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## Non-price equilibria for non-marketed goods<sup>☆</sup>

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### ABSTRACT

As part of the Resources for the Future *Frontiers of Environmental Economics* collection of papers, we consider the problem of general equilibrium feedback effects in non-price space as they relate to non-market valuation. Our overall objective is to examine the extent to which non-price equilibria arising from both simple and complex sorting behavior can be empirically modeled and the resulting differences in partial and general equilibrium welfare measures quantified. After motivating the problem, in general, we consider the specific context of congestion in recreation demand applications, which we classify as the outcome of a simple sorting equilibrium. Using both econometric and computable general equilibrium (CGE) models, we examine the conceptual and computational challenges associated with this class of problems and present findings on promising solution avenues. We demonstrate the relevance of accounting for congestion effects in recreation demand with an application to lake visits in Iowa. Our econometric and CGE results confirm that, for some plausible counterfactual scenarios, substantial differences exist between partial and general equilibrium welfare estimates. We conclude the paper by describing tasks that are needed to move forward research in this area.

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## 1. Introduction

Empirical studies of market activities draw on an elegant and coherent body of theory that describes household and firm interactions in the market place. Price taking households purchase goods produced by firms that compete to maximize profits under a variety of market power conditions. Theory provides behavioral predictions for households and firms as well as statements about how the aggregation of this behavior results in equilibrium price and quantity outcomes. Models of general equilibrium (GE) rely on this link between individual behavior and aggregate outcomes to describe how exogenous changes lead to both direct and indirect effects in price and quantity space. Often it is the indirect, or feedback, effects that are the most interesting in market studies. A variety of empirical and calibration techniques has been developed in economics to study these effects. The modern empirical IO literature focusing on particular industries provides a good example of the former while CGE models of whole sectors of the economy provide good examples of the latter. In both cases, the emphasis is on modeling and understanding equilibrium outcomes in price and quantity space.

The story is quite different in studies of non-market goods that are typically employed by environmental economists for purposes of non-market valuation. By definition non-marketed goods are not exchanged in markets, and therefore one cannot speak of equilibrium prices and quantities for the goods per se. Instead the emphasis is usually on understanding

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preferences in a partial equilibrium (PE) framework for a quasi-fixed level of a public good. For this purpose, an impressive array of structural econometric models capable of predicting individuals' valuations for exogenous changes in the level of the public good has been developed. For example, recreation demand modelers use increasingly sophisticated models of quality-differentiated demands to understand how recreation site attributes affect behavior and well-being. Hedonic property value models use ever increasing levels of spatially resolute data to parse out the contribution of a local public good to housing prices. Although the latter models make use of equilibrium concepts to motivate estimation, they rarely are capable of predicting feedback effects from large-scale changes in public good levels. Thus, with few exceptions, it seems reasonable to say that non-market valuation has focused primarily on PE analysis of the interactions between behavior and quasi-fixed levels of environmental quality.<sup>1</sup>

This emphasis is probably reasonable in general. Empirical models of behavior that use measurable environmental quality as explanatory variables usually find effects that are of second-order importance relative to non-environmental factors. For example, ambient water quality in recreation demand models is usually much less important in explaining site choice and visitation frequency than travel cost. Likewise, structural characteristics tend to explain much more of the variability in housing prices than does air quality in hedonic property value models. Water quality and air quality in these contexts are examples of non-price attributes that we might reasonably suppose to be exogenous to the behavior that we are attaching to them. In contrast, the levels of other types of attributes—such as congestion or angler catch rates in recreation models, or traffic levels in residential location choice models—are at least partially determined by the aggregation of behavior under analysis. We may therefore wonder if there are situations in which GE feedback effects in endogenous attribute space might be empirically important in non-market valuation. This might be particularly so for a large-scale policy intervention that substantially changes the level and spatial distribution of environmental quality. In this paper, we begin to consider the extent to which non-price equilibria and feedback effects can be identified and accounted for conceptually and in empirical non-market valuation studies.

To examine this question, we proceed as follows. We begin by providing a descriptive overview of how we will think about the concept of “non-price equilibria” in non-market valuation. We suggest working definitions of two general types of non-price equilibria and offer context and motivation by linking these definitions to specific examples and the existing literature. We then turn to study a specific type of non-price endogenous attribute: congestion in recreation demand models. We do this using both econometric and computable general equilibrium (CGE) models. We begin by laying out a general modeling structure that will be used in both the econometric and CGE models, which is followed by a description of the Iowa lakes data that motivates our empirical analysis in both modeling frameworks. We then consider an empirical model of recreation demand that explicitly includes site congestion as an explanatory variable, accounts for its econometric endogeneity, and allows computation of both PE and GE welfare measures. After presenting results from this analysis, we turn to the CGE model, which is used to explore more generally situations when PE and GE welfare measures can be different and under what circumstances it might be important to consider non-price feedback effects in empirical non-market valuation models.

With the three components of this paper, we provide three contributions in the spirit of the “frontiers” theme of this collection of papers. First, we lay out a research agenda that is motivated by the notion that large-scale policy interventions might lead to feedback effects in non-price variables. Second, we make use of both CGE and econometric modeling approaches to analyze the feedbacks problem and demonstrate how these quite different tools can shed light on the same problem from different angles. Since the behavior we are interested in is characterized by both intensive and extensive margin decisions both modeling approaches must admit binding non-negativity constraints. To this end, we further the development of CGE and econometric models that are flexible, tractable, and provide realistic and internally consistent representations of the behavior we are modeling. The final contribution involves the application to recreation visits to Iowa lakes and accounting for congestion in the model.

## 2. Conceptual overview

To ground our discussion of non-price equilibria, we consider the following behavioral setup. Agents in a closed economy maximize an objective function by choosing levels of activities that are defined by both price and a set of non-price attributes. In the case of consumers, the activities are demands for quality-differentiated goods; for firms, we can think of them as derived demands for quality-differentiated factor inputs. For the remainder of this discussion, we use terminology corresponding to the consumer's problem, although we will also provide examples that correspond to firm's behavior. Households consume the quality-differentiated goods in non-negative quantities and can, at the optimum, be at a corner solution for a subset of the available goods. The set of non-price attributes that describe the goods in the choice set can be divided into two types: those that are exogenously determined and those that are at least partially determined by the actions of individuals in the model (i.e., endogenous attributes). We are ultimately interested in understanding the extent to which the levels of endogenous attributes might change in response to exogenous or policy shocks, and what the resulting differences are between PE and GE welfare measures for policy interventions.

<sup>1</sup> Recent notable exceptions are the equilibrium sorting models of [5,28,29].

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