necessarily a cost but may be an opportunity to launch an inclusive growth path.

⁵ The well-known Greenwald-Stiglitz 1986 theorem states that the competitive market equilibrium is not Pareto efficient in the presence of externalities and that there could be policy interventions that are welfare enhancing.

⁶ see e.g. the issues with feed-in tariffs for solar electricity in Spain, Italy and Germany

In another scenario, policy inaction persists for another 10-15 years until the effect of climate changes become visible even in the developed countries, leading more likely to an abrupt implementation of climate policies and a sudden adjustment of asset values throughout the economy as a result of the recognition of losses from stranded assets. In this scenario, there is a possibility of systemic losses for the financial sector as a whole, based on its exposures to the fossil sector and the energy intensive sector. Given the rising levels of sovereign debt and the depletion of public budget across developed countries, it is unlikely that the financial sector could be rescued with public funds as it happened in the aftermath of 2008. This scenario represents an inferior economic equilibrium because both the financial sector and households,(through the pension funds) would suffer net losses.

Disclosure is needed. But policy timing is critical.

There is growing consensus towards initiatives such as the FSB Task force on climate-related financial exposures to encourage investors to disclose climate relevant exposures and to run climate stress tests. Indeed, a better disclosure is an important step to improve risk estimations and create the right incentives for investors. However, better disclosure may not be sufficient: the timing and credibility of the implementation of climate policies matter. An early and stable policy framework would allow for smooth carbon-asset values adjustments and lead to potential net winners and losers. In contrast, a late and abrupt policy implementation would have adverse systemic consequences for the financial system.

Finally, an important related discussion concerns the design of institutional arrangements (including a new architecture for sustainable finance) that relying on the driving force of financial markets can also foster the inclusion necessary to make the low-carbon pathway both economically sustainable and socially stable.

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