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Capital reallocation towards greener production under climate policy uncertainty*

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In this policy brief, we argue that an increase in climate policy uncertainty (CPU) induces capital reallocation from carbon-intensive sectors to low carbon-emitting sectors. We illustrate this mechanism in a DSGE model with two broad production sectors that differ in the carbon footprint of their production ("green" and "dirty"). In the model, uncertainty regarding climate policies that particularly affect carbon-intensive industries drives financial institutes to withdraw funds from the dirty sector and to shift their portfolio towards the green sector. Physical investment declines in the dirty sector relative to the green sector. Testing the predictions of the model with US firm-level data, we find that in response to CPU shocks financial markets markedly devalue firms with higher carbon footprint relative to low-emission firms. Moreover, substantial reallocation of physical investment takes place, in particular from the manufacturing sector towards services.

* The views expressed in this policy brief are those of the authors and do not necessarily reflect those of the Deutsche Bundesbank or the Eurosystem.

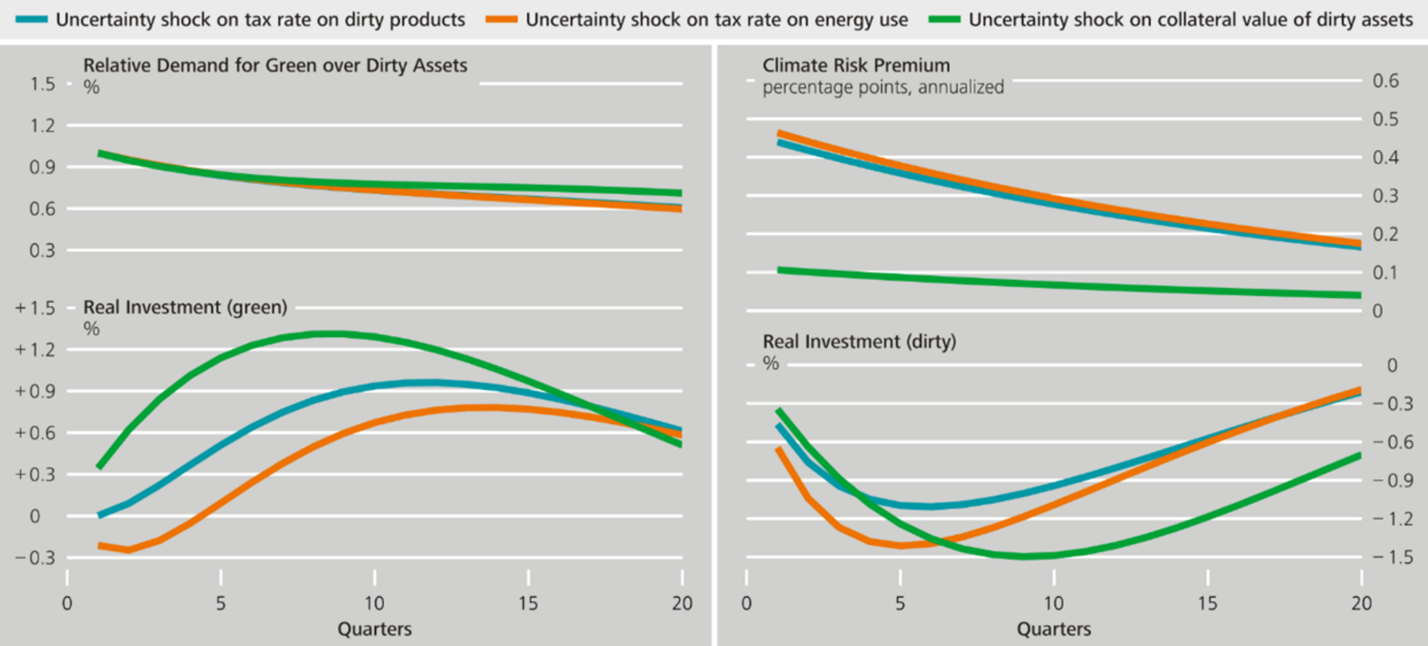
There is widespread awareness that climate policies might tighten in the future in many countries. In the European Union, member states are negotiating the terms of the European Green Deal. In the United States, so far a price on carbon emissions has not been adopted at the federal level, but this might happen in the future. At the same time, climate politics has often been characterized by reversals. This is exemplified by the temporary exit of the US from the Paris Agreement. In the EU, the energy crisis in the wake of the Russian invasion of Ukraine has created additional risks to the climate policy agenda. As the paths of future climate policies are shrouded in uncertainty, the question arises: What are the economic consequences of climate policy uncertainty?

