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Getting used to it: The adaptive global utility model

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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

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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:

$$GS = GS(DS_1, DS_2, \ldots, DS_J, Z) \qquad (1)$$

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

$$DS_j = DS_j(X_j, Z) \qquad (2)$$

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 comprehensive set of analyses on the German data to date, Clark (2008) conclude that "we cannot reject the hypothesis of complete adaptation to marriage, divorce, widowhood, birth of child and layoff. However, there is little evidence of adaptation to unemployment for men."

It could be that some of the results suggesting adaptation are explained by response shift (Sprangers and Schartz, 1999). Paraplegics, for example, might compare their happiness to other paraplegics, elevate their current ratings to reflect the contrast with the extreme despair immediately following the onset of disability, or adopt lower standards for the intensity of positive affect, all of which would lead to over interpretation of the degree of adaptation. Whilst response shift certainly makes inter-temporal and inter-personal comparisons of self-reports more difficult, it cannot explain all changes in preferences that take place. Importantly, there is strong evidence of adaptation even when physiological or behavioral measures are used, both of which should be less prone to response shift. For example, Krupat (1974) found that that prior exposure to threat reduced galvanic skin conductance (a physiological measure of threat) and Dar et al. (1995) found that war veterans with more severe past injuries could hold their finger in hot water for longer before classifying it as painful than veterans with less severe past injuries.

3. Theoretical model

Our approach builds upon the standard economic model of discounted utility maximization but deviates from it in three important respects. We will assume that: (i) individuals maximize utility across important life domains, such as health, work, leisure, social relationships, etc.; (ii) utility is a linear combination (for purely expositional purposes) of the levels of each domain based upon the utility weight that that the individuals assigns to each domain; and (iii) the utility weights are themselves subject to modification by the individual, typically as an adaptive response to changed circumstances. In principle, this suggests that utility maximization may be better modeled as a dynamic process, whereby current utility depends on the lagged values of some factors and is an explicit function of time. For this first model, however, we will ignore explicitly dynamic issues and explore a traditional static model, leaving a more complex dynamic model for future research.

The usual model assumes that agents possess a single preference relation, $\succcurlyeq$, which supports a one-dimensional ranking across all (pairwise) comparisons of commodity bundles $(\mathbf{x}_i,\ \mathbf{x}_j) \in \mathbf{X}^N$, where $\mathbf{X}^N$ represents the commodity space, and $\mathbf{x}_i$, $\mathbf{x}_j$ represent N-dimensional vectors of specific points in the overall commodity space $\mathbf{X}^N$. However, for our adaptive global utility model (AGUM), we assume that there exists a set of preference relations $\{\succcurlyeq_k\}$ where $k = 1, \ldots, K$. Let this particular preference profile be defined as $P \equiv (\succcurlyeq_1, \succcurlyeq_2, \ldots, \succcurlyeq_k)$, which represents the primitive preferences for a specific individual that maps the single bundle of commodities, $\mathbf{x}$, onto rankings that are defined across the K life-satisfaction domains, which are designated by subscripts. Further, let each of the preference relations possess the following properties:

1. Completeness: $\forall$ pairs $(\mathbf{x}_i, \mathbf{x}_j) \in \mathbf{X}^N$, it must be true that $\mathbf{x}_i \succcurlyeq_k \mathbf{x}_j$ or $\mathbf{x}_j \succcurlyeq_k \mathbf{x}_i$, or both;
2. Transitivity: $\forall\, (\mathbf{x}_i, \mathbf{x}_j, \mathbf{x}_l) \in \mathbf{X}^N$, if $\mathbf{x}_i \succcurlyeq_k \mathbf{x}_j$ and $\mathbf{x}_j \succcurlyeq_k \mathbf{x}_l$, then $\mathbf{x}_i \succcurlyeq_k \mathbf{x}_l$;
3. Reflexivity: $\forall\, \mathbf{x}_i \in \mathbf{X}^N$, $\mathbf{x}_i \succcurlyeq_k \mathbf{x}_i$;
4. Continuity: $\forall\, \mathbf{x}_i \subset \mathbf{X}^N$, the sets $P(\mathbf{x}_i | \mathbf{x}_i \succcurlyeq_k \mathbf{x}_0)$ and $I(\mathbf{x}_i | \mathbf{x}_0 \succcurlyeq_k \mathbf{x}_i)$ are closed
5. Local Non-Satiation (strict monotonicity): $\forall$ pairs $(\mathbf{x}_i,\ \mathbf{x}_j) \in \mathbf{X}^N$, $\mathbf{x}_i \geq \mathbf{x}_j \Rightarrow \mathbf{x}_i \succcurlyeq_k \mathbf{x}_j$.

Note that these relations only obtain within a particular preference relation in the set of all preference relations simultaneously held by the agent. Thus, if $\mathbf{x}_i \succcurlyeq_k \mathbf{x}_j$ and $\mathbf{x}_j \succcurlyeq_k \mathbf{x}_l$ it does not follow that $\mathbf{x}_i \succcurlyeq_m \mathbf{x}_l$ when $m \neq k$. In other words, a given ranking of bundles that is supported by preferences in one domain will not generally apply to the other preference domains that an agent possesses. For example, a bundle that contains a house with larger rooms but a less attractive school district may be preferred in the housing domain but not preferred in any other domains.

