CLIMATE ECONOMICS

Substantial risk for financial assets

After the global financial crisis, regulators turned their attention to non-traditional threats to financial assets, including the impacts of climate change. A new study estimates the magnitude of that threat, and shows investors should take it seriously.

Sabine Fuss

Unabated climate change can affect financial assets in two ways: by destroying them or accelerating their depreciation, or by disrupting economic activities backed by these assets through higher temperatures, changed patterns of precipitation, dry periods and extreme events. Recent political commitments to curb climate change at levels 'well below' 2 °C could mitigate these risks to a certain extent. Such ambitious decarbonization would, however, make vast reserves of fossil fuel resources 'unburnable'[1–3], thereby reducing the value of associated assets. The value of financial assets is thus at risk in the face of both unabated climate change and more ambitious climate policy.

Awareness of this issue has risen significantly as of late. Indications of this can be found in the more long-term-oriented actions of institutional investors such as pension funds in Norway, the UK and the Netherlands, within which discussion of divestment from carbon-intensive assets has gained momentum over the past year. The vast majority of asset owners do not account for the carbon emissions embedded in their portfolios[4], however. This makes assessment of their portfolio risk inherently difficult, if not impossible. As such, so far, there has been little in the literature that helps to estimate the magnitude of these impacts and measure the losses that global financial assets could potentially suffer as a consequence.

In *Nature Climate Change*, Dietz *et al.*[5] give such an estimate. They assess how much the global portfolio of financial assets stands to lose from climate change at a given probability. They estimate the climate 'value at risk' (VaR) of global financial assets by comparing GDP growth forecasts with and without climate change. In Fig. 1, the 99% VaR is shown to be at the 99th percentile of the distribution of the losses; that is, there is a 1% chance that at least this value will be lost. To derive these distributions for different scenarios, the authors use an extended version of the widely established Dynamic Integrated Climate–Economy (DICE) model, which has a Ramsey growth model structure, as it enables them to explicitly model the impact of climate change on both the growth rate (rather than having an exogenous growth rate) and the capital stock. They build on the assumption that in a diversified portfolio of assets, the undiscounted growth rate of the dividends must be growing at the same rate as the economy in the long run[6]. This allows them to analyse both of the ways in which unabated climate change can affect the value of financial assets.

They consider four dimensions of uncertainty: the rate of productivity growth, the parameterization of climate sensitivity, the way warming links to losses in GDP (that is, the shape of the damage function) and abatement costs. Monte Carlo simulations are used to ultimately generate the cumulative distribution functions of the present values of global financial assets in different scenarios. By looking at different percentiles of the difference between these distribution functions, the climate VaR can be determined at different probability levels (Fig. 1).

The results show that the expected climate VaR (without abatement) until the end of the century is 1.8%. Taking the Financial Stability Board's 2013 valuation of global non-bank financial assets of US$143.3 trillion[7], this amounts to US$2.5 trillion. However, the devil is in the distribution tails; if we look at the 95th percentile, the loss is 4.8%, and at the 99th percentile it is 16.9%, amounting to about US$24 trillion. Clearly, such massive losses, even at a lower probability of occurring, would be hugely disruptive, so investors should be taking climate risks seriously.

Dietz *et al.*[5] also provide estimates of the climate VaR for a mitigation scenario, where abatement restricts global warming to below 2°C above pre-industrial levels. In this case, abatement will have to be paid for, and many assets associated with a high carbon footprint will become stranded. In fact, the present value of financial assets would be lower than under the business as usual pathway. However, looking at the risk — the

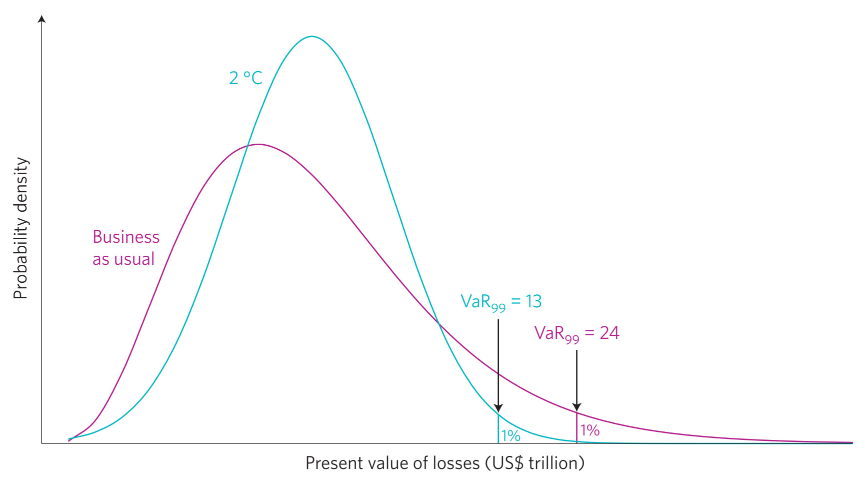

Figure 1 | Probability density function of present value losses in US$ trillion. **a**, The 99% value at risk (VaR_{99}) of the distribution under business as usual (red) is US$24 trillion, that is, there is a 1% chance that the loss will at least be US$24 trillion. 99% of the area under the curve is to the left of the solid line. **b**, Under ambitious climate policy (blue distribution function labelled with 2 °C), the VaR_{99} is substantially lower at US$13 trillion. Note that the distributions have been drawn for illustration, and do not necessarily correspond to the results in Dietz *et al.*. VaR is also not a coherent risk metric and does not convey any information about the structure of the tail, that is, what happens beyond the VaR.

expected climate VaR and the distribution tails — it turns out that mitigation will shrink the potential losses of financial asset value; under unabated climate change there is a 1% chance that at least US$24 trillion will be lost, but mitigating part of this climate change reduces the climate VaR to almost half, with a 1% probability that at least 9.2% of US$ 143.3 trillion (US$13 trillion) will be lost. This makes a strong case for mitigation.

