Commentary: What Is the Right Price in Discrete Choice Models of Health Plan Choice?

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The paper by Marquis et al. (2007) makes a contribution to the literature on health plan choice in the nongroup market, a topic that is likely to be of continuing interest for health policy debates in the United States. However, the authors have made an error in specifying the model they estimated. The result is bias toward zero in the estimated coefficients that are crucial to calculating estimates of the elasticity of health plan choice with respect to plans' premiums and quality.

This comment begins by providing some background on discrete choice models of health plan choice, a topic where I and the authors should be in agreement. Then it summarizes how the authors introduced price and quality into the model. I explain what they should have done and the bias that results from not estimating the correct model, and conclude with suggestions for future research.

BACKGROUND ON DISCRETE CHOICE MODELS

As a framework for the discussion I will use a general discrete choice model adapted from McFadden (1973) and Maddala (1983). Suppose an individual derives utility U_j^* from the j th health plan. One does not observe U_j^* but instead observes $U_j = 1$ if U_j^* is the largest element of the vector $(U_1^*, U_2^*, \dots, U_j^*, \dots, U_m^*)$ where $S = \{1, 2, \dots, j, m\}$ is the set of health plan choices available to the individual. Next, I specify the utility from each choice as consisting of a deterministic function of characteristics of the choice and of the individual (which might include interactions with choice characteristics), plus a random error. For simplicity, I omit the personal characteristics and write the utility function as

$$U_j^* = V_j + e_j \quad (1)$$

The j th plan will be chosen if it provides more utility than any other plan in the choice set, or

$$U_j = 1 \text{ if } V_j + e_j > V_k + e_k \text{ for all } k \neq j; j, k \in S \quad (2)$$

INCORPORATING PRICE AND QUALITY IN THE MODEL

The next topic is how price and quality should be incorporated into $V_j + e_j$. This is where the authors and I disagree.

The authors abstracted data for all the plans offered during the study period and provided it to Actuarial Research Corporation, which used the data to develop a measure of how much the plan would have paid for the health care used by each person in a standardized population. They refer to this measure as the “actuarial value” of each plan. I like to think of it as a measure of plan quality. This fits into a long literature dating back at least to Lancaster (1966) that views products as consisting of bundles of features, and those with more of the features that consumers prefer as having higher quality.

The authors divided the plan’s premium (p_j) by the measure of quality (q_j) to obtain the “price” per unit of quality (p_j/q_j). Next, they incorporated price and quality into the consumer’s utility function as

$$V_j = \alpha(y - (p_j/q_j)) + \beta q_j \quad (3)$$

Using equation (3) they estimated a nested logit model that specifies the demand for a particular health plan, given that the nest containing that plan has been chosen, as a function of price and disaggregated components of quality such as the deductible and coverage for specific services. The demand for different nests depends on characteristics that are common to plans within a nest but vary across nests, e.g., whether the plan is a PPO or an HMO. The estimated coefficients from both stages of the nested logit model can be used to calculate elasticities of health plan choice with respect to price and quality. I do not take issue with their choice of the nested logit model, although I do question their interpretation of the coefficients in that model.

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WHAT SHOULD THEY HAVE DONE?

In markets where each consumer uses only one unit of the good, it seems commonsense to say that utility depends on the quality of that good and the quantity other goods consumed (Rosen 1974). In the context of health plan choice, only one unit of the good is consumed because each individual enrolls in only one plan. If we normalize the price of other goods to be \$1, then the quantity of other goods is equal to the consumer's exogenous income (y) minus the out-of-pocket premium for the j th plan. Consequently, I write the general form of the V_j function as

$$V_j = V_j(y - \text{premium}_j, \text{quality}_j) \quad (4)$$

Next, we need to specify a particular form for the V_j function. If the consumer is risk-averse, we might choose a function that allows risk aversion to be constant, for example. For simplicity, and because the literature often uses a linear utility function, I will specify V_j as

$$V_j = \alpha(y - p_j) + \beta q_j \quad (5)$$

where α and β are constants, p the premium, and q the quality. So the difference between my form of V_j and the authors' is their division of p_j by q_j .

WHY DOES IT MATTER?

As I was a reviewer of the article, I communicated the discrepancy in equations (3) and (5) to the authors. Their response was:

We continue to argue that the actuarially adjusted price, or price per unit, is an appropriate concept. For example, if we replace the premium in the reviewers [sic] function with the actuarial price * quantity¹ we would conclude that the variables in the choice function would include price and quantity—which is what we have done. Moreover, this then provides us with estimates of the price response that control for quantity, which is the more typical demand response.