With these restrictions on the nature of the set of preference relations held by the agent, it must be the case that we can rationalize each preference relation using a functional relationship υ^k: $\mathbf{X}^N \rightarrow \Re^+$ such that if $\mathbf{x}_i \succcurlyeq_k \mathbf{x}_j$ then $\upsilon^k(\mathbf{x}_i) \geq \upsilon^k(\mathbf{x}_j)$. These functions $\upsilon^k(\mathbf{x}_i)\ \forall\ k = 1, \ldots K$ can be rationalized as value functions for each of the primitive utility domains, such that the single vector of commodities, $\mathbf{x}_i$, generates K measures of satisfaction. Each of these value functions is assumed to display the usual properties of being (at least) twice differentiable, invariant to monotonic transformation (though in this case, we will need to restrict admissible transformations to be those that are applied equally to all $1, \ldots, K$ domains simultaneously), and capable of representing the underlying preference orderings.

To identify the composite function $U(\upsilon^k(\mathbf{x}_i))$ that represents the ultimate value function, we must introduce a new primitive—a composition technology that will combine the domain value functions into a global utility function. To ensure that the global utility function preserves rationality, we impose two additional restrictions on the nature of revealed global preference behavior.

6. The global utility function is Paretian: $\forall\ U$: $P \rightarrow \Re^+$ and for any alternative commodity bundles, $\mathbf{x}_i$ and $\mathbf{x}_j$ it must hold be true that $U(\mathbf{x}_i) > U(\mathbf{x}_j)$ if $\mathbf{x}_i \succcurlyeq_k \mathbf{x}_j\ \forall\ k = 1, \ldots K$.
7. The global utility function is generalized utilitarian in form: $\forall$ permissible U: $P \rightarrow \Re^+$, it is the case that $U(\mathbf{x}) = \sum_k \omega_k(\upsilon^k(x))$, where $\omega_k(.)$ is increasing and quasi-concave.

The linear aggregation assumption, which can be relaxed with no loss in generality but at great expositional complexity, is thus defined as $U(\mathbf{x}) = \sum_k \omega_k(\cdot)\upsilon^k(x)$.

A final modification to the standard model that we will introduce is to incorporate the possibility that the weights, $\omega_k(.)$, attached to particular domains of life may change as the circumstances associated with those domains change. We assume that the utility weights attached to each life domain are themselves a function of individual choices—and subject to adjustment. Specifically, an individual must expend effort to maintain, or increase, or decrease, how much they value a particular domain of utility. This is essentially the insight provided by Lancaster (1966). In order to convert commodities into the raw stuff of utility – characteristics, in the Lancaster language – an individual must apply some household technology. Unlike Lancaster, however, we assume that the household technology is not free, but that opportunity costs must be incurred to utilize it. In the spirit of the literature on household production, we will assume that the opportunity cost of utilizing the household technology is the application of (non-market) "effort". Our notion of effort is then simply the resources that individuals allocate to each domain of their life.

For example, a sedentary person may realize that they are compromising their long-term welfare by failing to exercise which leads to weight gain. The person may respond by ignoring areas of their life affected by their weight, or even by migrating toward a peer group that places less emphasis on future health. Decreasing the effort allocated to BMI-influenced life domains would result in lower utility but the freed up effort can then be allocated to other non-BMI-influenced domains of life which would raise the utility received from those dimensions. The net result would be to mitigate the potential utility loss associated with higher BMI rather than to reduce BMI itself. This follows rather directly from the realization that resources are limited, and if a person invests more maintenance effort or pays more attention on one domain of life, he must reduce the effort or attention to other areas (in fact, this is a widely recognized conceptualization in psychology (Mann and Ward, 2007) and the model is very much in the spirit of Becker and Mulligan (1997), who model an agent's decision to invest effort toward changing their rate of time preference when she realizes that she is too impatient.

In our model, then, we assume that investments of effort, e_k are allocated to maintaining or adjusting each of an individual's utility weights, $\omega^k(e_k)$, and that this effort must be allocated according to a maximum time/effort constraint:

$$E - L = \sum_{k=1}^{K} e_k \tag{3}$$

where $\sum_{k=1}^{K} \omega_k(e_k) = 1$

where E corresponds to the maximum amount of effort available and L corresponds to the time/effort devoted to the labor market to generate income. Note that labor, L is simply another form of effort, e, but one which has a negative opportunity cost in the form of market wages—so that it will be convenient to distinguish it separately in our notation. Effort devoted to labor has a return equal to a market wage, m, and every other component of effort has an associated opportunity cost, π_k. Consistent with our definition of a generalized utilitarian global utility function, note that $\partial\omega^k(e_k)/\partial e_k \geq 0$, $\partial^2\omega^k(e_k)/\partial {e_k}^2 < 0$, and $\partial\omega^k(e_k)/\partial e_j = 0 \;\forall\; k \neq j$.

Thus, in a single period problem, a person will maximize the (static) utility:

$$U_i = \sum_{k=1}^{K} \omega^k(e_k) \cdot v^k(x_{ik}) \tag{4}$$

subject to,

$$\text{Income} = I_0 + mE - \sum_{k=1}^{K} [m + \pi_k] e_k - \sum_{i=1}^{N} P_i \cdot x_i = 0 \tag{5}$$

and where $\mathbf{x}_i \in \mathbf{X}^N$, m is the wage rate, π_k is the financial cost of effort devoted to non-labor activities (so that the full opportunity cost of allocating a unit of effort away from labor and toward attention to any utility sub-domain is $= m + \pi_{ik}$), and P_i correspond to market prices for the elements of $\mathbf{x}_i$. Thus the agent's problem is to choose e_k, x_n, and λ in order to maximize:

$$L_i = \sum_{k=1}^{K} \omega^k(e_k) \cdot v^k(x_n) + \lambda \left\{ I_0 + mE - \sum_{k=1}^{K} [m + \pi_k] e_k - \sum_{i=1}^{N} P_i \cdot x_i \right\} \tag{6}$$