Analysis of effects of climate policy uncertainty shocks in a stylized model …

In Khalil and Strobel (2023), we study the effects of climate policy uncertainty (CPU) shocks in a dynamic stochastic general equilibrium model. To investigate the allocation effects of climate policy uncertainty within the economy, we incorporate a financial sector as well as two broad production sectors, which differ in their energy intensity of production. In our analysis, we assume that the energy intensity of production is closely linked to its carbon emissions intensity. Hence, we label the sector with the lower energy intensity “green” and the other one “dirty”. We assume that climate policy uncertainty predominantly affects the dirty sector.

In practice, climate policy can take various forms. In our model, we consider three policy tools. First, a tax on the use of energy, which captures the policy of pricing carbon emissions, second, climate-related financial regulations, which affect the pledgeability of assets of dirty industries, and third, a tax on final goods that need a large amount of carbon emissions to be produced. The last tool represents a simplified form of capturing policies that aim to discourage the use of goods with higher production emissions. We model these tools as exogenous processes, which after policy shocks revert to their respective mean.

Effects of a climate policy uncertainty shock in the model* — Figure 1



Source: Bundesbank calculations using a DSGE model based on Khalil and Strobel (2023). * Shock sizes are set such that the relative demand for green over dirty assets increases by one percent.
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… predicts that in the face of rising climate policy uncertainty, investors divest from carbon-intensive sectors and shift their funds toward green sectors

The main result of the theoretical analysis is that an increase in climate policy uncertainty – a higher expected volatility of the future paths of the climate-related policy instruments – triggers a reallocation of capital from dirty to green production sectors (see Figure 1). In the model, the behaviour of risk averse financial institutions, which finance the capital stock of non-financial firms in both production sectors via equity, is central to this reallocation.[1] In the face of increasing climate policy uncertainty, they divest from assets associated with the high-emission sector. CPU shocks on taxes on energy or carbon-intensive products translate into uncertainty regarding the marginal revenue product of the capital employed by dirty firms. This in turn raises the uncertainty of the return on the claims on dirty capital, held by the financial sector. The third type of CPU shock in the model directly hits the pledgeability of the assets of the dirty industry. Consequently, in the face of any type of CPU shock, financial institutions demand a climate risk premium on assets from the high-emission industry. The market value of dirty-sector assets relative to green-sector assets declines.

The model delivers testable predictions. In the model, all CPU shocks lower the market value of the more carbon-intensive sector relative to the less carbon-intensive one and reduce physical investment and, subsequently, the capital stock in the highly carbon-intensive sector. At the same time, in some settings, in the less carbon-intensive sector, CPU shocks may raise the market value of firms, trigger investments and raise the capital stock. In any case, the model predicts a marked reallocation of capital towards greener production sectors. The effects of CPU shocks to economy-wide aggregates – such as consumption and GDP – are, however, far more moderate.

In US firm-level data, CPU shocks reduce the relative market value and physical investment of firms in high-emission sectors and stimulate investment in greener production sectors

To test the predictions of the model, we extract CPU shocks from a news article-based measure of climate policy uncertainty for the US (Gavriilidis 2021)[2] and investigate their effects in a panel of publicly listed US firms in sectors with different carbon footprint. The extracted shocks correspond well to anecdotal episodes in the sample. For instance, shocks are largely positive during the global climate strike in 2019. In order to characterize sectors by the total amount of the carbon emitted to produce one unit of output, we account for domestic and international input-output linkages.[3] This captures that firms do not necessarily emit carbon only directly but also indirectly via carbon-intensive inputs. We sort firms into five bins of more "green" and more "dirty" sectors (see Table 1).[4]

[1] Financial institutes are modelled as in Gertler and Karadi (2011).

[2] The index by Gavriilidis (2021) captures the scaled frequency of articles of leading US newspapers phrases that indicate uncertainty over policy, legislation, and regulation in the context of climate-related issues. We obtain exogenous CPU shocks by orthogonalizing the CPU measure with respect to US economic policy uncertainty (Baker et al. 2016), crude oil and natural gas spot prices, as well as macroeconomic and financial uncertainty (Jurado et al. 2015). The extracted shocks correspond well to anecdotal episodes in the sample.

