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Accounting for outside options in discrete choice models: An application to commercial fishing effort[☆]



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ABSTRACT

Discrete choice models often feature a generic outside option that combines all alternatives other than those of particular interest to the researcher, which allows overall demand for the alternatives of interest to be captured. I demonstrate that combining diverse alternatives into a single outside option can result in distorted parameter estimates and misleading predictions. To evaluate the practical importance of how outside options are treated, I use data on the Florida spiny lobster and stone crab fisheries to compare a discrete choice model that explicitly accounts for individuals' ability to target both species with one that includes stone crab alternatives in the generic outside option. I find that parameter estimates and predictions for the lobster fishery depend heavily upon whether stone crab alternatives are explicitly accounted for. In addition, I conduct a series of Monte Carlo experiments, which demonstrate that the sign and magnitude of differences in predictions between models are complex functions of the characteristics of the empirical environment. Together, these results highlight the importance of carefully considering the composition of outside options when estimating discrete choice models and making predictions based on the estimates.

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Introduction

Discrete choice models have become widely used to study individuals' selection among finite sets of alternatives. These models provide a tractable framework in which to estimate the drivers of agents' decision-making and allow researchers to make behavioral and welfare predictions. Often, the researcher is interested in choices over a subset of all possible alternatives, due to the aim of the study or due to data availability. However, if the researcher is interested in whether agents choose *any* of the alternatives of interests, then the choice set must include all possible alternatives, not just those of particular interest. This is typically accomplished by combining all other alternatives into a generic outside option.¹ This is the case in analyses spanning many areas of study, such as product demand (Berry et al., 1995), energy conservation (Cameron, 1985 and Allcott and Wozny, 2014), recreational demand (Morey et al., 1993), and commercial fishing effort (Smith, 2002) and (Smith and James, 2003).

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¹ For example, in estimating the determinants of demand for differentiated automobile models, not purchasing an automobile must be included in the choice set in order to allow overall demand for automobiles to depend on variables such as prices.

In this paper, I demonstrate that it is important to carefully consider the composition of agents' outside options when estimating discrete choice models and making predictions based on the estimates. When alternatives are combined to form a single outside option, they are implicitly treated as identical alternatives, regardless of their similarity to one another or their similarity to other explicitly-modeled alternatives. This can result in misleading parameter estimates and predictions for a number of reasons. First, outside options are made observationally equivalent by homogenizing alternative-specific characteristics. Second, variables are constrained to have identical effects on all alternatives contained in the outside option. In addition to biasing parameter estimates, these issues can distort estimated substitution patterns between choices that are explicitly modeled, particularly when some of the alternatives contained in the outside option share commonalities with modeled alternatives. Third, the set of policy predictions that the researcher is able to consider is limited to those policies that affect only explicitly-modeled alternatives.

I examine the quantitative effects of these issues in the context of a discrete choice model of commercial fishing effort. I consider a case in which the researcher is interested in modeling participation and location choice in the Florida spiny lobster fishery. In addition to fishing for lobsters, fishermen may engage in a number of other activities, and the researcher must determine how to characterize these outside options. I consider two characterizations. In the first, which I label the "naive" benchmark model, I combine all other possible activities into a single outside option. Many individuals that participate in the lobster fishery also participate in the stone crab fishery. Thus, in the second, which I label the "true" model for expositional purposes, I explicitly model both lobster and stone crab alternatives, and I combine all remaining activities into a generic outside option. Because stone crab alternatives are combined with all other activities in the naive model, values of alternative-specific variables, such as revenues and costs, are implicitly set to zero for stone crab alternatives, and other variables, such as weather, are constrained to affect stone crab fishing in the same manner that they affect all other outside options. Given that stone crab fishing is almost certainly more similar to lobster fishing than to non-fishery activities, these restrictions are likely to produce biased parameter estimates and misleading policy predictions.

I find that estimated marginal effects differ substantially in magnitude, and the predicted effects of policy changes differ both in magnitude and, in some cases, the direction of the effect. Specifically, using the fitted models, I simulate the effect of marine reserve establishment (area closures) – an increasingly popular regulatory tool – on total effort and the distribution of effort in the lobster fishery. When areas are closed to the lobster fishery only, both models necessarily predict a decrease in overall lobster fishing effort. However, the magnitude of the predicted response differs between models by more than 50%. When areas are closed to both fisheries, in some instances, the true model predicts an increase in overall lobster fishing, a result that is ruled out by the naive model. The increase in lobster fishing effort arises because individuals that had chosen to fish for stone crab in a now-closed area find it optimal to fish for lobster in a still-open area. The propensity to target another species in response to area closures cannot be captured by the naive model. As a result, the naive model predicts a decrease in lobster trips.

To determine the extent to which the empirical results depend on the specifics of the lobster and stone crab fisheries, I conduct a series of Monte Carlo experiments. In these experiments, I vary characteristics of the choice environment and evaluate how variations affect estimates and predictions of the misspecified model. This exercise reveals that both the sign and magnitude of biases in estimates and predictions are heavily dependent on the choice environment. While the relationships between characteristics and biases are, to a large extent, predictable, it is not straight-forward to forecast the sign and magnitude of biases when a number of characteristics interact. The empirical results and Monte Carlo analysis suggest that researchers and practitioners should explicitly model choices closely related to the decisions of interest whenever possible and, when not possible, carefully consider the potential biases introduced by pooling such choices with other outside options.

The treatment of outside options is not an issue that is limited to discrete choice applications. In demand analysis, the researcher is typically interested in modeling demand for a subset of goods and must decide how to treat all remaining goods. Several strategies have been developed to cope with this issue. If the goods of interest enter preferences through a weakly separable function, demand for these goods may be modeled conditional on total expenditures allocated to these goods. Alternatively, if the prices of goods not modeled vary proportionally across observations, the researcher may aggregate these goods into a single Hicksian composite good and model demand for the goods of interest as a function of own prices, the composite good price, and income. In most empirical applications, including the one studied here, the researcher will find the assumptions required to apply these methods too restrictive. A third option, the incomplete demand system approach, developed in Epstein (1982) and further analyzed in LaFrance and Hanemann (1989) and von Haefen (2002), involves modeling demand for the goods of interest as a function of own prices, all remaining goods prices, and income. A number of studies have used this approach to estimate recreation demand models.²

Although appealing, the incomplete demand system approach is not well-suited for discrete choice applications. When a good is not consumed, it is not the observed market price for the good that influences choices, but the price that would drive demand to zero (the "virtual" price), which is not observed by the researcher. A correctly specified incomplete demand system includes observed prices for goods that are consumed and virtual prices for goods that are not consumed. Although methods have been developed to consistently estimate complete demand systems when corner solutions are present, no feasible method currently exists for incomplete demand systems (von Haefen, 2010). Moreover, von Haefen (2010)

² See, e.g., Eom and Douglas (2006) and Phaneuf et al. (2009).

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