The F.O.C. for this problem are:

$$L_{e_j} = \omega_j^j(e_j) v^j(x) - \lambda [m + \pi_j] = 0, \quad \forall \quad j = 1, \ldots, K \tag{7}$$

$$L_{x_n} = \sum_{j=1}^{K} \omega^j(e_j) v_n^j(x) - \lambda P_n = 0, \quad \forall \quad n = 1, \ldots, N \tag{8}$$

$$L_\lambda = I_0 + mE - \sum_{k=1}^{K} [m + \pi_k] e_k - \sum_{i=1}^{N} P_i \cdot x_i = 0 \tag{9}$$

which has dimensionality of $D = K + N + 1$. The S.O.C. are the usual $\left|\bar{H}_2\right| > 0$, $\left|\bar{H}_3\right| < 0$, and

$$\left|\bar{H}_D\right| = \begin{vmatrix} \omega_{11}^1 v^1 & \cdots & 0 & \omega_1^1 v_1^1 & \cdots & \omega_1^1 v_N^1 & -[m+\pi_1] \\ \vdots & \ddots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & \cdots & \omega_{KK}^K v^K & \omega_K^K v_1^K & \cdots & \omega_K^K v_K^K & -[m+\pi_K] \\ \omega_1^1 v_1^1 & \cdots & \omega_K^1 v_1^1 & \sum_{j=1}^{K} \omega^j v_{11}^j & \cdots & \sum_{j=1}^{K} \omega^j v_{1N}^j & -P_1 \\ \vdots & \ddots & \vdots & \vdots & \ddots & \vdots & \vdots \\ \omega_1^1 v_N^1 & \cdots & \omega_K^1 v_N^1 & \sum_{j=1}^{K} \omega^j v_{N1}^j & \cdots & \sum_{j=1}^{K} \omega^j v_{NN}^j & -P_N \\ -[m+\pi_1] & \cdots & -[m+\pi_K] & -P_1 & \cdots & -P_N & 0 \end{vmatrix} \begin{matrix} > \\ < \end{matrix} 0 \text{ as } D \text{ is } \begin{matrix} \text{even} \\ \text{odd} \end{matrix}$$

With the first and second order conditions, we can calculate the relevant comparative statics in order to discover how our AGUM can contribute to understanding adaptive behaviors. First, solve implicitly for the optimum functionals for $\mathbf{x}(.)$, $e(.)$ and $\lambda(.)$, substitute these back into the F.O.C., and totally differentiate with respect to the parameters of interest. Taking the usual comparative static on price P_i for commodity x_n, we find as expected:

$$\frac{\partial x_n}{\partial P_i} = \lambda \left|\bar{H}_D\right|^{-1} C_{K+i,K+n} - x_i \left|\bar{H}_D\right|^{-1} C_{D,K+n} = \lambda \left|\bar{H}_D\right|^{-1} C_{K+i,K+n} + x_i \frac{\partial x_n}{\partial I_0} \tag{10}$$

which is the standard Slutsky equation, where $C_{i,j}$ represents the cofactor for the ith row and jth column of the Jacobian of the system, and the first term is the negative substitution effect when $n = i$. Similarly, effort devoted to attending to the kth domain in the global utility function also responds to changes in the price vector for commodities, as

$$\frac{\partial e_j}{\partial P_i} = \lambda \left|\bar{H}_D\right|^{-1} C_{K+i,j} + x_i \frac{\partial e_j}{\partial I_0} \tag{11}$$

Unlike the standard model, however, the total effect of changing the price of a good is not confined to the simple comparative static on price. To see how, consider the full effect of the change in the own-price for good x_n. By totally differentiating the last F.O.C. (9) with respect to P_n, solving for x_n and substituting back into (10), we get:

$$\frac{\partial x_n}{\partial P_n} = \lambda\left|\bar{H}_D\right|^{-1} C_{K+n,K+n} - \frac{\partial x_n}{\partial I_0}\left\{\sum_{j=1}^{K}[m+\pi_j]\frac{\partial e_j}{\partial P_n} + \sum_{\substack{i=1\\ n\neq i}}^{N} P_n\frac{\partial x_i}{\partial P_n}\right\} \tag{12}$$

Similarly, the own-price effect of the opportunity cost of effort is:

$$\frac{\partial \pi_j}{\partial P_n} = \lambda\left|\bar{H}_D\right|^{-1} C_{K+j,j} - \frac{\partial e_j}{\partial I_0}\left\{\sum_{i=1}^{K}[m+\pi_i]\frac{\partial e_i}{\partial P_n} + \sum_{\substack{i=1\\ i\neq n}}^{N} P_n\frac{\partial x_n}{\partial P_i}\right\} \tag{13}$$

