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THE MACROECONOMIC RISKS OF THE TRANSITION TO A LOW-CARBON ECONOMY

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Overview

The accelerated transition to a low-carbon economy involves structural change at such scale and pace that it entails growing risks for the economy. Transition risks are "the financial risks which could result from the process of adjustment towards a lower-carbon economy" (Carney, 2015). To assess these risks, economic actors mobilize forward-looking scenarios describing plausible transition paths, which are quantified with macroeconomic models. However, the state of the art of macroeconomic modelling of energy transitions does not always allow to properly take into account the feedback loops between the energy system and the broader economy.

Methods

We develop a multi-regional 'hybrid' model, KLEM-POLES, to simulate the macroeconomic impacts of four energy transition scenarios. In the *Net zero 2050* scenario, the world reaches carbon neutrality in 2050. In the *Below 2°C*, global warming is contained below 2°C. The *NDCs* scenario relies on the fact that currently pledged, some of them conditional, Nationally Determined Contributions (NDCs) are implemented fully. The reference scenario is the *Current Policy* scenario, where existing climate policies remain in place and there is no strengthening of ambition level of these policies. KLEM-POLES is the result of an iterative coupling of the growth model KLEM with the energy model POLES. POLES is a partial equilibrium model providing energy system trajectories, up to 2050, on international and domestic energy prices, energy imports and exports, and energy consumption of industries and households. KLEM is a recursive growth model representing two sectors, the energy sector and the composite sector (regrouping all other economic activities), specifically built to produce growth trajectories under energy system constraints. Hence, KLEM-POLES combines the strengths of the engineer's and the economist's views on energy transition assessment, at the high geographical granularity of 58 countries and regions connected through global international trade.

Results

At the world level, the *Net zero 2050* scenario implies the highest macroeconomic impacts with a 13% decrease of global GDP in 2050 compared to the *Current policy* scenario. The *Below 2°C* scenario is less stringent, leading to an 8% decrease of global GDP. The implementation of the NDCs has a small impact on global GDP which decreases by 1% compared to *Current policy* in 2050. Nonetheless, under this scenario temperature rises above 2°C. Hence, physical risks, which are not considered in this work, could cause further macroeconomic losses.

The impact of the transition to a low-carbon economy on GDP varies strongly across countries/regions. In the case of the *Net zero 2050* scenario, GDP changes range between +1% and -48% in 2050 compared to *Current policy* across countries/regions. The diversification of economic activity away from the energy sector allows some countries to limit the impact of higher energy costs on the economy. For example, in Saudi Arabia, the energy production falls drastically, consequently, more labor and capital become available for the composite sector, leading to a higher composite production than in *Current policy*. As the share of the energy sector in GDP is high, Saudi Arabia still suffers from high GDP losses (-17% in 2050 compared to *Current policy*). However, countries where a strong part of labor and capital goes towards the energy sector, such as Iran, see their composite good production decreasing the most, reinforcing the negative impact of the fall of energy output on GDP.

One key feature of our model is that it allows to study the impact of the transition on each economy in detail. For instance, the high level of disaggregation of the energy sector offered by POLES allows to analyze the substitution

between fossil fuels and low-carbon energies, for example, we develop the case of China where 22% of the gross domestic consumption comes from low-carbon energies in *Current policy* in 2050, against 57% in *Net zero 2050*.

Conclusions

The large disparities of the macroeconomic impacts of the transition between countries underline the need to consider the energy systems specificities of each country when analyzing the impact of climate policies.

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