The authors seem to be suggesting that the two forms of the utility function are equivalent, but their form has the added advantage of yielding estimates of the price response that control for quality. Unfortunately, the two forms are not equivalent.

Equations (3) and (5) can be made comparable by redefining the error term in the authors' equation (3) as follows:

$$U_j^* = \alpha(y - p_j) + \beta q_j + e_j = \alpha(y - (p_j/q_j)) + \beta q_j + v_j \quad (6)$$

where the new error term in equation (6) is defined as

$$v_j = e_j + \alpha p_j / q_j - \alpha p_j \quad (7)$$

The j th plan will be preferred to the k th plan if $U_j^* > U_k^*$ or:

$$\alpha(y - (p_j/q_j)) + \beta q_j - \alpha(y - (p_k/q_k)) - \beta q_k > v_k - v_j \quad (8)$$

The composite error term $v_k - v_j$ in equation (8) includes not only the random errors from the utility functions (e_j), but also $-\alpha p_j$ and $+\alpha p_j/q_j$. As a result, the composite error term is negatively correlated with the price of quality (p_j/q_j), and by definition, negatively correlated with the probability that the j th plan is preferred to the k th plan, leading to a positive bias in the estimate of α . By a similar argument, the composite error term is positively correlated with quality of the j th plan, and (still) negatively correlated with the probability that the j th plan is preferred to the k th plan, leading to a negative bias in the estimate of β . Thus, if my functional form is correct, the authors' estimates of α and β are biased.

What about the authors' contention that their specification is the "more typical demand response?" This statement is beguiling but inaccurate in the context of a discrete choice model. The demand function is a reduced form, so if we wanted to estimate the demand function, it would include the price of quality (or an instrument if price were endogenous) and the consumer's income. However, McFadden's (1973) fundamental contribution was to demonstrate that under certain assumptions about the error terms in equation (1), estimation of a discrete choice model identifies the *structural* parameters in the consumer's utility function.² In other words, $\hat{\alpha}$ is an estimate of the consumer's marginal utility of income and $\hat{\beta}$ is an estimate of the marginal utility of quality. These are not reduced-form estimates, as in the demand function.

It is accurate to say that the demand function and the utility function are related. McFadden (1973) showed that the probabilistic demand function for the j th plan can be derived from the estimated utility function as:

$$P(U_j = 1) = \exp(\hat{V}_j) / \sum_{k=1}^m \exp(\hat{V}_k) \quad (9)$$

From equation (9) we can calculate an estimate of the elasticity of demand with respect to product characteristics of any plan in the choice set. For example, the own-price elasticity of demand for the j th plan is

$$\frac{\partial P(U_j = 1) / P(U_j = 1)}{\partial p_j / p_j} = \hat{\alpha} p_j (1 - P(U_j = 1)) \quad (10)$$

But the estimated *structural model* is the consumer's utility function.

The nested logit model used by the authors and by me in prior research (Feldman et al. 1989) is a generalization that allows freedom from the assumption of “independence of irrelevant alternatives” that characterizes the conditional logit model (McFadden 1978, 1981; Ben-Akiva and Lerman 1985). Nevertheless, the nested logit model identifies the structural utility parameters, so my comments above apply to nested logit as well.

CONCLUSION

In estimating discrete choice models for health plans, it is important to specify correctly the equation to be estimated. If we believe that consumers derive utility from consumption of health plan quality and other goods, then the utility function should be specified as including quality and the consumer's net income after paying the out-of-pocket premium. In the group insurance market the premium often is subsidized by an employer and is paid with pretax income, in contrast to the individual insurance market where the consumer typically pays the full premium with posttax income. These factors need to be taken into account. In addition, we need to pay more attention to the form of the utility function, e.g., whether it is linear.

The authors have made a contribution to the literature on health plan choice by showing that product choice in the individual market is sensitive to price but overall market participation is less so. They also showed that changes in generosity of coverage also affect product choice more than market participation. However, these findings need to be considered with some caution because the authors' specification of the utility functions leads to bias toward zero in the estimates of choice responses to both price and quality.

The authors experimented with other specifications of the utility function, including one in which actual price rather was used instead of the adjusted price. The results suggest that the bias in the price response does not appear to be important, although the quality response was larger when they used the actual price rather than the adjusted price. In other applications the bias in the price response might be larger. Investigators should specify the utility function correctly to avoid this possibility.

NOTES

1. The authors refer to the amount of benefits offered by the plan as “quantity.”
2. The assumptions are that the errors are identically and independently distributed with probability density function $f(e_j) = \exp(-e_j) - \exp(-e_j)$.

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