Again, whilst the first term in (12) is the always-negative own-price substitution effect, the magnitude of the income effects in both (12) and (13) depend not only upon the responsiveness of the demand relationships of the other goods to the price of x_n or opportunity cost of e_j, but it also depends upon the distribution of effort to each utility domain selected by the agent, and how those distributions are affected by the own-prices. Using a similar approach, we can see that there is also a more complex effect on the demand for x_n and e_j from changes to the opportunity cost of effort, e_j than is evidenced in the traditional utility maximization:

$$\frac{\partial x_n}{\partial \pi_j} = \lambda\left|\bar{H}_D\right|^{-1}\sum_{j=1}^{K} C_{j,K+n} - \frac{\partial x_n}{\partial I_0}\left\{\sum_{\substack{i=1\\ i\neq j}}^{K}[m+\pi_i]\frac{\partial e_i}{\partial \pi_j} + \sum_{n=1}^{N} P\frac{\partial x_n}{\partial \pi_j}\right\} \tag{14}$$

$$\frac{\partial e_j}{\partial \pi_j} = \lambda\left|\bar{H}_D\right|^{-1} C_{j,j} - \frac{\partial e_j}{\partial I_0}\left\{\sum_{\substack{i=1\\ i\neq j}}^{K}[m+\pi_i]\frac{\partial e_i}{\partial \pi_j} + \sum_{n=1}^{N} P_n\frac{\partial x_n}{\partial \pi_j}\right\} \tag{15}$$

To see how adaptation reveals itself in this model, consider the equilibrium conditions implied by (7) and (9). Any two F.O.C. can be solved for λ (which is the marginal utility of income, as in the standard model) and set equal to each other to yield a familiar equality between the ratio of marginal utilities to the ratio of opportunity costs. This can be rewritten as an implicit function:

$$F(.) \equiv P_n\omega_k^k(.)\upsilon^k(.) - [m+\pi_k]\left\{\sum_{j=1}^{K}\omega^j(.)\upsilon_n^j(.)\right\} \equiv 0 \tag{16}$$

Differentiating this with respect to I_0, recognizing that $\omega^j{}_k = 0$ $\forall\ j\neq k$, and evaluating the expression only for points where $\partial F(.)/\partial I_0 = 0$ (i.e., only optimal points, which represent the income expansion paths or Engel curves) yields:

$$\frac{\partial e_k/\partial I_0}{\partial x_n/\partial I_0} = \frac{[m+\pi_k]\sum_{n=1}^{N} L_{x_n x_n} - \sum_{n=1}^{N} L_{e_k x_n}}{P_n L_{e_k e_k}} > 0. \tag{17}$$

where L_{xx}, $L_{ee} < 0$ by the S.O.C. and $L_{xe} = \omega_k^k(.)\upsilon^k(.) > 0$. One implicit assumption in this expression for the relative income expansion effects is that the x_n selected must be one that appears in the value function $\upsilon^k(.)$ to which the utility weight $\omega^k(e_k)$ is attached. Otherwise, the cross partial terms $\upsilon_n^k(.)$ in L_{xx} and L_{ee} would equal zero, and the ratio of expansion paths in is undefined. Given this assumption that x_n is a good that appears as an argument in the kth utility domain a necessary condition for $e_k(.)$ to be a normal good is for this arbitrary $x_n(.)$ to be a normal good.

This does not mean that only normal goods can be admitted in our model: for inferior goods, as income rises agents will begin to allocate effort away from those domains where inferior goods play a significant role. Thus, as incomes rise, the agent will decrease consumption of inferior goods for the usual reasons *and* decrease effort allocated to maintaining utility on that domain. This adaptation implies that the value of that domain of life in overall utility assessment will fall as income increases—further reducing the preference for not only the inferior good, but also for all other goods that are strong compliments to the inferior one in the household production. Obviously, the effect is symmetric for income increases for domains dominated by normal goods. Adaptation, therefore, reinforces the intrinsic demand characteristics for goods.

Adaptation is further evidenced in this model if we optimize the last F.O.C. in (9) and then totally differentiate with respect to exogenous income, I_0, to arrive at:

$$\sum_{j=1}^{K}[m+\pi_j]\frac{\partial e_j^*}{\partial I_0} + \sum_{n=1}^{N} P_n\frac{\partial x_n^*}{\partial I_0} = 1 \tag{18}$$

This implies that unlike the standard model, an exogenous shock in income will in general *not* be completely allocated across the vector of commodities being consumed. Rather, some of the income increase will be allocated to the effort devoted toward maintaining the importance of the utility domains relative to one another. The comparative statics of effort with respect to income may be positive or negative—so that utility weights may actually fall as income increases. Consequently, the response of the actual level of utility to changes in income may be more muted that one would expect if only the commodity vector is taken into account.

Finally, whilst this is a static model, it is possible to get some idea of what would be expected from dynamic behaviors by introducing past own-domain effort into the domain weight functions such that $\omega^j(.) \equiv \omega^j(e_j,\ e_{j,t-1})$, where $e_{j,t-1}$ represents a predetermined effort level, which can be interpreted as the prior period optimized effort. If we assume (for tractability) that $\omega^j_{e_j e_{j,t-1}} > 0$ and $\omega^j_{e_j e_{j,t-1}} = 0$ (i.e., predetermined effort induces a parallel positive shift in the (current) utility weight function), then the modified condition in (16) above can be differentiated with respect to $e_{j,t-1}$ and the ratio between the comparative static for the change in an arbitrary x_n and the change in e_j is:

$$[\partial x_n/\partial e_{j,t-1}/\partial e_j/\partial e_{j,t-1}]\cdot\frac{[P_n\mathcal{L}_{x_n e_j} - [m+\pi_j]\mathcal{L}_{x_n x_n}]}{[P_n\mathcal{L}_{e_j e_j} - [m+\pi_j]\mathcal{L}_{x_n e_j}]} < -1$$

Since the numerator of the second term is positive and the denominator of the second term is negative, the signs of the two comparative statics must be the same. It is an empirical question as to whether the responses of goods and effort are both positive (or negative) with respect to predetermined effort. The most plausible sign of $\partial e_j/\partial e_{j,t-1}$ is positive: that is, higher levels of predetermined own-domain effort should raise the productivity of (current) own-effort in generating global utility. If this is the case, then higher levels of predetermined effort for the jth domain of utility should lead to an increase in the consumption of goods that are important

Table 1
Domain utility models.

