POLICY BRIEF | ECONOMIC AND FINANCIAL IMPLICATIONS OF CLIMATE CHANGE IN EUROPE

INTEGRATED SOLUTIONS TO ADDRESS HIGH LEVELS OF CLIMATE CHANGE

We are not yet on track to meet the Paris Agreement's goal of limiting the rise in global mean temperatures to 2°C (and ideally 1.5°C) above pre-industrial levels. IMPRESSIONS modelling projects that higher levels of climate change will have substantial impacts on a range of sectors including agriculture, forestry, water, biodiversity and human health. This brief considers the economic and financial implications of these impacts in Europe, as well as the opportunities to transform to a sustainable and innovation-friendly growth path.

Key Messages

On current emission trends, Europe is heading towards a 3-5°C temperature rise by 2100. This could lead to substantial economic damage, ranging from 6% of GDP in the most optimistic models to as much as 80% in more recent models. A novel agent-based integrated assessment model was used to investigate three different ways in which these high levels of climate change can affect the economy, finding that:

- Where labour productivity is reduced (e.g. via heat stress on outdoor workers), the model projects significant reductions in GDP growth, even to negative values.
- When the capital stock of firms is damaged, more bankruptcies are expected, leading to knock-on effects for the financial sector.
- Where climate impacts increase energy demand (e.g. for cooling), this tends to generate additional revenue for the fossil fuel sector. In these circumstances, stronger policy action (higher carbon prices, more investment support) is needed to enable a green transition to low carbon energy.

Evidence from this study shows the need for a rapid increase in carbon taxes both in Europe and worldwide (or, where this is not politically feasible, much stronger regulations and standards on energy use and efficiency), together with more government investment and public funding for low carbon technology. These interventions can reduce emissions at the same time as fostering growth and innovation.

What are the economic and financial risks from high levels of climate change?

Models generally agree that if uncontrolled carbon emissions push average temperatures well above 2°C, there will be substantial damage to the economy. Climate change will directly affect labour productivity (e.g. via heat stress), capital stock (e.g. damage from extreme weather events) and industrial energy demand (e.g. through increased need for cooling), and impacts on sectors such as agriculture, forestry and energy will indirectly affect the European macro-economy. Uncertainty around key parameters (e.g. climate sensitivity and the damage function) leads to a wide range of potential outcomes, including catastrophic futures where a large share of economic production is lost. Using emissions scenarios equivalent to warming of around +5°C by 2100 (consistent with RCP8.5), the most optimistic estimates indicate an aggregate damage due to climate change of approximately 6% to 10% of global output (equating to around a decade of lost economic growth), while recent evaluations point to much higher impacts (a 40-80% loss in output[1]). Based on this range, it seems likely that the activities of financial institutions such as banks, investment funds and insurance companies will also be strongly impacted by the economic losses arising in different sectors. Our financial system must be prepared to absorb potential 'extraordinary losses' (losses arising from unforeseeable events) from both climate-related physical events and climate policy implementation (for example via stranded high-carbon assets such as coal and oil reserves).

A growing body of literature argues that future climate impacts should not be seen just as threats, but also as opportunities to foster certain trajectories of technological and societal development. Europe can move towards a sustainable and innovation-friendly growth-path if it implements the right policy mix to sustain a green transition, with economic growth decoupled from greenhouse gas emissions[2,3]. Appropriate financing schemes should therefore be designed to promote technological development and diffusion of low carbon energy generation, energy storage systems, direct air capture and other technologies that might reduce anthropogenic emissions and open up novel and sustainable development pathways. These risky investments traditionally require government investment and public funding to play a major role.

Novel models, novel insights

Standard integrated assessment models completely overlook frictions in the way the economy reacts to climate impacts (i.e. they assume that shocks are absorbed by price changes in perfectly competitive markets where production factors can adjust at any time). Many also do not distinguish between the way in which different impacts might reduce the overall level of economic and financial activities. Building on the blossoming literature on complex system approaches to climate change[4], IMPRESSIONS researchers have recently developed a micro-level agent-based integrated assessment model (the DSK model) to study a variety of climate impacts in a realistic simulated economy, and to test possible corrective policies[1,5,6] .

