Theoretical Background

In economics, food can be viewed as both a consumption good and an investment. Through flavor, texture, and relief from hunger, food provides immediate gratification. Through nutrients and calories, it also confers costs and benefits for future health and well-being. Thus, economic models often employ a dynamic framework to model demand for health (Grossman, 1972), nutrient intake (Behrman and Deolalikar, 1990; Barrett, 2002), food choices as they relate to health and labor market activities (Pitt et al., 1990), and food choices as they relate to health and body weight (Cawley, 2004; Cutler et al., 2003). Typically, such models assume that individuals maximize utility over some timeframe using a discounted utility model:

$$U_t(c_t,\ldots,c_T) = U(c_t) + \sum_{\tau=1}^{T} \delta^{\tau} U(c_{t+\tau}).$$

In this model, $U(c_{t+\tau})$ is considered to be the individual's well-being at time $t + \tau$, and δ^{τ} is the individual's discount function, or the relative weight attached at time τ to one's well-being in period $t + \tau$. As such, the value we place on future well-being is less than the value of today's well-being, and the value of each subsequent period decreases at a constant rate. Although this assumption—referred to as *exponential discounting*—has become the norm in economic analysis, empirical findings often violate its theoretical predictions or underlying assumptions (Frederick et al., 2003). One frequently observed anomaly is that individuals tend to behave more patiently (by making choices that are consistent with their future savings or health goals) when evaluating tradeoffs that will occur at some point in the future than they would if these same tradeoffs were to occur more immediately. For example, most individuals will prefer $110 in 31 days over $100 in 30 days. Yet many of these same individuals will also prefer $100 right now over $110 tomorrow. In contrast, an exponential discounting model would predict that an individual who chooses $110 in 31 days over $100 in 30 would also choose $110 tomorrow over $100 today.

Repeated observance of time-inconsistent preferences has led some researchers to develop models in which individuals have preferences that are biased to prefer immediate rewards and delayed costs. These *present-biased preferences* allow individuals to have a declining discount rate between now and the next period, and a constant discount rate from then on. The result is that individuals will prefer an alternative that is usually less desirable or valuable over some time period simply because it is available sooner. These models have been extended to model individual consumption and savings behavior (Thaler and Shefrin, 1981; Akerlof 1991; Ainslie and Haslam, 1992; Laibson, 1997; Mullainathan and Thaler, 2000; O'Donoghue and Rabin, 1999, 2001).[2] They have also been used to explain why individuals have problems related to self-control, why they demonstrate reversals in preference, and how they can improve their longrun well-being through some commitment, such as 401(k) plans, that limit current consumption levels and thereby preclude procrastination.

For food choice analysis, these models may not be entirely applicable because time-inconsistent behavior is attributed entirely to a reward's

[2]See Frederick et al. (2003) for a full review.

temporal proximity (Frederick et al., 2003; Loewenstein, 1996, 2000). In terms of food consumption, this means an individual will always be expected to choose the more immediately available food, regardless of his or her level of hunger. In reviewing the literature on weight loss, Herman and Polivy (2003) emphasize that making food immediately available is not sufficient to induce uninhibited eating bouts. Loewenstein (1996) develops a model that includes visceral influences—such as hunger, thirst, pain, and stress—in an individual's instantaneous utility function. An advantage of this model over the present-biased model described above (also referred to as hyperbolic or quasi-hyperbolic discounting models) is that it allows a broader range of situations to trigger present-biased behavior. At sufficient levels, visceral factors can create discrepancies between intended and actual behavior because an individual becomes unwilling to give up a good that alleviates the effects of a visceral influence in exchange for other goods that do not. For example, a man dying of thirst is unlikely to trade a glass of water for anything. This causes a collapsing of one's time perspective toward the present. Also, the discrepancy between the actual and desired value placed on a particular good or activity is assumed to increase with the intensity of the immediate good-relevant visceral factors.

To represent the influence of visceral factors on behavior, Loewenstein develops a representation of preferences that includes a set of variables, α_{ti}, which represent how changing levels of the visceral factors affect intertemporal utility:

$$U=\Sigma_t u(x_{t1},\ldots,x_{tn}, \alpha_{t1},\ldots\alpha_{tn}, t),$$

where U represents total utility experienced at time t, $(x_{t1},\ldots,x_{tn})$ is a vector of consumption goods, and $(\alpha_{t1},\ldots\alpha_{tn})$ is a vector of visceral factors, such as hours of food deprivation, experienced at time t. This model assumes preferences are separable temporally so that visceral factors experienced at time t only influence the value of goods consumed at that same time. It is also assumed that visceral factors can be partitioned into subsets that influence only a single consumption variable. In the simplest case, each consumption variable x_i is influenced by at most one α_I, and can be represented as follows:

$$U=\Sigma_t u(v_1 (x_{t1}, \alpha_{t1}, t),\ldots v_n (x_{tn}, \alpha_{tn}, t)),$$

where $v_1()$ is the value of consuming x_{t1} at time t in the presence of some visceral factor α_{t1}. Each v_i function is assumed to be increasing in the good offered, decreasing in time delay, and either increasing or decreasing in α_{ti}. Also, x_{ti} and α_{ti} are assumed to be complements. For example, hunger can be argued to improve the enjoyment of eating food, but can make you feel worse when there is none available. In short, this model explicitly assumes that consumer choices will be significantly affected by strong visceral factors.

This model can illuminate how and why certain situations give rise to seemingly inconsistent food choices. Under a more neutral state, an individual may choose to consume the types and quantities of foods that are consistent with his or her long-term health objectives. As visceral factors intensify, however, the value of current utility increases relative to the value of future utility and the consumption of goods that provide immediate gratification will be consumed in greater amounts than when visceral factors are less intense.