	Domain satisfaction with health	Domain satisfaction with household income	Domain satisfaction with dwelling	Domain satisfaction with amount of leisure time
Body mass index	−0.022***	−0.023***	−0.0049*	−0.0056*
	(−9.00)	(−7.39)	(−1.79)	(−1.82)
Gender of individual = male	0.043**	−0.17***	−0.056**	0.33***
	(2.00)	(−6.25)	(−2.27)	(11.95)
Age of individual	−0.010***	0.022***	0.021***	0.022***
	(−12.33)	(21.09)	(22.72)	(21.32)
Self-reported health good or excellent	2.40***	0.88***	0.62***	0.79***
	(105.33)	(30.31)	(23.72)	(27.03)
Individual reports being disabled	−1.05***	−0.16***	−0.13***	−0.0097
	(−31.18)	(−3.70)	(−3.38)	(−0.23)
Individual has cohabitating partner	−0.030	−0.12***	−0.11***	0.055
	(−1.02)	(−3.08)	(−3.21)	(1.45)
Married in last year	0.21**	0.44***	0.24**	−0.10
	(2.10)	(3.49)	(2.10)	(−0.82)
Divorced in last year	0.083	−0.83***	−0.13	−0.27
	(0.61)	(−4.81)	(−0.82)	(−1.56)
Number of persons in household	0.0089	−0.11***	−0.015	−0.16***
	(0.92)	(−8.82)	(−1.39)	(−12.54)
Household after-tax income	0.0000043***	0.000031***	0.000012***	0.0000010
	(7.74)	(43.73)	(19.66)	(1.47)
Working in labor force	0.00027	0.17***	−0.060**	−1.01***
	(0.01)	(5.63)	(−2.24)	(−33.51)
Secondary school degree	0.016	0.19***	0.17***	0.040
	(0.49)	(4.58)	(4.79)	(0.97)
Intermediate school degree	−0.024	0.020	0.27***	−0.16***
	(−0.73)	(0.49)	(7.37)	(−3.83)
Technical school degree	0.030	0.34***	0.26***	−0.26***
	(0.53)	(4.55)	(4.03)	(−3.49)
Upper secondary school degree	−0.057	0.27***	0.20***	−0.36***
	(−1.52)	(5.56)	(4.64)	(−7.52)
Constant	6.29***	4.31***	5.99***	6.34***
	(75.51)	(40.04)	(62.84)	(59.32)
Observations	25,617	25,176	25,499	25,537

T-statistics in parentheses. All models control for within person correlations using clustered errors.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

in that domain. Of course, true time effects remain to be explored in a future dynamic version of this model.

4. An illustrative example

To show how the AGUM can be applied in practice, consider an example of great interest to many health economists—obesity. Despite a range of efforts to encourage reductions in obesity, many people do not respond by lowering their body mass index (BMI). Many information and education-based interventions focus on motivational barriers that obese people may face when attempting to lose weight but if people find it easier to modify the importance of BMI-intensive life domains in their overall life satisfaction they may continue to under-invest from their own long-term perspective in weight-reducing efforts. Our model suggests that there are at least three classes of barriers to controlling weight and obesity, only one of which has been widely recognized and explored in the past. First, individuals may find it difficult to control their BMI because the opportunity costs of doing so (in terms of direct medical costs or foregone pleasure) are too high. This is the usual conceptualization of the problem.

Second, individuals may have difficulty in translating changes in BMI into changes in actual utility because of the limits in their individual production technology. It is possible that moderate changes in BMI may not lead to significant changes in each of the life domains that make up the ultimate utility function. Thus, the payoff from BMI reduction – even in the immediate term – may be too low to offset the opportunity costs of BMI reductions. Third, individuals may ultimately fail to reduce BMI (even if it would lead to significant changes in the utility domains) because they may find it less costly to adapt to lower values of some utility domains. That is, the opportunity cost of reducing one or more of the utility weights on the domains where BMI plays a large role may be lower than the opportunity cost of actually changing BMI. This is the essential insight of the AGUM approach.

The role of obesity in the AGUM can be illustrated using data drawn from the German Socio-Economic Panel (GSOEP) dataset. This longitudinal survey of Germans asks a series of questions about global life satisfaction, specific life domain satisfactions, and questions which capture aspects of the domain-specific "effort" (or attention) variables that play a central role in our model. As noted in the introduction, these data have been used to assess the relationship between global satisfaction and satisfaction in multiple life domains. There are limitations with these data (e.g., height and weight data exist in only three waves and the measurement of some life domains, such as work, are complex and require more attention than can be given in this paper) but we are able to provide some validation of our model, the exposition of which is the main focus of this paper.

To estimate our model, we extract 36,855 observations from the 2002, 2004, and 2006 waves of the GSOEP data which have complete responses on global satisfaction, four domain satisfactions, BMI, domain-specific effort and other respondent characteristics. Respondents are asked for assessments on a scale ranging from 0 to

Table 2
Adaptive global utility model (overall satisfaction with life at today).

