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Decomposing the structural identification of non-market values

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ABSTRACT

This paper addresses the issue of transparency in structural modeling by investigating how the assumptions of a structural model contribute to its identification of non-market values. Assumptions about the form of the utility function, the depiction of preference heterogeneity, and the definition for the choice set are shown to jointly identify a partition of preference space which explains observed behavior. The borders of the partition reflect substitution patterns. The regions in the partition set-identify preferences. Assumptions about the distribution of preferences within each region point-identify partial equilibrium welfare measures. Together, these observations provide a framework for decomposing the structural identification of non-market values. The new framework allows analysts to explain how their modeling assumptions influence estimates for benefits and costs. This addresses federal guidelines for quantifying uncertainty in the modeling assumptions which enter benefit-cost analysis. The framework is demonstrated by decomposing estimates of the MWTP for air quality.

1. Introduction

People differ in their preferences for amenities, they interact with their neighbors, and they adjust their behavior in response to large changes in health risk and environmental quality. Recent advances in discrete-choice modeling have allowed us to incorporate these basic notions about consumer behavior into models of the demand for non-market goods and services. While the new models can produce benefit estimates which reflect preference heterogeneity, social interactions, and general equilibrium adjustment, their increasing econometric complexity can make it difficult to understand how welfare measures are actually identified. This tradeoff is exemplified by equilibrium sorting models of household location choice.

Equilibrium sorting models build on the theory and econometrics of hedonic and discrete-choice models of differentiated product markets. They combine the information provided by an *equilibrium* hedonic price function [9,21] with a formal description for the choice process that explains how heterogeneous consumers *sort* themselves across segments of a market [7,17]. When applied to the market for housing, these models use information on households and their location choices to estimate structural parameters which characterize heterogeneity in preferences for local public goods and environmental amenities [6,10]. The results can be used to predict the distributional welfare implications of future policy changes, while recognizing that a sufficiently large shock will induce some households to move [24,25]. Equally important, these models are capable of reflecting feedback effects between people and their surrounding

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environment. For example, while people are affected by environmental amenities, their actions can degrade the ecosystems providing those amenities. The ability to model these interactions and analyze their welfare implications has expanded the scope for public policy analysis.

Recent applications have analyzed the welfare implications of large-scale changes to air quality, school quality, open space, climate, and other amenities [5,11,24–26,30]. These studies demonstrate that preference heterogeneity and feedback effects can have first-order policy implications. For example, Smith et al. [25] find that the benefits from air quality improvements attributed to the 1990 Clean Air Act Amendments vary dramatically within the Los Angeles region—from $33 to $2400 per household. This range reflects differences in initial air quality conditions, income, and general equilibrium price adjustments that occur as some households react to improved air quality by moving. Similarly, Walsh's [30] analysis of the demand for open space in North Carolina illustrates how the migration patterns which follow major land use changes can stimulate additional urban development. This feedback effect dominates welfare measures and helps to explain long-run development patterns.

The potential for using equilibrium sorting models to conduct high resolution policy analysis is exciting, but are their predictions reliable? In recent years, economists have become increasingly skeptical of structural modeling. While structural models require us to formalize our assumptions about the choice set, utility functions, and random parameters, the extent to which these assumptions ultimately drive empirical results is often unclear. Some researchers have turned to experimental and quasi-experimental methods as a way to achieve more transparent identification. Others have called on structural modelers to clarify how their assumptions contribute to the identification of key results [12,13]. Achieving this clarity is especially important in benefit-cost analysis, where structural modeling has the potential to influence environmental policy. This is underscored by the Office of Management and Budget's guidelines for benefit-cost analysis of federal programs, which requires economists to quantify how their modeling assumptions influence estimates for benefits and costs [28].[1]

This paper addresses the issue of transparency in structural modeling by presenting a new framework for decomposing the identification of non-market values. It uses an equilibrium sorting model of household location choice to illustrate how our assumptions about choice sets, utility functions, and random parameters influence what we learn about the willingness-to-pay for policy changes. While equilibrium sorting provides a timely example, the framework for decomposition is not limited to these models or to housing market applications. Its key features apply generally to structural discrete-choice models of the demand for a differentiated product.

The new framework builds on an extensive literature evaluating the role of structural assumptions in discrete-choice models [18,20,27]. It begins by extending Varian's [29] diagrammatic analysis of recoverability to illustrate how heterogeneous preference parameters are jointly identified by structural assumptions and observed behavior. This illustration leads to four insights that are broadly relevant within the literature. First, increasing the degree of preference heterogeneity increases the sensitivity of welfare measures to distributional assumptions. Second, welfare measures can be decoupled from assumptions about the distribution of preferences. Third, ignoring moving costs and other sources of friction in the market creates a false sense of precision in estimates for welfare measures. Finally, the identifying power of assumptions about the choice set and consumer mobility can be distinguished from the identifying power of assumptions on preferences. After describing these results, the new framework is used to decompose estimates of the willingness-to-pay for improved air quality from a model of equilibrium sorting in Northern California. Given a parametric form for the utility function and a definition for the choice set, estimates for *average* benefits can vary by up to 167% depending on the econometrician's assumption about the distribution of preferences. However, for a subset of *individual* households, benefit estimates can be identified to within a few percentage points, regardless of distributional assumptions.

2. The household's location choice problem

Hedonic and equilibrium sorting models of household location choice typically start by supposing that the availability of housing and public goods varies across an urban landscape, and that each household chooses to occupy the location in that landscape that provides its preferred bundle of goods, given its preferences, income, and the relative prices involved. Households are assumed to be freely mobile and each household pays for its location choice through the price of housing. In order to link a household's observed choice to its demand for an individual public good, the problem can be formalized using the characteristics approach to consumer theory [15]. This keeps the dimensionality of the problem manageable and allows locations to be treated as a differentiated product.

2.1. Characterizing behavior in a locational equilibrium

Let the urban landscape consist of $j = 1, \ldots, J$ locations, each of which is defined by a bundle of housing characteristics and public goods, h_j, g_j. The first element of the bundle, h_j, represents a vector of structural characteristics that fully describe the private good characteristics of housing at location j. This includes the number of bedrooms, the number of

[1] OMB suggests testing the sensitivity to alternative modeling assumptions and then reporting probability distributions of benefits, costs, and net benefits. This discussion can be found under "Treatment of Uncertainty".