Economic consequences of climatic changes in crop yields in water-abundant regions

Topic: Regional Input-Output Economics - I
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A concerning consequence of climate change is the impact that reduced rainfall and increased temperatures will have on agriculture yield. There is a growing literature showing the impact of changes in climate on output of the agricultural sectors, however the approaches used to date omit the wider consequences of these changes across the whole economy. Importantly, most studies are focussed on already water scarce countries. At the regional level, differences in economic structure will lead to a heterogenous direct economic exposure to climate changes, however the indirect exposure of regions to climate futures, taking into account interregional trade and intersectoral linkages, is less clear. We argue that even water abundant countries may experience severe impacts of climate change on agricultural yields, where regions that are crucial for agricultural production are more exposed to changes in climate.

Focussing on Scotland, we develop a micro-to-macro approach to investigate the consequences for the Scottish economy â€“ using a CGE model with two regions â€“ of projected changes in climate which are then linked to agricultural yields in each region. Whilst climate change may seem to be not a concern for a notoriously rainy country, starting from position of relative water abundance, Scotland is projected to see less rainfall and warmer temperatures over the coming decades as well as more weather extremes. Crucially, current projections show how the east side of the country, which is more populous and more agriculture intensive, is set to experience more frequent draughts especially in the growing season.

We begin by examining the historical relationship between rainfall and temperature with agricultural yields for four crop types (wheat, oats, winter barley and spring barley) using a simple econometric estimation. The estimated coefficients are combined with future climate projections for east and west Scotland to generate projections in agricultural yields.

Our final â€“ macro â€“ step introduces these via changes in productivity in the Agricultural sector into a two-region CGE model of West and East Scotland which captures the interconnectedness between regions through trade, and the system-wide consequences on output across sectors and regions of Scotland.

The CGE model includes water as an implicit factor of production embodied in land using conventional production functions. A crucial feature of the Scottish economy is that rainfed land represents the vast majority of farmed land in the country. We consider two land types, rainfed and irrigated. These are supplied in fixed quantities.

The results from our historical crop yield analysis illustrate how agricultural climate during the growing season is critical for crop yields, with summer rainfall particularly damaging for oats and barley. Our CGE results show how sectors, and each region, are affected by the projections of changes in crop yields, under a no-mitigation case. Importantly, results from our simulations show how a proportionate reduction in agriculture productivity in East Scotland has detrimental impacts that are transmitted to West Scotland. The east-west channel propagates shocks more heavily than the west-east channel due to the location of Scottish farms. We end by discussing possible sector and policy actions in reducing the negative economic consequences of future climate projections including irrigation.