	OLS	Arellano–Bond IV
Domain satisfaction with health in current wave	0.27***	0.17***
	(24.66)	(13.61)
Change in domain satisfaction with health from past wave	−0.0037***	0.00023
	(−4.09)	(0.17)
Domain satisfaction with health × number of physician visits in current wave	−0.00053	0.027***
	(−1.11)	(3.86)
Domain satisfaction with household income in current wave	0.24***	0.17***
	(22.82)	(8.70)
Change in domain satisfaction with household income from past wave	−0.0035***	−0.0032**
	(−3.87)	(−2.37)
Domain satisfaction with household income × annual hours of labor market work in	0.0000041***	0.000018
	(2.87)	(1.12)
Domain satisfaction with dwelling in current wave	0.073***	−0.0020
	(6.69)	(−0.07)
Change in domain satisfaction with dwelling from past wave	−0.0010	−0.0017*
	(−1.23)	(−1.67)
Domain satisfaction with dwelling × hours spent working on home in current wave	0.0012*	0.019*
	(1.80)	(1.94)
Domain satisfaction with amount of leisure time in current wave	0.059***	0.15***
	(5.93)	(4.12)
Change in domain satisfaction with amount of leisure time from past wave	0.0021***	0.0031***
	(2.61)	(2.78)
Domain satisfaction with amount of leisure time × hours spent on hobbies in curr	−0.00083	−0.027***
	(−1.38)	(−3.07)
Lagged satisfaction with life at today	0.31***	0.11***
	(35.80)	(5.27)
Constant	0.64***	2.67***
	(8.79)	(17.46)
Observations	22,217	20,024

T-statistics in parentheses. All models control for within person correlations using clustered errors.
Up to three-wave lagged interactions between domain satisfaction and effort choices are used as instruments in IV model.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

10 of their satisfaction with life overall ($U_{i,t}$), satisfaction with their health $\left(\nu^H_{,i,t}\right)$, satisfaction with their dwelling $\left(\nu^D_{,i,t}\right)$, satisfaction with their leisure time $\left(\nu^L_{,i,t}\right)$, and satisfaction with their household income $\left(\nu^I_{,i,t}\right)$. In addition, respondents were asked questions which are analogous to the domain-specific effort choices: number of physician visits ($e_{H,i,t}$), hours spent working on current home and in housework ($e_{D,i,t}$), hours spent on hobbies and in running errands ($e_{L,i,t}$), and hours of labor provided in market ($e_{I,i,t}$).

In our model, respondents have a set of characteristics in each time period (BMI, gender, age, self-reported health status, disability status, presence of a cohabiting partner, whether married or divorced in past year, number of persons in household, whether employed, and four educational attainment levels), which determine domain satisfaction levels at each wave. Theoretically, then, respondents choose the amount of effort to devote to each domain (our $e_{k,i,t}$, k = health, dwelling, leisure, income), which will in turn determine the weights attached to each domain in the global satisfaction function. Thus, the $e_{j,i,t}$ is endogenous in our model—which adds a further complication to the standard global satisfaction models estimated to date. We address the endogeneity of domain-specific efforts by estimating a dynamic panel version of (4) using the Arellano–Bond estimator, which estimates the parameters of the system by specifying the model in first differences and using lagged levels of the endogenous variables as instruments (Arellano and Bond, 1991). An OLS version is also presented for comparison sake, which ignores the endogeneity of domain effort.

Table 1 presents the results of the domain utility estimates. Note, with respect to our obesity example, BMI has a significantly negative effect on satisfaction across all domains, with the effect being largest for the health and income domains. Other factors are often significant predictors of domain satisfaction. Older individuals are less satisfied with their health, though more satisfied with other domains of life (which is consistent with other findings on well-being). Better health is utility-enhancing across all domains of life, as is income generally (though not for the satisfaction with leisure time). These results are consistent with those found elsewhere in the literature (Frijters, 2000).

The differences in building adaptation into our model appear when estimating the global satisfaction equation. Recalling (4) from above, we are ultimately estimating the empirical regression:

$$U_{i,t} = \sum_k \omega^k(e_{k,t})\nu^k_{i,t} + \alpha U_{i,t-1} + \varepsilon_{i,t} \qquad (19)$$

where we must model adaptation as chances to the $\omega^k(.)$ functions based upon past realizations of the individual domain satisfaction levels and on current effort devoted to that domain. A simple way to achieve this is to assume a linear adaptation function:

$$\omega^k \equiv \beta_{k,0} + \beta_{k,1}\nu^k_{i,t-1} + \beta_{k,z}e_{k,i,t}$$

such that we arrive at the estimating equation:

$$U_{i,t} = \sum_k \left[\beta_{k,0} + \beta_{k,1}\nu^k_{i,t-1} + \beta_{k,z}e_{k,i,t}\right]\nu^k_{i,t} + \alpha U_{i,t-1} + \varepsilon_{i,t} \qquad (20)$$

Table 2 presents the OLS (assuming the $e_{k,i,t}$ are exogenous) and panel IV results (assuming the $e_{k,i,t}$ are endogenous, and instrumented by all lagged values of $e_{k,i,t}$). The results are consistent with adaptation. Whilst all current domain satisfactions yield positive utility (except for dwelling satisfaction in the IV results), in all cases except for leisure satisfaction, individuals also exhibit reversion to the mean; that is, past satisfaction dampens current satisfaction.

If a person had a lower level of domain satisfaction in the past period than in the present one, less is taken away from the positive impact of that domain in the present period, whereas if the person had a greater level of domain satisfaction in the past, more is taken away in the present. The leisure domain seems to have the opposite pattern, where past satisfaction reinforces current satisfaction.

