



# Flexible Mixed Logit with Posterior Analysis: Eliciting Willingness to Pay for Grid Resilience

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The need to replace existing infrastructure and the aim to connect an increasing share of energy from renewable sources and distributed generation to the grid will drive major investments in electricity transmission and distribution networks in the coming decades. The economic viability of such investments depends on a comparison of benefits and costs. As transmission and distribution networks are natural monopolies, though, there is no real market for the related services and hence no market price to signal their value. Since the 1990s regulators of infrastructure industries around the globe have therefore implemented incentive regulation models that mimic market mechanisms to promote efficiency in such natural monopolies (Jamash et al., 2012). The challenge is to set the incentives such that the optimal level of service is provided. To determine and incentivise the optimal service level, regulators have to estimate the marginal cost curve and a demand curve (i.e. the customers' WTP) for the respective services.

Choice modelling is broadly regarded as the most suitable method for estimating consumers' WTP and thus mimic demand for service improvements. In fact, the estimation of WTP via stated choice experiments has become an important part of price review processes of regulators such as Ofgem, the gas and electricity market regulator in the UK. However, usually multinomial logit (MNL) models are employed to elicit consumer preferences. These models assume homogeneous preferences within presumed consumer segments and do not allow for differences in the consumers' randomness of choice.

This is despite empirical evidence of heterogeneity in preferences and WTP (see Devine et al., 2010 and McNair et al., 2011). In Ofgem's economic analyses for example customer preferences are assumed homogeneous within DNOs. In this paper we show that this is a critical and questionable assumption that is likely to lead to an inefficient level of service provision. We illustrate that if heterogeneity in valuations is not accounted for when determining the allowances, the transition of utilities to a socially efficient service level and a welfare maximising payment plan might be distorted.

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We present an alternative, less restrictive approach to explore customer preferences and WTP for resilience services. We account for preference heterogeneity in the population, allow for scale heterogeneity (i.e. heterogeneity in the randomness of choice) and exploit individual posterior distributions to improve the WTP estimates and thus the economic valuations. More precisely, we start off with the estimation of a heterogeneous scale mixed logit model in WTP space, derive the individual posterior distributions based on the individuals' choices and exploit them to segment the data post estimation to calculate the total valuations per DNO. We refer to 'posterior analysis' in the sense that we analyse the conditional estimates that exploit information on the choices made by the individuals. The results of different types of posterior analysis are discussed.

We demonstrate the practical relevance of this new estimation strategy based on a discrete choice experiment that informed the fifth distribution price control review (DPCR 5) in the UK. In our empirical analysis the valuations for undergrounding of overhead lines and for the resilience to storms are in focus. However, the approach is equally applicable to any other stated choice experiment set up to inform incentive regulation. Our approach is straightforward to implement, could improve policy evaluations and foster more efficient incentive setting.

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