

Consumer surplus for random regret minimisation models

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Background and motivation:

McFadden (1981), Small and Rosen (1981), and Hanemann (1984) were amongst the first to establish the theoretical relation between discrete choice modelling, specifically the Random Utility Maximisation (RUM) model, and welfare economics. Although the link between the RUM model and welfare has been well-defined, the same cannot be said for the recently introduced Random Regret Minimisation (RRM) model (Chorus, 2010). The lack of a formal connection to the realm of welfare economics limits the scope of the RRM model, since it remains unclear how to use estimated RRM models for economic appraisal. The goal of this paper is to be the first to derive a measure of consumer surplus for the RRM model, which can be used to evaluate the welfare implications of particular changes in the transport infrastructure.

The key difference between the RUM and the RRM model is that the latter is built around (a non-linear function of) attribute level differences across alternatives, rather than absolute attribute performance. That is, in the context of for example travel time and travel cost attributes, the regret of an alternative is entirely defined by the extent to which it is slower or more expensive compared to every other alternative in the choice set. By focusing on price differences across alternatives, the RRM model rules out income effects. The RRM model thereby lacks a direct connection between regret (as an analogue to utility) and money income. In absence of a (constant or non-constant) marginal regret of income it becomes a challenge to translate changes in regret, as for example measured by the change in the RRM LogSum measure (Chorus, 2012), into welfare effects. In this paper, we build upon a not well known theoretical result published in the field of environmental economics (McConnell, 1995). We show that that *price changes* instead of *lump-sum income compensation* can be used to derive a measure of consumer surplus for RRM models.

Methodology:

Like Small and Rosen (1981), we adopt the perspective of the representative consumer such that the RRM choice probability describes the expected demand for an alternative in the choice set. The choice probability of an alternative is assumed to be of multinomial logit form and well-behaved in the sense that it is monotonically decreasing in the price of that alternative. McConnell (1995) recognised that when plotting an alternative's choice probability as a function of price, one actually draws the uncompensated (Marshallian) demand function for that alternative. The area underneath the demand curve between the original price and the price at which demand reduces to zero represents the consumer surplus

of having that particular alternative in the choice set. In the context of the RUM model without income effects, the obtained measure of consumer surplus gives the same result as does the compensating variation computed by means of the classical LogSum-approach (McConnell, 1995).

Results:

We extend the result of McConnell (1995) to the realm of the RRM model and show that it can be used to determine the value of having a particular alternative in the choice set. The monotonicity of the RRM-probability function with respect to price ensures that consumer surplus exists and has a unique solution. We also analyse, building on model extensions proposed in McConnell (1995), how measures of (changes in) RRM-consumer surplus can be derived for the related case of changes in an alternative's attribute levels. These results create a formal connection between RRM and welfare economics, and as such they pave the way for economic appraisal using RRM-models.

Having established these consumer surplus measures for RRM, we go on to illustrate, using numerical examples based on empirical model estimation, how key character traits of the RRM model translate into consumer surpluses that are different from those obtained from linear-in-parameter RUM modes. For example, we show how so-called compromise alternatives (i.e., alternatives with an 'in-between' performance on each attribute) are associated with a larger consumer surplus in RRM models than in RUM models. These illustrations highlight that using the RRM model for economic appraisal can lead to new insights into the benefits of transport policies and infrastructure investments.

Scientific contributions:

There are several contributions in this paper. First, this is the first study that establishes a valid measure of consumer surplus for RRM-models. While we focus on the consumer surplus associated with having a particular alternative in the choice set, we analyse how the approach can be extended towards covering other situations, such as the one where an alternative's attributes are changed. Second, we illustrate how this measure can be used to gain new insights for the economic appraisal of transport policies and infrastructure investments. Our results can be used as a building block for the derivation of consumer surplus measures for other non-RUM models that have recently been proposed in the transport literature, such as the symmetric Relative Advantage Maximization model (Leong and Hensher, 2014).

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