The opposite signs on the effort interactions support the presence of adaptation. For each domain of life, we find that individuals counter the "natural" reversion to the mean with choices about the effort to devote to each domain: the signs on the effort × current satisfaction parameters are always opposite (where significant) to the lagged satisfaction × current satisfaction parameters. This is true even for the leisure domain, where reversion to the mean is not exhibited.

So, for example, an individual who finds that the importance of their health in overall utility is being pushed down could: (a) allocate resources away from dwelling investment and toward health care (in the form of physician visits) and increase the current overall utility gained from health (at the expense of lower current utility from the dwelling); or (b) do the opposite and shift resources away from health (even further reducing the utility gained from that dimension) and toward investments in the household. Which pattern of behavior is optimal will depend upon the magnitudes of the parameters at the point when a decision is made. Whilst complete exploration of the likely effort adjustments should be left to a more complete implementation of the AGUM model – with the most comprehensive set of satisfaction domains and effort measures – it is nonetheless evident from this simple model that adaptation is an important factor in individual behavior.

This adaptation can have substantial implication for policy. As an example of the importance of the AGUM model for obesity policy, we simulated the impact of a change in BMI on a hypothetical person using the results of our simple model. Consider an individual who has characteristics at the mean of the data (setting aside the fact that many of the variables are dichotomous). Using these mean values and the parameters from Tables 1 and 2, we imputed values for satisfaction with the domains and life overall for a baseline year (time = $t-1$) and the current year (time = t). We then assumed the hypothetical person experiences a 2.5 unit increase in BMI, from the average of 25.7–28.2 (i.e., a 10% rise). Without any reallocation of effort but allowing for the reversion to the mean discussed above, overall life satisfaction falls by about 0.007 points from a level of 6.666 in the baseline year. If we now assume the individual has two fewer doctor visits and works four more hours, then overall life satisfaction would remain unchanged in t compared to $t-1$. Similar effects on overall utility can be obtained by reallocating to leisure and home repair instead.

The model we present in Tables 1 and 2 is merely illustrative – it has only 4 domains and the effects of adaptation are assumed to be linear – and so it not intended to support detailed policy simulations. Yet even these results show that, when faced with a reduction in utility from increased BMI, our hypothetical person can essentially eliminate the utility loss by reallocating the effort devoted to maintaining the importance of various domains of life in overall utility—and therefore not necessarily by attempting to return body mass to its original level. If the opportunity cost of reallocating effort is lower than the cost of adjusting BMI then the rational utility-maximizing agent would choose to adapt rather than undertake weight loss. In such circumstances, public health attempts to encourage weight loss could be seriously compromised.

5. Discussion

The adaptive global utility model (AGUM) expands significantly the range of behaviors that can be explained using the neoclassical paradigm of maximization. Generally, economists have considered elasticities of demand in terms of market prices—or at least on the direct opportunity costs of goods. This model suggests that the demand for a market good may be subject to a more complex set of determinants. In particular, there are three main areas in which the AGUM expands the scope of admissible behaviors: (1) responses to own- or cross-good price changes; (2) response to changes in income; and (3) responses to shocks to domain utility weights.

For own- or cross-good price changes under AGUM, individuals' responses to price will not only involve the direct substitution effect and traditional (quantity-weighted) income effect, but will also involve shifting the allocation of effort devoted to maintaining utility weights. This last effect can serve to attenuate (accentuate) the price elasticity of demand whenever the individual "utility production" technology is such that changing the importance of a utility domain in which the good plays a major role is relatively easy (more difficult). That is, if a price increase affects primarily a good that is very productive in $v^k(x)$, but for which the marginal productivity of e_k in $\omega^k(.)$ is low, then utility will be adjusted both by decreasing the amount of x_n consumed, and also by reducing e_k and shifting that effort to other domains, e_j, where the affected x plays a less central role.

For changes in income under AGUM, we find that there is a dependency of the demand for goods on the nature of the household production function that determines the utility weights. This can serve to explain differences in what might be labeled "materialistic" compared to "non-materialistic" persons (Nickerson et al., 2003). If a particular domain of life – for example, housing – contains all normal goods, then increases in income will tend to lead the person to allocate even more effort to that life domain, and thus further reinforce the consumption of goods in that domain. Essentially, as income rises, such a person places ever more emphasis on maximizing utility through increasing the magnitude of the x_n vector in that domain. Alternatively, if the underlying preferences are such that as income rises the person initially reduces demand for some components of the x_n vector (because, for example, it contains income inferior goods) then it is possible (though not certain) that the individual's global utility maximization calculus could actually lead to increases in the effort allocated to that domain to compensate for the lost value associated with the lower magnitude of x_n. In this case, an individual focuses more effort on the less consumption-intensive domain—essentially becoming less materialistic.

For shocks to domain utility weights under AGUM, individuals will change the amount of effort devoted to producing utility across domains at the margin. Thus, if a person experiences a barrier to translating value from consumption in a given domain of life, she may respond by decreasing the effort she allocates to that domain in global utility maximization. This reduction in effort would translate into a reduction in the consumption of goods that appear in the value function for that domain. Lowering the realized level of the value function would further lower the incentives to allocate effort. In a dynamic model, this would imply that reductions in the level of domain satisfaction in one period would lead to additional reductions in the effort allocated to that domain in future periods.

