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Productivity in the face of climate change*

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Shifting towards an economy that is aligned with climate neutrality is both a crucial step for environmental sustainability and a strategic decision for sustaining long-term economic growth and resilience. Indeed, climate change and related policy measures will influence productivity in various ways that need to be comprehensively understood. On the one hand, physical risks, like changing weather patterns, and on the other hand, transition risks, such as policy changes, both affect traditional aspects of production - capital, labor, and total factor productivity. Southern Europe may see a decline in productivity due to rising temperatures and the diversion of resources toward adaptation measures. Transitioning to a carbon-neutral economy clearly presents challenges, but an orderly shift with gradual policy adjustments encourages innovation and ultimately enhances productivity. Tighter climate regulations may initially hinder productivity growth, yet they also have the potential to drive technological advances in the longer term. However, the impact varies across firms, with smaller entities facing more significant challenges initially. Additionally, the green transition involves redistributing resources across sectors, with mixed effects on productivity. Effective policies that manage these reallocation effects are crucial for maintaining productivity growth amidst climate challenges.

*In this article we share the results of European System of Central Banks (ESCB) Working Group on Forecasting (WGF) Expert Group on Productivity, Innovation and Technological Changes – Climate and Productivity Workstream, comprising staff from the European Central Bank (ECB) and the national central banks (NCBs) of the EU member states. The full report (Bijnens et al. 2024) can be found here and is co-authored with Sofia Anyfantaki, Andrea Colciago, Jan De Mulder, Elisabeth Falck, Vincent Labhard, Paloma Lopez-Garcia, Nuno Lourenço, Jaanika Meriküll, Miles Parker, Oke Röhe, Joachim Schroth, Patrick Schulte and Johannes Strobel.
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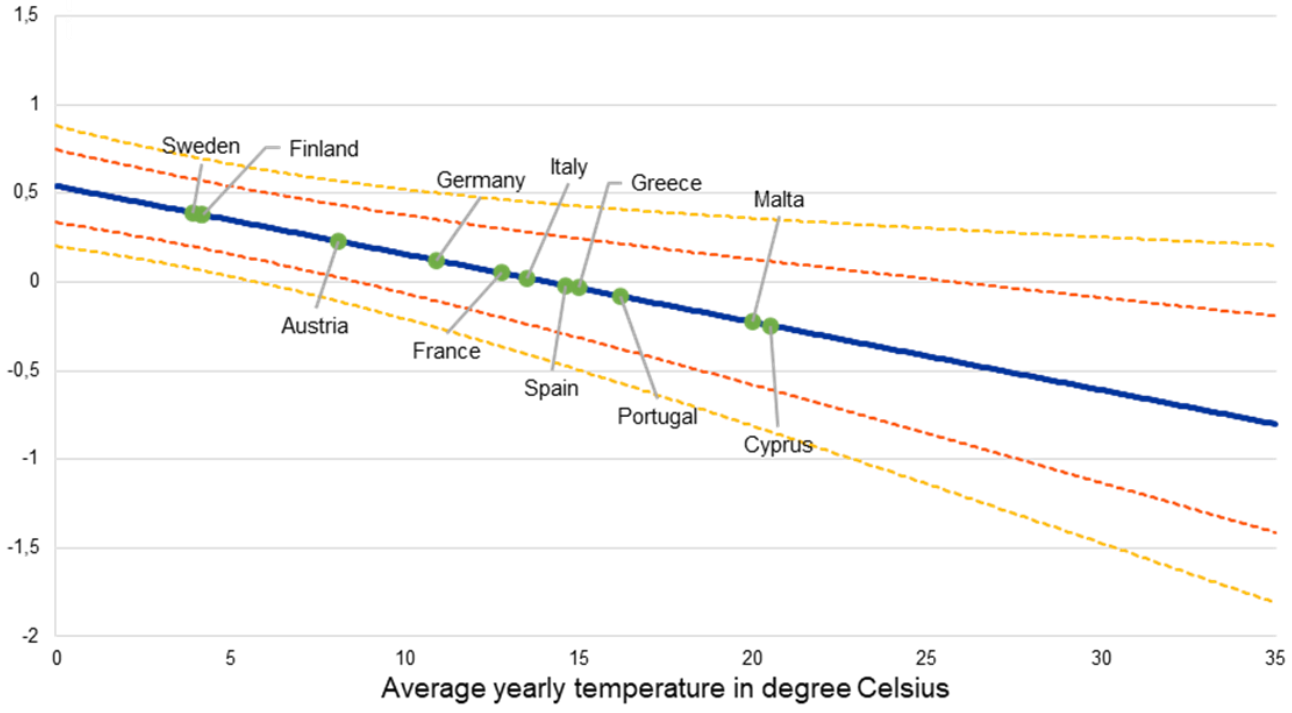
Both climate change itself and the policies implemented to mitigate and avert it will affect productivity

