Estimating energy demand in a Stock-Flow Consistent model: preserving household heterogeneity in the green transition scenario

Topic: Sustainable Production and Consumption Policies
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1. Overview

The energy transition is the main path that all types of economies will have to follow in the coming decades to contain the effects of climate change. Such a transformation path undoubtedly requires profound technological changes and calls for a careful and continuous assessment of the economic impact that society will have to face. Technological changes and their likely associated regressive effects on consumers require specific policy responses. A forecast of long-term changes in energy consumption choices and habits is necessary to predict the response of households to these policies, which will be progressively introduced with the aim of managing the energy transition in a context of likely enduring international uncertainty.

This paper investigates the energy consumption behavior of households, both for residential and mobility purposes, on the basis of socio-economic determinants such as demographic characteristics, income, prices and accumulated wealth. In particular, we emphasize the relevance of generational affiliation for long-term changes in the structure of consumption through the long-term influence of experiences, norms and information that can act differently on the behavior of heterogeneous subjects (Bardazzi and Pazienza, 2020, Malmendier e Shen, 2024, Bjelle et al., 2021).

2. Data and methods

The methodological approach is based on a long-term structural demand system, which uses both cross-section and time series data (Almon, 1998; Bardazzi and Barnabani, 2001). In this paper we estimate the pure effects of age and cohort on sectoral household consumption and with feedback effects on the demand system. The originality of the approach lies not only in the understanding of family disaggregation by age (Kim, Kratena and Hewings, 2015), but also the generational heterogeneity that persists at different ages. This source of heterogeneity is relevant in economic modelling of the long-term path of the energy transition (Dubois, et al. 2019).

The demand system is based on national accounts data provided by the Italian Statistics Office and on the annual Household Budget Surveys enriched with information on energy prices and taxes. Furthermore, the Bank of Italy dataset is utilized in order to introduce the effect of accumulated assets on household consumption behaviour.

The consumption functions are estimated as a stand-alone econometric model and then integrated into a national Inforum-type stock flow consistent multisectoral model of Italy. Subsequently, the change in the structure of energy consumption generates sectoral effects on production, income and employment, which propagate throughout the economy according to the structure of inter-industrial exchanges. Predictions of changes in demand are then compared through the counterfactual (when demographic variables are excluded from the model). The analysis therefore considers multiple simulations to evaluate the properties of the most coherent specification of the demand system estimate.

The final aim of this research is to link the economic model with an optimization energy model to complete the analysis of energy transition paths. This linkage will be bi-directional and time-specific: energy demand will be passed to the energy system and feedbacks will return in terms of produced energy mix and costs of energy technologies used.

3. Novelty

The research is characterized by its focus on the socio-economic determinants of different energy consumption behaviors. The objective is to estimate the long-term effects on the structure of the energy needs of households for mobility and housing coming from different socio-economic profiles. In particular, we try to understand the effects on the composition of household consumption determined by the main demographic aspects (age, cohort, volume and structure of the population), accumulated wealth, prices and disposable income.
The reason that pushes the research towards this direction is that, within the literature, a significant diversification has been found in the response of households through a change in consumption to different policy impulses (Biley et al. 2022). These differential effects can be traced both in generational membership and age, especially in relation to accumulated wealth and income. For a complete treatment of how the stocks of wealth influence consumption behavior in the long run the model also takes stock-flow consistent (SFC) relationships into account. The quadruple accounting typical of the SFC models (on the one hand, the incoming and outgoing flows between institutional sectors, on the other, the respective asset and liability stocks accumulated in each period as result of the latter flows) allows a dynamic understanding of the relationships that we consider as determinants of long-term changes of household energy consumption.

References

Almon C. 1998. A Perhaps Adequate Demand System. In Institute for International Trade and Investment