The DSK model has yielded major insights into the different ways in which climate change can affect the economy. It was used to study a reference scenario close to current trends (consistent with the RCP8.5 scenario), leading to a large temperature rise of +2.8 to 5.5°C from the pre-industrial average. Economic growth was assumed to be high (around 3.2%) without climate damage, and, in the absence of policy interventions, the energy mix was assumed to be 80% fossil fuels. Three different types of climate damage were simulated: reduced labour productivity; increased energy use per unit output at the company level; and damage to the capital stock of firms. The impact of these climate damages on the economic activities of firms is likely to be an essential driver of the aggregate macro-economic outcome.

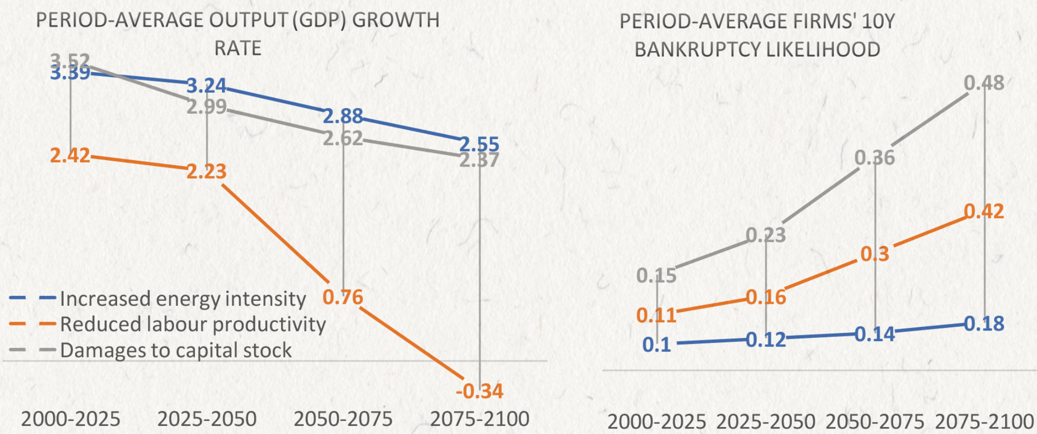


Figure 1. Left: average growth rates of the EU economy (a proxy for economic impacts); Right: average firms' 10-years likelihood of bankruptcy (a proxy for financial sector impacts); in four quarters of the simulation period (2000-2100) in the reference scenario (consistent with RCP8.5, +2.8 to 5.5°C), for three types of climate damage: higher energy intensity; lower labour productivity and damage to capital stocks.

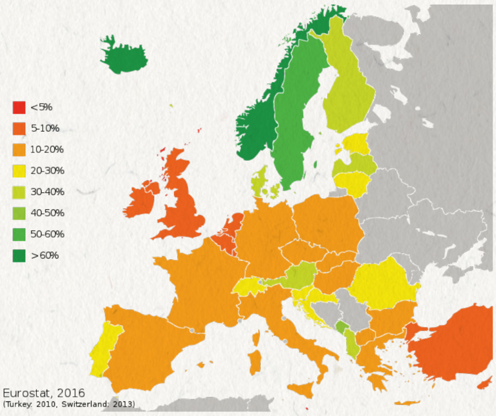
The model showed that in those economies where climate change reduces the productivity of workers (e.g. in sectors with a high share of outdoor work, such as agriculture and construction), the long run output growth rate is projected to decrease from 3.2% in the reference scenario (i.e. no climate damage) to reach negative values at the end of the century (Figure 1, left). When climate change results in increased energy intensity or damages the capital stock of firms, the impacts on growth are much lower. However, capital stock shocks incisively threaten the ability of firms to produce goods and services and, in turn, their very survival, increasing the bankruptcy rate (Figure 1, right). There are knock-on effects on the financial sector because bankruptcies imply that debt accumulated to financial institutions won't be fully repaid in the future. Such extraordinary losses will erode the equity value of banks and, hence, their solvency. These results show that economic and financial risks from high levels of climate change could vary across countries. Future research should uncover which countries are more exposed to certain types of shocks, rather than simply focusing on how much GDP might be reduced and how to counterbalance the welfare losses.

What is the role of climate policy?

The economic and financial consequences of high levels of climate change are likely to be disastrous without appropriate and timely policy intervention to limit carbon emissions and sustain investments in renewable energy technologies. The DSK model was used to test two of the most highly advocated tools for emissions mitigation: subsidies and taxes on energy technologies, and carbon pricing. These policies aim to shift the process of technical change away from fossil fuel technologies, by reducing their competitiveness while supporting investments in green energy sources. A 'green transition' to a new paradigm with dramatically lower carbon emissions would require an ambitious plan for renewable energy use (see Figure 2, left, for recent levels across Europe), but IMPRESSIONS researchers have shown that the EU can meet this challenge by exploiting the technological opportunities behind renewable energy and climate change management, while reducing the costs related to abandoning fossil fuels. Strong policies can pursue the double goal of reducing emissions to reach ambitious climate targets and fostering growth and employment5.