Changes to climate and weather, including both the long-run changes to temperatures and sea levels and more frequent and intense extreme events are commonly referred to as physical risks. The impacts that arise as the economy moves to a net zero carbon footprint are referred to as transition risks, which encompass both the implementation of climate policies, such as carbon taxes, regulation and other changes induced by changing preferences and consumer demand. These physical and transition risks will impact on all three aspects of the traditional production function framework, i.e. capital, labour and total factor productivity, with the latter being influenced by production technology.

The productivity impact of physical risks is expected to be mostly negative. A sustained rise in temperatures is likely to weaken productivity growth especially in Southern Europe given its higher initial average temperature and will thereby lead to larger growth differentials within the euro area (Figure 1). The productive capital stock may be partially destroyed by disasters or longer-term weather patterns, or by increased allocation towards non-productive adaptation measures. Climate-related migration may also occur, although historically most displacement takes place within countries rather than across borders, and Europe may benefit in aggregate from immigration from other more affected regions. Total factor productivity growth is also likely to be affected by more hostile climatic conditions, by disruptions to firms and supply chains, and by an increasing share of resources being spent on adaptation rather than on innovation.

Figure 1: Change in hourly productivity growth due to an increase in the average yearly temperature by 1 °C (in percentage points)

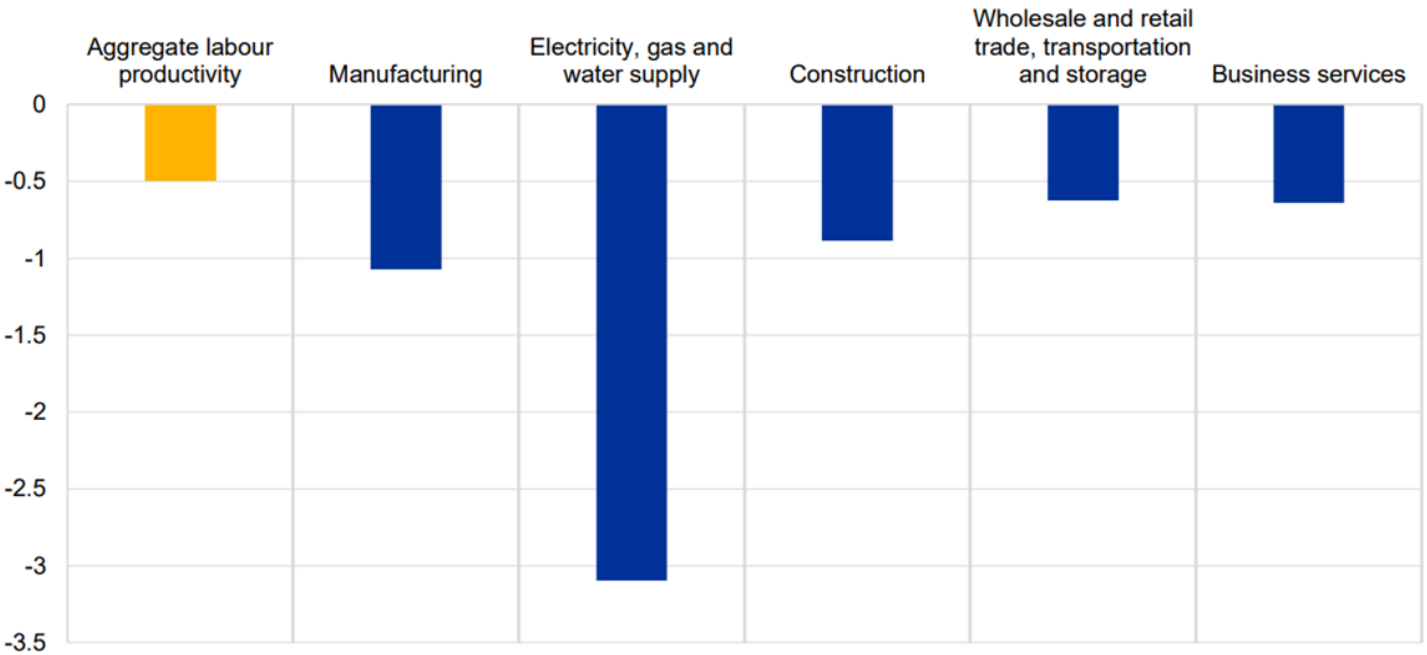


Sources: CRU TS climate dataset, Penn World Tables and Bundesbank calculations.
Notes: Estimated impact of an increase in the average yearly temperature by 1 °C on annual hourly productivity growth (in percentage points, vertical axis). The effects are estimated using a panel approach with historical data from 1963 to 2019, including year and country fixed effects. The panel encompasses data for all Member States of the European Union plus Iceland, Norway, Switzerland and the United Kingdom. Dashed lines show 68% and 90% confidence intervals.

An orderly path to carbon neutrality is preferred

While a disorderly transition might not impact productivity in the short term, in the medium and long term an orderly transition path seems preferable. A well-organized shift with gradual increases in carbon prices allows industries and businesses the time and resources needed to adapt and invest in sustainable practices and technologies. While there might be short-term setbacks in productivity due to rising costs and reduced demand, the long-term prospects are more favorable. An orderly transition not only reduces the abrupt shock to industries but also encourages innovation and efficiency improvements, which can enhance productivity in the long run. On the other hand, a disorderly transition, characterized by delayed or inconsistent policies, could have severe long-term consequences, especially for the energy sector (Figure 2). In such a scenario, the long-term costs of emissions would be significantly higher than in an orderly transition, leading to greater distortions and potential economic instability. Furthermore, a disorderly transition poses a higher risk of stranded assets, where investments made in carbon-intensive industries become unviable, resulting in significant financial losses. Therefore, opting for an orderly transition path is preferable in the medium to long term. It helps to minimize the economic shocks associated with abrupt policy changes and ultimately results in higher labour productivity through the adoption of cleaner technologies and practices. This transition is not just an environmental imperative but also a strategic move for long-term economic resilience and prosperity.

