

When does specification or aggregation matter for model simulation outcomes? An investigation into demand systems

The topics of choosing among demand system specifications as well as of aggregating household data in demand systems both have a long and continuing history in research. However, the bulk of the demand system specification-related literature is concerned with theoretical aspects and the testing of the fit of econometrically estimated demand systems to observed data (see, e.g., Pollak and Wales, 1995). Another body of literature investigates the importance of demand system specification in the analysis of optimal commodity tax design or commodity tax reform (see, e.g., Ray, 1999). Also the aggregation issue, i.e., the bias introduced by using a representative, aggregated household instead of individual households, has been extensively analyzed from theoretical and econometric perspectives. For a comprehensive overview, see Blundell and Stoker (2007).

But in addition to their role in statistical inference about consumption behavior and characteristics, demand systems are also frequently used as models for the simulation of policy and other economic changes, either as models on their own or as integral parts of larger and more complex economic models, such as Computable General Equilibrium (CGE) or microsimulation models. How relevant are the theoretical properties and the differences between specifications for scenario simulations? The detail of simulation models is continuously increasing with rising availability of more and higher quality data, computing power and improved solution methods. Nevertheless, with few exceptions, simple specifications, like the Cobb-Douglas (CD), Constant Elasticity of Substitution, and particularly the Linear Expenditure System (LES) are still dominating in economic simulation models. There is surprisingly little research on the implications of such a choice of a particular demand system specification for the outcomes of scenarios simulated. Moreover, the aggregation over consumers likely has an effect on a variety of outcome measures, in particular when incomes change differentially across households. Other outcomes, e.g., poverty impacts, cannot be measured at all without a high degree of household detail. Also this issue received little attention in the literature in the context of simulation models.

The closest literature with respect to the specification choice consists of three studies (Yu et al., 2003; Gohin, 2005; de Boer, 2009) which examine the sensitivity of simulation outcomes in the framework of CGE models with an aggregate, representative household and very particular scenarios. All of these find the specification choice to be more or less relevant for some outcome measures.

This paper aims to provide a generalizable contribution to the issues of choosing a demand system specification and the aggregation level. More specifically, we are interested in the unbiased effect of these choices in various stereotypical scenario simulations and considering several outcome measures. To this end, we consider scenario simulations solely based on demand system models without potential bias through other model components. We examine under which circumstances biases occur for which outcome measure and in what magnitude.

The approach of the study is as follows. Our starting point is a dataset derived from the estimates of a flexible, rank three Quadratic Almost Ideal Demand System (QUAIDS) which captures heterogeneity in demand based on various household characteristics and expenditure levels. The detailed household data from the QUAIDS estimation including household characteristics is used to calculate a set of demand elasticities for each individual household. Then, five demand model specifications popular in simulation modeling (CD, LES, Indirect Addilog System, Constant Difference of Elasticities, Almost Ideal Demand System) are selected for comparison, which range over the spectrum from inflexible to flexible and the ranks one and two. Each demand system specification is calibrated to the

household-specific demand elasticities, for each of the 6,887 households from the survey dataset separately, such that the parameterized model replicates precisely the household's observed budget shares at observed prices and income while also enforcing regularity properties. The calibration procedure is based on the information-theoretic generalized cross entropy approach (Golan et al., 1996) and tries to fit a demand system as closely as possible to the set of the estimated household-specific prior demand elasticities while incorporating all information available, i.e., the demand system specification itself, theoretical properties of consumer demand, and the observed household demand data. The resulting set of parameters for each of the 6,887 individual household demand system reflects the estimated behavior, modified as little as possible to account for the information available, and replicates the household survey data. The same approach is used to calibrate one aggregate national demand system of each specification.

The calibrated individual and national demand systems are adopted to simulate a number of stereotypical income and price shock scenarios and to compare the influence of the specification and aggregation choice on outcomes in terms of national quantity demanded, equivalent income, poverty, inequality, and cost-of-living indices.

We find a number of interesting, sometimes surprising, and generalizable results and provide pragmatic recommendations on the specification and aggregation choice conditional on the setting. Considering these results, it seems unwarranted nowadays to neglect the choices of the demand system specification and the level of aggregation across households. Alternatives can greatly improve the reliability of results and their application is manageable.

References

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