However, policy effectiveness depends strongly on the impact scenario (Figure 2, right). Increased energy demand (e.g. for cooling) tends to generate revenues for those technologies covering the largest share of the energy mix – typically fossil fuels. This reduces the chances of a green transition, compared to the other impact scenarios. Hence, in countries where energy demand is highly sensitive to the effects of rising temperatures, stronger policies are needed including more active support for green energy investments.

Investigation of carbon pricing reveals a similar picture (see Figure 3). The minimum carbon tax needed for a 50% chance of limiting the temperature rise to +2°C target rises over time, with the slope depending on the type of damage. Carbon taxes need to grow faster when climate change results in higher energy intensity. In contrast, where labour productivity is affected, economic growth is lower and therefore energy use is lower, and less stringent carbon taxes are needed.



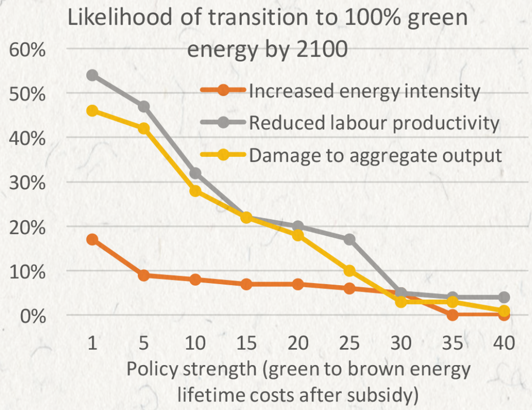


Figure 2. Left: Share of renewable energies in gross final energy consumption in 2016 by country (Eurostat). Right: Likelihood of transition to 100% green energy by modifying the relative competitiveness of green vs. brown energy technologies for three types of climate damage: increased energy intensity, reduced labour productivity and reduced aggregate output (DSK model, RCP8.5 emissions).

For all the types of damage modelled, the DSK model suggests that much stronger policy is needed compared to current practice (the EU-ETS carbon price is currently (Oct 2018) about €20/tCO_2) and to the predictions by many other models whose representation of technological development and diffusion is either exogenous or much more stylized. This evidence calls for a rapid increase in carbon taxes both in Europe and worldwide. However, considering the relatively scarce use of carbon taxes at global level, command-and-control policies (e.g. standards) can provide a viable and effective alternative[7].

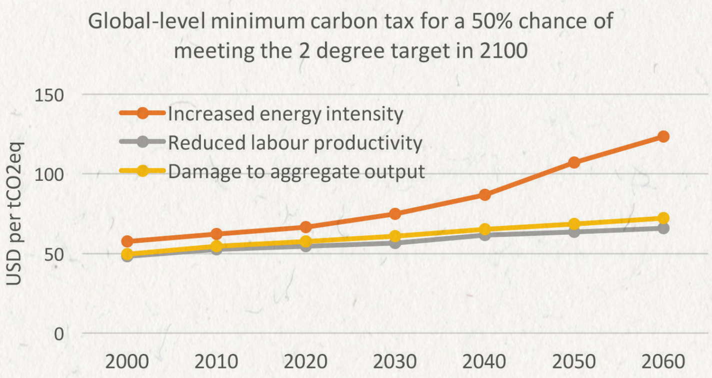


Figure 3. Minimum carbon tax for a 50% chance of meeting the +2°C target according to the DSK agent-based model, for three types of damage: increased energy intensity; reduced labour productivity and reduced aggregate output.

Policy Recommendations

- Increase government investment and public funding to support the development and uptake of low carbon energy generation, energy storage systems and other sustainable technologies. Increase carbon taxes in Europe, and encourage wider mitigation efforts globally through international co-ordination. Where this is not politically feasible, implement much stronger regulations and standards for energy efficiency and low-carbon energy.

- Investigate how different countries and regions are exposed to the various types of damage that climate change will bring to our economies, and consider the implications for the effectiveness of different climate policies.

- Foster both the resilience of financial institutions to extraordinary losses and their willingness to invest in green and climate management technologies. Europe might be inspired by the role covered by public banks around the world and, especially, in China.

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Find out more: www.impressions-project.eu.

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