Figure 2: Difference in projected labour productivity between a disorderly and an orderly transition in 2050 (in percentage points)



Sources: Bundesbank calculations based on the DSGE model EMuSe and projections by the NGFS.
Notes: Business services are defined as NACE sections M to N, i.e. professional, scientific and technical activities as well as administrative and support service activities.

Increased innovation could well be the silver lining of the transition, if the right policies are in place

The impact of tighter climate regulation on productivity growth is negative in the short-term and increases innovation and therefore productivity growth over the long-run. The success of innovation in developing green technologies that can rival carbon-intensive technologies relies on factors such as the nature of the company and the regulatory framework in place. Environmental regulations, by creating incentives for innovation, can improve productivity enough to offset the costs of regulation, a process known as the Porter hypothesis. We find some, qualified, support for this hypothesis. Better environmental protection is associated with a short-term increase in productivity growth at the industry level in countries that are at the technological frontier. Analysis at the firm level similarly finds that the most productive firms can achieve productivity gains, due to their access to advanced technology and resources for R&D and knowledge-based capital. Less advanced firms may require higher investments to comply with the new regulation, leading to a temporary decline in productivity growth. The impact also differs depending on the type of regulation, with market-based policies (such as carbon taxes) having a less distortionary effect and R&D subsidies being the most effective in spurring green innovation.

Mind the brown zombies

The green transition involves a significant reallocation of capital and labour away from brown sectors and firms, which will also affect aggregate productivity. When emission costs are increasingly accounted for, emission intensive industries are likely to contract due to higher relative prices. Given current productivity levels, these industries tend to have higher productivity than industries likely to expand driven by the green transition (notably construction). Hence reallocation of resources across sectors could be productivity-dampening. Stricter regulation and higher carbon prices might also reduce business dynamism, given that they are likely to push the least carbon efficient firms or "brown zombies" out of the market, and entry might decline because of the increase in the productivity threshold to enter the market. Within sectors, the impact on productivity of the reallocation of resources from brown to greener firms will vary, depending on their relative productivity. Our own analysis shows that in sectors like pulp or paper the most polluting firm are on average less efficient while in sectors like manufacturing of metals or minerals the opposite is true. Within a single firm, reallocation of production factors away from energy towards capital and labour is likely to have a negative impact on productivity due to diminishing marginal returns. Reallocation of economic activity goes hand in hand with reallocation of labour. While the overall negative effects of reallocation of labour to green activities should remain manageable, the impact will be heterogeneous across geographical areas, sectors, and types of workers.

References

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About the author

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