[3] For this purpose, we employ the World Input-Output Database and the corresponding environmental accounts (see Stehrer et al. 2014 and Román et al. 2016).

[4] We exclude the financial sectors and sectors with particularly high carbon emissions such as utilities, mining and coke/petroleum production.

Table 1: Emission groups

	Production carbon footprint	Largest 2-digit NAICS categories
1	0.13	Information, Wholesale Trade, Professional/Scientific
2	0.20	Professional/Scientific, Real Estate, Retail Trade
3	0.27	Manufacturing, Hospitality, Support Services
4	0.42	Manufacturing, Construction
5	0.79	Manufacturing (Durables- and Nondurables)

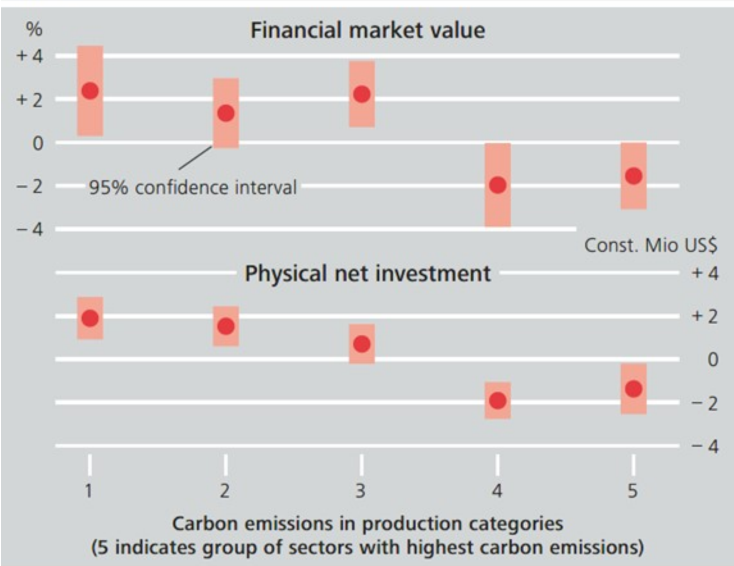
Note: Carbon footprints are carbon tons emitted to produce USD 1 million (constant 2019) of output taking into account input-output linkages. The reported values are group averages. The financial sector and sectors with particularly high carbon emissions, such as utilities, mining, and coke/petroleum production are excluded.

Our empirical results confirm the prediction that CPU shocks trigger a relative decline in the average market value of firms in industries that are responsible for a larger amount of carbon emissions, while greener sectors gain. Figure 2 estimates a shock roughly in the range of the 2019 climate-strike shocks. In the group of the 20% of firms with the largest carbon footprint, an average firm faces a 2% market valuation loss. At the same time, the average market value of firms in the quintile with the smallest carbon footprint increases by roughly 2%.

Figure 2 (lower panel) also shows that firms adjust their physical investment decisions. In response to a CPU shock, a firm in the quintile of the highest emitters decreases its quarterly net investment by around USD 1.5 million (constant 2019) relative to an average firm in the market. In contrast, a firm in the low-emission quintile increases investment by roughly USD 2 million. Overall, the empirical findings confirm the theoretical predictions of substantial capital reallocation toward less carbon-intensive industries – in practice, particularly from the manufacturing sector towards services.

Effects of climate policy uncertainty shock on outcomes of "green" and "dirty" firms in the US* — Figure 2

Average response to positive climate policy uncertainty shocks in the first two quarters



Source: See Khalil and Strobel (2023). Sample period: 2000Q1-2019Q4. No. of firms 11,445 (upper panel), 11,170 (lower panel). Dependent variables in period t are measured in deviation from period-t average.
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Conclusion

The empirical results are in line with the predictions of our model. CPU shocks trigger a capital reallocation from high-emission to low-emission industries. This holds for the market values of firms as well as the physical investment activity. Our results suggest that not only a higher stringency of climate policies but also greater climate policy uncertainty may reduce the carbon intensity of aggregate production and even trigger green investment, thereby supporting the decarbonisation of an economy. This said, higher climate policy uncertainty cannot, however, substitute for stringent climate policy actions (see Fried et al. 2022).

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