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Welfare calculations in discrete choice models when anticipated and experienced attributes differ: A guide with examples

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ABSTRACT

The attributes that consumers anticipate or expect when choosing among alternatives (i.e., prior to consumption) often differ from the attributes that they actually experience when consuming their chosen alternative. This paper describes, and illustrates with several examples, the calculation of consumer surplus in this situation and the loss in consumer surplus due to the imperfect foreknowledge about attributes. The procedures are useful in many settings, such as the assessment of damages for false advertising and the analysis of informational policies.

1. Introduction

In many choice situations, the consumer evaluates alternatives on the basis of the his/her concept of what the attributes of the alternatives are, but then finds, after making the choice, that the attributes of the chosen alternative are different than anticipated. The disconnect between anticipated and experienced attributes can arise from many sources: consumers might not accurately evaluate products (e.g., in choosing a car, consumers might not accurately translate differences in mpg into differences in operating cost); producers might misrepresent or withhold information about their products' attributes, or not know the attributes themselves (such as an undiscovered defect); or the attributes might depend on factors that simply cannot be known at the time of choice (e.g., vehicles' operating costs depend on future gas prices, which are not known at the time of choosing among vehicles.)[1] The situation can be said to arise from consumers' imperfect foreknowledge, but without any connotation that the imperfection is due to an error by the consumer.

The question that this paper addresses is how to measure consumer surplus in these situations, and particularly, how to measure the loss in consumer surplus that arises from imperfect foreknowledge of alternatives' attributes. This measure of loss has different uses depending on the source of the discrepancy between anticipated and experienced attributes. If consumer error is the source, then the loss represents, equivalently, the welfare gain that can be attained by correcting the error. If the discrepancy is due to false advertising, then the loss constitutes the compensation that is needed for the firm to atone for the incorrect information. And if the situation is unavoidable e.g. when attributes cannot be known with certainty in advance, then the measure of loss can be used to evaluate policies that alleviate the impact of the uncertainty.

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[1] In regard to this last source, the discrepancy is a natural outcome within the standard theory of decision-making under uncertainty. Consumers choose to maximize expected utility based on a probability distribution of possible attribute levels for each alternative. However, after the choice is made, some realization from the distribution is revealed, which is inevitably different from the expectation.

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Numerous papers have examined the role of perceptions in consumers' decisions, from both a general perspective (e.g., Kahneman, 1994; Manski, 2004) and in specific contexts (e.g., Delavande, 2008; van der Klaauw and Kenneth, 2008; Jensen, 2010).[2] However, the question of how to calculate consumer surplus when anticipated and experienced attributes differ has hardly been touched. I have found two papers that describe welfare calculation for this situation: Allcott (2013) and Schmeiser (2014). These authors give formulas similar to the ones I describe below and should be considered the originators of the procedure. However, their derivations are in the context of specific topics and constitute small sections of their papers, such that the general relevance could easily be missed by readers. The current paper gives the formulas prominence, explaining them in greater detail and providing illustrative applications. As will be shown, the calculations are straightforward for standard and mixed logit models, employing the familiar log-sum term and an additional easy-to-calculate term.

In many situations, the consumer can learn about product attributes – by seeking information, from experience with the chosen alternatives in repeated choices, and through the experiences of other consumers who make other choices – and this learning will reduce and perhaps eliminate the difference between anticipated and experienced attributes. The current paper does not address how consumers' concepts about attributes change over time. Rather, the procedures in this paper are useable for calculating consumer surplus at any given point in the learning process, and to represent the loss due to the gap that remains at that point.

2. Derivation of welfare measures

A person faces a choice among a set of discrete alternatives indexed $j=1,\dots J$. The utility the person expects from alternative j is W_j, which I call "anticipated utility." The utility that the person actually obtains is U_j, called "actual utility."[3] The difference between the actual and anticipated utility is $d_j = U_j - W_j$, such that $d_j > 0$ if the alternative is actually better than the person thought and $d_j < 0$ if worse. Kahneman (1994), Allcott (2013), and others have used equivalent terms, such as "belief utility" and "experience utility."

The person chooses among the alternatives based on anticipated utility but obtains the actual utility from the chosen alternative. The alternative that the person chooses is j^* for which $W_{j*} > W_j \ \forall\, j \neq j^*$.[4] The utility that the person attains from the choice is U_{j*}.

The alternative that provides the highest actual utility is k^* s.t. $U_{k^*} > U_j \ \forall\, j \neq k^*$. The loss due to the person's imperfect foreknowledge is then $U_{j*} - U_{k*}$. An implication, which can have a large impact on welfare calculations, is that a person loses from imperfect foreknowledge only if the person would have chosen a different alternative under perfect foreknowledge. If the same choice would have been made, such that $k^* = j^*$, then $U_{j*} - U_{k*} = 0$.

Suppose $k^* \neq j^*$ and $d_{j*} < 0$, such that the consumer incurs a loss due to their imperfect foreknowledge of alternatives ($k^* \neq j^*$) and a loss relative to anticipated utility ($d_{j*} < 0$). As long as $d_{k^*} \leq 0$, the loss due to imperfect foreknowledge is smaller in magnitude than the loss relative to anticipated utility:

$$U_{j*} - U_{k*} = W_{j*} - W_{k*} + d_{j*} - d_{k*} > d_{j*} - d_{k*} \geq d_{j*}$$

such that, since both terms are negative, $|U_{j*} - U_{k*}| < |d_{j*}|$.[5]

Measurement of these terms can be readily operationalized with a standard logit specification. Let anticipated utility be

$$W_j = -\alpha c_j + \beta x_j + \varepsilon_j$$

where c_j is the anticipated cost, x_j is a vector of other anticipated attributes, and ε_j is random and assumed to be iid extreme value. The choice probabilities are the standard logit formula based on anticipated utility:

$$P_j = \frac{e^{-\alpha c_j + \beta x_j}}{\sum_k e^{-\alpha c_k + \beta x_k}}$$

Actual utility is d_j different than anticipated utility: $U_j = W_j + d_j$. We assume, for the formulas below, that each ε_j is independent of the d_j's, in the same way that they are independent of c_j and x_j for all j.[6] Average consumer surplus from this

[2] Analysis of perceptions clearly relates to the current situation but can be more general. In particular, perceptions can affect equally the utility that the person anticipates and experiences. For example, people who think that owning a Tesla will make them look good in other people's eyes obtain utility from that perception whether or not it is true. The perception creates a difference between anticipated and experienced attributes only if any of these people discover after buying the car that other people haven't changed their opinions of them.

[3] I use the term "actual utility" instead of "experienced utility" for linguistic convenience. Stated in terms of experience, U_j is the utility that the person would experience if the person were to choose alternative j.

[4] Through the discussion, the possibility of ties is ignored, or, more precisely, is given a zero probability of occurring.

[5] The difference between the types of losses can have a large impact on legal actions. Suppose a firm is charged with false advertising. If found guilty, the firm might be required to compensate for consumers' loss relative to the utility they would have obtained without the false advertising, i.e., for $U_{j^*} - U_{k^*}$. If instead the firm is found guilty of a contract violation because of not providing the product that was promised, the firm might be required (depending on contract law) to compensate consumers for the loss relative to the promised product, which is d_{j*}.

[6] This assumption implies, importantly, that the distribution of the portion of anticipated utility that is unobserved by the researcher is the same as for actual utility. The errors for any one person need not be the same, but the distribution of errors over people is the same. An useful area for future research is