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# Getting used to it: The adaptive global utility model

W. David Bradford [a], Paul Dolan [b,*]

[a] Department of Public Administration and Policy, University of Georgia, United States
[b] Department of Social Policy, London School of Economics, United Kingdom

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ABSTRACT

This paper expands the standard model of utility maximization to endogenize the ubiquitous phenomenon of adaptation. We assume that total utility is an aggregate function of the utility associated with different domains of life, with relative weights that are optimized according to the effort that the individual expends on producing utility in each domain. Comparative statics from the general maximization problem demonstrate that the traditional Slutsky equation should incorporate an additional response term to account for adaptation processes. Our adaptive global utility maximization model can be used to explain responses to changes in health.



## 1. Introduction

The canonical model of economic decision making is based on the assumption that individuals choose different amounts of goods in order to achieve the maximum possible value of a utility function, given the constraints imposed by income and exogenously set prices. This simple model has proved enormously powerful and widely applicable, but its simplicity has also limited its applicability somewhat. Consequently, economists have continually proposed modifications to the basic theory to account for real world phenomena, e.g., decision making under uncertainty (von Neumann and Morgenstern, 1944) and the provision of non-market activities (Lancaster, 1966). In each case, the model expands upon the underlying assumption that agents' short-term decisions are consistent with maximizing a function that adheres to the five fundamental axioms of preference (completeness, reflexivity, transitivity, continuity, and non-satiation). In this paper, we continue this tradition by considering whether the standard model of utility maximization can be redefined in a way that brings the ubiquitous phenomenon of adaptation "into the fold".

Consider an agent who is maximizing utility and who receives an exogenous, permanent, increase in real income. The standard model clearly predicts that utility will rise permanently, as all of the increase in income will be allocated completely across the bundle of goods being consumed. Since consumption has risen, utility must rise by the full amount of the change in each commodity consumed multiplied by the appropriate marginal utilities. Yet one of the more persistent empirical findings on the relationship between income and directly reported measures of utility, such as happiness or life-satisfaction ratings, is that income has a much smaller than expected effect on these ratings (Easterlin, 1995) and that any impact appears to diminish over time (Diener et al., 1999). Despite recent evidence that may cast doubt on complete adaptation (Stevenson and Wolfers, 2008), the dampened response of utility to changes in income is difficult to explain using the standard neoclassical model.

As a second example, consider an agent who is living in a state of constrained utility maximization. She has arranged her budget such that the goods purchased achieve the highest possible level of utility, given her resources, market prices, household production technology, and the like. If this agent is in an automobile accident, and loses the use of her legs, we would expect utility to fall since some of the goods in her current bundle would no longer generate happiness as effectively as before and her household production technology would no longer be optimized to her new constraints. Yet, in most studies of health and utility, we find the analog of the effect of income: utility begins to rise again after an initial loss (which is itself often much less than predicted) and sometimes

* Corresponding author.
*E-mail address:* P.H.Dolan@lse.ac.uk (P. Dolan).

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even returns to its former levels in spite of continued restrictions to resource constraints (Dolan and Kahneman, 2008).

The issue of adaptation extends to other less dramatic examples, and may impact directly on behavior. For example, an overweight person may realize that he is compromising his long-term utility by failing to exercise. Rather than attempt to lose weight, however, he may find that the opportunity cost per unit of utility improvement is lower from simply adapting to being overweight and by expending effort on producing utility in other domains of life. Or, a person who is dissatisfied with her job and who faces a high opportunity cost of switching, may seek counseling to change her revealed tastes with respect to her job, or may invest in leisure pursuits that make the utility from work less important—as many people who 'live for the weekend' would do. This second example is very much in the spirit of Becker and Mulligan (1997), who model a person's decision to invest effort toward changing their rate of time preference when she realizes that she is too impatient.

In this paper, we posit a utility maximizing framework that explicitly incorporates these kinds of adaptation processes. Adaptation is a widely studied phenomenon in psychology, though much less well studied in economics (the word does not appear in the index of any core economics textbook that we are aware of). By adaptation, we mean a mechanism that causes the level of utility to change even in the face of constant resource constraints, prices and income. One possible response to losing the use of one's legs may be to invest in prosthetics, modifications to automobiles and the home, and other technological compensations and, as a result of these adjustments, the agent may be able to increase utility toward the pre-injury level. This is not what we mean by adaptation, which only occurs when utility adjusts independent of any changes to the commodity bundle (this is comparable to the definition found in Menzel et al. (2002). We make no normative claims about the adaptation process, only to show how it accords with an individual's preferences to maximize his utility.

