Estimating the economic stranded value from climate change physical risks using sector-specific capital and investments in a CGE model

Abstract

Introduction

Understanding the risks of climate change is of paramount importance given its widespread effects and impacts. On one hand, there are direct consequences which materialize due to the actual physical damages due to slow onset impacts, or also due to sudden extreme events. On the other hand, there are indirect effects derived either from the ripple effects of the abovementioned damages that propagate trough space and time, or even from actions taken to reduce global warming. Consequently, these climate change-related risks can be of two types. The first one refers to a climate change physical risk, i.e., impacts such as droughts, floods, or rising sea levels, which can directly impact physical assets with indirect consequences on the global supply chain. The second one is related to a transition risk, i.e., the introduction of climate policies to transform the system into a low-carbon economy. Both risks expose the overall economic and financial system to adjustments that should be taken into account for future projections not only for policy design but also for business planning and for harnessing the synergies of a low-carbon transition while at the same time dealing with the adverse consequences of global warming.

The economic costs of climate change impacts and policies have been widely studied in the literature focusing mainly of aggregate measures such as GDP or Welfare losses both at the national and subnational level using different tools (econometric, computable general equilibrium or integrated assessment models). Within this literature a reduced number of studies have focused on identifying assets that lose value before fully depreciating due to various reasons, including climate change risks. This type of asset falls under the terminology of stranded assets, and within that literature the transition risk is the most studied. Indeed, the transition to a low-carbon economy actively involves the fossil fuel sector, which is considered the most exposed to a risk of stranding. Moreover, the concept of stranded assets is directly related to investment decisions and their corresponding valuation. Most of the studies on stranded assets consider differences between a business-as-usual and other scenarios simulated under different policy mitigation alternatives (Pfeiffer et al., 2018; Caldecott, 2018).

However, other economic sectors may be put at risk by climate change's physical impacts on infrastructure, agriculture, or utilities, among others. For example, Vangimalla and Venkatachalam (2017) point out how the inherent risk factors of climate change will affect not only the energy sector but also the rest of the economy. They analyzed how agricultural assets risk becoming stranded by physical impacts such as drought or flooding, putting the entire food value chain at risk. Still, the current literature focuses primarily on the possibility of stranded assets only when there is a transition risk, that is, the economic or financial loss that an asset may suffer, directly or indirectly, due to the process of adapting to a low-carbon economy. Stranded assets related to climate risk, or the possibility of stranded value due to the occurrence of an extreme event, however, remain unexplored (Bressan et al, 2018). Understanding the economic risks from physical climate risk is crucial, as losses from a climate hazard affecting economic activities in a defined geographic area can also have cascading effects across the whole value chain (Carter et al., 2021; Benzie and Persson, 2019).

The objective of this paper is to assess stranded values and assets due to physical impacts of climate change as opposed to considering only transition risks, and therefore add an additional piece of information to the stranded value assessment literature. This is important since investment decisions depend on both transition and physical risks of climate change. For this purpose, the study uses a Computable General Equilibrium (CGE) model extended with sector-specific investments and sector-specific capital to provide an improved assessment of stranded values considering a set of climate change impacts such as agriculture, sea-level rise, riverine floods, energy demand, and labor productivity.

Methodology

The stranded value assessment is performed with a GTAP based CGE model using the GTAP-MRIO database (Carrrico et al., 2020). The database has been enhanced with sector/specific capital and investments using GTAP 10 time series data (Aguiar et al., 2019) and the World Input-Output (WIOD) Database (Timmer et al., 2015). Climate change impacts are adapted from the latest available data for the following impacts: agriculture, sea-level rise, riverine floods, energy demand, and labor productivity. The reference scenario is based on the SSP2 shared socioeconomic pathways data while the climate change scenarios include RCP4.5 and RCP6.0 with projections from 2014 to 2050. Besides the usual indicators for climate change costs such as GDP and welfare losses, the enhanced model provides the loss of capital by sector which allows to estimate the stranded value of output and capital for all sectors in the selected scenarios.

Expected results

The comparison between the climate change scenarios and the reference will allow to estimate the stranded value of output and capital by sector related to climate change physical risks which will provide additional information to be considered along with the existing estimates of transition risk based stranded assets estimations.

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