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Preference endogeneity in discrete choice models

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ABSTRACT

Existing models of disaggregate decision-making assume that preferences, as indicated by taste parameters and choice sets, are characteristics of the decision-maker that are exogenous to the choice situation and stable over time. Though the assumption has allowed travel demand analysts to use these models to forecast changes in observable behavior in response to changes in the decision-making environment, the assumption has overlooked the influence of these changes on the preferences underlying observable behavior. As a consequence, the use of these models has been limited to forecasting horizons over which preferences can reasonably be assumed to be stable. We build on Latent Class Choice Models (LCCMs) to allow for preference endogeneity. Conventional LCCMs formulate class membership as some function of the decision-maker's characteristics, but they ignore the impact of alternative attributes, which usually enter the class-specific choice models, on class membership. In this paper we introduce LCCMs with feedback from the class-specific choice models to the class membership model through the construct of consumer surplus. Class membership is hypothesized to be a function not only of the characteristics of the decision-maker but also of the consumer surplus offered by each class, which in turn is a function of alternative attributes, taste parameters and choice sets. The framework is applied to a case study on travel mode choice behavior. A comparison between LCCMs with feedback and traditional models that do not allow for preference endogeneity finds that the former performs better in terms of fit and offers greater behavioral insights, and that the latter can lead to biased forecasts.

1. Introduction

Discrete choice models of disaggregate decision-making have long relied upon the neoclassical assumption that preferences, as denoted by taste parameters and choice sets, are characteristics of the decision-maker that are exogenous to the choice situation and stable over time. The assumption has never been accepted within the social sciences (Hirschman, 1982; Hollis, 1987) and has additionally been criticized by studies in both public and welfare economics (Sen, 1973; Pollak, 1978) and behavioral economics (Tversky and Thaler, 1990; Bowles, 1998). Consider, for the sake of illustration, the case of travel behavior. National average commute times in the United States have increased from 21.7 min in 1980 to 23.4 min in 1990 to 25.5 min in 2000 (Pisarski, 2006). In the face of worsening freeway congestion, an individual making a commute trip by car might find herself thinking, "I wish my commute took as much time as it did before, but I also wish I could continue doing what I did before." In the presence of feasible alternatives and flexible constraints, there are two ways in which such an

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individual could choose to respond. The individual could switch to a different travel mode, take another route, make the trip during the off-peak or go to a different work location, without changing the time that it took her before to get to work. Or, if the individual wishes to continue doing what she did before, she could lower her value of time, thereby changing her preferences in response to a change in the decision-making environment but staying consistent in terms of her behavior. In this case, the change in preferences is driven by cognitive dissonance.[1] In other cases, it could be motivated by such disparate mechanisms as rationalization (or the tendency to make excuses to justify otherwise unacceptable behavior), habituation (or the decrease in response to a stimulus after repeated exposure), sensitization (the opposite of habituation in that repeated exposure to a stimulus may lead to a progressive increase in response), taste acquisition (or an appreciation for things that are unlikely to be enjoyed upon initial exposure), etc.

That preferences change over time in response to changes in the decision-making environment as a result of one or more of these behavioral mechanisms has never been a point of contention; debate has largely centered on whether economists should concern themselves with such changes (Weizsäcker, 1971). On the one hand, the assumption has allowed econometricians to forecast changes in observable behavior in response to changes in one or more variables that define the decision-making environment. On the other, as Samuel Bowles (1998) writes, "If preferences are affected by the policies or institutional arrangements we study, we can neither accurately predict nor coherently evaluate the likely consequences of new policies or institutions without taking account of preference endogeneity." Therefore, it has been argued that the use of extant models for forecasting must necessarily be limited to short term horizons over which preferences can reasonably be assumed to be insensitive to changes in the decision-making environment. Depending upon the nature of the problem, forecasting horizons may vary anywhere between a week and several years. As an extreme example, Metropolitan Planning Organizations employ travel demand models estimated with cross-sectional travel diary data collected over 1 or 2 days to predict changes in travel demand and land use patterns over planning horizons of 20–30 years. Though the effect of changes in socioeconomic variables, such as income, on preferences pertaining to travel and activity behavior is accounted for (Gunn, 2001), it is usually assumed that these same preferences are immune to changes in the transportation and land use system. Most would agree that the assumption that individual and household preferences pertaining to travel and activity behavior are immune to changes in the transportation and land use system over a period of two or three decades is one that is not reasonable.

This study develops discrete choice models that allow for preference endogeneity – Latent Class Choice Models (LCCMs) with feedback through consumer surplus. The model framework assumes that a decision-maker's taste parameters and choice set are some function of the choice situation that she is confronted with. For example, in the case of travel mode choice, the travel modes that a decision-maker considers for a particular tour and the relative importance that the decision-maker attaches to the different level-of-service attributes of each of the travel modes are hypothesized to be some function of the available travel modes for that tour and the level-of-service attributes associated with each of the travel modes. In this regard, LCCMs with feedback represent an operationalization of the notion of preferences as a "constructive, context-dependent process" (Tversky and Thaler, 1990) and allow for the use of these models for forecasting over longer horizons that are more consistent with the time scale of studies both within the field of transportation and land use behavior, and without.

The paper is structured as follows: Section 2 introduces the methodological framework for LCCMs with feedback through consumer surplus in greater detail and how it relates to model frameworks employed by previous studies in the literature on discrete choice analysis. Section 3 applies the framework to a case study on latent individual modal preferences and travel mode choice behavior in the San Francisco Bay Area. Section 4 concludes the paper with a summary of findings, contributions and directions for future research.

2. Methodological framework

Differences in preferences are defined as differences in both the taste parameters and the choice sets. Heterogeneity with regards to taste parameters may be captured systematically, through the use of observable socioeconomic variables, and randomly, through the use of mixture distributions. Endogeneity with regards to taste parameters could be captured through similar continuous functional forms, such as a non-linear utility specification. For example, in the context of travel mode choice, specifying the utility of any alternative to be linear in the logarithm of travel time would imply that the average value of time decreases as cumulative travel times increase, thereby allowing the value of time to be sensitive to the level-of-service of different travel modes.

However, how does one extend this simple and elegant formulation to incorporate endogeneity with regards to choice sets? Given that there are a finite number of unique choice sets, in capturing heterogeneity and endogeneity with regards to choice sets, a discrete formulation such as the LCCM appears a natural choice. LCCMs are nonparametric (or semiparametric) finite mixture discrete choice models. They were first developed in the field of marketing sciences as tools to identify relatively homogenous consumer segments that differ substantially from each other in terms of their behavior in the

[1] Note that the same behavior could just as well have resulted from the absence of feasible alternatives and the presence of insurmountable constraints that forced the individual to continue doing what she did before. In such cases, it would be wrong to infer continuity in behavior in response to changes in the decision-making environment as evidence of commensurate changes in individual preferences.