Distributional impacts of long-term renewable power policies: a multi-regional analysis for Brazil until 2050

Topic: Input-Output Modelling: Energy Policies - I
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Assessing the scale of green jobs and the socioeconomic effects of the energy transition is relevant and timely, while clear, comparable methodologies are still scarce. The discussion around just transitions, and the extent to which renewable energy creates more positive socioeconomic impacts than fossil fuels, increasingly attracts policymakers' and researchers' attention. However, data constraints, particularly in developing economies, expose a relevant gap in providing quantitative evidence for such discussions. Existing input-output tables are usually aggregated into activities irrespectively of technology or Greenhouse gas emission profile.

In this paper, we propose a replicable data triangulation approach to disaggregate the electricity sector into renewable and non-renewable generation sources in input-output tables applied to the case of Brazil, using the latest input-output data of the country, for 2015, energy generation statistics for the same year, mainly the National Energy Balance and the Statistical Yearbook of Electricity. Then, we calibrate a multi-regional recursive-dynamic CGE model with the resulting dataset and assess the distributional impacts of long-term renewable electricity capacity expansion scenarios through a soft-link with three energy-system models.

The research question of this paper is: what are the regional distributional implications of different electricity capacity expansion mixes up to 2050 resulting from different energy and climate policies for the electricity sector in Brazil? The novelty is that this is the first known research to assess long-term multi-regional distributional impacts of renewable electricity policies in an emerging or developing economy apart from China.

Brazil has relied on hydropower for the last decades, but climate change has impacted rainfall regimes, causing long droughts and higher hydrological risks. Moreover, most remaining hydropower potential lies in the Amazon region and is unlikely to be exploited due to socio-environmental regulation. Hence, Brazil must increase non-hydro renewable technologies for its electricity mix to remain renewable in the long run. Notably, the least developed region of Brazil, the Northeast (NE), concentrates most of the Brazilian territory's potential for wind and solar generation. Hence, there is a great potential for Brazil to use renewable energy policies to reduce regional inequalities.

The model used is the TERM-BR E15 model - a multi-region recursive dynamic computable general equilibrium model for Brazil with the electricity sector disaggregated into nine sources and the transmission and distribution sector. The TERM-BR E15 belongs to TERM models family, described in literature such as Horridge (2011) and Horridge et. al. (2005), and follows TERM-BR 10 (Diniz, 2019). The model distinguishes ten different labour grades by wage level, and ten different household income bands.

As a Baseline, we use the Brazilian official National Energy Plan 2050 scenario in which hydropower is the main source and a higher share of fossil-fuels remains until 2050. By its turn, wind and solar are limited to 50GW each, in terms of total installed capacity from 2020 to 2050. On the other hand, renewable policy scenarios were built considering (i) net zero economy-wide emissions by 2050 and (ii) the inclusion of the highest possible share of wind and solar PV in the electricity mix by 2050. The following table summarizes the main aspects of those scenarios.

Modelling results have indicated that scenarios with higher shares of non-hydro renewable electricity in the mix create a demand for higher-skilled labour nationally. However, multi-objective policies are necessary to create a migration from lower skills toward higher skilled jobs in the NE region. It is visible from the results that the NE is the greatest winner in terms of job creation of the process of renewable electricity capacity expansion. Across all scenarios and wage levels, employment increased relative to the baseline in the Northeast region. This shows that a renewable pathway is not only feasible but would create more jobs in Brazilâ€™s poorest region than a less-renewable pathway. However, most regions apart from the NE experience negative employment impacts in the policy scenarios, counterbalanced by the Northeast, indicating regional trade-offs.

In the renewable policy scenarios, the NE is the only region where real wage grows above the baseline and therefore the NE region it attracts workforce. Historically, however, the Northeast workers have migrated in search for better opportunities in the SE region, where wage levels are higher. The Northeast region is also the clear winner in terms of household consumption in policy scenarios. Household consumption gains are equal across income bands in this region, particularly in the case of electricity capacity expansion scenario (ii).