In the next section, we present a brief discussion of past extensions of utility maximization as well as a little more detailed exploration of the literature on adaptation that is relevant to our framework. Section 3 follows with a formal development of our adaptive global utility model (AGUM), including the traditional Slutsky-type equations that follow from the comparative statics. We develop a model that maintains the constancy of preferences and yet allows adjustments to the nature of the utility function such that it can respond in an adaptive manner to external shocks. Finally, Section 4 concludes with a general discussion of some of the areas in which the model could be applied, e.g., in response to changes in body mass index (BMI).

## 2. Background

Modern microeconomic analysis is largely built upon the notion that consumers make decisions by maximizing utility (Mas-Coleill et al., 1996). Given a small set of assumptions regarding the nature of individuals' preferences, one can demonstrate that a function can be derived which will represent a person's preferences by rank ordering all possible states of the world (usually expressed as different consumption bundles). This function forms the basis for most models of consumer behavior and is usually expressed as some variant of $U = u(\underline{\mathbf{x}})$ where $\underline{\mathbf{x}}$ is a vector of goods. Whilst the general tendency was to view utility as an abstraction, economists have long estimated specific functional forms, e.g., the McFadden Random Utility Model (McFadden, 1974).

The main modification to the standard model we propose here is that individuals maximize utility across life domains. That individuals may perceive aspects of their life in discrete groups, and might choose to make decisions as if those aspects are semi-separable, is actually an old concept in economics. For example, Jeremy Bentham considered pleasure across 14 distinct domains (sense, wealth, skill, amity, a good name, power, piety, benevolence, malevolence, memory, imagination, expectation, association and relief). Our paper draws more directly on work developed by Lancaster (1966), who assumes that the household contains a production relationship that translates activities and goods into characteristics—and it is those characteristics that individuals actually value.

Our work focuses on the increasing interest economists are showing in re-integrating the concept of utility with the psychological construct of subjective well-being (Bertrand and Mullainathan, 2001; Dolan et al., 2008). This literature on subjective well-being takes seriously the notion that in maximizing utility individuals seek to maximize a sense of happiness or life satisfaction, that this life satisfaction is quantifiable, and that inter-personal comparisons are possible (at least for broad policy analyses). In many ways, as mentioned above, this literature represents a return to the conception of utility put forward by Jeremy Bentham and Francis Edgeworth.

In the model developed here, we draw specifically on the work by van Praag et al. (2003) who have proposed that overall utility – "general satisfaction" – can be modeled as a (linear) combination of utility derived from multiple "domain satisfactions." In their model, global satisfaction (GS) may be expressed as:

$$GS = GS(DS_1, DS_2, \ldots, DS_J, Z) \tag{1}$$

where $DS_j$ represent individual domain satisfactions, and $Z$ is a vector of explanatory variables, and where

$$DS_j = DS_j(X_j, Z) \tag{2}$$

and $X_j$ is a vector of individual characteristics affecting the specific domains. Domains may include satisfaction with job, financial situation, housing, health, leisure, and so forth.

We extend the notion of global satisfaction as the sum of domain satisfactions to incorporate adaptation. Previous work on estimating global satisfaction models has found evidence in favor of our adaptation modification. For example, Frijters (2000) notes, in his models of life-satisfaction data from over 24,000 Germans over 15 years, that respondents "tended to find the areas of their lives they are dissatisfied with less important." This is the sort of evidence one would expect to find if, as we will assume below, people are able to invest effort into adapting to circumstances and thus can react to negative outcomes either by changing the outcome (which is costly in terms of effort and money expended to purchase inputs to the outcome production process) or by changing how much they care about the outcome (which is also costly in terms of effort expended to adjust expectations, peer groups, and the like).

There is widespread evidence of adaptation that is starting to make its way into the economics literature. In addition to the relatively small effects of income on happiness (Easterlin, 1995), there is evidence that the income an individual considers to be 'sufficient' is primarily determined by her current income (van Praag et al., 2003), and that adaptation appears to offset about two-thirds of the benefits of any increase in income (Frey and Stutzer, 2002). Using the German panel data, Lucas et al. (2003) show that, on average, people experience an increase in happiness in the years surrounding marriage but after the second year of marriage they appear to return to their baseline. Even in the case of widowhood, adaptation is close to complete after about eight years. It is worth noting that the same German data also highlight the point that adaptation is not found for all conditions. In the case of unemployment, for example, average life satisfaction falls from around 7.2 on a scale from 1–10 to 6.3 in the first year and is still only 6.5 in the fourth year of unemployment (Lucas et al., 2004). In one of the most com-