The stylized top-down approach employed by Dietz *et al.*[5] cannot answer all questions about how financial assets will be affected. In particular, it does not allow us to draw any conclusions on how different countries and regions will be affected, and we cannot use it to trace the repercussion effects throughout the economy. So far, such detailed analysis of on the ground impacts is inherently constrained by lack of data and a more thorough understanding of climate impacts.

Dietz *et al.*[5] offer first estimates of the magnitudes of climate impacts on the value of financial assets, relying on simple economic relationships. Though using a one-sector model (with a global damage function) falls short of considering heterogeneity of assets and possible reallocation in response to climate change — the impact of which could be large — the authors succeed in demonstrating that climate risks to financial assets could be substantial.

The study demonstrates that investors have multiple causes of concern, either about stranded assets and high abatement costs under ambitious climate policy, or about climate impacts on their assets under unabated climate change. This underlines both the need for full disclosure so that climate risks can be assessed and portfolios adjusted accordingly, and the need for more research to develop comprehensive estimates of the risk of such losses. ❐

Sabine Fuss, Mercator Research Institute on Global Commons and Climate Change (MCC), Torgauer Strasse 12–15, 10829 Berlin, Germany.
e-mail: fuss@mcc-berlin.net

References

1. *Unburnable Carbon 2013: Wasted Capital and Stranded Assets.* (Carbon Tracker Initiative & Grantham Research Institute on Climate Change and the Environment, 2013); http://www.carbontracker.org/report/carbon-bubble/
2. McGlade, C. & Ekins, P. *Nature* **517,** 187–190 (2015).
3. Edenhofer, O., Flachsland, C., Jakob, M. & Lessmann, K. *The Atmosphere as a Global Commons — Challenges for International Cooperation and Governance* Discussion Paper 13-58 (Harvard Project on Climate Agreements Discussion Paper Series, Mercator Research Institute on Global Commons and Climate Change, 2013).
4. *Global Climate 500 Index 2015* (The Asset Owners Disclosure Project, 2015); http://aodproject.net/climate-ratings/aodp-global-climate-500-index
5. Dietz, S., Bowen, A., Dixon, C. & Gradwell, P. *Nature Clim. Change* **6,** 676–679 (2016).
6. Covington, H. & Thamotheram, R. *The Case for Forceful Stewardship. Part 1: The Financial Risk from Global Warming* http://dx.doi.org/10.2139/ssrn.2551478 (2015).
7. *Global Shadow Banking Monitoring Report 2014* (Financial Stability Board, 2014).

Published online: 4 April 2016

ENERGY ECONOMICS

Cheap oil slows climate mitigation

Oil prices are notoriously tricky to predict. This uncertainty could slow climate mitigation unless policymakers implement stringent climate policy.

Laurent Drouet

The oil industry has a history of booms and busts, and prices have slumped significantly over the past two years. The drop in prices will have a rapid effect on the energy sector and global economy. Low oil prices result in less investment in the exploration for (and extraction of) oil and gas, and could simultaneously see increased demand for related equipment and services, stimulating the world's economy[1].

If cheap oil becomes the new normal, there may be no price constraint to prevent burning of the remaining underground oil and gas resources. In such a world, carbon emissions could continue to grow, and temperatures may rise to significant levels if no action is taken[2].

In *Nature Energy*, David McCollum and colleagues[3] explore the implications of oil price uncertainty on future emissions, and policymakers' ability to limit global warming to 2 °C above pre-industrial levels. They find that long-term oil prices have a significant impact on cumulative emissions: low oil prices hamper climate mitigation action whereas high oil prices boost it. The authors identify some critical uncertainties in the energy system with consequences for possible mitigation emission pathways.

They use the MESSAGE integrated assessment model to explore scenarios with sustained high and low oil prices, about US$110 and US$40 per barrel, corresponding to the levels observed in late 2014 and early 2016, respectively. They include a set of future uncertainties related to the evolution of the energy sector: the coupling of gas and oil prices; the potential of biomass; the availability and costs of technologies related to bio-fuels and synthetic fuels for electric, natural gas and hydrogen vehicles. For each factor, the two opposite scenarios were combined in order to explore the limits of uncertainty. A 'no climate policy' case was compared to a case where policies limit warming to 2 °C by 2100, using a global carbon tax.

The findings confirm that oil prices are an important driver of energy system changes and emissions levels. Climate policy remains the most important lever to mitigate long-term emissions, however, because a sustained high oil price does not have an equivalent effect to a carbon tax.

An important point is the difference in emissions between the wide-ranging oil prices scenarios: the magnitude is less than expected because it relies not only on oil prices but also on many other factors. For example, in terms of fuel substitution, cheaper coal may be consumed when oil prices are high. The main uncertainty in terms of energy system evolution is whether oil and gas prices are coupled, as was historically the case. This may change in the future, with the US looking at decoupling the prices. Uncertainty related to the potential of biomass is also important, as is the cost and capacity of electrification of the energy system.

In a scenario where warming is limited to below 2 °C, oil price uncertainty is less important because climate policy eventually removes a large share of oil from the energy mix anyway. More important in this case are the uncertainties about the other technical developments in the energy system, as they drive decarbonization.

To comply with the recent Paris Agreement, countries have provided climate policy commitments in intended