Generally, we hypothesize that domain utility weights evolve and may therefore not be entirely stable over time but we recognize that such weights may or may not be malleable, and this has clear implications for which categories of intervention are likely to prove most effective. If domain weights are malleable, then contingency management interventions may prove to be quite effective (as they appear to have been in the case of substance abuse: see Donohue and Azrin, 2001). Contingency management interventions, such as identifying environmental cues to eat excessively and then developing and practicing coping strategies to manage these cues more effectively, might be executed with more or less emphasis on peer or family involvement, or verbal and cognitive versus behavioral coping strategies, depending upon where the individual is in the evolution of their domain weights.

If domain utility weights are not malleable, then precursors of the problem should be identified and prevention interventions should to be developed early in the life course to target them. In the case of dealing with serious and persistent antisocial behavior in youths, for example, prospective studies early in the life course identified two distinct trajectories toward serious antisocial behavior in youth, the "early starter" and "late starter" pathways, the constellation of individual, family, and peer factors associated with these pathways, and the developmental sequencing or "scaffolding" of risk factor effects (Miller-Johnson et al., 2002). The identification of these pathways contributed to the modification of preventive intervention theories to incorporate additional risk factors for antisocial behavior and the development of preventive interventions focused on the "early starter" pathways (Loeber and Farrington, 1998). Whatever the malleability of domain utility weights, AGUM can be used to forecast which patients have excessive under-weighting of BMI-intensive domain satisfactions and then interventions can be selected that are best suited to each individual's utility function.

The most direct ways in which policy-makers could influence behavior in health and elsewhere, is to raise the importance of particular domains. One potentially effective way to do this is through peer groups and social norms, which heavily influence domain utility weights. Indeed, imitating what others do is considered an innate mechanism for (social) adaptation (Hurley and Chater, 2005) and we use our perceptions of peer norms as a standard against which to compare our own behavior (Perkins & Berkowitz, 1986). The role of social norms has been modeled formally in economics (e.g. Burke and Payton-Young, 2010). A social norm of some publicly observable variable exists and may change over time: the norm in any period represents the fraction of an agent's time spent on some activity, the fraction of her budget spent on some good, or qualities such as the brightness of clothing (Bernheim, 1994).

The formal models in economics assume that behavior is observable to other individuals but norms also work when behavior is not directly observable to other individuals. For example, Schultz et al. (2007) demonstrate how messages describing average energy usage in the neighborhood, combined with conveying social approval or disapproval, produced significant energy savings. Therefore, policy-makers may be able to influence domain utility weights by drawing attention to the importance that relevant others place on BMI-intensive domains or any other domains of policy concern, e.g., through targeted social marketing campaigns.

Any shift in domain utility weights (and the resulting adaptation) in our model clearly requires some effort on the part of individuals, and so it is worth noting that some things appear to be inherently easier – require less effort – to adapt to than others. According to Kahneman and Thaler (2006), the withdrawal of attention is the main mechanism of adaptation to life changes such as becoming wealthy, getting married or becoming sick. Attention is normally associated with novelty and so the newly rich, newlywed or newly ill is initially continuously aware of their changed state. As the new state loses its novelty, however, it ceases to be the exclusive focus of attention, and other aspects of life again become important. So things that retain their 'attention-seeking' status will be harder to adapt to. Consistent with this, in a study of college students, Weinstein (1978) found that annoyance with noise in college increased. It is probably also the case that unemployment (one of the few things from the German panel data that people do not appear to adapt to) is a constant reminder of lower self-esteem.

Wilson and Gilbert (2008) have developed the AREA model of adaptation to changes which begins with attention to the change, followed by a reaction to it, which is then followed by an explanation of the change, followed finally by adaptation to it. People exert effort to explain the meaning and importance of a good or bad event, and if they succeed in doing so, the event is deprived of significance. Some things will be easier (and hence require less effort) to explain than others. According to Wilson and Gilbert, we find it more difficult to explain a change if we do not have a prior schema (or "explanatory prototype"; Abelson and Lalljee, 1988) that accounts for it, and if there are a number of plausible explanations for the change. The more unexpected an event is, the more difficulty people have explaining it but when people expect an event to happen, they often do some of the explanatory work in advance (Wilson et al., 2004). Studies of bereavement, for example, have found that people have more trouble adjusting to the sudden death of a loved one than to the death of a loved one from a terminal illness (O'Bryant, 1991). Moreover, the less certain people are about the nature of an event, the less likely they are to explain it. For example, people adapt more quickly to news that they definitely have a serious illness than to news that they might have a serious illness (Frederick and Loewenstein, 1999) because they do not try to explain events until they know precisely which event needs explaining.

Wilson and Gilbert's model is also consistent with the finding that unexplained pain is worse (in intensity and in terms of its effects on disability and fatigue) beyond six months than it is in the first six months (Peters et al., 2000). In contrast, it is likely to be much easier to adapt to conditions such as obesity, which probably have reasonably clear explanations in our minds. This makes it much more efficient to maximize our utility by devoting effort to explaining our weight gain (and to adjusting our domain utility weights accordingly) rather than by devoting effort and resources to obesity control programs. Whatever the precise relativities across health conditions, and between health and other domains of life, it is important to reiterate that the discussion of adaptation in general and our model in particular applies to positive and to negative changes—and also to events and circumstances that are endogenous as well as exogenous.

At a very basic level, adaptation is part of the human condition and it is surprising that economists have devoted very little attention to the phenomenon. The AGUM we propose helps us to explain how rational economic agents respond to various incentives in the presence of adaptation across life domains. We have used longitudinal data on domain satisfactions and BMI to illustrate the dynamic and predictive qualities of the AGUM and hopefully set the scene for further empirical work in this regard. AGUM provides a powerful way of helping to explain and predict individual preferences, behavior and response to incentives in important areas of health and public policy.

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